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ABSTRACT

The symposium on the physical and psychomotor aspects of sports covered a variety of topics. Among those contained in this report are: discussions on the taxonomies of sports; the time dimension of physical activity including response variables, judgment of temporal order, and duration discrimination; memory; information and its use in physical activity; training and the transfer of training to performance; the academic discipline of sports; attitudes of the athlete; cooperation and competition in sports; anxiety and other emotions aroused in athletics; the causes of success; motivation; the implications of participation in sports activities; and other psycho-social aspects of sports. (JMF)

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REVUE DE L'ASSOCIATION DES PROFESSIONNELS
DE L'ACTIVITÉ PHYSIQUE DU QUÉBEC

ACTES DU 7e SYMPOSIUM CANADIEN EN APPRENTISSAGE PSYCHO-MOTEUR ET PSYCHOLOGIE DU SPORT

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Le Comité canadien d'apprentissage psycho-moteur et psychologie du sport de la C.A.H.P.E.R. a créé des précédents qui témoignent de sa vitalité sur la scène nord-américaine. Ce symposium disciplinaire de haute qualité, tenu à Québec, regroupe des chercheurs canadiens et américains et marque l'émergence d'un pourcentage important de francophones, tout spécialement dans le domaine de l'apprentissage moteur. Toutes les sessions plénières et les réunions disciplinaires parallèles disposent de la traduction simultanée et les présentations et discussions se tiennent en anglais ou en français. Mais le plus important précédent est sans contredit la distribution des actes avant même le déroulement du symposium, permettant ainsi une beaucoup plus grande efficacité de participation.

Je remercie très sincèrement tous les auteurs dont la diligence a permis cette parution. Ma gratitude va aussi au Comité organisateur qui travaille depuis un an à la réalisation du Symposium. La collaboration du Département d'Éducation Physique de l'Université Laval fut tout aussi essentielle à la tenue de cet événement. L'apport financier du Secrétariat d'État du Canada a rendu possible la traduction simultanée. Et finalement, je rends un hommage tout particulier à l'Association des Professionnels de l'Activité Physique du Québec (APAPQ) dont le dynamisme a permis cette publication.

JOHN SALMELA,
responsable du Symposium

L'aide apportée à la correction des épreuves par Magdeleine Yerlès et Erlene Waghorn nous a permis de rencontrer nos échéances.

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THE STRUCTURE OF MOTOR TASKS

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At the present time, there does not seem to be any adequate means for classifying motor tasks. As a consequence, experimental studies of motor learning and performance variables yield information having limited generalizability. Rather than providing a basis for a broad conceptual framework, our research efforts tend to give rise to specialized domains in which theory development and theory testing are tied inherently to a narrowly defined motor task such as horizontal positioning responses or tracking or simple reaction time situations. Even the extension of findings from a straightforward data paper is not possible as the relationship between the motor tasks used in our investigations is not clear. In addition to these problems, our inability to specify commonalities in motor tasks has contributed to the difficulty in applying findings derived from laboratory analysis to practical situations involving the learning and teaching of motor skills. This last inadequacy is particularly important in our research program at Teachers College. We have assumed that continued research effort should produce information that *eventually* has some educational utility.

For these many reasons, we have been engaged in a series of studies over the last five years in which various strategies for classifying motor tasks have been examined. The purpose of this paper is to summarize this research concerned with our development of a taxonomy of motor tasks. The paper has been organized into three sections. In the first section, there is a brief review of the various stages through which we have progressed in our attempts to arrive at a tentative taxonomy. The second section is focused upon the experimental strategies that have been used in our most recent work. Lastly, the research findings that provide the basis for our current taxonomy are presented.

STAGES IN THE DEVELOPMENT OF A MOTOR TASK TAXONOMY

Open/Closed Motor Tasks

The first stage in our efforts to explore classification procedures involved an extension of the analysis of motor tasks made by POULTON (1957). Using the type of prediction required for a particular movement, Poulton had identified categories of skills and had applied the terms "open" and "closed" to two such categories. However, the basis for his distinctions seemed to be primarily in terms of processes not readily observable, that is, anticipatory processes within the organism. Influenced by the concepts of LURIA (1966), BERNSTEIN (1967), and BRUNER (1968), we came to recognize that these predictive processes could be related quite directly to the environmental conditions under which the movement was performed. Re-defining POULTON's two categories of motor tasks in terms of environmental conditions provided an anchor to clearly observable events and, thus, was amenable to verification.

The important assumption with which we started was that movements must match environmental constraints in order to produce a particular outcome or change in that environment. Given that an individual has established a goal, for example, to throw a ball at a stationary target, the movement pattern must conform to the spatial constraints inherent in the task if that outcome of hitting the target is to be produced. In this example, the spatial characteristics of the movement are restricted or determined by the positional characteristics of the target as well as the size, shape and weight of the ball. These environmental events are, therefore, regulatory in the sense that the movement pattern must mold or conform to these conditions for successful goal-attainment. Although an underlying continuum was assumed, two types of environmental control were identified and were labelled closed and open. Motor tasks in which regulatory environmental conditions were fixed, stable and stationary throughout the execution of the movement were defined as closed. When the regulatory conditions involved objects or persons moving in space and, thus, involved events that changed positions in space during the movement, the task was considered open. In closed motor tasks, the spatial but not the temporal organization of the movement was assumed to be limited by the spatial constraints of the stationary environment. In contrast, the spatial and temporal characteristics of movements used in open tasks were thought to be restricted by the temporal/spatial characteristics of the variable regulatory conditions of the "moving" environment.

Beyond these differences concerning the nature of environmental control and the constraints imposed on movement organization, open and closed motor tasks were purported to vary in several important ways. As developed in detail elsewhere (GENTILE, 1972), it was proposed that acquisition and performance of open and closed motor tasks differed in:

(a) the information processing and predictive demands of the task,

(b) the nature of changes in movement organization that took place during learning,

(c) the conditions of practice appropriate for skill acquisition, and

(d) the need for specific types of augmented information feedback.

Our initial research efforts produced very encouraging results in terms of the tenability of this classification strategy. HIGGINS and SPAETH (1972) demonstrated that changes in movement organization during acquisition of open/closed tasks followed our predictions in terms of fixation and diversification of motor patterns. BURKE (1972) found that athletes selected on the basis of participation in open or closed sports environments differed in information processing and predictive characteristics as measured by reaction and movement times in certain and uncertain tasks.

Similarly, BERGER (1972) produced evidence that closed and open skill athletes differed on a number of selected personality characteristics. Recently, evidence has become available concerning differences in conditions of practice during acquisition of open and closed tasks (WITT, 1975). These data supplement the earlier observations of HAMPTON (1970) and DEL REY (1971, 1972) concerning the differential effectiveness of two types of augmented information feedback (i.e., feedback pertaining to the movement versus feedback related to the outcome) upon acquisition of open/closed tasks. On the basis of these initial findings, it appeared that this simple dichotomy of open/closed tasks did have some experimental validity.

At this point, it seemed reasonable to explore another dimension that could be used to classify tasks, namely, the type of movement required. Several lines of evidence suggested that any classification based upon the actual movement used in the task should distinguish between two broad categories of motor response:

(a) movement patterns used for postural adjustment (that is, maintaining or changing total body position in space), and

(b) movement patterns involving the upper limbs and hands that are used for maintaining or changing the position of objects in space.

First, there appeared to be differences in the neurophysiological control processes for these two categories of movement. Second, phylogenetic and developmental comparisons had emphasized the importance of the hands, especially in tool using behaviors, as a more complex mode of interaction than simpler postural processes (PAILLARD, 1960; BRUNER, 1968). Lastly, from work such as STARK's (1968) in bioengineering, a division of control processes into postural and "voluntary" was proposed (see HIGGINS, 1972 for a more detailed presentation in this area). Therefore, we employed these two dimensions (posture and independent upper limb transport/manipulation), dichotomizing each into two levels (body stability/body transport and absence/presence of manipulation), and arrived at a four-category system for classifying tasks in terms of the nature of the movement required. In combination with the open/closed distinction related to the nature of environmental control, an overall system of eight categories was attained (table I).

Table I – Initial Taxonomy Based Upon Environmental and Movement Requirements.

Nature of Environmental Control	Nature of Movement Required By Task			
	Total Body Stability		Total Body Transport	
	No LT/M[1]	LT/M	No LT/M	LT/M
Closed (Spatial control: stationary environment)	Sitting Standing	Typing Writing	Walking Running	Carrying or handling objects during locomotion Javelin throw
Open (Temporal/spatial control: moving environment)	Standing on a moving train Log rolling Riding an escalator	Reading a newspaper on a moving train Skeet shooting Batting in baseball	Dodging a moving object Walking in a moving train Dancing with a partner	Run and catch a moving object Throwing on the run Dribbling in basketball

1. LT/M = Independent limb transport and manipulation, usually involving maintaining or changing the position of objects in space.

This overall system was very attractive to us as it provided a means to integrate other aspects of skilled performance with the task classification. For example, summarized in table II is an analysis of the oculomotor/visual processes that seemed to be associated with each task category (see BIZZI, 1974; YARBUS, 1967; ZINCHENKO, 1972). Thus, we were interested in pursuing research that would allow for the evaluation of this approach. One research strategy utilized was a factor analysis of performance measures on 16 tasks selected so as to be representative of each category (two tasks per category). The results of this study (GENTILE, 1972), reported at this Symposium a few years ago, offered partial support for this system. However, subsequent investigation of this classification strategy was curtailed as it became necessary to reconsider our original definitions of open/closed tasks.

Table II - Oculomotor Adjustments and Visualmotor Analysis Related to Motor Task Categories.

Nature of Environmental Control	Nature of Movement Required by Task			
	Total Body Stability		Total Body Transport	
	No LT/M	LT/M	No LT/M	LT/M
Closed (Spatial control: stationary environment)	Visual orientation (VO)	VO Simple search (SS)	VO Rate analysis (RA)	VO SS RA
Open (Temporal/spatial control: moving environment)	VO Tracking (TR)	VO SS TR	VO RA TR	VO SS TR RA

Note: VO = Convergence/divergence and compensatory eye movements that provide input relative to verticality and relationship of head/body and external objects.

SS = Primarily saccadic eye movements providing input regarding location and features of stationary external objects.

RA = Convergence/divergence to derive input regarding environment into which the body is moving; point of focus (distance) determined by the rate of total body motion.

TR = Slow pursuit and saccadic eye movements providing input regarding the spatial/temporal features of moving objects.

Confounded

During the time Dr. Lawrence ABRAHAM was associated with our laboratory, he raised several irksome questions concerning the definitions of open and closed tasks. For example, one question posed was how to classify a task that involved a moving object that did not vary from one occurrence to the next. A shooting gallery display would be an instance of this type of environment. Similarly, tasks such as putting in golf or high jumping did not seem readily classifiable; the regulatory conditions in the environment were stationary during the execution of the movement but varied from trial to trial. It became obvious that the original definitions of open/closed motor tasks were confounded. Rather than consisting of two levels of one variable, the definitions involved variation along two dimensions: intertrial variability in regulatory conditions was one factor, stationary/moving environmental conditions was a second factor. Closed tasks had been defined as involving stationary *and* stable events; open tasks as involving moving *and* variable conditions. Thus, it was necessary to modify the original definitions and procedures for classifying motor tasks. Each variable was considered separately and a four-category system for environmental control was obtained (table III).

Table III – Initial Modification of Motor Task Taxonomy.

Nature of Environmental Control	Intertrial Variability: Absent	Intertrial Variability: Present
Stationary	*(Category 1)* Batting off a stationary tee what remains in one fixed position	*(Category 3)* Batting off a stationary tee with height of tee varied from one attempt to the next
Moving	*(Category 2)* Batting a ball pitched by machine at one fixed rate and flight pattern	*(Category 4)* Batting a ball pitched by machine: a) At one fixed speed but with different flight patterns b) At different speeds with the same flight pattern c) With variation in both speed and and flight pattern from trial to trial

This modified classification system, based only on the nature of environmental control, provided the framework for the experiments to be reported in this paper. Hence, some elaboration concerning the characteristics of the four categories seems appropriate. In accord with our initial classification strategy, it was assumed that stationary environments imposed solely spatial constraints upon movement organization; whereas moving environments were assumed to impose both temporal and spatial constraints. In terms of the predictive demands of these environments, regulatory conditions that involve moving objects or persons always require the performer to compensate through anticipation for the inherent time lags in his information processing capabilities. However, the time stress within a trial, concerning the gathering and processing of information and the selection and execution of a response, would be reduced markedly if the performer had prior information concerning the environmental constraints. When conditions do not vary from trial to trial, such information is available and intertrial predictive processes can reduce the intratrial predictive demands.

We suspect that one reason the original formulation was confounded is that, in nature, moving objects tend to vary in their spatial/temporal characteristics from one occurrence to the next. Only through man's ingenuity have devices been developed that provide for objects to be moved the same way over repeated presentations. Any researcher who has attempted to have an object move consistently in an experimental task would appreciate how difficult it is to produce this condition. Indeed, only through the intervention of mechanical or electronic means is it possible to produce the same motion twice in succession. Thus, moving but invariant tasks (category 3, table III) are primarily the product of the laboratory.

Using laboratory devices to structure environmental conditions allows for other alterations in moving objects that are not normally possible. For example, tasks can be designed so that the spatial or the temporal characteristics of the moving object can be varied independently. Objects that move "naturally" have concurrent variation of these parameters. However, in laboratory situations in which, for example, the moving object is a target, the task can be structured so that:

(a) the same target, following the same course, is presented on each trial while the speed of target is varied, or

(b) the same speed is used on each trial while the location of the target is varied.

Of course, a third condition in which both the spatial and temporal parameters are varied is also feasible. Thus, in a laboratory analysis of this modified classification system, moving *and* variable tasks (category 4, table III) could be subdivided according to the relative variability in spatial or temporal constraints.

The research reported in this paper involved the evaluation of this modified classification system including the subdivisions of category four. The research strategy involved a detailed analysis of the movement organization used by performers under the variations in environmental control specified by this four-category system. The procedures developed for the analysis of movement and the results of our studies are discussed in the next sections of this paper. However, to complete this historical introduction, a brief overview is presented of the most current stage in our taxonomic efforts that has evolved as a consequence of our research findings.

Current Status

The third taxonomy that has been derived from our recent experiments using movement analysis is surprisingly similar to the open/closed dichotomy with which we had started. Considered only in terms of environmental regulation, there does appear to be two broad categories of motor tasks. One category is identical to the open task condition specified initially: regulatory conditions that involve moving *and* variable environments. The other broad category includes two types of task conditions:

(a) "closed" tasks as defined initially involving stationary and stable environments and

(b) "limited interaction" tasks involving stationary or moving environments that vary from trial to trial primarily in terms of one dimension, that is, spatially or temporally but not both concurrently.

In addition to clarifying our classification procedures, the data from our recent experiments seems to invalidate some of our initial assumptions. First, although we had assumed that environmental events controlled movement organization, we had always modified our statements by indicating that the morphological constraints of the individual performer were also important determinants. We were wrong. To a far greater extent than we had supposed, the abstract features of the movement's framework are determined by environmental constraints. Secondly, it had been proposed that stationary environments restrict only the spatial characteristics of the movement pattern. Again, this assumption seems to be incorrect. Both the spatial and temporal characteristics of the movement are a direct function of environmental conditions regardless of whether that environment involves moving or stationary objects.

Thus, in a much more profound sense than we had believed possible, the nature of environmental regulation determines the structural elements and abstract features of movement patterns used by adult performers. Based upon our experiments, these conclusions seem reasonable and tenable. Let us now discuss the procedures and findings that provided the basis for our current views.

METHODOLOGICAL CONSIDERATIONS

Overview and Rationable of Research Strategies

This overview focuses upon three primary questions:

(a) what was the level of analysis used and why was it appropriate for the study of a taxonomy of motor tasks,

(b) how was the taxonomy reduced and translated into a laboratory and experimental research setting, and

(c) what was the method and rationale for reducing cinematographic records of the movement to quantifiable and abstract parameters of the movement?

To date little, if any, research has focused upon the movement in relation to systematically varied environmental conditions. Investigators interested in motor skills have concentrated their research efforts mainly upon the outcome of the movement and have had little concern with the movement that produces the outcome. We began our studies with the basic premise that detailed analysis of movements performed under laboratory conditions (where spatial and temporal dimensions of the environment are carefully controlled and systematically varied) allows considerable insight into the underlying mechanisms and processes involved in the organization of movement.

The research reported here is from a series of performance studies using a dart throwing task in which no attempt was made to evaluate the data within a learning paradigm. For the purposes of these studies, we selected one type of movement condition, namely, body stability with limb transport/manipulation (table I). Specifically, the movement used was throwing a dart from a stationary standing position at a target.

The Level of Observation

The level of observation selected to directly analyze the movement involved in the dart throwing task was to use cinematographic techniques to record and quantify selected parameters and features of the movement. Specifically, it involved the detailed analysis of the pattern of movement, in space/time, by specifying prior to the analysis the structural elements of the movement. These elements were then systematically analyzed in relation to the environmental condition.

The *structural elements* of a pattern of movement consist of related displacement, velocity and acceleration characteristics. These elements can be reduced to an abstract representation of the spatial and temporal components of the movement. (The detailed procedures will be developed in the final section dealing with data reduction). Thus, the "movement" level of analysis used is a four-level reduction progressing from the pattern of the movement to an abstract representation of its spatial/temporal character. This type of analysis provides the investigator with valuable information concerning the underlying organizational schema of the movement.

To more adequately understand the underlying mechanisms involved in the organization of movement, we have attempted to determine the functional relationships between the spatial and temporal components of the movement *and* conditions of the environment. Finally, we expected that detailed analysis of the structural elements of the movement would yield information related to "rules", "strategies", "processes", "codes", etc., that the performer uses in meeting the varied demands or constraints imposed by the spatial and temporal conditions of the environment. Movements *are* the reflection of underlying mechanisms and processes of organization.

The Taxonomy and Experimental Conditions

In order to test any hypothetical model, in this case the modified taxonomy of motor skills, it is necessary to reduce the abstract dimensions of the model to conditions compatible with laboratory analysis. Table III operationalizes the taxonomy in terms of real world examples. However, now it is necessary to reduce the taxonomy to the laboratory conditions employed in our studies. Thus, the general task and apparatus will be described followed by a discussion of the specific experimental conditions.

The Task and Target Apparatus

A dart throwing task was selected for several reasons:

(a) it is a relatively simple limb transport/manipulation movement in which each phase of the ergonomic cycle (preparation, action and follow-through) are easily determined,

(b) the actual execution of the movement occurs primarily in the sagittal plane of motion and thus, is easy to record with single-camera (two-dimensional) cinematographic techniques,

(c) the critical anatomical points used for analysis remain in constant view within the film record,

(d) the task provides for easy variation in target configuration without radically altering the movement parameters and body position of the performer, and

(e) the target array can be manipulated with respect to location (spatial dimension) and speed (temporal dimension) allowing for a variety of experimental conditions.

The target was displayed by a speciallv designed, motor-driven, Variable Array and Target Speed Apparatus (VATSA). This apparatus allowed us to independently vary or covary the spatial and temporal parameters of the target presentation (see SPAETH, 1973 for a complete description of the VATSA). Through a small "viewing window" the target could be presented in different spatial locations at different speeds. In all of our studies, the "viewing window" had a horizontal dimension of six inches and a vertical dimension of eleven inches. The rationale for this small viewing space was based upon the need to restrict subjects' movements to one plane of motion in order to facilitate cinematographic analysis. The target location was varied in the vertical direction along three positions (high, middle or low). The target moved in a horizontal direction from right to left. For any condition and trial the speed of target was constant (i.e., no acceleration during target presentation).

Reduction of the Taxonomy to Experimental Conditions

Each category of the modified taxonomy has been reduced to a set of experimental conditions (table IV). The first category was represented by a condition in which there were no spatial or temporal changes occuring within or between trials. The task consisted of throwing a dart at a stationary target which retained the same spatial location form trial to trial. Category two involved a moving target that did not vary in location or speed between trials. Category three involved stationary environmental conditions in which the spatial location of the target varied from trial to trial. In this condition, one of three vertically arranged targets was tested on each trial. Category four was represented by a set of three different conditions all of which involved a moving target and intertrial variability. The first condition in category four involved variation in target speed from trial to trial while holding target location constant. The second condition varied the target location [illegible] holding speed constant across trials. The third condition [illegible] varied both target location and speed between trials.

Table IV - Experimental Reductions of Modified Taxonomy.

Nature of Environmental Control	Intertrial Variability: Absent	Intertrial Variability: Present
Stationary	*(Category 1)* Target stationary with fixed location from trial to trial (ROSEN and HOROWITZ-HANDE)	*(Category 3)* Target stationary with spatial location varied from trial to trial (ROSEN)
Moving	*(Category 2)* Target moving with speed and spatial location fixed from trial to trial (ROSEN and HOROWITZ-HANDE)	*(Category 4)* Target moving: a) Spatial location fixed with speed varies from trial to trial (SPAETH, 1973) b) Speed of target fixed with spatial location varied from trial to trial (O'BRIEN, in progress) c) Target speed and location covaried from trial to trial (MILLER, MAURIELLO, and O'BRIEN)

Movement Analysis

Cinematographic techniques were employed to record each subject's dart throwing movements during one of the specific experimental conditions outlined above. The procedures used for data analysis and reduction were the result of considerable pilot work. For example, we selected the wrist as the critical anatomical point for movement analysis only after detailed evaluation of several other anatomical points had been undertaken. The wrist yielded all data appropriate to our questions, and was a satisfactory reflection of all limb segments participating in the throwing movement.

Procedural Details

All subjects were volunteer, male undergraduate or graduate students at Columbia University. They reported to the laboratory for each session where they received a standardized set of instructions. Finger tabs were connected to the thumb and index finger of each subject prior to testing. When the dart was grasped by the subject an electronic circuit was completed which activated a neon light appearing in the camera view (but not in view of the subject). Deactivation of this light indicated when the dart was released at the end of the throwing movement. White noise was presented through headphones placed over the subjects' ears (under the moving target condition) in order to mask any effect of the sound of the motor driving the target. Subjects were positioned six feet in front of and directly opposite the right edge of the viewing window. All subjects assumed an identical standing position.

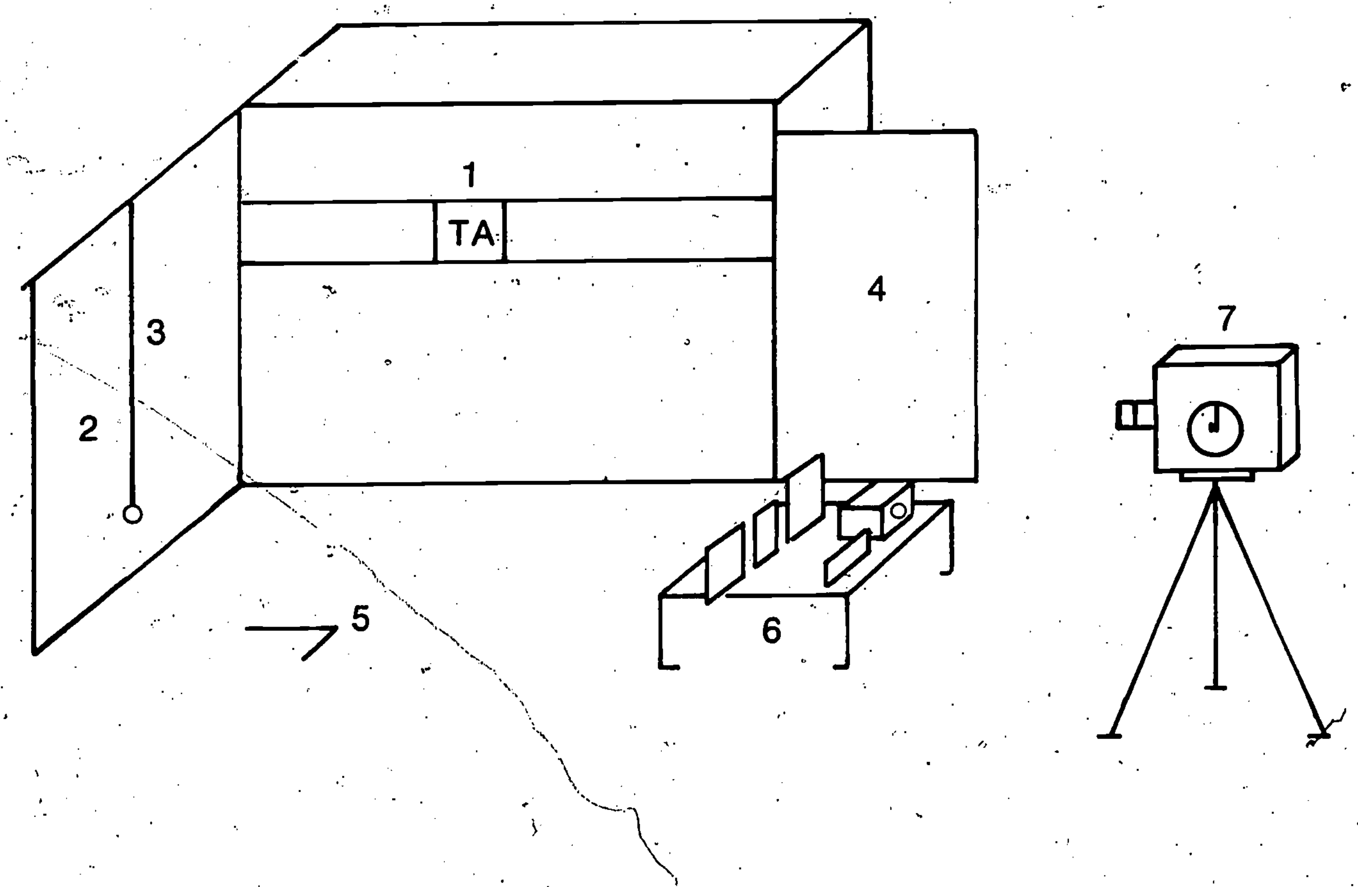
Five-inch long metal darts with plastic vanes and weighing 7/16 ounces were used. For all studies, the target face was 11 × 11 inches with a colored 1 × 1 inch center. Subjects were instructed to aim for the center square.

In order to facilitate the cinematographic analysis, two lights were arranged within the camera view. One light indicated when the subject released the dart and served as the "entry" or "anchor" point for analysis of the film. The second light indicated when the target entered the viewing window and provided information about the time delay between target presentation and initiation of the movement ("preview"). Also included in the camera view was s series of identification numbers designating subject, trial number, and experimental condition being filmed.

Procedures for filming, camera and light set-up were standardized across studies and followed those outlined by MILLER and NELSON (1973). Following is a list of cinematographic specifications used throughout:

1. Camera — Bolex H-16, 16mm/spring drive with a Vario Switar 100 zoom lens.
2. Lens settings — distance twenty-one (21) feet, wide angle "18".
3. Film speed — the camera setting was 64 frames per second with an actual film speed of 66.67 f.p.s.
4. Distance from camera to subjects' right foot was twenty feet, 9 inches.
5. Film type — Kodak Tri-X reversal (SPAETH, 1973) and Kodak 4-X reversal.
6. Lights — four colortran and two minilight. A schematic representation of the VATSA, subject area and camera set-up is shown in figure 1. Subjects were filmed from their right side in all studies.

Figure 1 – Laboratory arrangement and apparatus. 1 – target area; 2 – backdrop; 3 – plumb line; 4 – experimenter shield; 5 – subject standing location; 6 – equipment including neon lights and clock; 7 – camera. (SPAETH, 1973).



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Data Analysis

A very specific and detailed type of kinematic analysis, developed in our laboratory, was used in the reduction of film records to numerical values describing the temporal and spatial features of the movement. Four orders of data reduction were employed and each order yielded increasingly abstract values with respect to the actual movement (table V). The reduction of the film record to abstract values and not "real" values should be noted as an important departure from traditional biomechanical/kinesiological modes of analysis.

We were not interested in obtaining a description of the microstrategies used by individual subjects in movement organization. Rather, we were attempting to derive measures that would be indicative of the stable and invariant features of the movement pattern, that is, the underlying structure not the superficial details of the movement. This approach is based upon an assumption that these abstract movement descriptors are a more direct reflection of internal motor processes (the gross framework or general schema of the movement) than are the "real" values associated with biomechanical description.

Table V – Order of Reduction and Abstraction of the Movement.

Order of Reduction	Operation	Abstraction	Information
First	X-Y coordinate	Beginning of movement Turn-around point Release point	Spatial referents
	Frame number	Beginning of movement Turn-around point Release point	Temporal referents
	Frame numbers	Target first enters viewing window and beginning of movement	Preview referent
Second	Length of movement by phase — geometric function	Linear extent — preparatory and action phase	Spatial features of the moveme
	Number of frames by phase	Temporal duration preparatory and action phase	Temporal features of the movement
	Number of frames between target presentation and movement initiation	Preview latency	Information processing delay
Third	Measure angles defined by preparatory and action phase	Angular relation between movement phases	Nonlinear spatial parameter
Fourth	Ratio of linear extent to duration of movement	"Rate" of movement	Spatial/temporal feature

Once the cinematographic record was obtained (table V), data points in terms of coordinate x-y values were determined through frame by frame analysis, using the Vanguard Motion Analyzer. Thus, the first order of reduction provided coordinate x-y data points (spatial referents) for the wrist at point of release, turn-around point, and beginning of preparatory phases of the movement. Onset of a light, visible in the film record, was used as the "entry" point for obtaining the coordinate data for the point of dart release. The turn-around point of the movement was specified as the beginning of the action phase and was defined as the frame in which there was a clear indication that the subject's wrist was moving forward towards the target. The beginning of the preparatory phase of the movement was defined as the frame in which there was a clear indication that the wrist moved continuously backward and/or upward with respect to the target. One aspect of the first order reduction, therefore, provided information about the spatial location of the wrist at specific points during the movement. In addition to obtaining the x-y coordinate data for these three points within the movement pattern, temporal data was also derived, that is, the frame numbers for the point of release, turn-around point, and beginning of the preparatory phase. The frame number for the point at which the target first came into the viewing window was also determined. These frame numbers provided information which served as temporal referents and were used in the second order reduction of the data.

The next stage in our analysis involved the transformation of the spatial and temporal referents into two types of information for the preparatory and action phases of the movement:

(a) linear extent, and

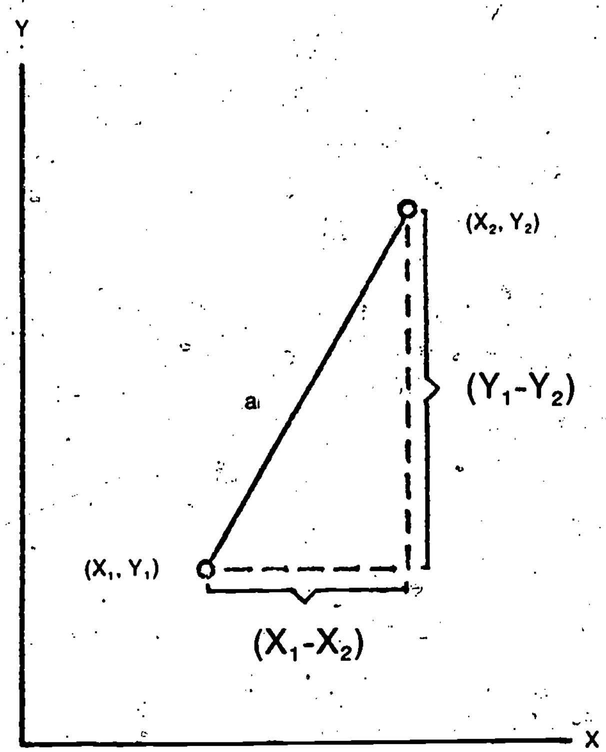
(b) duration.

Linear extent for preparatory and action phases was determined by calculating the relative distance between the coordinate x-y point:

(a) for the beginning of the preparatory phase to turn-around, and

(b) for the turn-around to the point of dart release.

Figure 2 - Schematic representation of procedure for obtaining angular measures from displacement patterns.
Vector a = $(X_1 - X_2)^2 + (Y_1 - Y_2)^2$. (SPAETH, 1973).



This distance (figure 2) is determined simply by solving for the hypotenuse of a right triangle (vector measure). To determine the duration of the movement for the preparatory and action phases we counted the number of elapsed frames between the beginning and turn-around points, and between the turn-around and release points. These linear extent and durational measures provided information about the abstract temporal and spatial features for each phase of the movement. In addition, a preview latency measure, indicating the delay between target presentation and the initiation of the movement, was derived (table V). This value was used in our analysis to help examine possible strategies subjects were using in solving the motor task. Obviously, this information was collected only for those conditions where the target was moving.

The third order of data reduction involved a determination of the angle described by the wrist during each phase of the movement. The angle for the preparatory and for the action phase was calculated in relation to the absolute horizontal. That is, the angle described by a line between beginning of the movement and the turn-around point with the horizontal (P-H); and the angle described by a line between the turn-around point and release point with the horizontal (A-H) (figure 3). The derivation of these angles involved using a trigonometric function which solved for each of the two angles. These angular measurements provided a nonlinear spatial parameter describing the movement.

Finally, a fourth order of reduction allowed us to describe the abstract relationship between linear extent and duration of the movement. This is a quasi "rate" value which was abstracted by dividing the durational measures into the linear extent measures to produce information about the spatial/temporal features of the movement.

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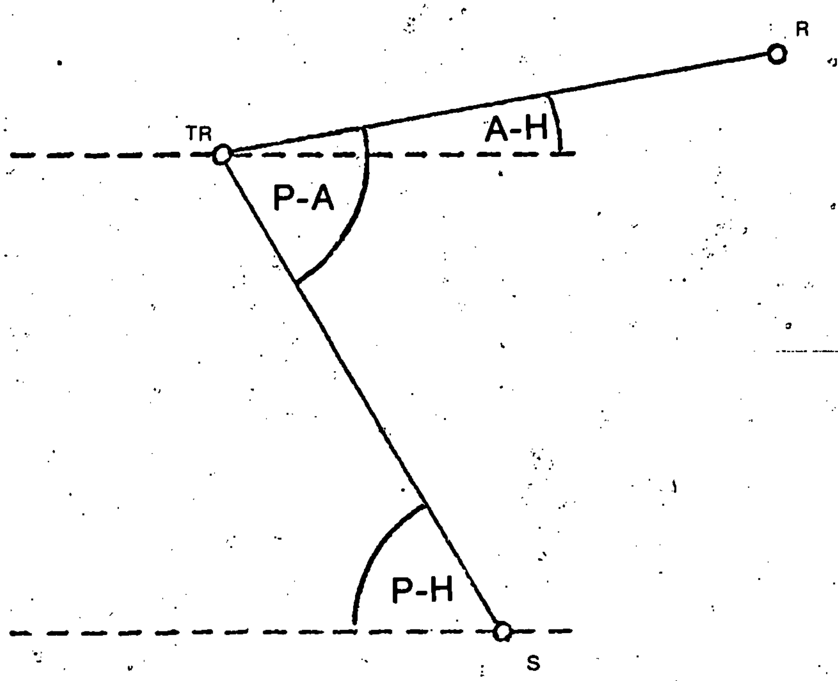
Figure 3 – Schematic representation of derivation of selected angles from mean wrist displacement data for a given target position. P-H: angle between line of preparatory phase and the horizontal; P-A: angle between preparatory phase and action phase; A-H: angle between line of action phase and horizontal; S: beginning of the movement; TR: turn-around point; R: release point. (SPAETH, 1973).



EXPERIMENTAL RESULTS

Motor Task Categories One and Two

Rosen and Horowitz-Hande (note 1) investigated the organization of movement used in tasks that involved both stationary and moving environments in which there was no intertrial variability (table IV). In one condition, the environment was stationary, with a fixed target location for all trials. The other condition involved a moving target that was maintained at a fixed speed and spatial location from trial to trial. Under the stationary target condition, three subjects threw darts at the fixed target which was located in the VATSA viewing window. In the moving target condition, three subjects threw darts at a target that was presented at a constant speed (8.46 inches per second) and moved from right to left into the same target et window over all trials. The subjects were filmed during the first block of six trials, and the last block of six trials out of the total of thirty trials. Cinematographic data was transformed to the abstract measures of linear extent and temporal duration as described in table V. For each block of trials, mean extent and mean duration were calculated for the preparatory phase and the action phase of the movement. The sum of both phases was considered to be total extent or the total duration of the movement.

Since our concern was with movement organization after it had become relatively stabilized, means and standard deviations are reported for the last block of trials. This decision was supported by the fact that the blocking factor interacted significantly with other factors in the two-way analysis of variance. These interactions reflected a change in the movement pattern after the first block of trials. Statistical evaluation of extent and duration measures indicated a significant effect of movement phase, both for linear extent, $F(1, 4) = 10.31$, $p < .05$, and for temporal duration, $F(1, 4) = 22.94$, $p < .01$. Action phase of movement was found to be longer in extent, but shorter in duration than preparatory phase under both target conditions (table VI).

It can be seen from table VI that the abstract parameters of the movement did not differ significantly under the two target conditions. Although linear extent of movement was slightly shorter for the moving target, this difference was not significant. Since there was some difference in linear extent between the two conditions, the similarities between the durational measures is even more striking. The mean duration of both preparatory and action phases, as well as total duration, is almost identical across target conditions. It should be noted that under the condition of moving target, there was an increase in variability around the mean. This

Table VI – Means and Standard Deviation of Linear and Durational Measures Expressed as Vector Measures and Elapsed Film Frames[1].

Target Condition		Linear Extent: Preparatory phase	Linear Extent: Action phase	Linear Extent: Total Extent	Temporal Duration: Preparatory phase	Temporal Duration: Action phase	Temporal Duration: Total Duration
Stationary target	$\bar{X}$	.6646	.8607	1.5257	23.78	10.78	34.56
	S.D.	.2049	.3622	.5063	3.90	2.07	4.47
Moving target	$\bar{X}$	.5535	.7468	1.3003	23.39	10.94	34.33
	S.D.	.4356	.2946	.6359	15.28	3.28	17.38

1. ROSEN, B. and HOROWITZ-HANDE, E. (note 1).

1. Rosen, B. M. and Horowitz-Hande, E., *The effects of stationary versus moving environment on the organization of movement.* Unpublished manuscript, Motor Learning Laboratory, Teachers College, Columbia University, 1975.

increase in variability occurred in the preparatory phase of the movement and was true for both linear and durational measures.

Motor Task Category Three

ROSEN (note 2) investigated the effects of intertial variability in a stationary environment by changing the designated target from trial to trial (table IV). Three target centers, six inches apart, and of different colors, were arranged vertically and attached to the VATSA so that the center target coincided with the center of the target window. These targets were visible at all times. After a "ready" signal, subjects were instructed (by the naming of the target color) to throw the dart at the color of the target to be acquired. Target designation varied from trial to trial in the following manner: high, medium, low, low, high, medium. Subjects were instructed to take as much time as they needed to aim and throw the dart accurately. Thus, a high degree of intertrial variability was employed, but within a stationary environment with no temporal constraints.

A total of 60 trials was given, arranged in five blocks of 12 trials each, with each target position presented four times within each block. Three subjects were filmed during the first, third and fifth blocks of trials and data analyzed. In keeping with the previous study, means and standard deviations will be reported for the last block of trials only (table VII).

Analysis of variance again revealed a significant difference between the phases of the movement for both linear extent, $F(1, 2) = 11.86$, $p < .10$, and temporal duration, $F(1, 2) = 155.55$, $p < .01$. An alpha level of .10 was established for statistical evaluation as the number of subjects that are feasible to use in a cinematographic study must, of necessity, be small. An interaction between target and phase was found for linear extent, $F(1, 2) = 5.29$, $p < .10$. Individual comparisons were carried out and revealed significant differences between the phases of the movement (critical value = .133, df = 2, 8; $p < .05$). No significant differences were found between target positions for each phase of movement, but the proportion of the total extent of movement that was allotted to each phase varied as a function of target position. The preparatory phase became relatively shorter and the action phase correspondingly longer at the center position of the three target locations.

Table VII – Means and Standard Deviation of Linear and Durational Measures Expressed as Vector Measures and Elapsed Film Frames[1].

		Linear Extent			Temporal Duration		
Target Position		Preparatory phase	Action phase	Total Extent	Preparatory phase	Action phase	Total Duration
High	$\bar{X}$	1.3087	.8422	2.1509	36.58	10.83	47.41
Medium	$\bar{X}$	1.2581	.9243	2.1824	36.42	10.92	47.33
Low	$\bar{X}$	1.2034	.7947	1.9981	33.50	9.67	43.17
Overall	$\bar{X}$	1.2567	.8537	2.1105	35.55	10.47	46.03
	S.D.	.4836	.4111	.8780	8.66	4.81	13.10

1. ROSEN, B. (note 2).

2. Rosen, B. M., *The effects of intertrial variability, in a stationary environment, on the organization of movement.* Unpublished manuscript, 1975.

Coordinate data was transformed into angular relationships between the movement phases (figure 3). An analysis of the angle between the horizontal and both preparatory and action phases revealed that subjects were systematically varying the angle of the action phase with respect to the absolute horizontal (F_{max} = 90.50, $p < .05$). The action phase was clearly adjusted according to target position (table VIII), obviously allowing subjects to match dart release to relative height of target, (Friedman ANOVA, X^2 = 6.0, $p < .05$). No such angular relationship was found for the preparatory phase of the movement.

Table VIII - Angular displacement of Preparatory and Action Phase from the Horizontal by Subject and Target for the Last Block of Trials[1].

		Targets		
Subjects	**Phase**	**High**	**Medium**	**Low**
1	Preparatory	22°30'	20°45'	17°50'
	Action	6°45'	3°45'	– 1°42'
2	Preparatory	79°05'	77°20'	78°06'
	Action	– 3°10'	– 8°15'	– 11°40'
3	Preparatory	44°05'	39°30'	43°45'
	Action	– 8°55'	– 8°05'	– 21°00'

1. ROSEN, B. (note 2).

In response to the spatial constraints of the environment that varied from trial to trial, subjects altered the spatial features of the movement pattern while keeping the general framework of the movement constant. There was a remarkable similarity in the linear extent and temporal duration of the movement across the three target positions, and even more remarkably, across experiments. The means for the linear extent and the temporal duration measures of the action phase of movement obtained in this experiment are very similar to those measures obtained under motor task categories one and two in the previous experiment (tables VI and VII). The fact that these data are close to identical is even more surprising since they represent three different groups of three subjects each, with each group performing under either a different environmental constraint or a different degree of intertrial variability.

Motor Task Category Four

In order to explore the effects of both a moving environment and intertrial variability on the organization of movement, SPAETH (1973) used a target that varied in speed from trial to trial, but maintained the same spatial location each time (table IV). The target was presented at three speeds:

(a) fast (F) = 12.85 inches per second,

(b) medium (M) = 8.46 inches per second, and

(c) slow (S) = 4.98 inches per second.

Six subjects were tested under these task conditions for a total of 60 trials (five blocks of 12 trials each). The ordering of speeds within each block consisted of the pattern S-F-M-F-S-M repeated twice. Thus, each block contained four presentations of the same speed. Blocks one, three and five were filmed and data were analyzed. Consistent with the prior experiments, data is reported for the last block of trials only.

SPAETH (1973) found a significant effect of movement phases for the temporal duration measures, F (1, 5) = 72.65, $p < .01$, with preparatory phase longer in duration than the action phase. In addition, the duration of preparatory phase was directly related to the speed of the moving target, F (2, 10) = 116.58, $p < .01$, with the duration of the preparatory phase ordered in direct correspondence with the target speed. The action phase under the medium and slow speeds did not differ; however, both were significantly longer than under fast target speed (table IX). No significant differences between means were found for linear extent measures although changes did occur over blocks of trials. It is evident that the mean linear extent measures of the movement was quite similar across target speeds indicating a stable spatial feature of the movement despite variability in the speed of target between trials (table IX). In addition, the actual mean extent of action phase is almost the same as that found under task conditions for category three (ROSEN, note 2). Further, length of preparatory phase was comparable to that observed under category three task conditions (ROSEN and HOROWITZ-HANDE, note 1). A comparison between the durational measures shows a striking similarity in duration of action phase across all three of these studies (tables VI, VII and IX). The duration of both movement phases at the medium speed in the present experiment was very similar to those measures observed for the moving target condition that did not involve intertrial variability (ROSEN and HOROWITZ-HANDE, note 1). The medium speed of the target was identical to that used for the ROSEN and HOROWITZ-HANDE experiment.

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Table IX - Means and Standard Deviation for Linear Extent and Temporal Duration Expressed as Vector Measures and Elapsed Film Frames[1].

		Linear Extent			Temporal Duration		
Target Speed		Preparatory phase	Action phase	Total Extent	Preparatory phase	Action phase	Total Duration
Slow	$\bar{X}$	.76	.93	1.69	34.24	10.54	44.79
	S.D.	.59	.39		8.97	4.26	
Medium	$\bar{X}$	.61	.91	1.52	24.75	10.33	35.08
	S.D.	.59	.34		6.80	3.65	
Fast	$\bar{X}$	.63	.83	1.46	16.17	7.99	23.96
	S.D.	.68	.32		5.17	1.92	

1. SPAETH, R. K., 1973.

The results of the present experiment seem to indicate that under the medium target speed used for both experiments the temporal feature of the movement pattern was invariant in spite of the presence of intertrial variability. The medium speed seemed to serve as a reference point for subjects. When the target speed was faster or slower than this reference, the subjects appeared to adjust the temporal feature of the preparatory phase while maintaining the same gross framework of the movement observed in the prior studies.

MILLER, O'BRIEN and MAURIELLO (note 3) investigated the organization of movement under experimental conditions in which both target speed and location covaried from trial to trial (table IV). Two target speeds (fast and slow) and two target positions (high and low) were used. The fast speed was 14.66 inches per second, and the slow speed was 3.25 inches per second. Two targets were used in which the higher target center was one and one-half inches above the lower target center. Covarying speed and position resulted in four unique combinations: fast-high (FH), fast-low (FL), slow-high (SH), and slow-low (SL). These were presented in the following order: SH, FH, SH, FL, FH, FL, SL. Subjects were tested for a total of 80 trials per day (subdivided into five blocks of 16 trials each) for three consecutive days. Cinematographic records were obtained for the first, third and fifth blocks of trials on day one, and for the fourth block of trials on day three. Means and standard deviations are reported for the last block of filmed trials (table X).

3. Miller, E. A., O'Brien, R. and Mauriello, A., *Intertrial variability and the effects of covarying spatial and temporal environmental constraints on the organization of movement.* Unpublished manuscript, Motor Learning Laboratory, Teachers College, Columbia University, 1975.

Table X - Means for Linear Extent and Temporal Durational Measures Expressed as Vector Measures and Elapsed Film Frames [1].

Target		Linear Extent			Temporal Duration		
Speed	Position	Preparatory phase	Action phase	Total Extent	Preparatory phase	Action phase	Total Duration
Fast	High	.13	.56	.69	5.92	10.67	16.59
	Low	.17	.50	.67	9.17	10.50	19.67
Slow	High	.12	.50	.63	11.08	12.17	23.25
	Low	.14	.54	.68	12.33	12.25	24.58
Overall		.14	.53	.67	9.63	11.40	21.03

1. MILLER, E., O'BRIEN, R., and MAURIELLO, A. (note 3).

An analysis of variance for temporal duration measures showed a significant effect of target speeds, especially upon the preparatory phase of the movement, $F(1, 14) = 26.49$, $p < .01$. This observation is in accord with SPAETH's (1973) data.

Analysis of variance on the linear extent data produced an effect of phase, $F(1, 14) = 85.2$, $p < .01$, with action phase longer than preparatory phase. In addition to the difference in the relative length of the phases. the values for phase lengths look very different from the data produced in all of the other experiments. Linear extent of preparatory phase is markedly reduced under target conditions; action phase is also somewhat shorter in extent than in the other experiments. These disparities suggested that in a moving environment in which spatial and temporal dimensions covary from trial to trial there was a clear alteration in movement organization in comparison to all other motor task conditions examined in prior studies.

Inspection of preview duration data revealed a main effect of speed of target, $F(1, 2) = 496.28$, $p < .01$. This finding was in accord with SPAETH (1973). $F(2, 8) = 36.77$, $p < .01$. Both studies record a relatively short preview duration for fast target speed, compared to a relatively longer one for slow target speed (table XI).

Close inspection of the preview duration data at the fast speed in this experiment, coupled with the durational measures for preparatory and action phases suggested that at least two out of the three subjects were utilizing a particular strategy for dealing with unpredictable changes in target position under high temporal stress. For these two subjects, preview duration at the low target was shorter than at the high target, along with a concomitant increase in duration of preparatory phase. This suggested that these subjects were "looking low" or initiating the movement more quickly (i.e., with less preview time), when the low target came into view, while waiting longer to start moving if the "expected" low target was not forthcoming. The lack of corroborative evidence from subject one does not necessarily mean that he was not utilizing the same strategy. It may be that he was switching the position of the "expected" target equally between high and low targets.

Table XI - Means and Standard Deviations for Preview Latency Measures Obtained with Two Task Conditions for Category Four.

Target Speed		Task Conditions: Target Location Fixed and Speed Varied [1]	Task Conditions: Both Target Location and Speed Varied [2]
Fast	$\bar{X}$	18.17 [3]	8.71
	S.D.	2.48	7.01
Slow	$\bar{X}$	81.92	119.63
	S.D.	26.62	15.3

1. SPAETH (1973).
2. MILLER *et al.* (note 3).
3. Cell entries are expressed in terms of number of elapsed frames (1 frame = .015 sec.).

Further inspection of the original data uncovered another pervasive difference between this experiment by MILLER *et al.* (note 3) and all of the other studies. While there were a few "zero" preparatory phases (complete elimination of preparatory phase) observed infrequently throughout the other studies, subjects two and three in the present experiment produced 32 and 36 trials, respectively, out of a total of 64 in which no preparatory phase was discernible. In addition, the mean duration of the preparatory phase of subject three was well below that observed previously. This phenomenon accounts for the large reduction in the means for both extent and duration of preparatory phase discussed previously. The reduction in extent and duration of preparatory phase, the differential utilization of preview duration according to target position, and the changes in duration of both phases of the movement all led to the conclusion that the spatial and temporal features of the movement pattern (i.e., the gross framework) under the motor task conditions in which both the target speed and the target position varied from trial to trial was markedly different from all other experiments reported here.

Summary

Based upon the findings of these several studies of movement organization under task conditions defined by our modified taxonomy, four general conclusions seemed tenable.

1. The spatial/temporal characteristics of the environment, structured in terms of the variations in the tasks that we employed, resulted in similarities in movement organization that were remarkable. We had not expected that the abstract features of the movement, assumed by reflecting the gross framework or motor schema, would be invariant across most of these studies involving both moving and stationary targets. However, this was indeed the case for all motor task conditions except those involving a moving target in which the spatial and temporal characteristics covaried over trials. For all other task conditions, the abstract spatial and temporal features of the movement seemed determined by the task constraints regardless of individual variation in morphology, past experience, or skill level of our subjects. In undertaking our research, we has assumed that the movement organization was influenced by individual morphology. Further, we had assumed that stationary environments imposed only spatial control. Both assumptions are no longer tenable. For the two phases of action in dart throwing, both the spatial and temporal features of the movement were determined by the task regardless of whether the environment was moving or stationary and regardless of the individual differences between subjects.

2. For the two phases of action in dart throwing, the effect of intertrial variability in regulatory conditions was upon the abstract features associated with the preparatory phase of the movement. Furthermore, modification of the spatial or temporal features of the preparatory phase was a direct function of the nature of environmental variation. For example, when the target speed varied over trials, the subjects varied the temporal duration of the preparatory phase.

3. Alteration in the spatial or temporal features of the preparatory phase appeared to follow a type of range effect. The middle value of three task conditions resulted in movements having abstract features in common with those observed under fixed, stationary conditions. The other two task conditions (e.g., faster or slower target speeds) resulted in preparatory phases that were faster or slower than this "reference" movement observed under the medium target speed. Intertrial variability that involved only one dimension (spatial or temporal but not both concurrently) seemed to be handled by redefining one, relevant parameter (or specification) within the gross movement framework following typically observed range effects.

4. In terms of the relationship between task conditions and movement organization observed in our studies, there appeared to be two broad categories of motor tasks. In one category, the gross organization of the movement was maintained across task conditions involving: fixed/stationary, fixed/moving, and variable/stationary environments as well as those variable/moving environments in which only one dimension changed across trials (spatial or temporal but not both concurrently). Although alteration in one abstract movement feature was used to match variability within these task conditions ("closed" or "limited interaction"), the general features of the movement pattern were maintained. In contrast, moving/variable environments in which the spatial and temporal dimensions covaried over trials elicited a new and different gross framework for the movement. These task conditions are in accord with our initial definition of "open" tasks. Thus, it seemed as if our data provided support for the two-category system with which we had started. However, the more precise specification of the first category, in terms of closed and limited interaction tasks, is an extension and refinement of our original efforts.

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TOWARDS A TYPOLOGY OF APRAXIA[1]

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The term apraxia refers to a variety of pathological conditions resulting from brain damage which involve the inability to carry out purposive, voluntary movements in the absence of motor paralysis, ataxia, or dementia. While many forms of apraxia have been identified (see DE AJURIAGUERRA and TISSOT, 1969), the focus of this paper is only on those which affect the praxis of limb movements (i.e. limb-related apraxias). A brief description of the clinical symptoms surrounding each apraxic syndrome is provided. Then these apraxias are examined from three perspectives:

1 – in terms of the site of brain damage,

2 – in terms of the secondary symptoms associated with the apraxic disturbance, and

3 – in terms of the pattern of disabilities to limb praxis evident [illegible] apraxic syndrome. Using this information, a typology is developed. This typology with its emphasis on the disorder underlying the apraxia is discussed in terms of how it can be used to study apraxia and in terms of its implications for models depicting the organization of motor skill.

CLINICAL SYNDROMES

While some time could be spent recounting the development of clinical investigation into apraxia, rather more fruitful discussion can be devoted here to examining the clinical symptoms associated with each of the several syndromes of apraxia. An historical perspective to this area can be gleaned from DE AJURIAGUERRA and TISSOT (1969).

The classifications of apraxia in use today differ somewhat from those developed by LIEPMANN (1908). The symptomology within each classification has been expanded over the years and, as well, new classifications have been added. To the classical forms of apraxia (ideational, ideomotor, and limb-kinetic) have been added DENNY-BROWN's (1958) kinetic apraxia and Luria's kinesthetic apraxia (LURIA, 1966) both of which bear some resemblance to limb-kinetic apraxia; also further delineations of constructional apraxia have been suggested. Finally, apraxia following damage to the frontal and premotor areas has also been identified.

Limb-kinetic and Related Apraxias

Limb-kinetic apraxia involves the inability to perform particular isolated movements (e.g., match striking in the movement sequence involved in lighting a candle). The rapidity and delicacy of movement are disturbed independently of the degree of ideational complexity. This disorder may be specific enough to involve a particular muscle group: the muscles of several fingers, for example. It appears that the difficulty of a particular act is determined by the complexity of the muscular coordination involved for its execution and not by the psychomotor complexity (DE AJURIAGUERRA and TISSOT, 1969).

This type of apraxia is always unilateral and contralateral to a lesion in the primary motor areas except when it involves the face or the buccophonatory organs (larynx, tongue, mouth). Since these areas are bilaterally innervated, a unilateral lesion, right or left sided, in the motor area will cause a bilateral disorder.

Kinesthetic apraxia described by LURIA (1966) represents a disorder very similar to that present in limb-kinetic apraxia. This apraxia results from lesions in the post central motor cortical region, the cerebral cortex and, like limb-kinetic apraxia, is unilateral and contralateral to the side of the lesion. Unlike limb-kinetic apraxia kinesthetic sensory loss is attendant, while loss of strength is not. Further, while in limb-kinetic apraxia, the poor execution of components of a movement sequence can be ascribed to motor impairment due to damage of the motor cortex. In kinesthetic apraxia the observed clumsiness of movement is more the result of loss of kinesthetic feedback due to damage to the sensory areas in the sensorimotor area.

Another type of apraxia similar to limb-kinetic apraxia is kinetic apraxia. DENNY-BROWN (1958) described two types of kinetic apraxia: that due to mesially placed lesions of the frontal lobe (magnetic apraxia) and that due to lesions of the parietal lobe (repellent apraxia). In magnetic apraxia there is a profound grasping reflex and an irrepressible tendency to follow objects which touch the hand or merely enter the visual field. This exaggerated tendency to fixate on objects prevents the patient from shifting his attention or activity and so interferes with the performance of all activity. In repellent apraxia, on the other hand, the tendency is for the patient to avoid anything touching the hand, foot or mouth. There is not only a tendency to withdraw from any contact but a difficulty in making contact as the limb is too withdrawn and the fingers too extended in all phases. As with magnetic apraxia this disorder prevents the normal practic manipulations.

DENNY-BROWN (1958) described these as contrasting types of kinetic apraxia. One is traceable to perseveration of all contactual reactions (magnetic apraxia), while the other represents a perseveration of all withdrawal responses (repellent apraxia). This type of apraxia represents a defect in the kinetic aspects of behaviour: an imbalance between two The motoric signs of perseveration and difficulty in evolving a response are thought to be too nonspecific. They are common to almost all types of cerebral pathology. The spatial dyskinesia is limited, however, to egocentric space and

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opposing systems. Denny-Brown and Chambers (in DENNY-BROWN, 1958, p. 22) showed that magnetic, exploratory aspect of behaviour is managed by the parietal lobe and released by the frontal lobe. Conversely, the repellent, negative bias in behaviour was shown to be determined primarily, by parts of the premotor area of the cortex and released by the parietal lobe. Damage to either system releases abnormal activity in the other resulting in either approach or avoidance behaviour. As with limb-kinetic apraxia these disorders are unilateral and contralateral to the side of the lesion.

These types of apraxia (limb-kinetic, kinesthetic, kinetic) then, represent a disturbance of practic behaviour which is unilateral and which, generally, appears to be independent of the planning of action. Limb-kinetic and kinesthetic apraxia involve a disruption of particular movement patterns due to the loss of motor or sensory representation in the sensorimotor region. Kinetic apraxia, however, does not involve the loss of movement patterns per se. Rather, it involves the disequilibrium between two opposing systems, approach and avoidance, with one or the other under inordinate control. While limb-kinetic and kinesthetic apraxia would make movements look clumsy and inarticulate, kinetic apraxia seems to make any goal-directed behaviour almost impossible.

Ideomotor Apraxia

According to Liepmann, ideomotor apraxia was the disconnection between the will to perform a particular act or gesture and the action patterns (motor engrams) used to carry it out (LIEPMANN, 1908). The substratum of the engram, considered by Liepmann to be in the cortical cells in the Rolandic region, was thought to be dissociated from the rest of the brain. A type of dissociation was thought to be present in the absence of damage to either the plan or the engram since the patient, although unable to perform actions to command [3], could perform the same actions spontaneously with object use. More recent work (e.g. HECAEN, 1968; BROWN, 1972) concurs with Liepmann's view suggesting that there is not a disruption of planning of the act to be accomplished but rather the execution at the level of the elementary sequences is disturbed. They suggest that the practic disorder may manifest itself either in the absence of response or by diffuse, disorganized and poorly aimed movements involving either the confusion of two different movements or the perseveration on a previous movement.

While Liepmann and his followers ascribe the ideomotor dysfunction more or less to the motor domain, another group of workers, notably MORLAAS (1928, in BROWN, 1972, p. 163) and more recently DE AJURIAGUERRA and TISSOT (1969) ascribe the disorder to a spatial dykinesia or agnosia. This, they suggest, explains why ideomotor apraxia is particularly apparent in gestures, both symbolic (e.g. sign of the cross) and meaningless (e.g. opposition of the fingers or of the hands to each other), which centre around the body. Since these patients generally, are able to identify the symbolic value of the gesture in question as well as point out mistakes that the examiner may make in carrying it out, the disorder cannot be attributed to gnostic disturbances in the visual realm.

represents an inability to orient movements around the body. Indeed right-left disorientation is sometimes seen in conjunction with this apraxia.

While these approaches appear at odds, it is probably the case that ideomotor apraxia involves both of these kinds of disorders, although it is uncertain which predominates. Evidence from constructional apraxia is instructive in this regard. It has been shown that constructional apraxia involves two types of disorder: a visual-spatial agnostic component when damage is in the right cerebral hemisphere and an executive disorder upon left cerebral damage. Since cerebral damage in ideomotor apraxia is generally bilateral (DE AJURIAGUERRA and TISSOT, 1969), it is reasonable to suppose that as in severe bilateral cases of constructional apraxia, both a spatial gnostic disturbance and an executive disorder contribute to the apractic syndrome.

Ideomotor apraxia generally results from bilateral lesions in the parietal area particularly around the supramarginal gyrus. In examining many cases of ideomotor apraxia DE AJURIAGUERRA and TISSOT (1969) reported that while the supramarginal gyrus was most often implicated quite frequently the lesion included the whole of the parietal lobe and immediately adjacent parts of the temporal and occipital lobes.

Ideational Apraxia

Ideational apraxia was, classically, thought to involve the impairment of the planning of a gesture or motor act due either to the inability to retrieve the plan from memory (amnesic apraxia) or to the ineffectual organization of sequence of actions into a coherent pattern (LIEPMANN, 1920).

Generally, it is bilateral and is characterized by an impairment of the harmonious and logical sequence of several elementary movements that make up a complex act, though each movement itself is performed correctly. Single objects are misused, as for example, using a razor as a comb, but the difficulty is particularly apparent when a more complex act involving a sequence of actions with two or more objects is performed. For example, the ideational apraxic will be unable to light a candle with a match. Actions such as trying to light the match on the candle or trying to light the candle with an unlit match often occur.

PICK (1905) characterized the disturbance as involving three types of error:

a) impairment in the temporal sequence of individual movements,

b) termination of the movement prematurely, and

c) perseveration.

He suggested, along with MARCUSE (1904) that there was a loss of attention directed to the voluntary action in which the patient forgot the next step in the sequence of activity. Subsequently random activity followed which bore little resemblance to the original purpose of the act or gesture. As such, Pick vie d ideational apraxia as intermediate between agnosia and omotor apraxia.

3. The inability of apraxic patients to respond to verbal command may have three origins. First, damage to the area responsible for the comprehension of speech (Wernicke's area) will make it almost impossible for the affected patient to respond. In this case, however, the problem is one of aphasia and not necessarily apraxia although in many cases one is superimposed on the other making meaningful interpretation of the apraxic problem more difficult. Secondly, BROWN (1972, p. 160) observed that one patient consistently failed to show how to "Hold a shovel", but immediately responded when told to "Shovel snow". Thus, the specificity of the command is of importance. Finally, damage to the corpus callosum described first by LIEPMANN (1906) and recently discussed by GESCHWIND (1975) makes response to verbal commands almost impossible due to the lack of interhemispheric communication. Since in many of the apraxias discussed in this paper, some form of callosal damage may be present, this type of syndrome could also be present.

LIEPMANN (1908) basically accepted Pick's views and went on to suggest that, although ideational apraxia was associated with perceptual difficulties, it did not depend on these; rather, it related to the ideational plan of action. He suggested that there were two forms of this apraxia. Failure to arouse the correct movement pattern resulted in amnesic form, while an insufficiency of the plan once evoked led to the other form.

Liepmann's dichotomy of ideational apraxia appears to present some problems in differentiating it from ideomotor apraxia especially when considering the second form. To be totally independent of the first, in which the incorrect plan is selected, the second class of ideational apraxia would, necessarily, have to involve the patient selecting the correct plan but being unable to execute it properly. This does not fit well at all with Liepmann's original classification in which ideational apraxia was seen as a disturbance in programming with ideomotor apraxia being the disordered execution of the action. His second class of ideational apraxia seems to be remarkably similar to ideomotor apraxia. Undoubtedly, this has led to much confusion concerning the separation of these two forms of apraxia. Several workers (NATHAN, 1947; DENNY-BROWN, 1958) felt that they could not be adequately separated, while others (ZANGWILL, 1960; HECAEN, 1968) felt that ideational apraxia was just a more severe form of ideomotor apraxia. HECAEN (1968) posited that, in the most severe cases of apraxia, ideational apraxia was superimposed on ideomotor apraxia not because the movements required with objects were more complex, but because the defect was so profound that even the presence and manipulation of concrete objects no longer had a facilitating influence on the movements.

Another group of researchers, notably Morlaas (in BROWN, 1972, p. 163), chose to dispense with Liepmann's explanation; they viewed apraxia as a specific manifestation of a general gnostic disturbance involving the space around the body. Based on the observed inability of the ideational apraxic to use objects within the body space Morlaas suggested that the disturbance was one of agnosia of utilization. Although the patient would identify the object and describe its use, he was unable to utilize the object upon command. That some form of spatial agnosia was present was supported in the observation that, as in ideomotor apraxia, spatial disabilities such as right-left disorientation were sometimes evident.

Others (DE RENZI, FAGLIONI and SPINNLER, 1968; BROWN, 1972) have likened the disorder in ideational apraxia to that present in aphasia. Indeed, in many cases, ideational apraxia occurred in conjunction with aphasic disorders. Ideational apraxia was viewed as a disturbance in concept formation, linked with the aphasias. The disruption of organization of the act, the appearance of partial movements at the wrong time in the movement sequence, substitutions into conceptually or morphologically related actions, and the inability to evoke a movement when it is needed, are all reminiscent of the defects which pervade in aphasia. They suggested that this may be considered a fluent type of apraxia similar to fluent aphasia: there are an abundance of partial movements, each normal in itself, which, although disorganized, have an ease and effortless quality often seen in the speech of the jargon aphasic.

Taken together these views suggest that there may be two disorders present in ideational apraxia. The first would seem to be an amnesia for the proper movement sequences involved in performing a particular gesture or action. When asked to perform a particular gesture (e.g. salute) or demonstrate how to use a particular object (e.g. a razor), the patient is usually unable to do so properly; however, unlike the ideomotor apraxic who quite often cannot even begin, he performs some action even though it usually is not appropriate. It is important to note, further, that this amnesic property pertains only to the conscious voluntary control of the action sequence, i.e., when asked to perform during a clinical examination. Under the appropriate circumstances, for example, making the sign of the cross in church, this apraxic is quite able to perform the gesture properly. This would suggest that the apractic disorder would affect most recently acquired action most markedly which it, in fact, does (DE AJURIAGUERRA and TISSOT, 1969). Further, it would imply that the patient would have great difficulty in learning any new skill. This, as yet, has not been investigated.

A second disorder which seems apparent in ideational apraxia is a spatial dyskinesia similar to that suggested to be present in ideomotor apraxia. This is apparent in that gestures around the body are difficult for the patient. Moreover, however, since a model provided by the examiner does not facilitate performance, as in ideomotor apraxia, this spatial dyskinesia might be considered more severe than in ideomotor apraxia.

The brain damage attendant in ideational apraxia involves basically the same areas as in ideomotor apraxia except that the damage tends to be more extensive and more posterior. It tends to be bilateral involving the majority of the parietal lobe and very often extending into the occipital and temporal lobes.

Constructional Apraxia

KLEIST (1934) first described this form of apraxia. It appears to represent a disorder specific to movements under visual control, particularly affecting the spatial components of a task. Constructional apraxia becomes particularly apparent in all constructive tasks (e.g. drawing, block design) which involve the representation of objective space. In drawing tasks perspective disappears and is replaced by inaccurate projection of planes on the drawing akin to that observed in the child. The patient is unable to articulate the parts of even a slightly complex figure (e.g. a two dimensional drawing of a house). The most severely affected patients are not even able to draw simple geometric figures such as circles, squares and crosses.

This syndrome was first described as a result of damage to the left cerebral hemisphere but later work by PATERSON and ZANGWILL (1944) and PIERCY (1964) showed that it also occurred following damage to the right hemisphere. Much work has subsequently been carried out to determine the nature of the disorder both quantitatively and qualitatively, with reference to the particular hemisphere in which the lesion resided.

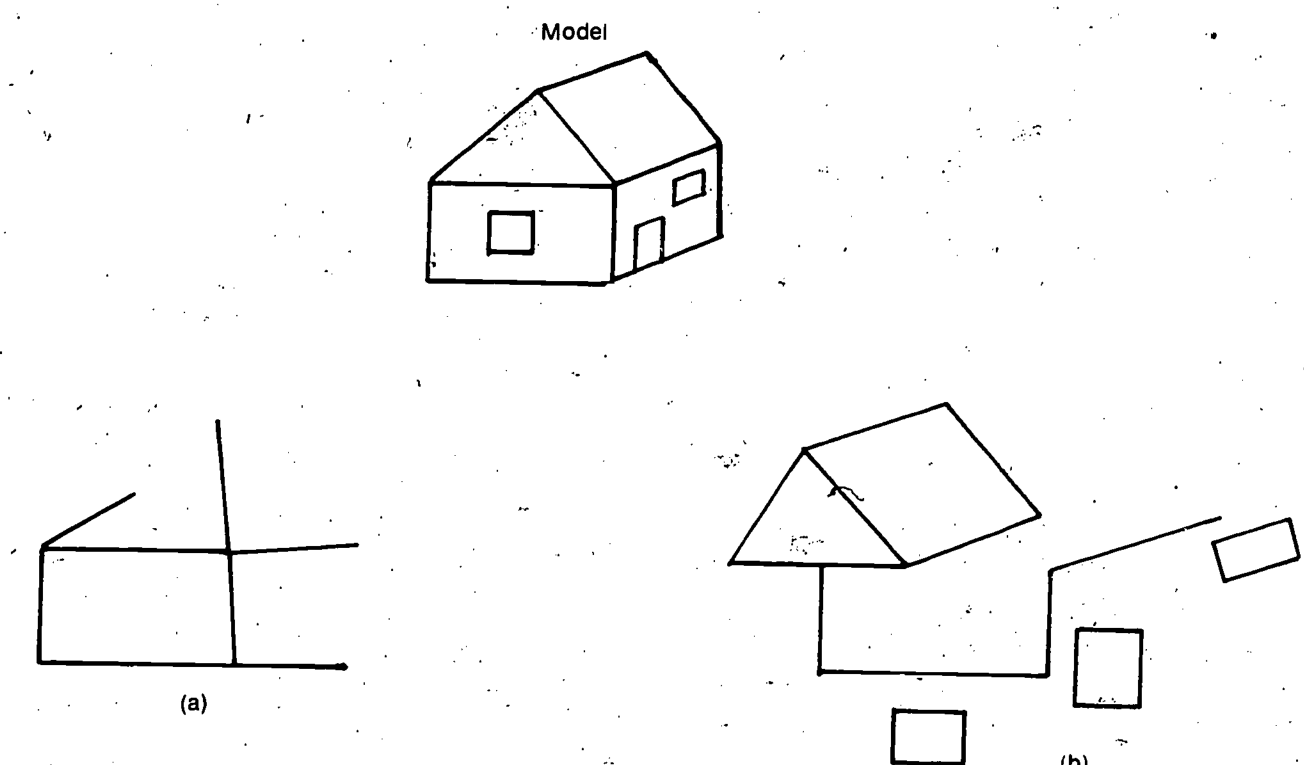
From a quantitative standpoint, there has been much controversy over whether the syndrome was more severe in the left or in the right hemisphere. Early work (e.g. PATERSON and ZANGWILL, 1944; PIERCY, 1964; PIERCY, HECAEN and DE AJURIAGUERRA, 1960) suggested that damage to the right hemisphere produced more severe symptoms. Work by BENTON (1962) and later by ARRIGONI and DE RENZI (1964) criticized these early investigations since they were based on purely qualitative, clinical observations. They proposed the use of graded tests using precise scoring procedures in which the apraxics could be distinguished from the non-apraxics by setting a cut-off point at a score exceeded by only a certain percentage of the control group, usually 5%. Tests such as the Benton visual retention test were graded on a scale of 0 (least errors), 1, 2 (most errors) according to such criteria as the number of improperly formed angles, the number of missing lines and the degree of spatial disorientation relative to the model. Further, ARRIGONI and DE RENZI (1964) stressed controlling for the severity of brain damage because it is possible that right hemisphere patients might have more progressed damage than those with left hemisphere damage due to the longer period before diagnosis. Associated aphasic symptoms, which quite readily bring left hemispheric patients for treatment, are usually not present in right-sided cases. Arigoni and De Renzi, thus, introduced a reaction time measure as a possible way of estimating the degree of impairment of the central nervous system. Previous work by BENTON and JOYNT (1959) had shown that reaction time was raised in brain-damaged patients.

Using these quantitative measures for determining both severity of apraxia and severity of brain damage, Arigoni and De Renzi compared three groups of subjects, right-hemisphere cases, left-hemisphere cases, and controls on a number of constructional tasks. They found that when the right- and left-hemisphere groups were equated for severity of damage (i.e., reaction time), the difference in incidence and severity of constructional apraxia was no longer obtained. On the basis of these data, they went on to suggest that the earlier reports of more frequent and severe constructional apraxia in the right hemisphere were artifacts due to poor control for differing size of lesion between the two hemispheres.

WARRINGTON, JAMES and KINSBOURNE (1966) also used a quantitative method for measuring performance in drawing tasks. Patients, selected by the presence of unilateral cerebral hemisphere disease, were each given a series of drawing tests which were subsequently rated on a scale from 1 (very bad) to 4 (satisfactory) by independent judges. Their findings concurred with those of ARIGONI and DE RENZI (1964) in that no hemispheric differences in terms of frequency or severity of dysfunction were observed.

Although there appear to be no quantitative hemispheric differences in constructional apraxia, there are discernible differences both in terms of quality of drawing and associated symptoms. One of the most complete accounts of the qualitative differences is provided by McFIE and ZANGWILL (1960). They described the drawings of right-hemisphere patients as being scattered and fragmented showing a loss of spatial relations along with faulty orientation, while left-sided cases showed spatially coherent but simplified versions of the model, poor in outline and lacking in detail. An example of this difference is provided in Figure 1. The right-sided lesions (Figure 1b) show good detail but it is as if the model had exploded; the left-sided cases (Figure 1a), on the other hand, represent the spatial reactions and orientation well, but it is very over-simplified. McFie and Zangwill further noted that the right-sided cases drew energetically often adding more strokes in an effort to make the picture correct, while the left-side cases drew very slowly, putting the few parts in with apparent difficulty.

Figure 1 – Disordered Drawings in Constructional Apraxia.



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Work by PIERCY *et al.* (1960) and ARIGONI and DE RENZI (1964) supported the differences observed by McFie and Zangwill. Further, however, PIERCY *et al.* (1960) found that providing a model as opposed to spontaneous (from memory) drawing enabled more accurate reproduction only in the cases involving left-hemisphere damage. This suggests, that, following damage to the right hemisphere, the left hemisphere is unable to compensate for the disorientation caused by right-hemisphere damage: the drawing looks just as "exploded" regardless whether a model is provided. On the other hand, the right hemisphere appears able to assume some of the analysis function normally performed by the left-hemisphere, but lost following damage to it, since providing a model enables a more detailed drawing of the figure, i.e., the oversimplification characteristic of drawings of left-sided cases is much less apparent. These observations imply, then, that the dysfunction produced in constructional apraxia following damage to the right hemisphere is one akin to a perceptual or gnostic disorder, while that following left hemisphere damage appears more related to a disorder in execution resulting from an inability to correctly analyze and subsequently draw the constituent parts of the figure. This implication is partially supported by WARRINGTON *et al.* (1966) who suggested that the cases involving left-side damage were less able to analyze the model in terms of its constituent parts. These patients although able to occasionally draw acceptable copies, did so by slavishly reproducing the various lines without logical sequence. These observations are reminiscent of those of McFIE and ZANGWILL (1960) alluded to above who stressed the large degree of effort expended by left-hemispheric patients in their drawings.

The second aspect of the qualitative differences between the hemispheres relates to the associated disabilities. Before dealing with these, however, a word of caution must be made regarding the interpretation of these results. Since cortical lesions are usually widespread it is important to distinguish between associated and multiple disorders. An association may be more apparent than real. Just because one deficit coincides with another does not necessarily imply that they both represent a disturbance of the same underlying functions. In this regard, PIERCY and SMYTH (1962) have argued that if one is to clearly associate a deficit with constructional apraxia due to damage in, for example, the right hemisphere, it is necessary to show that these defects distinguish not only between right- and left-hemisphere apraxics but also between apraxics and non-apraxics within the right hemisphere. In general, none of the research to date has met these criteria completely although some authors (PIERCY and SMYTH, 1962; WARRINGTON *et al.*, 1966) have attempted. Nevertheless, the data is still quite interesting.

McFIE and ZANGWILL (1960) have stressed that there is a difference between the right- and left-sided cases in terms of the associated disorders. Unilateral neglect, dressing apraxia and poor topographical memory (e.g., poor route finding ability) were closely associated in apractic disorders in right-sided cases, while left-right disorientation of the body was seen primarily in left-sided cases. PIERCY *et al.* (1960) also examined associated deficits and found deficits similar to those reported by McFie and Zangwill; further, however, they found that in their left-sided cases, there was an association between constructional apraxia and other classical forms of apraxia (ideational and ideomotor).

Further work by KIMURA (1963) and WARRINGTON and JANES (1967) using purely perceptual tasks (e.g. visual retention tests) have shown that right-hemispheric patients perform significantly worse than those with left-hemispheric damage. Finally, BENTON (1961), found some evidence of a correlation between the elements of the Gerstmann syndrome (agraphia, acalculia, left/right disorientation, and finger agnosia) and the presence of constructional apraxia although no clear association with hemispheric localization of apraxia was apparent.

Taken together, these data on associated symptoms tend to corroborate the evidence from examination of the drawings of constructional apraxics suggesting that the dysfunction seen in right-hemisphere cases may be indicative of a more general gnostic disturbance involving some spatial neglect, while the left-hemisphere disorder may be a manifestation of a more general apractic disturbance involving disordered executive functioning and/or a general disorientation in space which prevents the spatial synthesis necessary to properly orient in the environment. Evidence provided by DE AJURIAGUERRA, HECAEN and ANGELERGUES (1960) showing that 74% of those with ideational and ideomotor apraxia also manifested constructional apraxia as well as evidence alluded to by LURIA (1966) in reference to the relationship between left-right disorientation and left-sided constructional apraxia lend support to both of these suppositions.

Frontal Apraxia

Mention was made earlier of a kinetic apraxia due to frontal damage (DENNY-BROWN, 1958) in which there is a perseveration of approach tendencies resulting in abnormal grasping reflex activity. Denny-Brown suggested that this apractic disorder was the result of a release of inhibition on the e[illegible]ratory, approach tendencies of the parietal lobe. As s[illegible]n, he and other workers (HECAEN, 1968; DE AJURIAGUERRA and TISSOT, 1969) have suggested that this dyspraxic pathology is not a true apraxia but simply a disequilibrium between two types of motor reactions that are normally in equilibrium.

More detailed analysis of frontal apraxia by LURIA (1966) and other Russian investigators (e.g. FILIPPYSHEVA, 1952, in Luria, 1966, p. 237-240), however, suggests that although the reflex disturbances described by DENNY-BROWN (1958) are present, there is a discernible practic disturbance remarkably similar to that observed in ideational, ideomotor and left-sided constructional apraxia. This disorder is characterized by a marked inability to initiate movement, by perseveration, and by fragmentation of sequential motor act into disorganized, isolated movements. For example, when asked to light a match, the patient would not inhibit the action once it had begun, i.e., he would continue to strike on the match box even if the match was lit. When performing actions consisting of several successive links (e.g. lighting a cigarette with a match), these patients often substituted isolated fragments of movements for the required composite action or combined individual components into a single, undifferentiated act (e.g. they lit a match and immediately put it out or put it in their mouth). Moreover, their disturbance was increased if asked to perform an act that was not as familiar (e.g. lighting a candle) and having some elements similar to a more habitual action (e.g. lighting a cigarette). In these cases, the patient would substitute into the required action elements from the more habitual act (e.g. upon lighting the match he would try to smoke it or "butt it out" in a convenient ash tray). Even if an action was demonstrated in front of him, his performance became no better. The plan of action readily disintegrated and was replaced by isolated, fragmentary acts. These symptoms readily recall those of the ideational and ideomotor apraxic.

Reminiscent of left-sided constructional apraxia are the drawings made by the frontal apraxic which show a great lack of detail although the spatial aspects are preserved. In the most severe cases when asked to draw a figure (e.g. triangle, circle) the patient usually can begin ; however, because of the great tendency to perseverate, he often does not go beyond the first couple of lines. Perseverative movements develop which make it impossible to draw the details of the figure. In less severe cases, although some perseverative activity remains, he is usually able to complete the figure, but with a marked diminution in detail (LURIA, 1966).

Premotor Apraxia

Premotor apraxia develops from damage to the premotor area of the cerebral motor cortex (LURIA, 1966) and represents a disturbance of the kinetic organization of the motor act. Very simple movements involving little sequencing of movements (e.g., touching finger to nose), generally, are not affected, while more complex activity (e.g., lighting a candle and placing it on a table) is more severely disordered. The patient shows a profound tendency to perseverate on one movement in the sequence which prevents him from alternating from one movement to another in a sequence. Related to this is that these patients have great difficulty in terminating an ongoing movement. This is exemplified in that rhythmic tapping becomes almost impossible if changes in rythm are required in a tapping pattern. Further, when asked to draw a pattern such as without lifting the hand from the paper, the patient begins to draw each stroke separately or to develop a simple motor stereotype consisting of the repetition of a single element (LURIA, 1966). These observations suggest that the difficulty is not so much in controlling the flow of differentiated impulses to individual muscles groups, but, rather, in integrating these impulses in time (i.e. sequencing).

Towards a Typology of Limb-related Apraxias

Attempts at defining a typology of apraxia have been made over the past half century. For example, HECAEN (1968) characterized the apraxias in terms of disturbances of particular types of symbolic activity, while DE AJURIAGUERRA and TISSOT (1969) discussed apraxia in terms of the Piagetian concepts relating to the acquisition of space. Few, however, have specifically tried to typify the apraxias in terms of the basic organizational processes thought to be disturbed. Although LIEPMANN (1920), DENNY-BROWN (1958), and LURIA (1966) have all discussed apraxia from this perspective, work remains to be done in order to more clearly understand the organizational disorders underlying apraxia.

In examining the various apraxic syndromes, DE AJURIAGUERRA and TISSOT (1969) could find no clear relationship between area of brain damage and type of disturbance to limb praxis. This led them to state that the symptomatic structure of apraxia may be due more to the mass effect of the lesion than to its strict localization. While this statement may be true, it obscures meaningful interpretation of apraxia in terms of the basic organization processes thought to be disturbed. Rather than taking such an uncritical view, it would seem more to the point to try to analyze these pathological behavioural syndromes discussed above from three perspectives :

1 - in terms of the nature of disturbance of limb praxis,

2 - in terms of the known functions of each of the cortical areas which has incurred damage, and

3 - in terms of the secondary disorders associated with the disturbance of limb praxis.

This type of analysis has been done and is presented in Table 1. It represents a synthesis of the symptomology presented in the previous section.

Table I – A Synopsis of Various Apraxic Syndromes.

Clinical Symptoms	Type of Apraxia					
	Ideational	Ideomotor	Frontal	Premotor	Limb-Kinetic	Kinesthetic
Characteristics of Disordered Limb Praxis						
Perseveration	X	X	X	X		
Improper sequencing	X	X	X	X		
Difficulty in initiating movement		X	X			
Difficulty in terminating movement			X	X		
Disturbance in individual movements in sequence					X	X
No improvement with object use	X					
No improvement with imitation	X					
Decreased accuracy in reproducing limb positions						X
Associated Symptoms						
Spatial disorientation	X	X				
Difficulty in intellectual planning			X			
Loss of strength					X	
Loss of kinesthetic sensation						X
Area of Brain Damage						
Parietal	X	X				
Occipital	X	X				
Temporal	X	X				
Frontal			X			
Precentral Motor					X	
Postcentral Motor						X
Premotor				X		

In examining the characteristics of disordered limb praxis in Table I it is apparent that there are two discernible patterns of disordered limb praxis:

1 – an inability to properly sequence movement involving, to some extent, perseveration on a particular component within the movement sequence (ideational, ideomotor, premotor and frontal apraxia) and .

2 – an inability to perform the components of a movement sequence with smooth muscular contractions while not affecting the sequences of the movement components (limb-kinetic and kinesthetic apraxia).

These observations suggest that the first pattern may represent either a disorder in planning or a disorder in executing a previously planned sequence of movements, while the latter seems to involve an inability to execute the individual components of a sequence of movements.

In examining the first pattern it is important to determine whether one can differentiate between an inability to plan and an inability to execute a planned sequence of movements. If one looks at the secondary symptoms and the area of brain damage associated with each apraxia, some information pertinent to this differentiation becomes apparent. First, there are three areas of brain damage involved: frontal, parietal-occipital and premotor. The first two of these areas have been implicated as important in planning while the latter area serves more of an executive function (LURIA, 1966). Thus, possibly all those apraxias associated with damage to either the frontal or parietal-occipital areas (i.e., ideational, ideomotor, constructional and frontal apraxia) may have, as an underlying disorder a disturbance in planning, while those associated with damage to the premotor area (i.e. premotor apraxia) may possess an underlying executive dysfunction. In support of this suggestion, it is known that the frontal lobes are primarily involved in planning motor activity, while the parietal lobes and the bordering parietal-occipital areas are concerned with orientation in space. Further, the frontal areas function in planning and initiating movement is based on information received from among many other areas, the parietal-occipital area. Consequently, due to the interdependence of these two cerebral areas, damage to either area could conceivably result in a disorder in planning a motor action. On the other hand, ECCLÈS (1967) and more recently ALLEN and TSUKAHARA (1974) suggest that the premotor and motor areas serve primarily an executive function with little role in planning movement. In this typology (Table II) then, frontal, ideational, ideomotor and constructional apraxia are all classified as planning apraxia, while premotor apraxia is depicted as executive apraxia.

Table II - A Proposed Typology of Apraxia.

A. Planning Apraxia
   1. Primary (Frontal Apraxia)
   2. Secondary (Ideomotor, Ideational and Constructional Apraxia)
B. Executive Apraxia (Premotor Apraxia)
C. Unit Apraxia (Kinesthetic Apraxia and Limb-Kinetic Apraxia)

Planning Apraxia

Planning apraxia is seen to have two components: primary and secondary. This differentiation is based on examining the associated secondary symptoms. The primary component, which becomes evident following damage to the frontal lobe, is seen to represent a true disorder in planning and initiating movement. Patients having this damage typically display an inability to perform sequential motor or intellectual activity without concomittant spatial disorientation observed as a result of parietal damage suggesting that the planning per se has been disturbed.

The second component of planning apraxia finds its origin in parietal-occipital damage. While damage to this area undoubtedly precipitates a disturbance in planning, the disturbance in this case is not seen as a true or primary planning apraxia since a concomittant disorder in planning non-motor activity, present as a result of frontal damage, is not evident (see Table I). Although the planning of action is definitely disturbed, the source of this disorder does not lie in an inability to plan per se; rather, because of damage to the parietal-occipital regions the spatial information sent to the area (frontal) responsible for planning is disordered resulting in the inability to properly plan motor behaviour. Thus the planning disorder is viewed as secondary to and a necessary result of a disturbance in spatial orientation and, as such, has been classified as secondary planning apraxia.

In terms of other typologies secondary planning apraxia is seen to represent LIEPMANN's (1920) ideational and ideomotor apraxia and KLEIST's (1934) constructional apraxia all of which can be attributed to a disorder in spatial abilities or spatial dyskinesia as MORLAAS (1928, in DE AJURIAGUERRA and TISSOT, 1969 p. 48) called it. Ideational and ideomotor apraxia are here viewed as a common disorder resulting from a common origin. To this observer, the only means for differentiating them is in terms of degree of impairment. Ideational apraxia represents a more severe case of ideomotor apraxia in which there is impaired praxis to not only command, as in ideomotor apraxia, but also to imitation and, ultimately, to object use (see Table 1). This common classification of these practic disturbances originally thought by Liepmann to be distinguishable is in accord with other current suggestions (ZANGWILL, 1960; DENNY-BROWN, 1958; HECAEN, 1968; DE RENZI *et al.*, 1968).

With reference to constructional apraxia although the qualitative aspects of this apraxia have been seen to be different depending whether the damage is right-sided (spatial disorientation in reproduction) or left-sided (exaggerated simplicity), the disturbance is attributed to a common etiology: disordered spatial abilities in accord with LHERMITTE (1933). When the damage is left-sided the ability to analyze the model appears disturbed. It is suggested that this results in insufficient detail in the reproduction since the information available to the areas responsible for planning (frontal) and executing (motor and premotor) is inadequate. When the damage is right-sided, on the other hand, the ability to analyze the model is not disturbed (if anything, this process seems exaggerated since the patient has a profusion of detail). Rather, the ability to orient the movements into a coherent spatial pattern is faulty. This disturbance results in spatially disorganized, almost exploded, reproduction since the spatial information within which the areas responsible for planning organize the motor output is in gross disarray. Support for the suggestion that a common disorder may underly ideational, ideomotor and constructional apraxia comes from the observation that 74% of those exhibiting constructional apraxia also showed symptoms of ideational and ideomotor apraxia (DE AJURIAGUERRA, HECAEN and ANGELERGUES, 1960).

Executive Apraxia

The second major classification in this scheme is termed executive apraxia (Figure 2). Originally, Liepmann viewed ideomotor apraxia as a disorder in execution, however, subsequent work (see DE AJURIAGUERRA and TISSOT, 1969) showed that it was difficult to distinguish ideomotor apraxia from disturbances in planning (ideational apraxia) which, necessarily, exhibited disordered sequencing but only as a feature secondary to the primary disorder in planning. Although attempts at classifying ideomotor apraxia as a pure disorder in execution had failed, ablations in the premotor region seemed to hold more promise in this regard (see section on premotor apraxia). Since neither the frontal area, responsible for planning motor activity, nor any of the sensory areas (e.g. parietal-occipital regions) supplying information to the frontal area were damaged and, further, since no associated spatial deficits nor associated deficits in intellectual non-motor planning were apparent (Table I), it appeared that execution per se might be at fault.

That execution per se may be disturbed receives support from two other sources: work on stimulation of the premotor cortex and observation of apraxic performance of habitual skills in the proper contextual environment. Work by Penfield (PENFIELD and RASMUSSEN, 1950), among others, has shown that the pre-motor area subserves, not single isolated movements as in the motor cortex, but sequences of movements. For instance, experiments by FULTON (1935) and WYSS and OBRADOR (1937) showed that stimulation of a particular part of the premotor region leads, after a long latency period, to the appearance of complex, integrated movements including rotation of the eyes, head, and whole trunk, followed by movement of the upper limb resembling a grasping action. Damage to the premotor area would, thus, seem to disturb the natural ability to execute a smooth, sequential movement pattern.

Evidence related to the performance of habitual skills provides even more compelling support for the notion that premotor damage leads to an executive rather than a planning disorder. Since habitual skills are highly overlearned, it follows that the commands for and, hence, the execution of these habitual actions may be preprogrammed. Further, evidence provided by ALLEN and TSUKAHARA (1974) suggests that preprogramming may involve the premotor cortex in conjunction with the nuclei of the cerebellum. If this is so, habitual skills would seem to require very little planning since they are highly automated action patterns. One could predict from the above that only when damage to the preprogramming areas (i.e. premotor area) is incurred should these habitual skills become difficult to perform under all circumstances. This prediction is confirmed upon examining the differing abilities of frontal and parietal-occipital patients versus premotor patients in the performance of habitual skills in a related context.

Following damage to the frontal area or to the parietal-occipital area, patients are usually able to carry out habitual skills (e.g. making the sign of the cross) in the proper context (e.g. in a church) but rarely when requested during a clinical examination. Upon damage to the premotor area, however, patients are unable to perform habitual skills even given the proper context (LURIA, 1966). Since frontal and/or parietal-occipital damage does not involve the premotor area largely responsible for preprogramming motor activity, it is quite feasible that given the proper context, patients incurring this insult should be able to perform habitual skills. On the other hand, it seems equally probable that damage to the premotor area itself should result in the marked disturbance of habitual skills even given the proper context since the area responsible for their programmed execution has been incapacitated. Even though the planning of behaviour is not directly affected, these premotor patients remain unable to act out coherent movement sequences because of damage to the executory apparatus.

Unit Apraxia

The final classification, termed unit apraxia, is seen to represent disordered execution of individual movements within a sequence independent of the planning and execution of the movement sequence. That this syndrome differs from that involving premotor (executive apraxia), and frontal-parietal-occipital damage (planning apraxia) is evident from Table I. First, damage in areas other than the pre- and postcentral motor areas results in disordered sequencing of movement while leaving the individual components of the sequence intact, while damage in motor cortex precipitates poor execution of individual movements sparing the sequencing of those movements. Secondly, the pattern of associated secondary symptoms is different. Damage to the motor cortex results in either loss of strength (damage to precentral motor cortex) or loss of kinesthetic sense with a concomittant inability to duplicate limb positions (damage to postcentral motor cortex) but does not include the symptoms of impaired spatial orientation, impaired intellectual planning, or perseveration evident in damage to the other areas.

Unit apraxia is seen to arise from damage to one of two areas of the motor cortex: precentral and postcentral. Damage to the precentral motor cortex resulting in what LIEPMANN (1920) called limb-kinetic apraxia involves an inability to carry out isolated movements since the cortical representation through the pyramidal tract is lost. Damage to the postcentral motor cortex, on the other hand, resulting in what LURIA (1966) called kinesthetic apraxia involves essentially the same disorder evident following precentral damage although for apparently different reasons. In this case, kinesthetic information necessary for the smooth control of movement is lost resulting in jerky, halting movements (LURIA, 1966).

DISCUSSION

An attempt has been made here to provide a more concise, less ambiguous means of classifying the limb-related apraxias in terms of the basic organizational processes thought to be disturbed. The system in which the apraxias are classified purely in terms of the disturbances to limb praxis has been augmented to include information about the known functions of the brain-damaged areas as well as the symptoms associated with disturbance in practic behaviour. While the former approach has tended to lead to confusion due to the subjective nature of purely clinical observation, the latter approach tends to be more objective, enabling a more concise and precise classification. For example, ideational and ideomotor apraxia, previously seen as different based on clinical observations, have been classified as gradations of basically the same disorder since they both are subserved by essentially the same brain damage and show similar associated spatial disorders. Alternately, ideomotor and premotor apraxia might be considered to represent the same disorder (i.e. executive disorder) since they both exhibit the same clinically observable pathology. However, when one considers the site of the brain lesion in each disorder and the associated symptoms it becomes apparant that the components of the pathology are not the same. Ideomotor apraxia, although demonstrating disordered sequencing similar to that in premotor apraxia is seen to be a disorder in planning, while premotor apraxia is seen to be a more or less pure disturbance of execution.

Implications of This Typology for the Study of Apraxia

What value is the typology in the study and/or treatment of apraxia? This typology should provide a starting point for a more detailed analysis of apraxia since a more objective method of classification has been used. By knowing the relationships between type of brain damage and type of underlying disorders, work on more clearly identifying the practic disorder can be made. For example, one may reasonably look for characteristics of disturbances in planning of movement following damage to the frontal or parietal-occipital areas while attempting to identify signs of disturbance in execution of movement upon damage to the premotor area. This approach can be greatly facilitated by the use of modern cinematographic and improved electromyographic recording techniques (see LETTS, WINTER and QUANBURY, 1975 for an interesting example).

In terms of the treatment for apraxia, this typology may aid in both the diagnosis and subsequent remediation of the apraxic syndrome. In the past there were so many types of apraxia identified that it was often difficult to diagnose exactly what type the patient had let alone attempting to ameliorate his condition. Using this typology, the clinician can gather evidence not only concerning the pattern of disturbance to limb praxis but also concerning area of brain damage and associated secondary symptoms. A much less ambiguous means for classifying the patient, then, becomes available. Further, once the patient has been properly classified ways and means of improving his condition quickly suggest themselves, thus, also facilitating the treatment process. For example, a patient displaying improper sequencing of movement in conjunction with both frontal lobe damage and poor intellectual planning as evidenced by one of several standardized IQ tests would be classified as a planning apraxic. Since his problem is one of a disorder in planning, remediation should involve helping him to relearn the process of planning. A good example of this is provided in a paper by LURIA and TSVETKOVA (1964).

In examining their patient, he appeared to have a great deal of difficulty planning the correct sequence of activities so as to construct a block pattern (Koh's blocks) similar to a presented model. They hypothesized that if the problem was one of planning, providing the patient with a sequence of instructions describing how to proceed would enable him to perform the construction task. A series of verbal instructions were developed involving the following commands: find the necessary number of blocks, count how many squares in the row, arrange the blocks as needed to the same number, compare your own row with the row given in the pattern (LURIA and TSVETKOVA, 1964, p. 100). These same commands were provided for each row of the design. Luria found, as predicted, that this immensely helped his patient. In fact, after some practice with this system, the patient applied it to more complex block design which he eventually completed, a feat not ever previously accomplished.

Although this typology potentially can have important implications for the study and treatment of apraxia, much work remains to be done to corroborate its validity. Other patients must be examined to determine if they display a pattern of symptoms similar to those displayed by the reported cases used to develop this typology.

This typology not only has implications for the study of apraxia but also has clear implications for models depicting the organization of motor skill. These will be considered in detail in the following section.

Implications of Typology for Models of Motor Skill Organization

A model for the organization of motor behaviour may be developed from two distinct sources: from studies on the acquisition of motor skill and from studies on the desintegration of motor behaviour following brain trauma. Both of these approaches provide clues as to how motor activity is organized in the skilled individual. Acquisition data provide evidence as to how a particular skill is integrated into a coherent pattern of goal-directed movements. Such data traditionally have formed the sole basis on which models of skill performance have been developed. Data on the pathology of motor patterning following brain injury, however, have profound implications for such models. Indeed, any comprehensive model of the organization of motor skill must take into account both types of data.

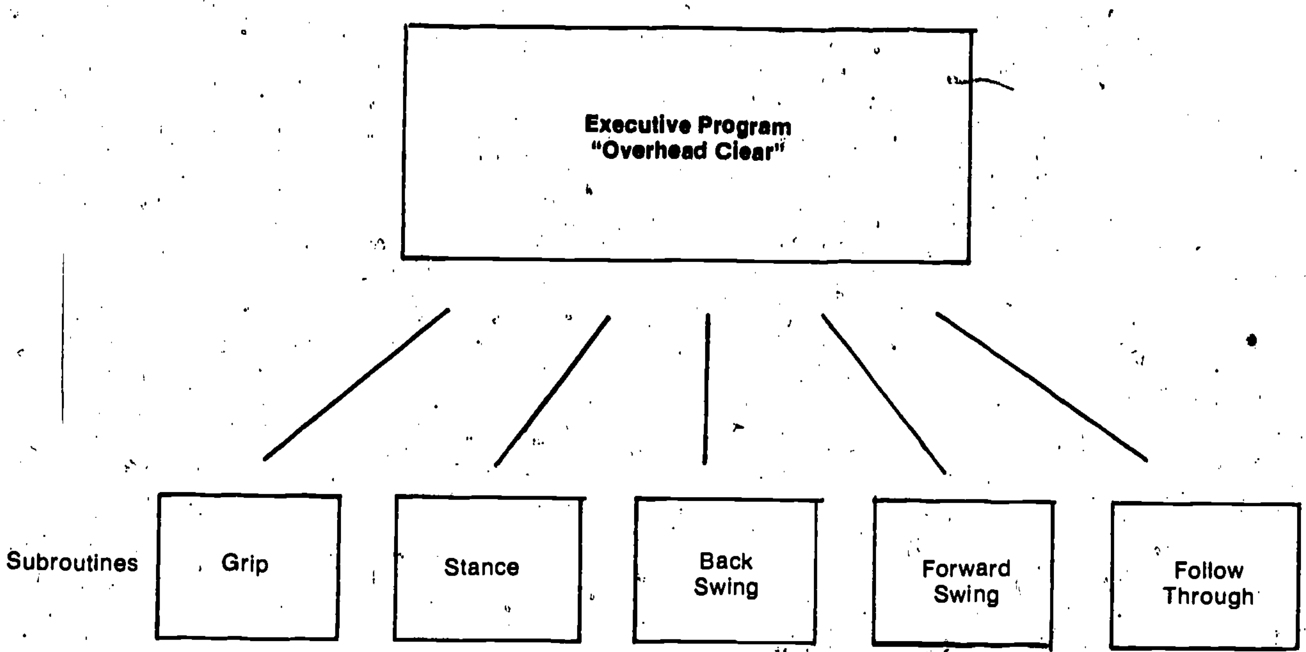
Implication for Heirarchical Organization

Recently, models derived from work in the area of skill acquisition (e.g. Marteniuk, 1972) portray an hierarchical organization from the overall plan of action to the specific subroutines involved in a single movement sequence.

The overall plan directs the motor act in a wholistic fashion in that it sets the goal of the movement sequence and initiates the activation of the various subroutines. These subroutines have, under their command, programs which involve the varied action sequences which go into executing the act. At an even lower level of the heirarchy are the individual movements within the action sequence.

In observing the patterns of pathology exhibited in these forms of apraxia one can readily see the analogy to an heirarchical model. At the summit of the heirarchy is the plan or schema (PEW, 1974; SCHMIDT, 1975) by which behaviour is directed. An inability to select the appropriate plan of

Figure 2 - The Hierarchical Organization of Skill.



Adapted from Marteniuk, R. G. *Journal of the CAHPER*, 38, March/April Supplement.

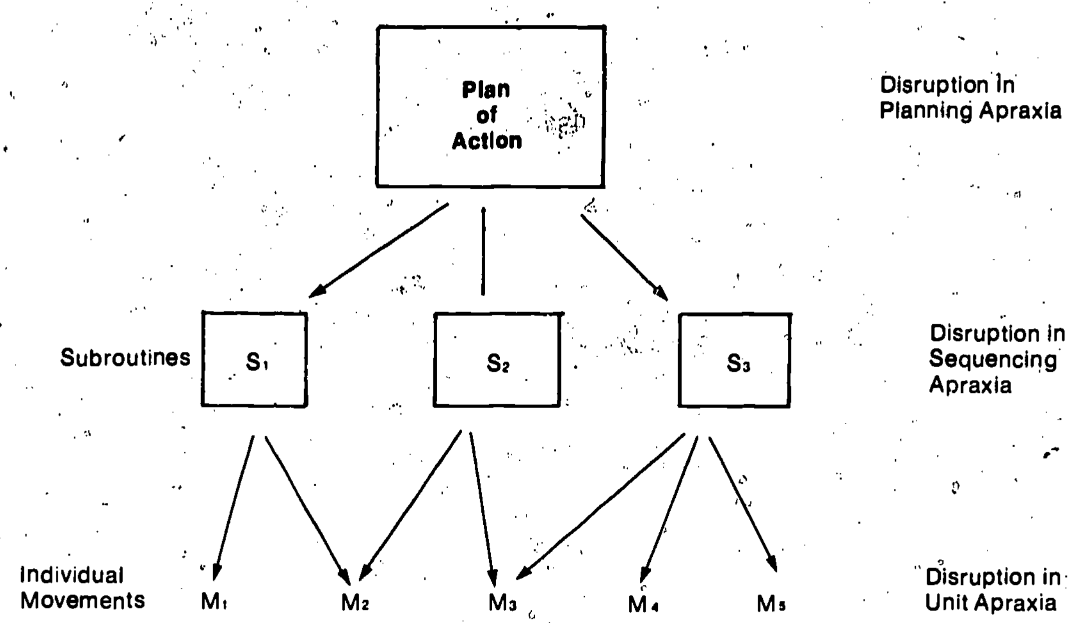
action would result in the improper sequencing of the constituent movements while not necessarily affecting the individual motor components (Figure 3). Just this situation is observed in planning apraxia where the behavioural pathology centres around an inability to effect a plan of action.

At a somewhat lower level in the heirarchy are the various sequences involved in the execution of the plan. Here there might occur a derangement independent of either the plan or the individual motor components comprising the particular sequence (Figure 3). That is selecting the correct plan so as to organize the action is in tact but the sequential ordering of the behaviour is lacking. The disordered behaviour exhibited in executive apraxia reflects this situation well in that only the sequential ordering of the action is affected.

Finally, the lowest level in the heirarchy is occupied by isolated movements which comprise the sequential patterns. Pathology in these individual actions independent of the higher levels in the heirarchy is characterized in unit apraxia (Figure 3).

Thus it is apparent that the behavioural pathology characterized by these apraxias does suggest an heirarchical organization of motor activity. Planning apraxia represents a dissolution of the plan, the highest level in the heirarchy, while executive and unit apraxia characterizes the behavioural consequences of disrupting progressively lower levels in the heirarchy. Evidence from the disintegration of behaviour in apraxia, then, can be added to the evidence from skill acquisition in support of an heirarchical model for the organization of motor behaviour.

Figure 3 - Hierarchical Levels of Apraxic Disturbance.



Implications for Sensory and Motor Integration

While several models derived from skill acquisition depict an heirarchical organization of motor skill, others stress the role of sensory and motor integration (e.g. HOWARD and TEMPLETON, 1966; CONNOLLY and JONES, 1970). Integration of visual with other sensory information is seen as important for the orienting of the body within some spatial framework prior to the execution of the act. Moreover, the integration of the visual-spatial coordinates with information from motor output is considered important in the accurate completion of visually based motor tasks. Support for these notions may also be gained from examination of yet another form of apraxia termed constructional apraxia. This condition is characterized by the inability to reproduce a visual model (WARRINGTON, 1969) no matter what activity is involved in the reproduction (e.g. drawing, block design; three dimensional construction tasks).

An examination of the drawings seen in Figure 1 provides interesting clues as to the etiologies of the deficit. While these apraxics have adequate hand fine-motor control, normal skill in visual recognition and visual memory, and I.Q.'s within the normal range, their major difficulty appears to lie in their inability to integrate all of the available information. This difficulty has two distinct yet related aspects. In some cases there is an inability to translate the visual analysis of the model to be drawn into appropriate motor patterns, while for others this analysis-translation process appears in tact but they lack the ability to organize the motor output into a coherent visual-spatial pattern. Both cases reflect basically a dysfunction in integration.

In the first case (Figure 1a) which is associated more with injury to the dominant left cerebral hemisphere, there appears to be a disruption in integrating the visual features of the model into fine motor output so as to duplicate the model. In the second case associated with right hemisphere damage the above type of visual-motor integration appears in tact; that is, the copy does not lack in detail. Rather, the patient appears unable to integrate the motor output into a coherent spatial framework (DE RENZI and FAGLIONI, 1967). Data from these patients, then, corroborates that from normal subjects during skill acquisition suggesting the need for models of motor performance to relegate an important role to sensory-motor integration.

DISCUSSION

The behaviour exhibited by patients with apraxia provides strong corroborative evidence for the notion of an heirarchical organization of skill with a paramount role in the heirarchy played by sensory and motor integration. Planning and executive apraxia can be viewed as a dysfunction in the planning and sequencing of motor patterns and suggest clearly that the top of the heirarchy is occupied by a "plan of action". Constructional apraxia, moreover, suggests that this "plan of action" is a complex integration of information from several senrory channels in conjunction with a motor program for outputting the plan. These considerations might suggest a model of motor performance like the one depicted in Figure 4.

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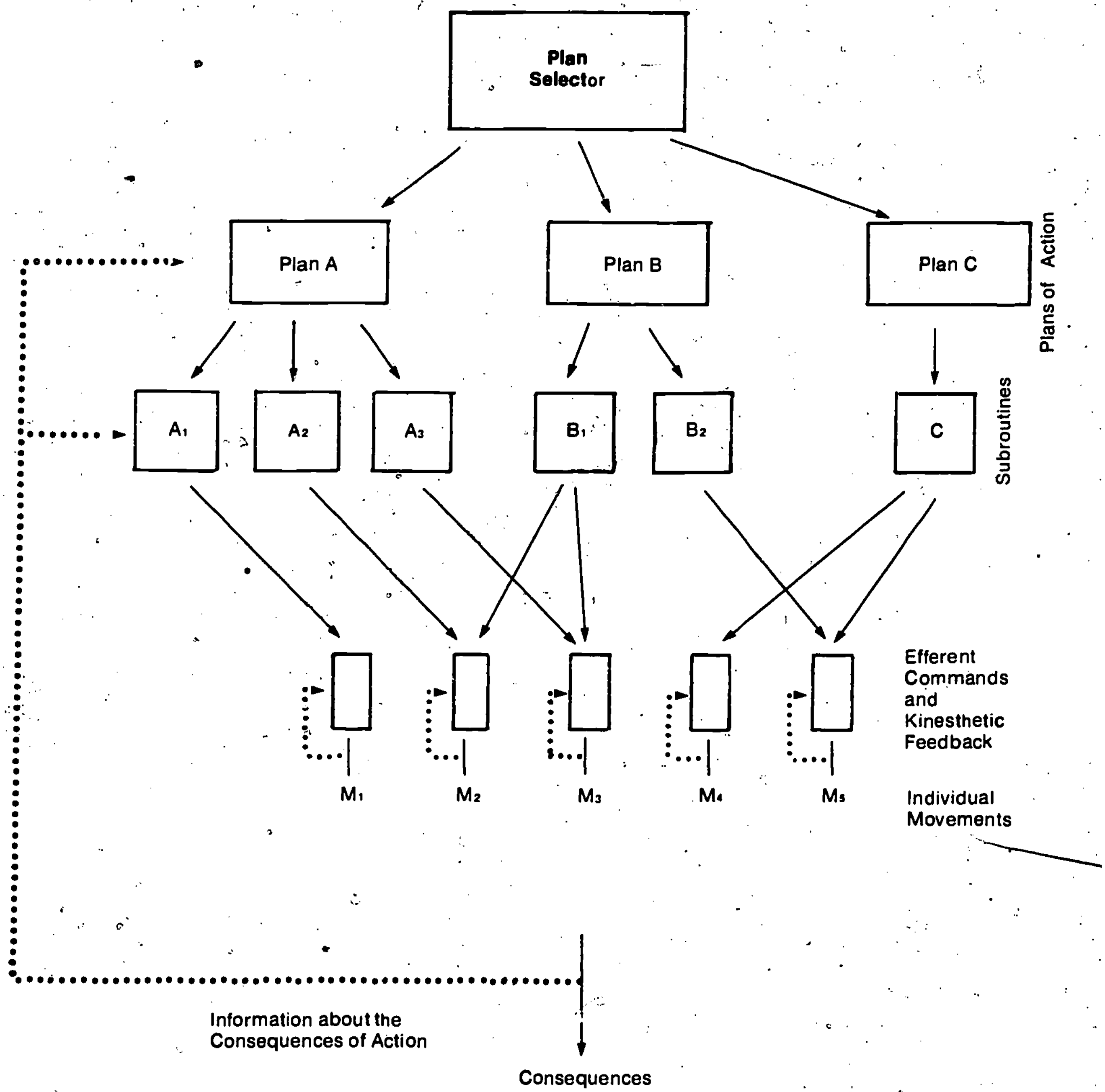
Figure 4 - A Proposed Model for the Organization of Motor Skill.



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At the summit is a plan selector or executor which selects the correct plan of action. It is suggested that this executor is employed primarily in situations when a decision must be made concerning the most appropriate plan to be put into action. When the context suggests the correct plan of action, this level in the heirarchy may be bypassed. For example, it has long been observed that in the apraxic state that some movement sequences may be more successfully carried out in an appropriate situation or context than when requested for arbitrarily during an examination. The patient with secondary planning apraxia, especially the ideational type, as an example, may be quite able to light up a cigarette following force of habit as when having coffee after dinner, but be completely unable to initiate the appropriate movement sequence, upon demand in an unfamiliar context. This suggests that the plan of action for lighting up is not disrupted per se. Rather, it would appear that the patient cannot select in an unfamiliar context the one plan of all those possible all of which involve thumb and finger grasp, striking movements, lifting the hand upwards, etc., which lead to successful completion of the act in question.

Lower in the heirarchy are the plans of action themselves each involving particular subroutines of movement sequences. These plans of action are seen to be affected in two forms of apraxia but in discernibly different ways. In primary planning apraxia the area responsible for planning is itself damaged indicating that the plan of action per se is disturbed. In executive apraxia, however, the plan per se is not disturbed but the ability to carry out the sequences within the plan are affected. This distinction is partially confirmed by the observation that in executive apraxia only complex integrated movements are severely affected, while in primary planning apraxia all movement, regardless of complexity, is disturbed. Although the distinction between these two apraxic syndromes is not entirely clear except in very simple movement, there nevertheless appears to be a disturbance in planning or in executing a planned action.

The model portrays three plans decreasing in degree of complexity from A which involves three subroutines incorporating several movement sequences to C which involves only one subroutine. Such a differentiation in terms of movement sequencing complexity is indicated from the observation that the less the complexity of the task (e.g. touch the nose versus light a candle) the less secondary planning and executive pathology observed following brain trauma. Since the trauma causing secondary planning and executive apraxia involves primarily corticular damage, these less complex actions, which are not as subject to apraxic disorder, might be under relatively subcorticular control requiring very little decision (capacity) on the part of the performer. That is, these less complex actions may be fairly automated thus sparing them from apraxic disturbance. Indeed, secondary planning and executive apraxia obey the Jacksonian principle that the greater the voluntary nature of and the less automatic the act, the more will it be disrupted following brain trauma (JACKSON, 1958).

The disorder exhibited by the executive apraxic provides additional suggestions as to the form of the heirarchical model. While the secondary planning apraxic could not select the correct plan of action without the appropriate context, the executive apraxic in the same unfamiliar context may be able to select the appropriate plan but is unable to carry out the initial movement sequence or may carry out the individual movements in a completely inappropriate sequence. The executive apraxic may be unable to carry out a coherent movement sequence because, due to damage to the premotor area, the ordering of the various subroutines has been disturbed. This raises the interesting possibility that order or sequencing is not an integral part of the subroutines. Rather it suggests that the order in terms of what subroutine follows another depends to a large extent on feedback. The word feedback at this stage in the heirarchy does not imply feedback in the usual sense of the word (i.e. kinesthetic feedback) but instead feedback in the sense of both the contextual cues within which the motor action occurs and the information about the consequences of executing each subroutine (e.g. striking the match and seeing it light up). As learning progresses these feedback cues may become incorporated into the program suggesting that, when fully automated, an action pattern involves both the specific subroutines and the order in which they are to occur.

Finally, the lowest level of the heirarchy is comprised of the individual movements which comprise the actions sequences in each subroutine. These individual movements form a pool from which each plan of action draws. For example, the plan involved in lighting a cigarette and in brushing one's teeth while incorporating similar individual movements clearly involve a different sequencing of those movements to attain the desired goal. Thus it is quite conceivable to observe, as in the motor apraxic, a selective disruption of only these movements themselves leaving unaffected the selection and competent execution of the appropriate plan of action.

It is suggested that the integrity of these movements at this stage may depend not only on the presence of relevant recurrent kinesthetic feedback, but also, and perhaps more importantly, on copies of the efferent commands to the individual muscles concerned. Indeed, since unit apraxia often follows very specific trauma to the primary motor areas of the cortex (DENNY-BROWN, 1958) a large part of the pathology here may be due to a disruption in the efferent copy.

In conclusion, it is obvious that to evaluate the worth of these speculations much work needs to be done examining the disturbances in apraxia in more detail. At any rate, even the cursory treatment provided here reinforces the need for models of motor skill that incorporate the features of heirarchical organization and sensory-motor integration. Moreover, the fact that highly practised skills are often spared apraxic disturbance suggests further that models of human motor performance include the conception that over time some motor acts will become fully automated. The study of apraxia, however, not only has implications for model building, but also the investigation of the progress of apraxic patients during treatment may be able to tell us something about how to train skills in intact individuals. This latter aspect, of course, forms quite another line of enquiry, but a line of enquiry that should be pursued in the future.

GENERAL DISCUSSION

The investigation of behavioural pathology is a necessary pursuit in that it not only provides clues as to the etiology of the pathology which, subsequently, may suggest a treatment regimen, but also it may facilitate an understanding of how in tact behaviour is organized. In the case of apraxia, this pursuit is particularly important since one of man's primary means of dealing with the environment, the skilled use of his arms and hands, is severely disturbed.

The purpose of developing this typology was to try to understand the etiology of apraxia in terms of disturbance to the basic organizational processes of planning and execution of movement. Although this approach tends to be concise, two important points must be considered. First, this approach has tended to consider disturbances in practic behaviour as a result of damage to the cerebral hemispheres without considering possible damage to subcortical areas and/or to the corpus callosum. While this may be a shortcoming, it, nevertheless, seems possible to distinguish between practic disorders due purely to cortical damage and those of subcortical or callosal origin. Subcortical damage in conjunction with cerebral damage results in the already observed difficulties in sequencing (planning and executive apraxia) or in executing component movements (unit apraxia); also, however, an ataxic-like disturbance is superimposed on the above disorders making isolated movements severely disturbed. Moreover, perseverative activity may be increased when already present due to cortical damage or may present itself when purely cortical damage did not produce it (LURIA, 1966).

With callosal damage, on the other hand, practic disturbance is frequently, but not always, limited to one hand (GESCHWIND, 1975) and resembles that present following damage to the frontal or premotor cerebral areas (i.e., difficulty in planning and sequencing movement). With cerebral damage, the disturbance is usually always bilateral. When, however, the disturbance following cerebral damage is unilateral (unit apraxia), it does not resemble the unilateral deficit present in the callosal syndrome.

A second important consideration is that the dichotomy of planning apraxia into primary and secondary components requires evidence of cortico-cortical information transmission, especially between the parietal-occipital and the frontal regions. Evidence provided by McCULLOCH (1944), NETTER (1972), and most recently by HAAXMA and KUYPERS (1974) indicates that these lines of communication do exist and have great functional significance.

These suggestions as to a typology of apraxia represent only a first step toward a more detailed and precise analysis of apraxia. Work must be done to cross-validate this proposal on patients other than those described here. Further more detailed analyses of the movement disorders must be attempted. These might include an analysis of more complex movement patterns than, for example, simply lighting a candle. Particular emphasis should be paid to alterations in direction, velocity and extent of movement. Recent work by LETTS, WINTERS & QUANBURY (1975) using electronyography and cinematigraphy in the study of abnormal gait patterns suggests that these techniques might be put to use in the study of apraxia.

In summary it is hoped that these suggestions will provide an impetus for more fruitful research in the area of apraxia. Through a more precise definition of the disorders underlying the various apraxic syndromes more adequate treatment for the apraxic can be developed, and, further, a more lucid model of the organization of motor skill may follow.

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LE GARDIEN DE BUT AU HOCKEY: UNE STRATÉGIE PSYCHO-MOTRICE DE RECHERCHE

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INTRODUCTION

Le gardien de but au hockey exécute un éventail complexe de tâches psycho-motrices, pour lesquelles n'ont été déterminées à ce jour, ni l'importance relative de chaque tâche, ni les exigences propres à chaque tâche. L'importance relative des éléments fondamentaux, qui font partie des performances actuelles des gardiens de but, n'apparaît qu'après une analyse de tâches effectuée à l'intérieur d'un cadre conceptuel précis. Un tel cadre de référence, pour une analyse de tâches utilisant les concepts de manipulation de l'information, a déjà mis en évidence un certain nombre de stratégies nouvelles de recherche sur le volleyball. (SALMELA, 1975). Cependant, bien que ce genre d'analyses ait une valeur heuristique, en s'inscrivant dans le cadre de théories contemporaines, il nous reste un certain nombre de données à accumuler parallèlement à ces analyses de tâches. Cette recherche devrait être effectuée à l'intérieur d'un schème qui permette à la fois l'élaboration de modèles psycho-moteurs et la réalité des situations sportives.

Jusqu'à présent, les composantes comportementales de la performance d'un gardien de but n'ont pas été systématiquement identifiées et évaluées. On peut dire toutefois que, lorsque le jeu se déroule à distance, le gardien de but est pratiquement immobile tout en demeurant attentif. Par contre, lorsque le jeu se déroule près des buts, le gardien doit se déplacer d'un côté à l'autre, être vigilant afin de réduire les angles possibles de lancers, et réagir avec vitesse et précision pour attraper ou dévier les rondelles lancées. Toute cette série de gestes précis nécessite une grande variété de comportements sur la glace. Selon la nature de ses exigences psycho-motrices, chaque composante comportementale du gardien de but serait également susceptible d'analyses expérimentales ultérieures. Cependant, certaines données en psychologie expérimentale peuvent déjà servir à expliquer plusieurs composantes de la tâche. À titre d'exemple, disons que le degré de vigilance du gardien de but pourra varier avec la fréquence relative des signaux importants durant les longues séquences de jeu. (MACKWORTH, 1964). Sa tâche de détection visuelle sera fonction du rapport signal/« bruit » de l'environnement, ou encore du rapport rondelle ou joueurs/arrière plan du jeu, dans le sens traditionnel de la détection des signaux de SWETS (1964). L'acte de poursuite visuelle et motrice conduira à une réduction des angles possibles de lancers. Pour compléter ces exemples de processus psycho-moteurs, on pourrait émettre l'hypothèse que les composantes d'attente (« readiness »), de détection, d'anticipation, tout autant que la réponse motrice elle-même, sont importantes dans l'acte de blocage d'un lancer.

Ces réflexions n'ont d'autre but que de souligner la nécessité de l'adoption d'un système de référence ayant la capacité d'intégrer les données d'une analyse de tâches à des performances psycho-motrices et à la théorie qui les soustend. Ce qui n'a été le cas de la recherche ni dans le domaine du volleyball (SALMELA, 1975) ni dans celui du hockey.

À titre d'exemple, le but de cette présentation sera d'esquisser les grandes lignes d'une stratégie de recherche sur les comportements de gardiens de but au hockey, afin de combler le fossé existant entre la réalité sportive de cette tâche multi-dimensionnelle et la littérature dans le domaine de la performance psycho-motrice.

LA TÂCHE CHOISIE

Parmi la variété des comportements à étudier chez un gardien de but, les tâches de détection, de réaction et d'exécution d'un arrêt de la rondelle ont été sélectionnées. D'une position stationnaire au centre des buts, les capacités des gardiens d'exécuter une variété de réponses suite aux phases de détection et d'anticipation seront analysées. Ces gestes seront mesurés et évalués afin de mieux comprendre les exigences de cette tâche sportive.

LA STRATÉGIE DE RECHERCHE

La présente série de recherches est basée sur l'analyse d'incertitudes des habiletés sportives, analyse qui a été développée ailleurs. (SALMELA, 1974; 1975). La tâche comportementale est analysée à l'intérieur d'un schème de référence où l'incertitude est manipulée systématiquement.

La phase I de cette série de recherches consiste à analyser le concept populaire de « réflexes », compris comme étant une qualité essentielle du gardien de but. L'expression : « un gardien de but a de bons réflexes », implique une séquence précise d'événements au moment où il opère dans son environnement spécifique. La réactivité du système psycho-moteur dans ce contexte de « réflexes » est évaluée en utilisant les techniques classiques de temps de réaction. Cette première phase a déjà été effectuée et présentée par DROUIN et SALMELA (1975).

La phase II de cette stratégie tient compte de la durée des temps de réaction de la phase I, en relation avec la vitesse et la distance des lancers.

Le but de la phase II est d'identifier spécifiquement à quelle séquence précise du lancer le gardien de but réagit. Si on pouvait démontrer que les durées des temps de réactions de la phase I excèdent la plupart des mesures typiques des lancers au hockey, on pourrait alors déduire que le gardien de but utilise des informations prégestuelles avant de réagir.

La technique essentielle de cette phase II implique des séquences filmées d'une variété de joueurs lançant des rondelles vers la caméra placée dans le filet. Ces séquences incluent des lancers différents soit le lancer frappé, le lancer

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du revers et le lancer du poignet. La vitesse et l'endroit où la rondelle se loge dans le but seront enregistrés. La redondance relative des différents lancers est analysée en arrêtant les séquences filmées, soit à intervalles réguliers précédant le départ de la rondelle, soit à des positions anatomiques pré-déterminées. La dépendance séquentielle des différentes phases des lancers est reflétée par la précision des sujets quant à leur prédiction du point d'entrée de la rondelle. Les variables manipulées sont basées sur la quantité d'information ou la durée de la séquence filmée et sur la qualité d'information ou le genre de lancer utilisé. La tâche est comparable à la technique de «Masking» utilisée par WHITING (1969) pour la prédiction des trajectoires d'objets. En d'autres termes, c'est la dimension d'*incertitude événementielle* qui est étudiée. Le problème à l'étude est de déterminer le moment précis où, au cours de l'élan qui précède le déclanchement du lancer, le gardien de but a suffisamment d'information pour prédire correctement le point d'entrée de la rondelle. Ce choix n'est exigé qu'après une brève durée d'une ou deux secondes dans des conditions qui ne sont pas limitées dans le temps.

La phase III a pour objet de découvrir comment un gardien de but opère sur l'incertitude *spatiale* de son environnement durant la période qui précède l'action du lancer.

La méthodologie expérimentale nécessite à nouveau les séquences filmées de la phase II, ainsi qu'un appareil pour l'enregistrement des mouvements oculaires. La nature des stratégies de balayage visuel, par rapport aux indices spatiaux qui relèvent de la tâche, est examinée à nouveau à l'intérieur de et entre les trois genres de lancers mentionnés. Il est donc possible que ces stratégies de gardien de but changent en fonction de la durée du film qui se déroule avant le déclenchement du lancer.

La phase IV n'est qu'une extention de la phase précédente, une fois mieux connus les comportements que le gardien de but utilise afin de réduire l'*incertitude spatiale*. Dans cette phase d'expérimentation, la dimension d'*incertitude temporelle* est ajoutée à la tâche expérimentale en exigeant que le sujet devine le quadrant dans lequel la rondelle va se trouver *avant* que la durée entre le déclenchement de la rondelle et son passage dans le filet soit écoulée. Le gardien de but exprime sa prédiction en appuyant sur l'un des quatre micro-commutateurs représentant les quatre quadrants du filet. Cette réponse implique des exigences motrices minimales car le geste comme tel est simple et d'un haut niveau de compatibilité stimulus-réponse. Les modifications subséquentes du balayage visuel étudié en phase III pourrait être considérées à nouveau, avec les contraintes additionnelles du domaine temporel.

La phase V de cette stratégie de recherche est identique à la phase IV, mais avec une réponse motrice qui ressemble à celle exécutée par la main pour bloquer un lancer dirigé dans un des quatre coins du filet. Donc, plutôt que tout simplement prédire puis exécuter une réponse motrice simple, le gardien de but devra prédire puis exécuter un geste plus complexe, demandant de couper un rayon de lumière dans le quadrant approprié. En sachant que les retards pour sélectionner et exécuter des réponses complexes sont proportionnellement plus longs, ces composantes additionnelles de l'*incertitude de la réponse* pourraient changer les stratégies dynamiques des phases III et IV.

Une vue d'ensemble de cette stratégie de recherche, c'est-à-dire, les principales questions expérimentales, la tâche expérimentale et la pondération relative de l'incertitude impliquée, est présentée dans le tableau I.

CONCLUSIONS

La stratégie de recherche proposée traite, sous différentes conditions expérimentales, du comportement de gardiens de but prêts à détecter, anticiper, et réagir pour exécuter une réponse motrice simple. Même avec les nombreuses interactions entre ces composantes psycho-motrices, l'importance relative de ce comportement par rapport aux autres comportements de cette tâche sportive, restera inconnue jusqu'au moment de la réalisation d'une analyse de tâches en situation de jeu. La fréquence relative des déplacements latéraux, en poursuivant la rondelle latéralement ou en profondeur, pour couper les angles des lancers; les tâches complexes de détection de la rondelle parmi les coéquipiers, les adversaires et l'arrière plan; les probabilités de lancers à un endroit spécifique en fonctions du type de lancer et l'endroit où se déroule le jeu; tous ces éléments demeurent des champs de recherche fructueux du point de vue de l'analyse de tâches ou de l'expérimentation. La stratégie de recherche décrite est semblable à celle que WILLIAMS et McFARLANE (1975) ont utilisée, pour étudier le temps de réaction et la vitesse de mouvement dans une tâche d'attraper des balles. Cependant, dans notre stratégie de recherche, l'analyse des processus perceptuels et d'anticipation devrait compléter les informations communiquées par ces auteurs considérant que les données seront traitées d'une façon multidimensionnelle.

Tableau I – Stratégies de la recherche sur les gardiens de but.

Phase	Tâche expérimentale	Questions expérimentales	Incertitudes* dominantes			
			IR	IS	IT	IE
I	Temps de réaction classique en situation de jeu	Qu'est-ce que le concept de « réflexes » ?	X			
II	Technique de « Masking » et séquences filmées	Quand débute l'initiation du geste approprié ?				X
III	Mesure de mouvements oculaires avec séquences filmées	Sur quoi se fixent les yeux ?		X		
IV	Prédictions avec contraintes temporelles et gestes simples	Comment les prédictions modifient-elles la vitesse en fonction de gestes simples ?			X	
V	Prédictions avec contraintes temporelles et gestes complexes en situation de jeu	Comment les prédictions se modifient-elles en fonction de la vitesse dans des gestes complexes ?			X	

* Incertitudes dominantes: IR : incertitude de la réponse
IS : incertitude spatiale
IT : incertitude temporelle
IE : incertitude événementielle

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LA TÂCHE DE GARDIEN DE BUT ET LE TEMPS DE RÉACTION CLASSIQUE: UN TEST DU CONCEPT DE «RÉFLEXES» *

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En consultant la littérature on s'aperçoit que le concept «temps de réaction», est étudié depuis environ un siècle. Les premiers intéressés par la mesure du temps de réaction furent les astrologues; mais il semble que les premières expériences scientifiques concernant le temps de réaction appartiennent à Helmoholtz et datent de 1850. (FITTS et POSNER, 1967).

Par la suite des chercheurs tels que CATTELL, DOLLEY, HIRSCH, HIPP, DONDERS, WUNDT, FRAEPLIN, EXNER, LANGE KULPE et WILLIAMS, (WOODWORTH et SCHLESBERG, 1954) contribuèrent à identifier le concept temps de réaction. Dans son article TEICHNER (1954) mentionne plus de 163 études traitant uniquement du temps de réaction simple.

En général les recherches concernant le temps de réaction sont réalisées à l'aide de la manipulation de différentes variables. De nombreuses études de BEEBE (1938) BURBY (1944) GOTTSDANKER, BROADBENT (1963) HENRY (1960) LAPP (1935) SIDOWSKI et MORGAN (1958) ont fait l'objet de recherches sur le temps de réaction simple et discriminatoire. D'autres chercheurs, FARBER et SPENCE (1956) FROEBERG (191. OFFENBERGER (1912) SLATTER-HAMMEL (1955) et DROUIN (1973) ont investigué les effets de l'intensité et de la durée des stimuli. Présentement nous avons des données sur les effets de l'âge sur le temps de réaction ATWELL et ELBEL (1948) BELLIS (1933) MENDRYK (1960) WOODWORTH et SCHLOSBERG (1954) sur les effets du sexe BELLIS (1933) HENRY (1952) sur la condition physique et la fatigue ELBEL (1940) MYERS et SIMMERLI (1969) PHILLIPS (1963) sur la motivation HENRY (1951) (1952) HOWELL (1953) JOHANSON (1922) et des études sur les effets de la compatibilité entre le stimulus et la réponse par BRAINARD (1962) et HICK (1952).

Un bon nombre de chercheurs se sont également intéressés sur les effets de la durée de la période préparatoire et la valeur d'un signal préparatoire, (BOTWINICK et BRINELY, 1962) (DRAZIN, 1961) et TELFORD (1931) pendant que d'autres études ont traité des incertitudes temporelles et spatiales de la présentation des stimuli. (ADAMS, 1964) (ADAMS et XHIGNESSE, 1960), (AIKEN et LITCHENSTEIN, 1964) (BARTLETT et BARTLETT, 1959), (CONRAD, 1953), (KLEMMER, 1956) (WILSON, 1959), (SCHMIDT), 1967).

Dans ses tentatives d'application du concept temps de réaction dans des tâches exigeant de l'anticipation motrice, Poulton se basant sur une série de recherches systématiques (1950, 1952 (a), 1952 (b), 1957, 1968, 1969) fait une distinction entre l'anticipation dite sensorielle et l'anticipation perceptuelle. Pour lui, l'anticipation est sensorielle (1950, 1952 (a), 1952 (b)) lorsqu'une tâche donne de l'information avant le déroulement de l'événement; l'anticipation est perceptuelle (1950, 1952 (a), 1957) lorsqu'il y a absence d'information précédant l'événement mais que ce dernier présente certaines caractéristiques régulières permettant au sujet d'apprendre les séquences temporelles ou spatiales réduisant l'incertitude événementielle. Poulton mentionne même qu'il existe deux catégories d'anticipation perceptuelle; une anticipation perceptuelle temporelle et une anticipation perceptuelle spatiale. La première référant à la prédiction temporelle en relation avec le début de l'événement pendant que la seconde réfère à l'endroit précis du déroulement de l'événement.

C'est donc dire qu'actuellement nous possédons une quantité de données en relation avec le temps de réaction. Cependant il faut admettre qu'à l'exception de la série d'études de Poulton, les données sont très isolées les unes des autres en plus d'offrir très peu d'explication sur les éléments inhérents de détection, de poursuite, d'anticipation et de prédiction qui précèdent l'initiation de mouvement. Nous pouvons affirmer que jusqu'à présent très peu de chercheurs ont tenté d'étudier systématiquement les conditions d'environnement dans lesquelles évolue le gardien de but au hockey.

Pour sa part FURLONG (1968) nous donne quelques statistiques sur les temps de réaction de quatre gardiens de buts de la ligue nationale. L'étude de DROUIN et LARIVIÈRE (1974) qui incluait sept gardiens de buts de calibre différent démontra qu'il y avait très peu de différence entre les temps de réaction obtenus en laboratoire et ceux enregistrés sur la patinoire. Cette même étude fournissant des considérations spécifiques sur la dimension des buts et l'équipement.

À la suite de cette courte rétrospective de la recherche sur le temps de réaction il est nécessaire de rappeler que l'application des données seraient appropriées seulement dans les situations de jeu ou le gardien de but performe dans des conditions de temps de réaction classique. Plus spécifiquement ces conditions comprennent un signal préparatoire qui favorise un état d'éveil, une période préparatoire aléatoire afin d'empêcher le sujet d'initier une réponse motrice avant la présentation de l'information et une réponse motrice simple. On peut donc préconiser que les conditions mentionnées favorisent un comportement d'éveil, d'anticipation et de prédiction donc conséquemment une mesure valable du temps de réaction. Nous voulons différencier entre le concept temps de réaction qui varie selon les conditions potentielles pour optimiser ce temps, et le temps de réactivité qui représente davantage une mesure honnête des capacités de répondre.

Cependant il faut souligner que ces mesures du temps de réaction seraient appropriées en situation de jeu pour expliquer seulement le temps de réactivité qui s'écoule à compter du moment précis que la rondelle quitte le bâton du joueur qui lance vers le but. C'est uniquement pour ces situations qu'il est opportun et valable de mentionner qu'un gardien a de «bons réflexes»; ce concept de réflexes qui est tant utilisé

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par les différents média d'information lors d'une joute de hockey. C'est donc en cumulant une série de données sur le temps de réaction qui permettra de considérer l'importance de cette mesure. Par la suite, les temps de réaction « bons réflexes » en relation avec les composantes vélocité et distance de la rondelle déterminera la valeur et l'importance de cette mesure.

CONDITIONS EXPÉRIMENTALES

Le but de cette première étude était d'obtenir des données sur le temps de réaction. Douze sujets participèrent à l'étude. Chaque sujet exécutait un total de 96 essais, soit 48 temps de réactivité pour chaque main. Pour chaque essai le sujet profitait d'un signal préparatoire, d'une période préparatoire aléatoire et d'un choix de côté. Ce choix de côté étant conditionné par la possibilité d'un seul choix de lumière, de deux choix de lumière et de quatre choix de lumière.

Matériel

Le temps de réaction, qui était chronométré à la milliseconde, était enregistré au moment précis où la main relâchait un micro-commutateur qui était fixé à environ deux pouces en haut du genoux. Le signal préparatoire, un « buzzer », et la période préparatoire étaient contrôlés à l'aide d'un chronomètre à intervalle ajustable. Les stimuli visuels, des lumières blanches étaient montés sur un tableau de 4' × 8' placé à environ quatre pieds du sujet. L'arrangement du tableau comprenait sur le plan vertical quatre lumière de chaque côté; ces lumières ayant une distance de 13¼. Le contrôle de la présentation des stimuli visuels était synchronisé par un deuxième chronomètre à intervalle avec la durée de la période préparatoire.

Méthodologie

Pour la durée de l'expérience, le sujet était debout les jambes légèrement fléchies. Le sujet était encouragé à prendre la position qu'il lui permettait d'initier un mouvement de la main le plus rapide possible. Chaque essai était précédé d'un signal préparatoire auditif, d'une période préparatoire aléatoire d'une à quatre secondes. Pour chaque essai, les stimuli visuels, des lumières blanches, offraient la possibilité d'un seul choix de lumière, de deux choix ou de quatre choix de lumière. La réponse motrice de la main droite ou de la main gauche étant fonction du nombre de choix de lumière, du côté et de la période préparatoire.

RÉSULTATS

L'analyse de variance indique que le facteur du choix de lumière est très significatif en-dessous du degré .01 (F, $(2,132) = 9.79$, $p < .01$). Le F ratio obtenu pour le facteur sujet étant de (F, $(11,132) = 2.26$, $p < .05$). Les variables concernant les facteurs côté, répétition et la période préparatoire n'indiquant aucun effet significatif. Cependant l'absence d'interaction significative entre les variables indépendantes et les sujets indiquent que les 12 sujets démontrèrent un comportement semblable pour les conditions expérimentales exploitées.

Une analyse plus détaillée des moyennes du facteur choix de lumière indique que lorsque la condition expérimentale offrait un seul choix de lumière une moyenne de temps de réactivité de .308 secondes fut enregistrée. La moyenne du temps de réactivité pour deux choix étant de .336 secondes pendant que pour quatre choix de lumière elle était de .332 secondes. Pour ces mêmes conditions les moyennes des temps de mouvements furent de .259 secondes, de .286 secondes et de .290 secondes.

DISCUSSION

À la suite des mesures expérimentales obtenus il faut reconnaître que même si l'on considère la moyenne du temps de réaction la plus rapide .301 secondes il devient évident qu'aucun gardien de but ne parviendrait à bloquer de la main une rondelle ayant une vélocité de 75 mph. sur une distance de 25 pieds, puisque cette rondelle franchirait la ligne des buts en moins de .227 secondes. Il ne faudrait pas négliger d'insister que ce temps de .301 secondes est uniquement un temps de réactivité comprenant un mouvement de déplacement spatial de la main presque nul. Par la suite, les informations recueillies indiquent que si on tient compte de la moyenne du temps de réaction la plus courte .301 secondes et celle du temps de mouvement .260 secondes on cumule un temps de réponse totale de .561 secondes. Ce temps de réponse total de .561 secondes rend physiquement irréalisable l'arrêt d'une rondelle ayant une vélocité de 50 mph. provenant d'une distance de 25 pieds, puisqu'elle franchirait la ligne des buts en moins de .341 secondes.

En général les données de l'étude corroborent avec celles de LAPP (1935) BEEBE (1938) McGOUCH (1952) SIDOWSKI (1958) et HENRY (1960) qui précisaient que le temps de réaction discriminatoire est plus lent que le temps de réaction simple. Les mesures du temps de réactivité contribuent uniquement à préciser les limites physiques pour l'initiation de mouvement. Il faut donc admettre que ce genre de mesure signifie très peu pour expliquer les exigences comportementales de la tâche de gardien de but au hockey. À la suite de cette première étape d'une stratégie de recherche il nous semble essentiel de procéder à l'isolement systématique des comportements inhérents à la tâche, c'est-à-dire les comportements de poursuite visuelle, de détection, d'anticipation et ou de prédiction. (SALMELA, 1975). C'est donc dans cette optique que notre perspective de recherche entreprendra une seconde phase dont l'objectif sera d'analyser systématiquement les comportements qui précèdent l'initiation des gestes typiques de gardiens de buts.

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PERFORMANCE MOTRICE : DIMENSION TEMPORELLE

AN ELECTROMYOGRAPHICAL STUDY OF STIMULUS LIMB DOMINANCE AND MEASUREMENT CONDITIONS ON FRACTIONATED RESPONSE VARIABLES

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In a previous study by WYRICK and DUNCAN (1974), the electromyographical (EMG) response of a falling limb to joint displacement was described. As the abducted, prerelaxed arm is suddenly released from a supporting electromagnet, the EMG is recorded and analyzed for initial latencies. In the ipsilateral or stimulus limb, the fall of the prerelaxed arm results in a rather synchronous stretch reflex followed by a period of relatively no activity and finally followed by the premotor EMG which is the EMG activity responsible for the voluntary stop of the arm. On the contralateral limb which is supported by a wooden brace, the premotor EMG to raise the arm is recorded from a stationary limb thus no reflex activity is present.

In a comparison of unilateral and bilateral measurement conditions, DUNCAN (1975) hypothesized that central facilitation may be responsible for faster bilateral measurement times. The ipsilateral premotor time (IPMT) which is alone in the unilateral measurement condition was significantly faster in the bilateral measurement condition which involved both IPMT and contralateral premotor time (CPMT). In addition to the difference in measurement conditions, CPMT was found to be faster than IPMT. In the previous study, two basic causes of this difference in latencies were hypothesized. (1) The presence of the stretch reflex preceding IPMT has resulted in a slower premotor time. (2) The use of a non-dominant stimulus arm resulted in a consistently faster CPMT on the dominant limb. The present study was designed to replicate the premotor difference and to study the influence of stimulus limb dominance on IPMT and CPMT.

METHODOLOGY

Subjects

Twenty-three healthy male university students volunteered to be Ss for study. Their mean age was 299.4 ± 57.6 months; mean height was 181.84 ± 6.1 cm, and their mean weight was 76.6 ± 9.0 kgs. All Ss stated that they were right-hand dominant. Twenty of the Ss were high school or college athletes.

Apparatus

Instrumentation has been developed so that either one or both of a Ss arms were held in an extended horizontal position from the shoulder and then suddenly released so that one arm began to fall downward toward the S's side. The arm was held by a soft iron disc, partially encased in a leather wrist cuff that is attracted to a battery operated 6 volt electromagnet. The electromagnet is attached to a wooden brace; when electrical current is discontinued, the magnetic field collapses releasing the S's arm from the wooden brace. The release of the arm and the consequent accelerated fall of the limb provide changes in the glenohumeral joint angle thus evoking proprioceptive feedback that may be responded to by the S. A more detailed description of this apparatus and technique may be found in WYRICK & DUNCAN (1974) and DUNCAN, WYRICK & MILLER (1974).

EMG potentials were amplified by a Honeywell Accudata 108/109 system and were read directly from a Tectronics 5103N 4 channel storage oscilloscope. Three channels were employed: one channel to display the release of the magnet, one channel to display the ipsilateral response, and a third channel to display the contralateral response.

Procedures

Ss were seated with either one or both arms straight and abducted at approximately right angles. Under the unilateral condition, one arm was abducted while the other rested in the S's lap. Under the bilateral condition, both arms were abducted.

Two wire electrodes, size 40 AWG, were implanted via a 25 gauge needle into both middle deltoideus muscles; while a gound electrode was placed on one of the ear lobes. Ss were trained to achieve complete relaxation of the muscle prior to each trial by relaxing until their oscilloscopic feedback revealed electrical silence. Ss were also trained to respond to the sudden displacement of one of their arms (the stimulus arm) in one of two ways: by stopping the falling of that arm (unilateral response) or by stopping the fall of the stimulus arm and also by raising their contralateral abducted arm (bilateral response). EMG potentials from the ipsilateral myotatic reflex and the voluntary stopping of the falling arm (premotor latency) were recorded on one channel, and the premotor latency of the contralateral response was recorded on another channel.

Ss were provided 15 unilateral trials in which the preferred arm was both the stimulus and responding arm (unilateral dominant stimulus, UDS), 15 unilateral trials in which the nondominant arm was both the stimulus and the responding arm (unilateral nondominant stimulus, UNDS), 15 bilateral trials in which the stimulus arm was the nonpreferred arm (bilateral trials in which the stimulus arm was the non-preferred arm (bilateral, nondominant stimulus (BNDS). Although the 15 trials of each measurement condition were alternated, the presentation of the two dominance conditions was rotated among Ss.

Experimental Design

The experimental design was a single group design in which the effect that the independent variables of measurement condition (ipsilateral or bilateral), source of response (dominant or nondominant stimulus arm) and trials (15) had upon the dependent variables of reflex latency, reflex duration, IPMT, CPMT, and the relationship between IPMT and CPMT when they occurred on the same trial, i.e., under bilateral measurement conditions were shown.

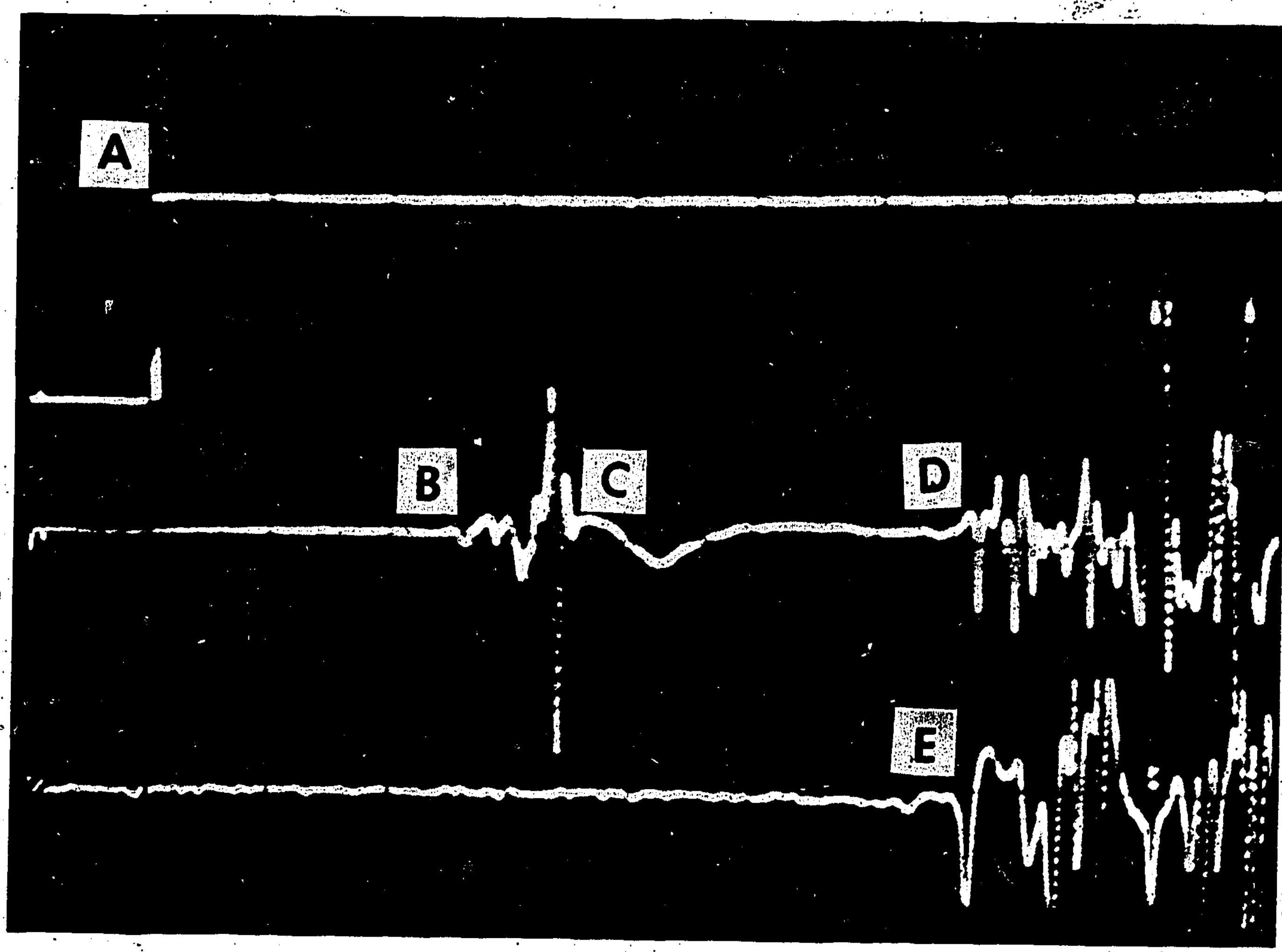
Independent Variables

In all trials responses were made to the sudden release of an arm from the electromagnet; thus the stimulus was proprioceptive information that the arm was falling. This stimulus is referred to hereafter as the stimulus arm. The three independent variables studied were measurement condition, source of response, and trials. Measurement condition refers to whether the response to the stimulus arm was made only unilaterally, that is by the stimulus arm, or bilaterally, by both the stimulus arm and the contralateral arm. The source of the response as a variable refers to whether the stimulus arm was the S's dominant or nondominant arm. Trials, the third factor, refers simply to the number of trials provided (T = 15).

Dependent Variables

The five dependent variables analysed were reflex latency, reflex duration, IPMT, CPMT, and premotor time as a comparison of IPMT and CPMT in the bilateral measurement condition. Reflex latency was defined as the time in msec from the release of the magnet to the first deflection of the EMG response (A to B, Figure 1). Reflex duration was defined as the time from reflex latency to the termination of the initial EMG burst (B to C, Figure 1). IPMT was the time in msec between the break of the magnet and the recording of continuous muscle action potentials on the ipsilateral (stimulus) arm (A to D, Figure 1). CPMT, which only occurred under bilateral trial conditions, was defined identically to IPMT except that it was monitored from the limb contralateral to the stimulus arm (A to E, Figure 1). Premotor time as a dependent variable refers to the comparison of IPMT and CPMT when they occurred on the same trial (only under bilateral measurement conditions, e.g., D to E. Figure 1).

Figure 1 - Photograph of a bilateral trial was taken from the deltoid muscles and recorded at 20 msec/division. A = magnet break. B = beginning of reflex EMG (reflex latency, A to B), C = end of reflex EMG (reflex duration, B to C), D = ipsilateral voluntary EMG (IPMT, A to D), E = contralateral voluntary EMG (CPMT, A to E).



Analyses

A three-way within subjects analysis of variance was used to analyse reflex latency, reflex duration, IPMT, and the comparison between the premotor times of both limbs. CPMT, however, occurred only under bilateral conditions, thus a two-way within subjects analysis of variance was used to analyze the dominance and trials effects. Since the means in the comparison between IPMT and CPMT were also analyzed in the single analyses of these variables, this final comparison is not orthogonal. Generalizations from this final analysis of variance, therefore, are somewhat delimited.

RESULTS

Means for the dependent variables and a summary of the analysis of variance tests are included in Table 1. The specific source table for each analysis of variance test is

Table I – Summary of Findings.

Dependent Variables (msec)	Measurement			Independent Variables Dominance			Trials	Interactions		
Reflex Latency	Unilateral	38.2	F**	DS	39.0	F-NS	F-NS	F-NS		
	Bilateral	39.4		NDS	38.5					
Reflex Duration	Unilateral	27.6	F*	DS	28.1	F-NS	F**	F-NS		
	Bilateral	29.1		NDS	28.6		(decrease)			
Ipsilateral Premotor Time	Unilateral	102.7	F-NS	DS	103.0	F-NS	F***	F-NS		
	Bilateral	103.6		NDS	103.3		(faster)			
Contralateral Premotor Time	(No comparison relevant)			DS	101.1	F***	F*	F-NS		
				NDS	93.3		(faster)			
Premotor Times	IPMT	103.6	F***	DS	102.2	F***	F***	F***		
	CPMT	97.2		NDS	98.6		(faster)			
	Premotor × Dominance Interaction								DS	NDS
								IPMT	103.2	104.0
								CPMT	101.1	93.3

F = Variance estimate between Ss/variance estimate within Ss.
P = Probability level.
I = This comparison involves only bilateral data.
DS = Dominant arm as stimulus.
NDS = Nondominant arm as stimulus.
NS = Not significant.
* = Significant at .05 level.
** = Significant at .01 level.
*** = Significant at .001 level.

listed in Table 2. Mean times when compared to previous studies (WYRICK & DUNCAN, 1974; DUNCAN, 1975) are longer due to the elimination of a delay of approximately 15 msec due to residual magnetism. The newer circuit involved in this study eliminated this delay (DUNCAN, WYRICK, & MILLER, 1974). The findings, however, are unaffected except for absolute values.

Table II – Analysis of Variance Source Tables.

Variable	df	M.S.	F
Reflex Latency			
Measurement	1	526.02	9.53 ***
Dominance	1	92.87	1.68
Trials	14	48.10	.87
Measurement × Dominance	1	133.99	2.43
Measurement × Trials	14	25.97	.47
Dominance × Trials	14	21.24	.38
Measurement × Dominance × Trials	14	45.29	.82
Reflex Duration			
Measurement	1	811.13	3.88 *
Dominance	1	89.79	.43
Trials	14	422.14	2.02 **
Measurement × Dominance	1	62.63	.30
Measurement × Trials	14	223.96	1.07
Dominance × Trials	14	135.65	.65
Measurement × Dominance × Trials	14	157.69	.75
Ipsilateral Premotor Time			
Measurement	1	287.61	.99
Dominance	1	30.16	.10
Trials	14	3081.81	10.58 ***
Measurement × Dominance	1	60.94	.21
Measurement × Trials	14	196.04	.67
Dominance × Trials	14	106.31	.37
Measurement × Dominance × Trials	14	151.32	.52
Contralateral Premotor Time			
Dominance	1	110409.28	34.34 ***
Trials	14	556.94	1.84 *
Dominance × Trials	14	120.49	.40
Premotor Time			
Laterality	1	114188.86	41.14 ***
Dominance	1	4289.48	12.44 ***
Trials	14	2093.28	6.07 ***
Laterality × Dominance	1	6208.21	18.00 ***
Laterality × Trial	14	279.34	.81
Dominance × Trials	14	126.07	.37
Laterality × Dominance × Trials	14	108.52	.31

* = Significant at .05 level.
** = Significant at .01 level.
*** = Significant at .001 level.
df = Degrees freedom.
M.S. = Mean Squares.
F = Variance estimate between Ss/variance estimate within Ss.

When variables were compared in the unilateral and bilateral measurement conditions, reflex latency was faster in the unilateral measurement condition (38.2 msec) than in the bilateral measurement condition (39.4 msec). The duration of the reflex was longer in the bilateral condition (29.1 msec) than in the unilateral condition (27.5 msec). The measurement comparison for IPMT revealed no differences in the unilateral (102.7 msec) and bilateral (103.6 msec) measurement conditions. Since no CPMT is present in unilateral trials, the unilateral versus bilateral analysis is not relevant to CPMT or to the IPMT versus CPMT comparison.

The dominance comparisons were not significant for reflex latency, reflex duration or IPMT. Mean values for dominant stimulus limb and nondominant stimulus limb are as follows: reflex latency (DS 39.0 msec, NDS 38.5 msec), reflex duration (DS 28.1 msec, NDS 28.6 msec), IPMT (DS 103.0 msec, NDS 103.3 msec). Dominance comparisons for CPMT and the IPMT versus CPMT were significant and as follows: CPMT (DS 101.1, NDS 93.3) and premotor time combined variables (DS 102.2, NDS 98.6). In addition the interaction of the premotor × dominance comparison was significant and indicated that when the two favored conditions of the contralateral response occurring with the nondominant stimulus (contralateral response from the dominant limb) coincided, a very fast premotor time was the result: IPMT (DS 103.2, NDS 104.0) and CPMT (DS 101.1, NDS 93.3 msec.).

A significant "F" value for the fifteen trials was found for all dependent variables except reflex latency. Figures 1 and 2 are graphs of dependent variables over trials. Inspection of the trials reveals an apparent decrease in duration of the reflex over trials; and for all premotor trials, which represent a cognitive component, a tendency for faster trials can be seen.

Figure 2 – Mean values for reflex latency and duration over trials.

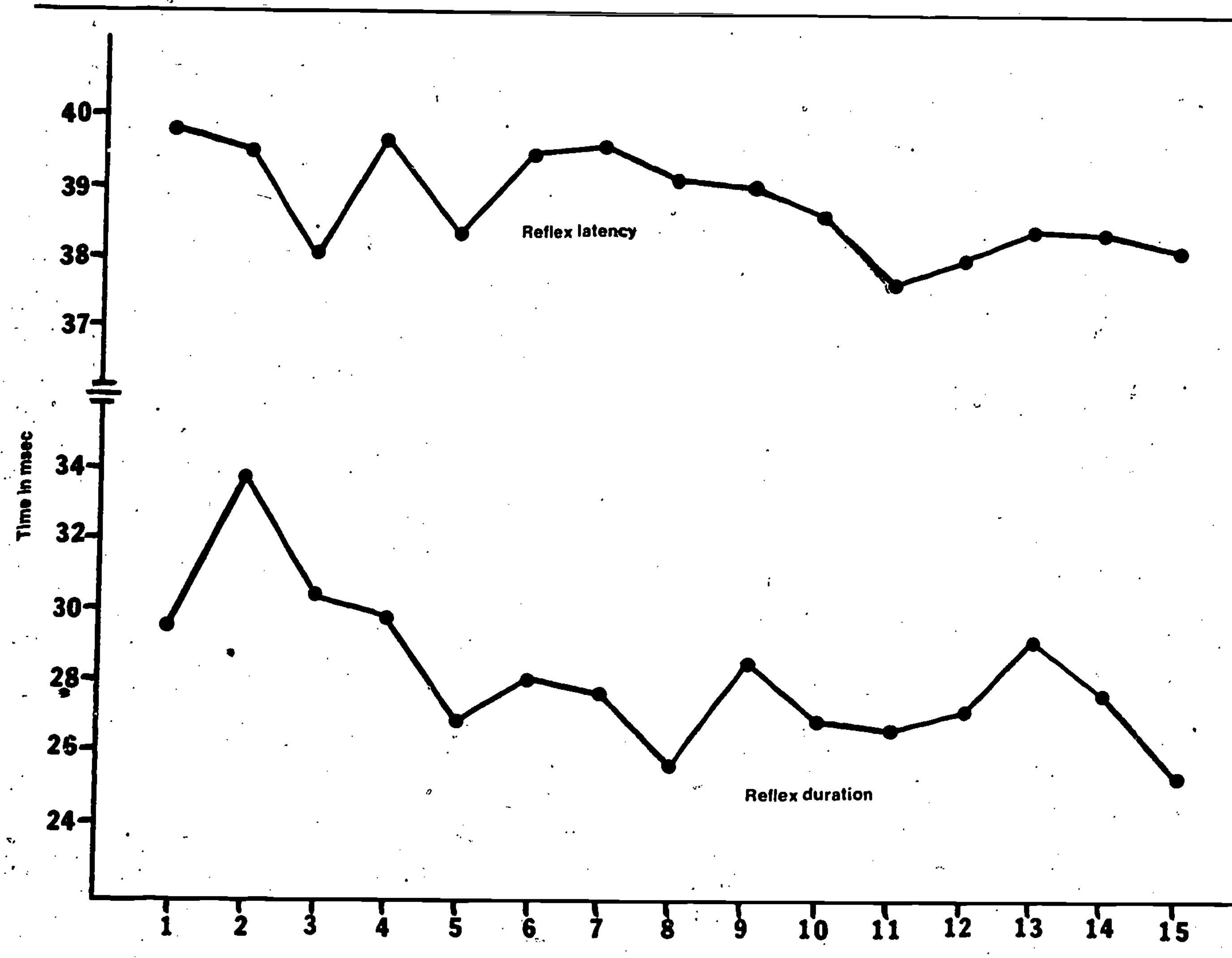


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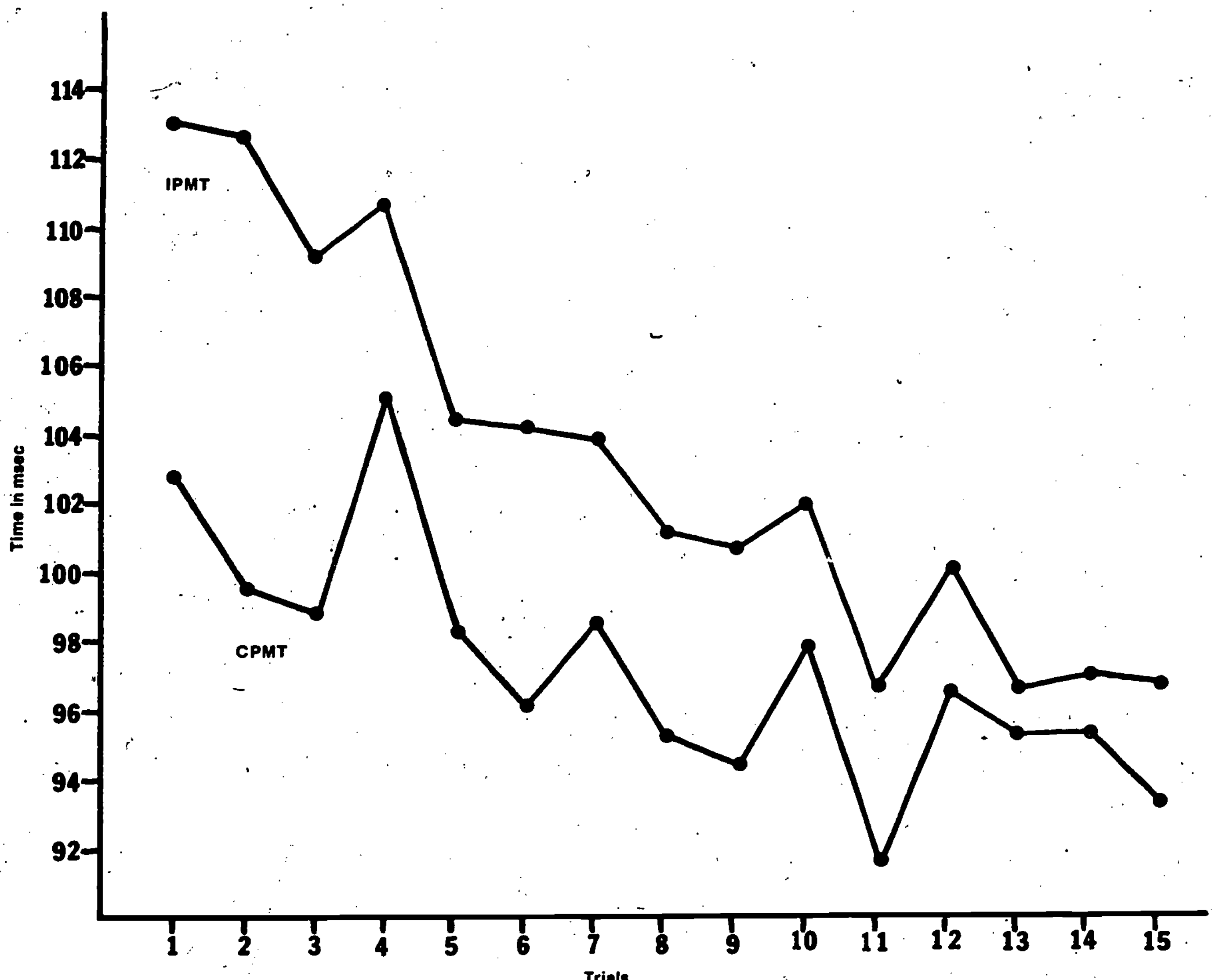
Figure 3 - Mean values for premotor times over trials.



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DISCUSSION

The observation that reflex latency was significantly faster under unilateral measurement conditions was not consistent with DUNCAN's (1975) finding, nor with the observation that in this study reflex duration was longer under bilateral conditions. Since the mean differences between the measurement conditions in Duncan's study and in the present investigation were only 0.9 and 1.2 msec respectively, it is tempting to speculate that measurement and statistical error account for the small differences. The difference between the reflex duration in the two measurement conditions, although small (1.5 msec) was nevertheless significant at the .05 level. The reflex appeared therefore to start somewhat later under bilateral conditions but to be more active when it was activated. Central facilitation resultant from the activity of both limbs and the anticipation of responding with both limbs is a plausible explanation for the greater reflex activity. Supraspinal commands to both limbs may be unconfounded by the need to inhibit one limb while responding with the other and thus result in recruitment of a greater number and longer firing of motor units in the reflex burst.

IPMT, although significantly faster in the bilateral condition in DUNCAN's study (1975), was not significantly faster in the present study. This failure to replicate the proposed central facilitation by the addition of the bilateral response cannot be explained with present conflicting evidence. The 1975 study utilized galvanometer driven light sources deflected onto light sensitive paper driven at a limited speed of 100 mm/sec. The measurement resolution from this source is poor and is the reason for the recommandation that such recording procedures be limited to overall analyses of EMG patterns (DUNCAN, WYRICK, & MILLER, 1974). This poor resolution coupled with the fact that the IPMT following the reflex burst is more difficult to interpret may have resulted in measurement error for the previous study. The considerably larger variation of IPMTs than CPMTs in the earlier paper probably reflects this problem. Additional study of this phenomenon is recommended.

Dominance did not appear to be a factor until both arms were involved. It may be observed in Table 1 that when both limbs were active, as in the CPMT and premotor time analyses, the fastest responses occurred in the dominant limb when it responded to the nondominant stimulus arm. This main effect of speed of response in the dominant limb should, however, be interpreted along with the results from the IPMT and CPMT interaction that is shown in the bottom right corner of Table 1. From the means it can be seen that the fastest conditions are the two in which the stimulus occurs in one arm and the response is made with the other; further, the fastest condition is the response by the dominant arm to the nondominant arm stimulus. It may also be seen, however, that the dominant IPMT response in the bilateral condition (104.0 msec) is almost identical to the IPMT when obtained by itself (103.3 msec). This similarity is also true for the nondominant IPMT response in the bilateral condition (103.2 msec) and in the unilateral condition (103.0 msec).

Two mechanisms may be proposed to explain faster CPMTs than IPMTs: active inhibition of the premotor times when they follow the reflex burst that exists on the ipsilateral side, and a hemispheric specialization or "division of labor" model. Active inhibition from Renshaw cells (RC) may be raising the threshold of the motoneuronal pool so that it takes a more prolonged efferent command to reactivate the motoneuronal pool. The task involved in this study is a phasic movement, and it has been shown by several investigators that RCs are triggered predominantly by large phasic motoneurons (GRANIT, *et al.*, 1957; ECCLES, *et al.*, 1961 a,b; TAN, 1972; RYALL, *et al.*, 1972; & HELLWEG, *et al.*, 1974). HELLWEG (1974) has also shown that a fast stretch of muscle produces primarily a phasic response that consequently activates larger motoneurons. He has also shown that the frequency and duration of RC response are related to the rate and length of stretch of muscle; therefore a greater active inhibition in the ipsilateral cord from RCs might be expected when muscle spindles are suddenly unloaded with a relatively synchronous stretch of muscle at a relatively fast rate of stretch. Concurrently, the activity of RCs which also stimulate inhibitory interneurons, specifically to the antagonist muscle (BURKE, 1970, p. 76) may reciprocally facilitate the contralateral homologous motoneurons during the silent period that is evident in the ipsilateral response. The ipsilateral premotor voluntary impulses arrive therefore on an actively inhibited motoneuronal pool; while the contralateral premotor voluntary impulses arrive on a facilitated motoneuronal pool.

Hemispheric specialization and a division of labor may account for the fact that the CPMTs are even faster when they occur in the dominant arm. According to KIMURA & ARCHIBABD (1973) the left hemisphere is specialized in sequential motor movements; while CARMON (1970) and LEVIN, *et al.* (1973) reported that the right hemisphere is specialized in using proprioceptive information. SUSSMAN (1975) for instance, found that the best of four combinations for motor control in a tracking task occurred when an acoustical target was received in the left ear thus going to the right hemisphere for analysis, and the cursor was received in the right ear thus going to the left hemisphere which is specialized for motor control. In the present study when the stimulus is the nondominant arm and the response is the dominant arm, both hemispheres are operating in their area of specialization: the right hemisphere is analyzing the proprioceptive stimulus and left hemisphere is controlling the response. This is the fastest condition. When the stimulus is the dominant arm, a division of labor accounts for a somewhat faster time than that which occurs in the ipsilateral condition; but since both hemispheres are not operating in their specialization, the times are slower than in the reverse condition.

In summary, to explain the faster CPMTs than IPMTs it is necessary to postulate an interaction that exists between the facilitatory state of the motoneuronal pool and the restraints placed upon the voluntary descending commands as they are processed. The primary explanation may be the facilitatory state of the motoneuronal pool, thus explaining the main effect of CPMT being faster than IPMT. But when right and left CPMTs are examined, hemispheric dominance and the division of labor model account for the superiority of the nondominant stimulus arm condition.

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SELECTIVE ATTENTION AND THE JUDGMENT OF TEMPORAL ORDER

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In the early part of this century, TITCHENER (1908) hypothesized that attention modified the order perception of closely-occurring temporal events. He formally stated this theorem as one of his "laws" of attention, which was later termed the doctrine of prior entry. In effect the doctrine infers that when a pair of hetero-modal stimuli are presented in close succession or in simultaneity, the stimulus which the subject is predisposed to perceive reaches consciousness before any other signal. Studies which were an extension of the problem of the "personal equation" in early astronomical calculations; (BORING, 1950), had provided data which were best explained in terms of the prior entry model (VON TCHISCH, 1885; ANGELL & PIERCE, 1891; GEIGER, 1902); however, shortly after Titchener proposed the law, it was somewhat discredited by DUNLAP (1915) who concluded that the prior entry effect was due to artifacts associated with the experimental methodology of the earlier researchers. Later experiments by STONE (1926) and STERNBERG, KNOLL, & GATES (1971) avoided many of the problems posed by Dunlap and provided temporal order judgment (TOJ) data which confirmed Titchener's doctrine. Figure 1 is a modified version of the concurrent reaction time task and temporal order judgment paradigm employed by STERNBERG, *et al.* (1971). The methodology required subjects to determine which of two signals occurred first in a dual stimulus presentation, the subjects' attention having been biased to one of the signals by requiring a rapid response to it when it occurred. An idealization of the STONE (1926) and STERNBERG, *et al.* (1971) findings is given in figure 2. The displacement of the psychometric functions supports the notion that the attentional locus of the subject influences his judgment of temporal order. In the words of STERNBERG, *et al.*, "this means that the same stimulus pair can be consistently perceived in two different orders, depending on the state of attention" (p. 12). The spirit of the prior entry law, then, is that temporal perception is biased by attentional set.

Considering the ramifications that prior entry has for high speed perceptual-motor tasks involving multi-sensory input, we found it incredible that there had been such a paucity of

Figure 1 - Concurrent reaction time task and temporal order judgment paradigm.

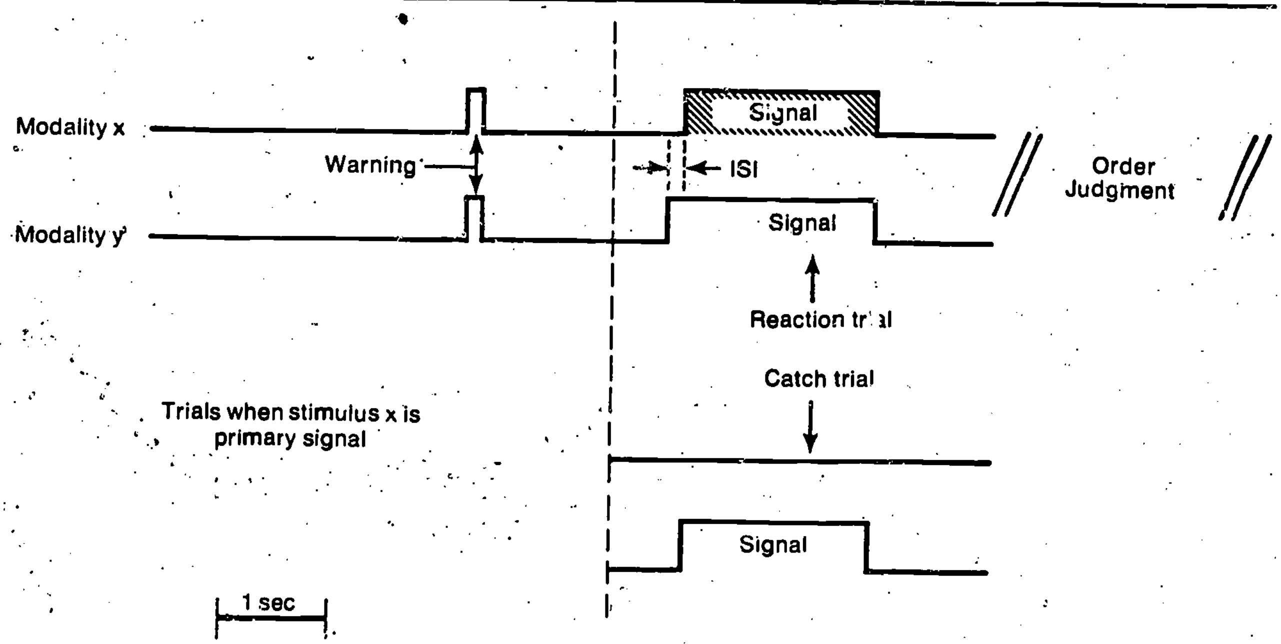
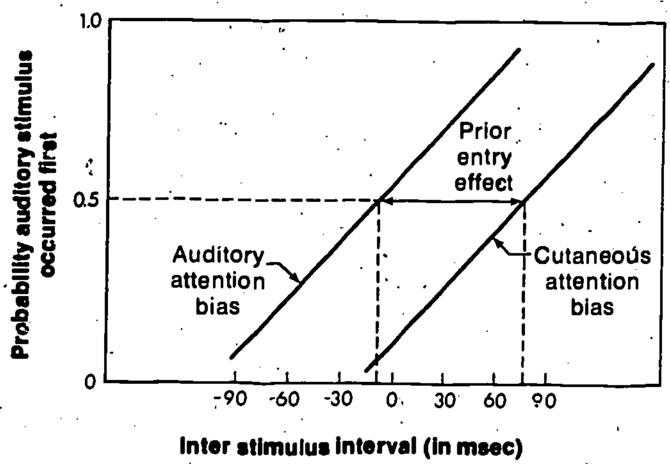


Figure 2 - An idealization of the effect of attentional bias on the temporal order of two discrete stimuli. After Sternberg, *et al.* (1971).
(Negative values on abscissa represent inter-stimulus intervals in msec when cutaneous signal preceded auditory signal. Positive values represent intervals when auditory signal preceded cutaneous signal. The zero value is the point of objective simultaneity of the two signals).



published experimentation in this area. Furthermore, it was of interest to note the subject pool from which the law had been tested and confirmed. For all of the studies relevent to prior entry, the total subject population numbered only 14, five on whom were the researchers themselves, and three more of whom were students in psychology, possibly acquainted with the prior entry law that they were testing. In view of the above, a possible explanation for the results thus far reported was that the prior entry effect may be closely related to the *a priori* knowledge of the "law" and subsequent expectations of the performer.

It has been suggested that the prior entry effect will shed light not only on how judgments of temporal order are accomplished, but also on the nature of attentional selectivity (STERNBERG, *et al.*, 1971). If this is true then it is important to reveal what, if any, constraints or qualifications should be given to the doctrine. In this regard, it was the purpose of this study to further test the law of prior entry by using subjects who had no *a priori* knowledge of it and who had no conscious nor unconscious interest in the experimental outcome. We felt that if TOJs were biased by the attentional state of the subjects then the prior entry doctrine would be more convincingly supported. If, however, subjects' TOJ ability were unaffected by the locus of their attention, then the validity of the doctrine would certainly be open to further inquiry.

METHODOLOGY

The experimental methodology was similar to that employed by STERNBERG, *et al.*, (Figure 1). In the present experiment, visual (white light) and auditory (1 000 Hz tone) stimuli at varying inter-stimulus intervals (ISIs) were presented. Attention to one of the signals, (the primary stimulus), was biased by means of a reaction time task. Immediately after selectively reacting to the primary signal, the subject was required to indicate which stimulus had occurred first. Catch trials were presented at random to ensure that reactions were selective. In these trials, only the signal not to be reacted to, (the auxillary signal), was presented.

Prior to the main experimental condition, control procedures were employed to determine the effect of the TOJ task on RT performance, as well as to determine the effect of the concurrent RT task on TOJ precision (the slope of the functions). Simple reaction time (SRT) for each modality was also recorded and used as a base line for reaction time analyses.

The subject sat facing a speaker/light ensemble in a dimly-lit, sound-attenuated experimental room. All relays and signal generating devices, as well as the experimenter himself, were located outside of the experimental room.

Subjects were six (6) University of Alberta graduate students in physical education. The three male and three female volunteer subjects had no previous experience in psychomotor experimentation nor any *a priori* knowledge of the law of prior entry. Subjects received instructions before each experimental session via tape recordings to ensure uniformity of presentation.

RESULTS

A subject by treatment design was used to test the TOJ ability of subjects under the various attentional biasing conditions. Three levels of attentional bias, nine ISIs, and six subjects comprised a 3 × 9 × 6 factorial matrix for this design, (repetitions were averaged to give probability scores as the dependent variable in this analysis). The analysis of variance, $F(2,10) = < 1$, showed no difference between subjects' TOJ ability when under the different attentional conditions. Such a result infers that attentional state had no effect on subjects' ability to judge temporal order. Figure 3 compares the results of the STERNBERG, *et al.* (1971) study and this investigation. The fact that all three curves lie in such close proximity is directly contrary to the predicted location of these curves by the law of prior entry.

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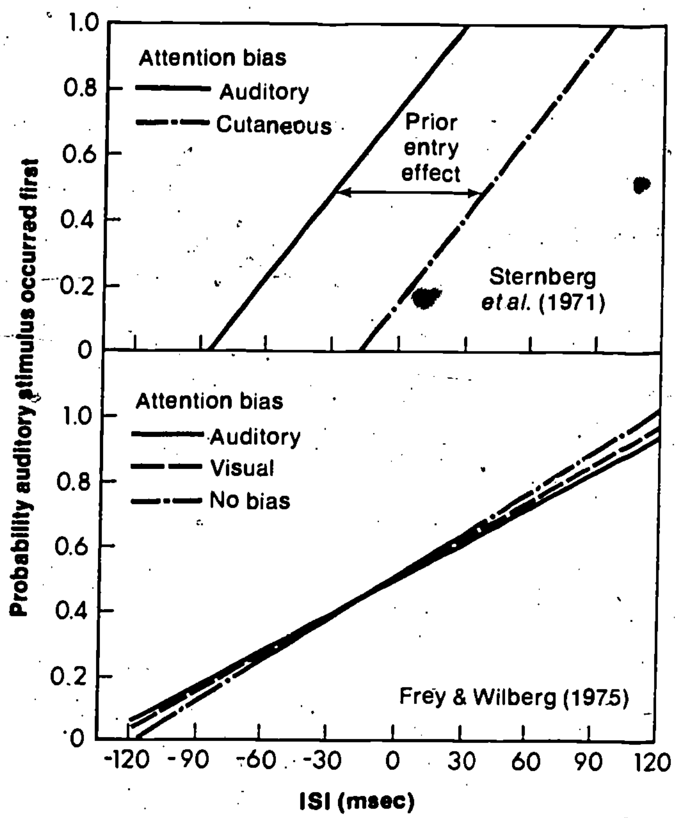
Figure 3 - Comparison of TOJ results of Sternberg, et al. (1971) and present study. Ordinate is the probability of the subject reporting that the auditory signal occurred first. Across the abscissa from left to right are the ISIs employed, with the non-auditory signal becoming more delayed relative to the auditory signal.
(*Note:* In the Sternberg, et al. study there was no curve given for the "no bias" condition).



DISCUSSION

Crucial to any test of the doctrine of prior entry is the requirement that attention be successfully biased toward a particular signal. Idealistically, the RT task was used to bias the performer's attention toward the stimulus reacted to; the assumption being that unless attention were successfully biased, RT performance would suffer. There was an average increase of 87 msec over SRT per modality in the RT control condition when no TOJ was required. Such an increase is congruent with expected RT performance when choice is added to an SRT task. An analysis of RT data revealed that subjects were able to maintain their performance almost perfectly when order judgments were added. Due to such stable RT performance, it was inferred that attention remained biased to the primary signal despite the addition of the TOJ task.

In view of the fact that attention appears to have been adequately biased to the primary signal, the results of the TOJ analysis clearly do not favor the doctrine of prior entry. Rather, subjects' ability to judge the temporal order of two stimuli occurring in close succession and in different sense modalities, seems unaffected by the induced attentional focus of the subject.

CONCLUSION

When TITCHENER (1908) propose the "law" of prior entry he placed emphasis on the fact that it was not to be understood dogmatically but was rather to be taken as a "general statement of the behavior of conscious contents given in the state of attention" (p. 211). To Titchener his "laws" were generated largely for the purpose of considering arguments and results that made against their universal validity. To Titchener, "the 'law' is rather a challenge, an appeal to the bar of fact" (p. 211).

The results of this study support the contention that temporal order judgments, in the complication task, are not affected by the attentional locus of the performer. In particular, the results show that an experimentally-induced attentional bias had no more effect on judgment ability than completely unbiased order judgment ability. In view of these findings, it is concluded that Titchener's "law" is an artifact, possibly due to the *a priori* expectations that the subjects in the earlier studies brought with them to the laboratory. The fact that subjects totally unfamiliar with the perceptual phenomenon associated with the "law", provided data completely contrary to it, supports this hypothesis. Research currently underway, addressing itself to the interaction between attention, reaction, and judgment ability may provide more distinct interactive associations between these component entities. In any event it is concluded that the results of this study have provided a "challenge, an appeal to the bar of fact" that further research will either substantiate or refute.

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EFFECT OF VARIATION IN FOREPERIOD DURATION ON FRACTIONATED REACTION TIME COMPONENTS

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Each behavior or action requires time to complete. Due to the precision with which time can be measured, WOODWORTH and SCHLOSBERG (1954) indicate that speed is a most readily assessed dependent variable. They suggest that time as a measurement has two general uses. First, speed can be used to assess achievement, for as one improves, the time required to complete a task is decreased, and second, as a measure of task demands on the organism, for tasks of greater complexity require more time to complete than those of a simpler nature. Since reaction time is the simplist of tasks, it is easy to understand that it has been used to describe differences between individuals in groups, such as athletes and non-athletes (KNAPP, 1961), and to contrast the efficiency of initial body positions prior to a movement requiring speed of response (SLATER-HAMMEL, 1953; COTTEN and DENNING, 1970).

It has been accepted that reaction time differs not only between individuals but within the individual under varying conditions. Differences in stimulus modality and intensity and the motivational conditions of the situtation are among the variables known to influence the total reaction time. Although considered a simple and uncomplicated task, reaction time has been shown to improve as a function of practice. These and other intraindividual variations have been of interest to investigators concerned with the mechanisms that control movement. A question that has received considerable attention is whether the intraindividual differences are central or peripheral.

To determine whether changes in total reaction time (TRT) due to variation in preparatory interval (PI), motivation, and age occur in the central nervous system or in the periphery, WEISS (1965) fractionated reaction time (FRT) to a simple auditory stimulus into two components. The TRT was recorded as was an electromyogram (EMG) of the muscle action potential of the extensor digitorum communis. The interval between the instant of increase in muscle action potential and the release of a telegraph key was labeled motor time (MT). Premotor time (PMT) was calculated by subtracting MT from TRT. The subjects were 24 male volunteers ranging in age between 18 and 80 years. A total of 24 practice and 12 recorded trials following randomly arranged PIs of 1, 2, 3, and 4 secs. were measured under each of two conditions, non-schock and shock, on day. In general, WEISS' results supported the hypothesis of central rather than peripheral changes, however, he cautioned that, as the subjects were unpracticed, changes attributed to motivation may have been confounded with practice effects.

In attempting to extend WEISS' findings, BOTWINICK and THOMPSON (1966) manipulated the anticipatory set both by contracting the the duration of the PI and by introducing regular and irregular series of PIs of different duration. Each subject responded to a simple auditory stimulus a total of 169 times, with 84 of the responses following PIs arranged in either a regular ascending or decending series and 85 irregulars or randomly arranged PIs. However, EMGs were recorded on only 82 of the trials. The analysis of the results indicated that PIs of different duration had a significant effect on TRT within each series. Similarly, a contrast of the regular and irregular series revealed a significant difference in TRT. The analyses of MT data showed no significant differences either between PIs within the respective series nor was a significant difference noted for the effects of regular vs irregular serios. However, PMT differences were found to closely parallel those of TRT with significant differences noted for contrasts both within and between the regular and irregular series. As a consequence of these results, it was concluded that anticipatory set is a function of the premotoric process.

KROLL (1973) used the FRT components as dependent variables in an investigation concerned with the mechanisms of muscular fatigue. Rather than administering all trials to the subject on one day, Kroll attempted to stabilize strength and reaction time values by administering 75 trials on each of four consecutive days. These sessions were followed by four days during which the effects of fatiguing bench stepping and knee extension isometric contractions were assessed by measuring fractionated reaction time components. While MT did not change significantly across days, both TRT and PMT decreased significantly following the first practice day. This indicated that practice effects or learning must be considered in investigations using FRT components as the dependent variables.

This investigation was an attempt to determine the effects of learning or practice on the distribution of FRT responses following randomly presented PIs of different duration.

METHOD

Subjects

The subjects were 25 male college students who volunteered to participate. The subjects, all of whom right-hand dominant, ranged in age between 18 and 26 years.

Apparatus

The subject sat at one end of a table that was 150 cm. from a vertical board which contained three neon lights affixed at approximately eye height for the seated subject. The top light was red and continually illuminated to serve as a fixation point. The middle light, located 2.5 cm. below the fixation bulb, was yellow in color and served as the stimulus. Located 2.5 cm. below the stimulus bulb was a yellow lamp that served as a ready lamp, which, when illuminated, served to inform the subject that the next trial could begin. This lamp was extinguished when the subject depressed a normally open micro-switch that served as the response key.

All measurement apparatus was located in a room adjacent to the one where the subject was seated. TRT was recorded on a Hunter Klockcounter. Two Hunter Interval Timers were employed, one was used to control the preparatory interval and the second served to delay the horizontal sweep of an oscilloscope that monitored the muscle action potential of the extensor digitorum communis.

Procedures

A subject met with the experimenter on each of four consecutive days. Prior to testing on each day surface electrodes were located on the right forearm on the subject over the motor point of the extensor digitorum communis and a ground electrode was located medial to and equal distant from each of the reference electrodes. The placement of the electrodes was marked to insure consistant positioning each day. A maximum of 5K ohms resistance was tolerated between the ground and reference electrodes.

Following the application of the electrodes the subject was seated before the stimulus display panel. The bottom of the three neon lamps, the ready lamp, was illuminated by the investigator following the selection of the desired PI. This signaled the subject to depress the reaction time key, which, when accomplished, started the interval timer that controlled the length of the PI and simultaneously extinguished the ready lamp. On each test day the subject reacted to 100 trials arranged in four blocks of 25 trials each with a one-minute rest provided between the blocks of trials. The PIs that preceded the stimulus presentation were randomly varied between 1, 2, 3, and 4 seconds with the constraint that each PI was employed 25 times per test day. An additional 10 catch trials were randomly arranged among the 100 simple reaction time trials.

At the end of the PI, the interval timer completed circuits that illiminated the stimulus bulb, started the electronic clock, and started a second interval timer. The second interval timer was employed to delay the sweep of the trace across the oscilloscope, thereby allowing a more precise measurement of the increase in muscle action potential. TRT was the interval between the onset of the stimulus and the release of the normally open switch that was depressed by the index and middle fingers of the right hand. PMT was the interval between the onset of the stimulus and the instant of observed increase in muscle action potential recorded on the oscilloscope. MT was determined by subtracting PMT from TRT.

RESULTS

Intraclass correlation coefficients were calculated for each of the FTR components. A coefficient of .92 was obtained for TRT, with values of .90 and .99 obtained for the PMT and MT components respectively.

Means for the TRT, PMT, and MT values were calculated for each subject for each of the four days. These values served as the data for analysis. Grand means for each of these values were calculated and are in Figure 1.

Separate variance analyses were completed on each of the FRT components for the effects of days and of PIs. The results of these analyses may be seen in Table I.

Total Reaction Time

The analysis of differences among days was significant, F (3,360) = 35.67, p .01. TRTs recorded on Days 3 and 4 were found to be significantly faster than those on Days 1 and 2. The contrast of PIs was also found to be significant, F (3,360) = 12.90, p .01. PIs of 2 and 3 secs. were significantly faster than either PIs of 1 and 4 seconds. The interaction between PIs and days, however, was not significant.

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Figure 1 - Mean total reaction time, premotor time, and motor time in milliseconds of 25 subjects, as functions of four test days and four preparatory intervals.

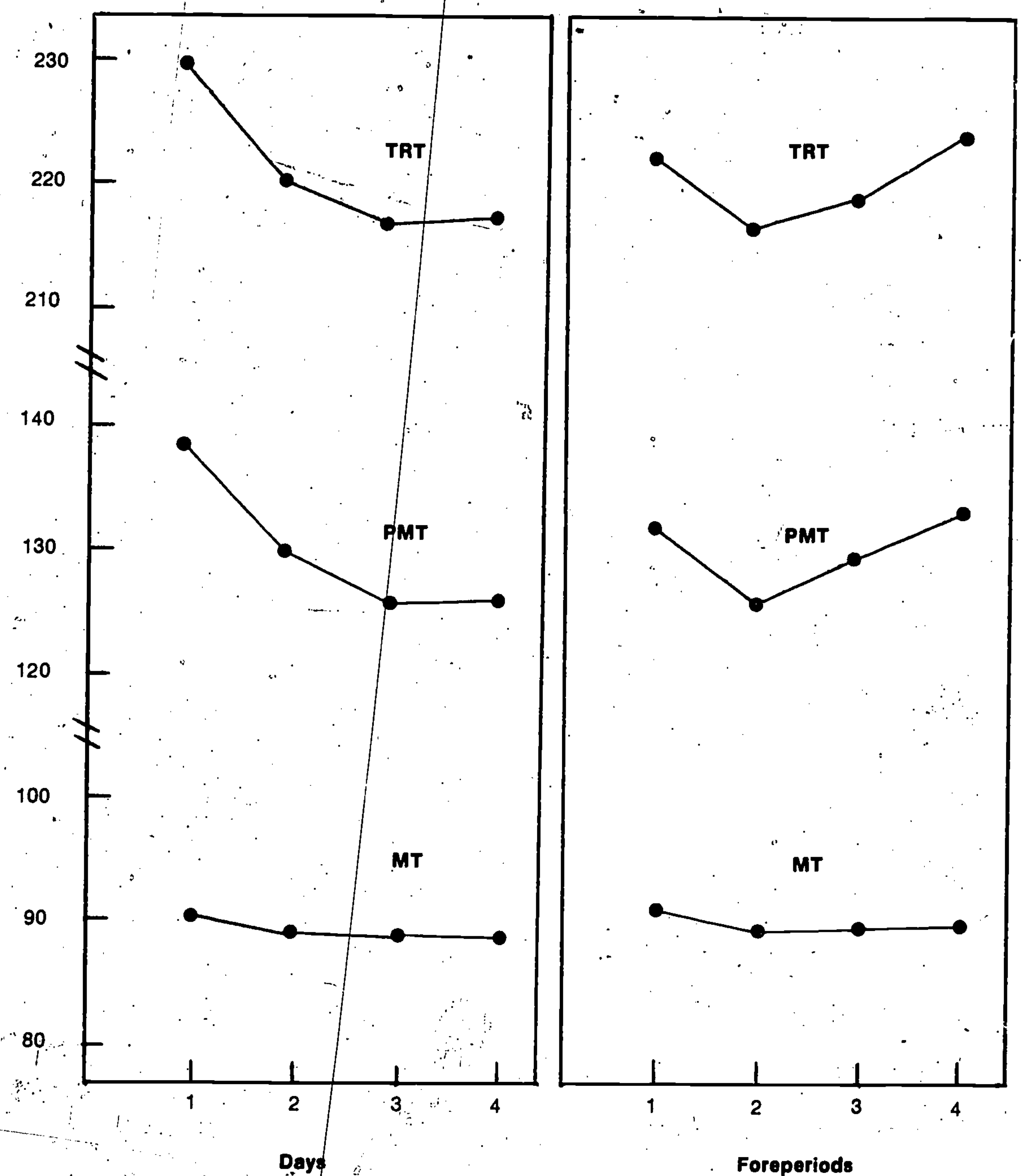

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Table I – Analyses of Variances of TRTs, PMTs and MTs across Days and PIs.

Source	df	TRT		PMT		MT	
		MS	F	MS	F	MS	F
Subjects	24	7099.75		4917.97		1254.68	
Days	3	3536.27	35.67 *	2969.96	30.30 *	10.37	4.09 *
Foreperiods	3	1280.21	12.90 *	793.25	8.09 *	9.68	3.82 *
Days × Foreperiods	9	40.10	< 1.00	17.70	< 1.00	0.81	< 1.00
Error	360	99.13		98.02		2.54	
Total	399						

$p < .01$.

Premotor Time

As shown in Figure 1, the profile of PMT values parallels that for TRT. The results of the analysis of variance for days was significant, $F(3,360) = 30.30$, p .01 Similarly, the contrast of PIs was also significant, $F(3,360) = 8.09$, p .01. Results of follow-up tests of the day and PI contrasts were the same as recorded for TRT, with Days 1 and 2 being significantly slower than Days 3 and 4. PMTs following PIs of 2 and 3 secs. were faster than those following PIs of 1 and 4 secs. The interaction between days and PIs was not significant.

Motor Time

The profiles for MT as shown in Figure 1 indicate that little variation occured due to differences in PIs or in days. The results of the analysis of variance, however, indicated that both the effect of days, $F(3,360) = 4.09$, p .01 and PIs, $F(3,360) = 3.82$, p .01 were significant. But, follow-up tests could not detect where the differences were located.

Intercorrelations

Pearson product-moment correlations were calculated among the FRT components, for days and PIs. As may be seen in Table II, the correlation between TRT and PMT were high, with a mean (by Z' transformation) of .92, p .01. The correlations between TRT and MT were also significant, with a mean value of .52, p .05. The relationships between PMT and MT at across days and PIs, were not, however, significant.

Table II – Correlations among TRT, PMT, and MT by Days and PIs.

Day	TRT-PMT	TRT-MT	PMT-MT
1	.93	.53	.25
2	.93	.52	.19
3	.92	.43	.06
4	.90	.59	.19
PI			
1	.93	.50	.17
2	.92	.54	.17
3	.93	.53	.17
4	.93	.51	.18

DISCUSSION

The reliability of the measurement schedule to assess FRT components was considered adequate. Intraclass correlations were approximately equivalent to those obtained by KROLL (1973). However, since a significant decrease in TRT and PMT was found between Days 1 and 2 when contrasted with Days 3 and 4, the means of trails obtained on Days 3 and 4 would be free of practice or learning effects due to the four day testing schedule.

Day-to-day improvement is apparently a function of central rather than peripheral changes. The correlations between TRT and PMT remained approximately the same from day-to-day while significant decreases in TRT and PMT occured. As indicated by BOTWINICK and THOMPSON (1966), since PMT and MT are uncorrelated, the variability of TRT is a direct function of the relative size of the variance of the components. Thus, PMT rather than MT is the variable that accounts for the majority of TRT differences. Similarly, the variance in TRT following PIs of different duration was also a function of PMT rather than MT. This is consistant with the findings of WEISS (1965) and BOTWINICK and THOMPSON (1966).

Investigations that propose to use FRT components as the dependent variables, especially when independent variables are within-subjects contrasts, are cautioned that learning or practice effects are likely to confound conclusions based on TRT and PMT components.

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APPLICATION OF THE LIMITED CAPACITY MODEL TO DURATION DISCRIMINATION

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Studies in duration discrimination have been preoccupied with the problem of the energy cues influencing the discrimination of duration. Since duration is part of a stimulus pattern consisting of various dimensions, it was hypothesized that an O did not only use the temporal extent of a stimulus in order to evaluate its duration. That is, energy cues amongst others may be used in assessing stimulus duration. For instance, for duration (T) of less than critical value, the apparent brightness of a constant intensity flash will be inversely proportional to its duration (STEVENS & HALL, 1966; STEVENS, 1966). Such findings seem to support the above hypothesis. Experimental testing of this hypothesis has been undertaken extensively over the recent years. The results show that for T in the 100 msec. range, luminance of filled visual intervals (ALLEN, KRISTOFFERSON, & WIENS, 1971) and empty visual intervals (NILSSON, 1969) does not appear to have any systematic effect on duration discrimination. Similarly, energy cues proved inefficient in affecting performance in studies with filled auditory signals (ABEL, 1972; CREELMAN, 1962) or empty auditory intervals (CARBOTTE & KRISTOFFERSON, 1973). Although the issue is not completely clarified, it is generally assumed in psychophysical theories of duration discrimination that the internal duration representation (I_t) of a stimulus is only function of its temporal extent, T, meaning that at input, I_t is an independent or orthogonal dimension.

Furthermore, results from studies involving temporal judgement on signals originating in different modalities (HIRSH & SHERRICK, 1961; ROUSSEAU & KRISTOFFERSON, 1973) have been widely interpreted as an indication that duration is processed by a common central processor (STERNBERG & KNOLL, 1973). Thus, a general assumption can be put forth: duration discrimination tasks require the processing by a central mechanism of an independent stimulus dimension: duration.

We would like to argue that a through evaluation of the orthogonality of duration needs to go further than the type of studies previously referred to. That is, one should assess the load put on the central processor by the monitoring of duration. One way of evaluating the independence of duration is in terms of the limited capacity characteristic of the central processor by means of the simultaneous multidimensional discrimination technique.

Indeed, it has been shown that an O cannot attend to independent stimulus dimensions at the same time (BROADBENT, 1958; TREISMAN, 1964; WELFORD, 1968). Thus, if an O has to discriminate simultaneously on two values of duration and two values of some other independent stimulus dimension (e.g.: spatial position), a drop in performance is expected on one or both dimensions as compared to the performance level in a unidimensional task for each of the dimensions.

However, in order to produce an overload on the central processor, the duration of a given stimulus has to be short enough so that complete processing of both dimensions is not possible within that amount of time. LINDSAY, TAYLOR and FORBES (1968) showed that the performance decrement observed in a multidimensional simultaneous discrimination task was reduced by an increase in duration of the stimulus presentation for values of 67, 133 and 200 msec.

In the present experiment, an O had to discriminate simultaneously between durations d_0 and d_1 and spatial positions left and right of a small spot of light. Nonetheless, a staightforward application of this experimental procedure with duration discrimination is complicated by the risk of confounding variables arising from interrelations between stimulus duration and the discriminability of spatial position. It could very well be that spatial position discriminability is a function of the stimulus duration. Such an interaction weakens considerably the orthogonality assumption of the dimensions. So, precautions had to taken so as not to have judgment on spatial position dependent on stimulus duration. The relationship:

$$P(C_p/d_0) \quad P(C_p/d_1)$$

where C_p is a correct response on position, had to hold or else it could be argued that the judgment on the temporal extent of the stimulus was not based on the temporal information alone.

It has also been proposed that duration is a function of non-temporal features of a stimulus condition: the amount of processing done in a task (FRAISSE, 1957; ORNSTEIN, 1969; MICHON, 1970). Therefore, in the present case d_0 and d_1 could yield different processing times for spatial position, thus, making available to the O a non-temporal cue for discrimination on stimulus duration. Then an argument based on an increase in processing load in a bidimensional situation could not be maintained because the O would ot be necessarily monitoring two independent dimensions.

In the present experiment, three O's were subjected to three experimental conditions where both spatial position and duration varied randomly from trial to trial. In the first condition the O's were asked to respond to changes in position only; in the second condition they had to respond to variations in duration; in the third condition they had to respond to variations in both dimensions.

METHOD

Apparatus and Experimental Set Up

The stimulus was presented in a 2 channel tachistoscope, (Gerbrand's), with back illumination. The visual signal was a circular spot of light of .5 degrees and 2.53 c/ft which varied in position .08 degrees to the left or right of a center point in a visual field predetermined by a square, aim adjusting signal (7.5 cm). O had his head supported on a chin rest.

An audio frequency oscillator (HP model 201) produced the auditory warning and feedback signals of 250 msec given to the O through earphones: to the left and right ear respectively.

The O responded by depressing push buttons according to instructions.

The experiment took place in a semi-illuminated room with ambient white noise.

Subjects

Three male volunteers of college age were used. They were paid $1.50 per session including the pre-experimental ones.

Procedure

A warning signal of 1 500 Hz initiated every trial. The aim adjusting signal followed immediately for 1 100 msec and was succeeded by a 1 000 msec interval. Then, the target stimulus appeared. The O pressed the appropriate response buttons according to the experimental condition. O then received auditory feedback.

In the unidimensional situations, the O received a single auditory feedback corresponding to the stimulus signal presented in that trial. A single pulse auditory signal represented the T 50 msec or the left position while a two pulse signal represented the T of .80 msec or the right position.

In the bidimensional situation, the O received feedback on both dimensions sequentially, corresponding to the order the O used to respond.

The O's. who had previously been trained (520 practice trials for both duration and position). had attained an asymptotic performance level for each dimension when the actual experimental sessions started. A session was composed of three blocks of trials, one for each experimental situation: two unidimensional blocks (one for T and the other for position) during which the O had to respond to variations in only one dimension through the whole block of trials; during the bidimensional block, the O had to respond to variations on both dimensions.

Each block consisted of 60 trials. Both dimensions varied randomly from trial to trial. Each value of both dimensions came out an equal number of times. The O received a 2 min. rest period between blocks.

The experiment proper lasted six sessions. In each session the three blocks were randomly distributed. The results were calculated 180 trial/stimulus in the unidimensional conditions and 90 trial/stimulus in the bidimensional one.

RESULTS

The data was pooled over the three O's. Therefore, all the analysis were done on 540 trial/stimuli in the unidimensional and 270 trial/stimuli in the bidimensional situations.

A first test for dimension independence of duration and position comes from an analysis of the relationship between the P(C) on position given its duration of presentation. Table I shows the probability of a correct response on position for both d_0 and d_1, $P(C_p/D_i)$. In both the unidimensional and bidimensional conditions, duration did not initially affect the discriminability of spatial position. Although no statistical test was run, an idea of the statistical significance of the difference between the proportions can be obtained by using the binomial variance of the proportion found in both situations. In the unidimensional condition the standard deviations for $P(C_p/D_0)$ and $P(C_p/d_1)$ are .109 and .019 respectively. Thus, it is unlikely that the small difference observed reaches any level of statistical significance. Similarly, in the bidimensional condition, the difference can be considered as being non-significant.

A further evaluation of duration independence comes from an analysis of the effect of the bidimensional response requirement on performance level in the bidimensional situation. As is argued above independence should yield a drop in performance on one or both dimensions. The P(C) for each dimension in both condition is reported in Table II. It is apparent that there was a drop in performance in the bidimensional condition. The decrement in P(C), on the average, was 7% on duration and 5% on position. If the rationale of binomial variance is used on this data, the proportions of the unidimensional and bidimensional conditions are at least 2.5 standard deviations away from each other for each dimension. Such differences are considered as significant.

A final analysis was made in order to verify if the drop in performance in the bidimensional condition was due to a shift in decision making strategy. This was done by calculating the d' for both conditions. Table II shows that d' values diminished therefore, suggesting that the drop in performance did not probably originate in a shift of strategy.

Table I - Probability correct on spatial position for d_o and d_i.

	$P(C_p/d_o)$	$P(C_p/d_i)$
Unidimensional	.71	.72
Bidimensional	.65	.67

Table II - P(C) and d for unidimensional and bidimensional situations.

Dimension		Situations: Unidimensional	d	Bidimensional	d
Duration	50 msec	.734	1.30	.602	.89
	80 msec	.750		.734	
Position	Left	.804	1.17	.768	.88
	Right	.622		.560	

DISCUSSION

The aim of the present experiment was to verify the feasibility of using the simultaneous discrimination technique in the testing the orthogonality of duration. As is mentioned above, a basic assumption of the model is that independent dimensions require simultaneous processing. Thus, care had to be taken so as to be sure we were dealing with internal dimensions corresponding to the respective physical correlate, only. The present findings have definitely supported such an assumption. Indeed, in both conditions $P(C_p/d_o$ and $P(C_p/d_i)$ was not different.

Independence between the dimensions has been further supported by a drop in performance in the bidimensional situation as compared with performance in the unidimensional one.

We may then generally conclude that in the above experimental conditions duration is an independent variable which has to be attended to in order to perform an accurate judgment on it.

Yet, even if the data supports the above statement, we are still left with a puzzling problem. That is, how do we explain the greater drop in performance on d_o as compared to d_i? It is all the more puzzling by the fact that performance on position is not correlated to d_i. A tentative explanation for this comes from the fact that one dimension is static, the other dynamic. No matter the duration of the stimulus a minimum duration C can be defined for attaining a given performance level on position. Thus as d_i approaches C_i, the effect of C on the variability of the internal representation of d increases. As d increases, the proportion of the total stimulus extent spent in processing position becomes smaller and eventually, negligeable. We have gathered further data in our laboratories supporting this explanation. For stimuli in the 500 msec range, no drop is observed in the bidimensional condition. However, we believe that by increasing the processing requirements on position similar results as those [illegible] in the present experiment should be observed.

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AN INFORMATION PROCESSING APPROACH TO TEMPORAL ANTICIPATION *

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INTRODUCTION

The effect of variability of foreperiod (FP) intervals on reaction time (RT) appears to be cortically mediated. (FITTS and POSNER, 1967; KEELE and POSNER, 1972; BUCKHOLZ, 1975; and BUCKHOLZ and WILBERG, 1975) Several authors have proposed that these cortically mediated effects can be accounted for by temporal uncertainty (TU) and S strategies based on conditicnal probabilities. (MOWRER, 1940; POULTON, 1950, 1956; DEESE, 1955; ELITHORN and LAWRENCE, 1955; BROADBENT, 1958; GOTTSDANKER, *et al.*, 1963; KROLL, 1969; GOTTSDANKER, 1970; ROTHSTEIN, 1973; and BUCKHOLZ and WILBERG, 1975) WELFORD (1968) has proposed that the temporal uncertainty effects observed, even when no response is required, may be due to single channel delays. The majority of evidence cited to support this point employed short FPs or inter-stimulus intervals. It seems plausible to consider that the increased RT to the second of two stimuli, when responses to both S_1 and S_2 are required, may be due to motor aspects (WELFORD, 1968; GREENWALD, 1973) added to an already existing effect of temporal uncertainty-conditional probability (TU-CP). If a response was not required to the first stimulus the observed effects would be less pronounced, suggesting TU-CP effects alone. The purpose of the studies reported in this paper were to examine some aspects of the TU-CP question. It is suggested that S may be viewed as an information processing system employing complex strategies in dealing with perceptual data. The TU-CP hypothesis is consistent with the view of BUCKHOLZ and WILBERG (1975) that an information reduction theory would be a parsimonious explanation of the effects of FP variability and that the "immediate foreperiod effect" is due to the a priori probability of all succeeding FPs.

REVIEW OF LITERATURE

In surveying the literature, three rather different effects of FP variability have been noted. In several studies (BREITWEISER, 1911; WOODROW, 1914; TELFORD, 1931; KARLIN, 1959; and HOHLE, 1965), most of which used the method of constant presentation, expectancy appeared high at the beginning of a range of intervals. Generally, as the FP lengthened RT increased.

In other studies expectancy appeared to be low immediately after a warning signal, high at the mean FP, and low after the mean. (WOODROW, 1914; MOWRER, 1940) MOWRER (1940) used a range of intervals from 3-24 seconds with increments of 3 seconds. The results observed were hardly unexpected since, of a total of 69 trials, 61 of the trials were at the midpoint of the range, 12 seconds, WOODROW (1914) used a variable method of presentation to elicit RT. The intervals were randomly varied from 4-20 seconds by increments of 4, with each randomly selected interval presented 25 times before the next randomly selected interval. Several studies reported by BERGSRUND (1967), which employed random presentation of FPs, also reported U-shaped RT curves.

Finally, in a large group of studies expectancy appeared to be low immediately after a signal and then increased over the full range of intervals. The observed effect was that RT varied inversely with the length of the FP interval. Studies in which this result has been reported have typically presented FPs over ranges of 6 seconds or less. (KLEMMER, 1956; BAILEY, 1959; KARLIN, 1959; DRAZIN, 1961; HOHLE, 1965; NICKERSON, 1965; SANDERS, 1965; PAIGE, 1969; ROTHSTEIN, 1973; GUIARD and REQUIN, 1973; POSSAMAI, *et al.*, 1973; and REQUIN, *et al.*, 1973). The TU-CP hypothesis appeared to be a reasonable explanation of the observed effects but the FPs, ranges, and probabilities employed give serious question to its' universality.

Evidence produced by SNODGRASS (1969) and SNODGRASS, *et al.* (1967) would seem to support the view that Ss estimate the intervals and that RTs less than "true reaction time" would be evidence that Ss were anticipating FPs on the basis of estimates from the warning signal. The TU-CP hypothesis proposes a strategy, based on information processing, by which the S guides behavior. The "S is unwilling to prepare early in the range because he knows that momentary probability is low" (GOTTSDANKER, 1970). If the TU-CP hypothesis is viable that RT distributions should be predictable on the basis of conditional probability.

The studies reported by STADULIS (1967) and BERGSRUND (1967) were sufficiently different from the rest to warrant detailed consideration. STADULIS (1967) investigated the finding of WOODROW (1914) that RT was fastest at a 12 second interval when it appeared at the mid-point of a range. Since many of the studies which had reported decrease in RT with increase in FP used small intervals it was important to determine whether the two findings were compatible. Three ranges were employed: 10, 10.5, 11, 11.5, 12; 11, 11.5, 12, 12.5, 13; and 12, 12.5, 13, 13.5, 14. It was hypothesized that the ranges employed would be similar, in their effect on RT, to shorter ranges. No significant differences were observed. It was concluded that the differences between adjacent intervals were not sufficiently large enough for Ss to ascertain that they were different. Two of the studies to be reported deal with this problem.

BERGSRUND (1967) used short FP intervals, 1, 2, 3, 4, and 5 seconds, and manipulated the probabilities of the 2 and 4 second intervals. There were seven treatment groups, as illustrated in Table I. The top number in each row indicates the probability of that particular interval and the lower number indicates the number of times that interval actually occurred. A total of 800 trials were given to each S over two

* The research for Experiments I, II, and III was conducted under the supervision of A. M. Gentile while the author was a student at Teachers College, Columbia University.

Table I – Unequal probability treatment groups. (BERGSRUND, 1967).

Group	FP	Seconds 1	2	3	4	5
I	p	.20	.20	.20	.20	.20
	#	160	160	160	160	160
II	p	.15	.40	.15	.15	.15
	#	120	320	120	120	120
III	p	.10	.60	.10	.10	.10
	#	80	480	80	80	80
IV	p	.05	.80	.05	.05	.05
	#	40	640	40	40	40
V	p	.15	.15	.15	.40	.15
	#	120	120	120	320	120
VI	p	.10	.10	.10	.60	.10
	#	80	80	80	480	80
VII	p	.05	.05	.05	.80	.05
	#	40	40	40	640	40

testing days. Unfortunately, Bergsrund did not do a complete factorial analysis on the data so some of the comparisons are not possible until this is completed.

The groups in which the probability was .40 at the 2 and 4 second interval followed a similar overall pattern, RT decreased as FP lengthened to the 4 second interval than increased slightly, but significantly, at the 5 second interval. This may be understandable since the j.n.d. for temporal measures has been reported as 20% but there would be much individual variability. More than half of the Ss in the equal probability group and in the 40% probability groups showed decreasing RT over the total FP range, supporting this possibility.

In groups V and VII, .60 and .80 probability at 4 seconds respectively, RT decreased as FP lengthened, but in group VII the observed difference between the 4 and 5 second interval was not significant. In contrast groups IV and VI, .60 and .80 probability at 2 seconds respectively, tended to be inconsistent. In VI the fastest RT was obtained at the 2 second interval, while in group IV both 5 and 2 second intervals tended to be fastest.

Increasing probability seems to have an effect at 2 seconds when increased from .20 to .40 and from .60 to .80 and at 4 seconds only the increase from .20 to .40 effected a significant decrease in RT. It will be interesting to compare the results obtained by BERGSRUND with the results to be reported here under Experiment II.

Summary

It was indicated that the most common effect of FP variability on RT was a decrease in RT as FP lengthened. This effect was assumed to be cortically mediated and indicative of the "immediate foreperiod effect" which was due to the a priori probability of all succeeding FPs. (BUCKHOLZ and WILBERG, 1975) This concept was expressed as TU-CP indicating that on the basis of temporal uncertainty of FP intervals, which may be manipulated by E, the S formulates conditional probabilities and RT changes as a consequence. Two studies, STADULIS (1967) and BERGSRUND (1967) fit into the studies to be reported here.

It is hypothesized that if TU-CP were an adequate explanation of Ss RT behavior under conditions of FP variability than:

- The absolute length of a FP would not matter but its' relative length and thus its' position in a range of FPs, would affect RT.
- The probability of a particular FP should effect RT to the extent that it changes the CP of that particular FP. Increasing the frequency of occurrence should decrease RT.
- If the S cannot extract probability information, i.e., if adjacent FPs do not exceed the required j.n.d., than no TU-CP effect should be observed.
- The Ss RT should more closely approximate CP in later blocks of trials.

METHOD

Subjects

The Ss used in the four experiments to be reported were female, with the exception of those in Experiment I. All Ss were college age, average age 22, range 17-27. They were naive to the express purpose of the experiments, except for the instruction that reaction time was of interest. All Ss used their dominant hand and wore glasses, if necessary. The number of Ss used were: Experiment I, 21; Experiment II, 21; Experiment III, 45; and Experiment IV, 16.

Design

In Experiment I the design was a 3 × 5 factorial with repeated measures on the second factor. The first factor was group, defined by the position of a 2.5 second interval, and had three levels as indicated in Table II. The second factor was interval position and had five levels.

Table II – Treatment groups in experiments I–IV [1].

Exp.	Group	Foreperiod 1	2	3	4	5
I	1	.50	1.00	1.50	2.00	2.50
	2	1.50	2.00	2.50	3.00	3.50
	3	2.50	3.00	3.50	4.00	4.50
II	1	5.70	6.90	8.30	10.00	12.00
	2	8.30	10.00	12.00	14.40	17.30
	3	12.00	14.40	17.30	20.80	25.00
III	1	.50	1.00	1.50	2.00	2.50
	4 [2]	.40	.15	.15	.15	.15
	5 [2]	.60	.10	.10	.10	.10
	6 [2]	.15	.15	.40	.15	.15
	7 [2]	.10	.10	.60	.10	.10
	8 [2]	.15	.15	.15	.15	.40
	9 [2]	.10	.10	.10	.10	.60
	1	1.50	2.00	2.50	3.00	3.50
	2	11.00	11.50	12.00	12.50	13.00
	3	1.50	1.60	1.70	1.80	1.90
	4	8.30	10.00	12.00	14.40	17.30

1. Except where noted numbers in table are foreperiod values.
2. Values in groups 4-9 are probability values, the foreperiod intervals are the same as in group 1.

In Experiment II the 3 × 5 factorial design was repeated except that the foreperiod values were changed. In this study the position of the 12 second interval was varied and an inter-interval size of 20% was maintained. The intervals used are illustrated in Table II.

In Experiment III a 3 × 3 × 5 factorial design with repeated measures on the last factor was used. The first factor was probability and had three levels: .20, .40, .60. The second factor was FP position of increased probability and also had three levels: first, third, or fifth position. The final factor was foreperiod position and had five levels. The treatment groups are illustrated in Table II. In experiments I, II and II mean RT was used as the score.

In Experiment IV a 4 × 5 factorial design with repeated measures was employed. The first factor was a combination of range length and j.n.d. The four resulting treatment groups are presented in Table II. As before the second factor was FP position. The score used for analysis was mean RT difference. This was obtained by subtracting overall mean RT from the mean at a particular FP interval.

Apparatus

The equipment used in this study was standard RT equipment. The experimental situation has been described elsewhere. (ROTHSTEIN, 1973) The only differences were in the intervals used.

Procedures

In each of the experiments the Ss were tested in a single session. The major differences among the studies were in the number of trials used. Since several authors have suggested that RT and RT variability decreases with practice it is clear that, in spite of the significant results to be reported, the number of trials employed were far too small. The trials for Experiments I, II, III, and IV were 50, 60, 60 and 105 respectively. For the fourth study the first 15 trials were considered as practice; for the other experiments practice trials were provided before testing but were not recorded.

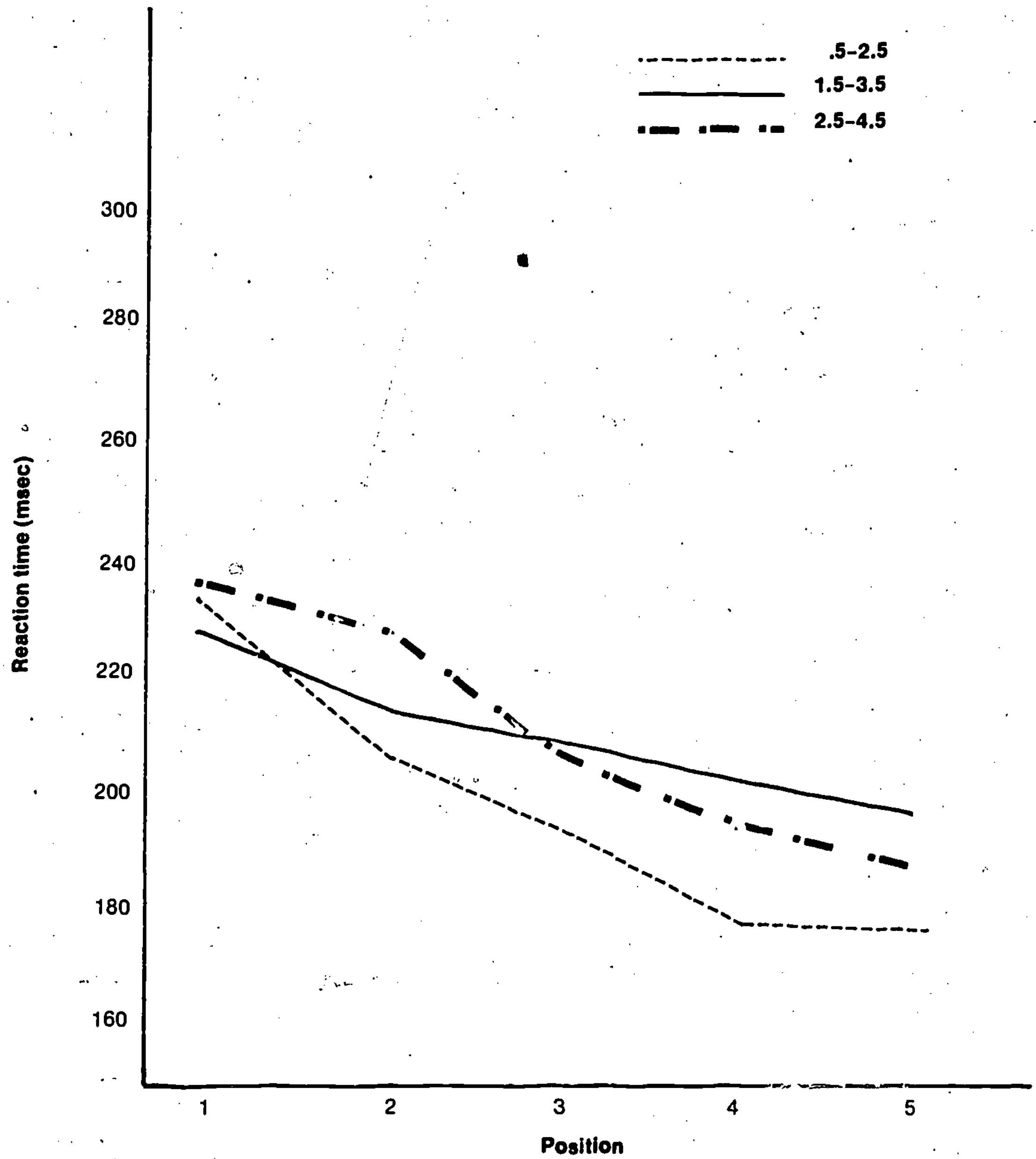
The Ss were instructed that the E was interested in the speed of RT to a light stimulus and that the stimulus would follow a warning signal. This warning was a bell in Experiments I, II and III, and the offset of a light in Experiment IV. No attempt was made to prevent anticipation.

RESULTS

Experiment I

The initial purpose of Experiment I was to explore the effect of FP position on RT. It was predicted and confirmed that RT would decrease as a 2.5 second FP was moved from first to middle to last position in a range. As a consequence of those results and the observation that the first FP in each of the ranges was significantly slower than all others, which showed a downward trend as indicated in Figure 1, it was decided to employ the same techniques with a twelve second interval.

Figure 1 - EXPERIMENT I: Mean RT for three short FP ranges. (ROTHSTEIN, 1973).



Experiment II

The purposes of Experiment II were to: replicate STADULIS (1967) study using the appropriate j.n.d. between intervals; ascertain the effect of the position of a twelve second interval on RT; further investigate the CP hypothesis proposed by ROTHSTEIN (1973); clarify the results of WOODROW (1914) and MOWRER (1940).

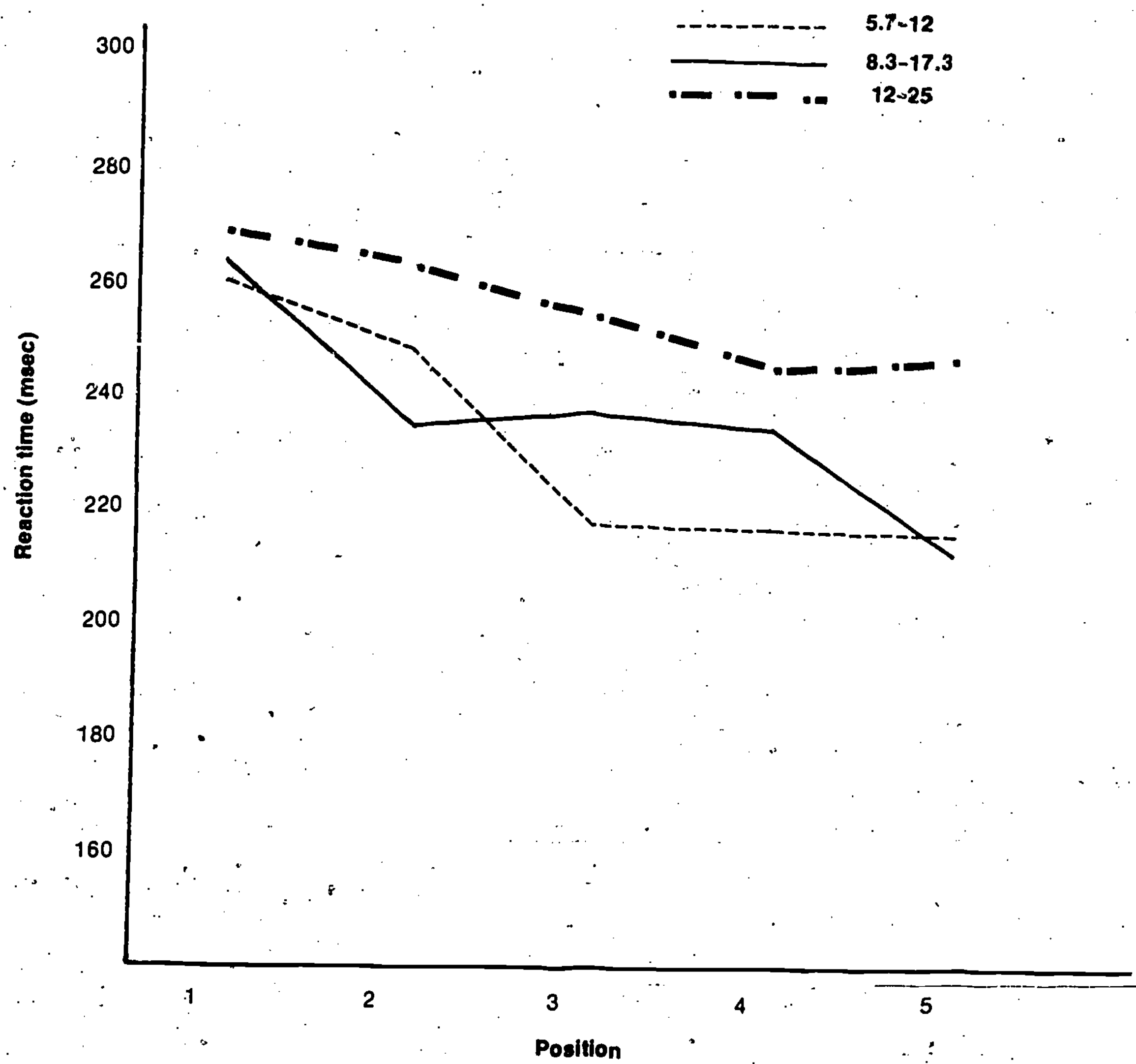
It can be seen in Table III that the particular range did not produce a significant difference in overall RT, although it appeared (see Figure 2) that RTs to the FPs in the 12-25

Table III – ANOVA for mean RT for three ranges of foreperiods with a common foreperiod of 12 seconds.

Source of variation	SS	df	MS	F
Total	131964.533	104		
Between	92569.733	20		
Groups (A)	9122.133	2	4561.067	< 1
Error	83447.600	18	4635.978	
Within	39394.800	84		
Position (B)	17624.057	4	4406.014	18.96 **
AB	5041.486	8	630.186	2.71 **
Error	16729.257	72	232.350	

** $p < .01$.

Figure 2 – EXPERIMENT II: Mean RT for three long FP ranges with j.n.d. equal 20%.



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second range were slightly greater. The overall effect of position of a FP was significant at the .01 level. The mean RT for positions 1, 2, 3, 4, and 5 were 265, 253, 242, 238, and 231 msec respectively. Individual comparisons revealed that RT at position 1 was slower than RT at position 2 and all others, and RT at position 2 was slower than RT at position 3 and all others but that positions 3, 4, and 5 were not significantly different.

There was a significant interaction between range and position and individual comparisons revealed that for the 5.7-12 second group RT at the 5.7 and 6.9 second interval were significantly different from each other and from all other intervals. For the 8.3-17.3 second range RT at 8.3 was significantly slower than RT at all other intervals and RT at 14.4 seconds was significantly slower than that at 17.3 seconds. No significant differences were noted for the 12-25 second group.

The results of this experiment were expected, given the small number of trials. The trend of the group mean RTs seems to be downward but further study with increased trials would be necessary before considering the results seriously in terms of the TU-CP hypothesis. When contrasted with the results of STADULIS (1967) experiment it appeared that a minimal j.n.d. was necessary for Ss to be able to differentiate among intervals. The difficulty with the 12-25 second range may be due to the inability of Ss to discern differences, in spite of the 20% j.n.d. or to the aversiveness of maintaining attention over long time intervals. (GOTTSDANKER, 1974).

Experiment III

In designing Experiment III it was reasoned that if the TU-CP hypothesis was viable than manipulating the probabilities and position of increased probability would affect RT. The results of the ANOVA are presented as Table IV. Although significant results were observed for position of increased probability, (B), FP position, (C), and the interaction of BC and probability (A) with BC, these results represent early learning.

Table IV - ANOVA for mean RT for foreperiod position, interval of increased probability, and probability.

Source of variation	SS	df	MS	F
Total	4138.20	224		
Between	2564.62	44		
Proby (A)	29.94	2	14.94	< 1
Position (B)	526.97	2	263.49	5.13*
AB	158.22	4	39.56	< 1
Error	1849.49	36	51.37	
Within	1573.58	180		
Foreperiod (C)	745.41	4	186.35	47.78**
AC	8.82	8	1.10	< 1
BC	104.69	8	13.01	3.34**
ABC	152.47	16	9.53	2.44**
Error	562.19	144	3.90	

* $p < .05$.
** $p < .01$.

The results for position of increased probability, as shown in Table V, indicate that an increase in probability for the first FP decreases RT significantly over increases for the third and fifth FPs, 18.8, 22.5, and 22 respectively. For FP position, which was significant at the .01 level, individual comparisons of the means in Table VI revealed that RT at FP 1 was slower than RT at FP 2, 3, 4, and 5, and RT at FP 2 was slower than RT at FP 3, 4, and 5, but RTs at FPs 3, 4, and 5 did not differ.

The interaction of position of increased probability and foreperiod position was significant at the .01 level. Individual comparisons were conducted and revealed that in each case the means, presented as Table V, for FP 1 were associated with slower RT and that the RTs for the groups with increased probability at the first position were faster than RTs for the groups with increased probability at the third or fifth positions. It should be noted that the mean RTs for group 1 were closer to those for groups 2 and 3 at FP positions 2, 3, 4, and 5 than at FP 1.

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Table V – Mean RT for position of increased probability and foreperiod position.

FP	Foreperiod position 1	2	3	4	5	
1	20.6	19.1	17.7	18.4	18.4	18.8
2	26.4	21.9	21.1	20.5	20.8	22.5
3	26.7	21.4	20.9	21.0	20.2	22.0

Table VI – Mean RT for probability, position of increased probability, and foreperiod position.

Proby	FP	Foreperiod position 1	2	3	4	5
	1	22.6	18.9	17.3	17.1	16.9
.20	2	25.0	22.2	21.4	20.4	21.0
	3	25.1	20.7	21.0	20.9	21.0
	1	20.9	19.6	18.3	19.5	19.6
.40	2	27.0	23.2	21.5	20.0	19.7
	3	24.5	19.6	19.3	19.8	18.7
	1	18.4	18.9	17.4	18.6	18.6
.60	2	27.2	20.3	20.5	21.1	21.8
	3	30.5	23.8	22.6	22.2	20.9
		24.6	20.8	19.9	19.9	19.8

The three way interaction, foreperiod position, probability and position of increased probability, is presented in Table VI and in Figures 3 through 8. It appeared that when probability at FP 1 was increased RT, 22.6 for .20, 20.9 for .40 and 18.4 for .60 probability, decreased. The differences for the latter two groups may be seen in Figure 4. There were no significant differences for the other FP position. When probability of FP position 3 was increased no significant changes in RT were noted. For changes in probability at FP position 5, see Figure 6, an increase in RT for FPs 1, 2, and 3 was noted when probability was increased from .20 to .40 to .60.

Figure 7 illustrates the differences in RT obtained when probability was increased to .40 at various positions. The RT was fastest at the .5 second interval when probability of that interval was increased; when the probability of the 1.5 second or middle interval was increased RT at the .5 second interval slowed. Similar changes in the RT were observed for the 1.0 and 1.5 second intervals, when the probability of occurrence of the middle interval was increased to .40 RT was increased more at the first three intervals than when probability was equal or when .40 probability was associated with the final interval.

When probability was raised to .60, all illustrated in Figure 8, comparisons at all FPs were significant. As with the .40 probability increasing the probability at the initial FP significantly decreased RT, in this case over all FPs. For the .5, 1.0, and 1.5 second intervals it appeared that changing the position of increased probability from the first to the last interval in the range tended to increase RT.

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Figure 3 - EXPERIMENT III: Mean RT for equal probability FP range.

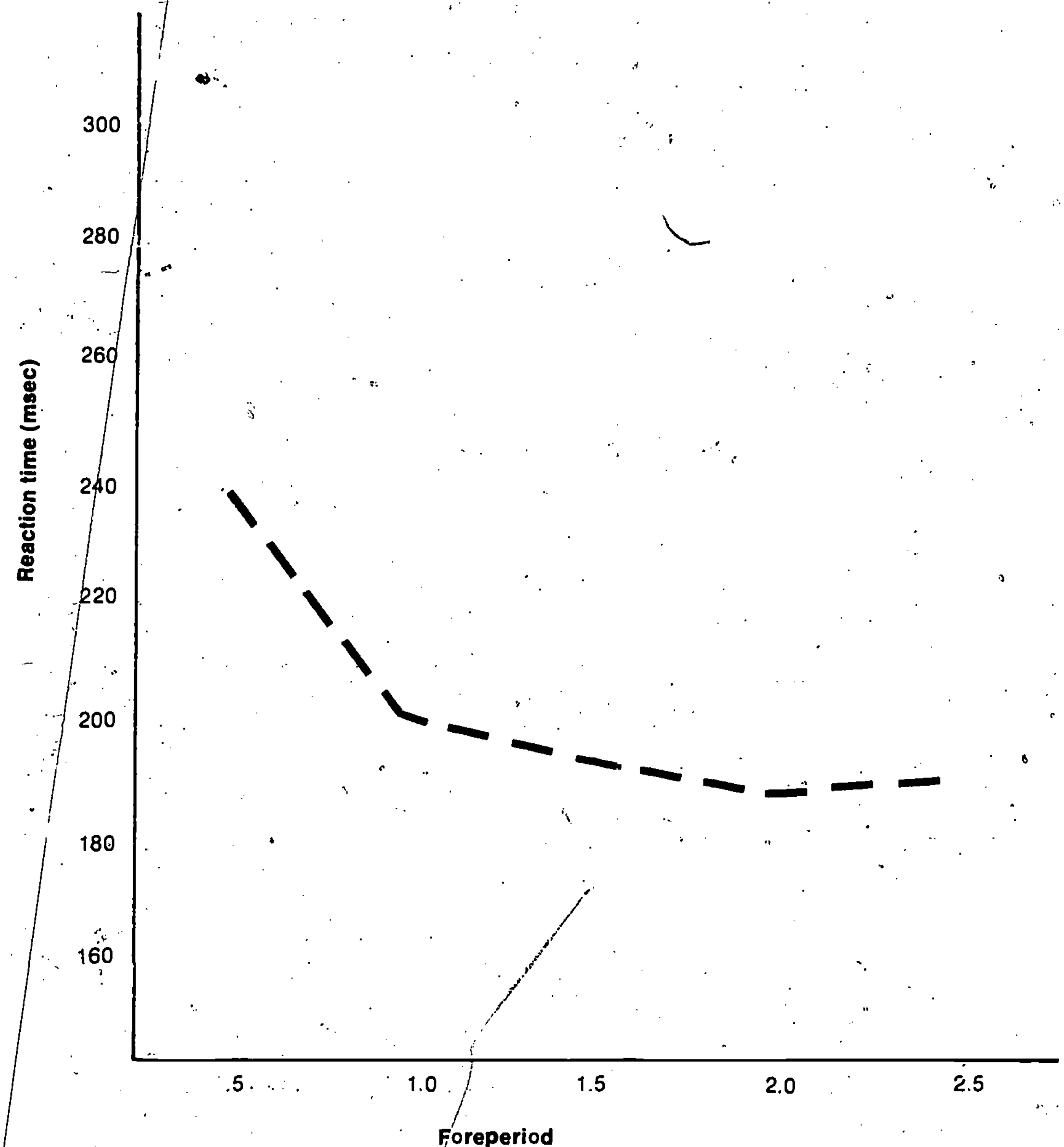

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Figure 4 - EXPERIMENT III: Mean RT for ranges with increased probability at .5 second FP.

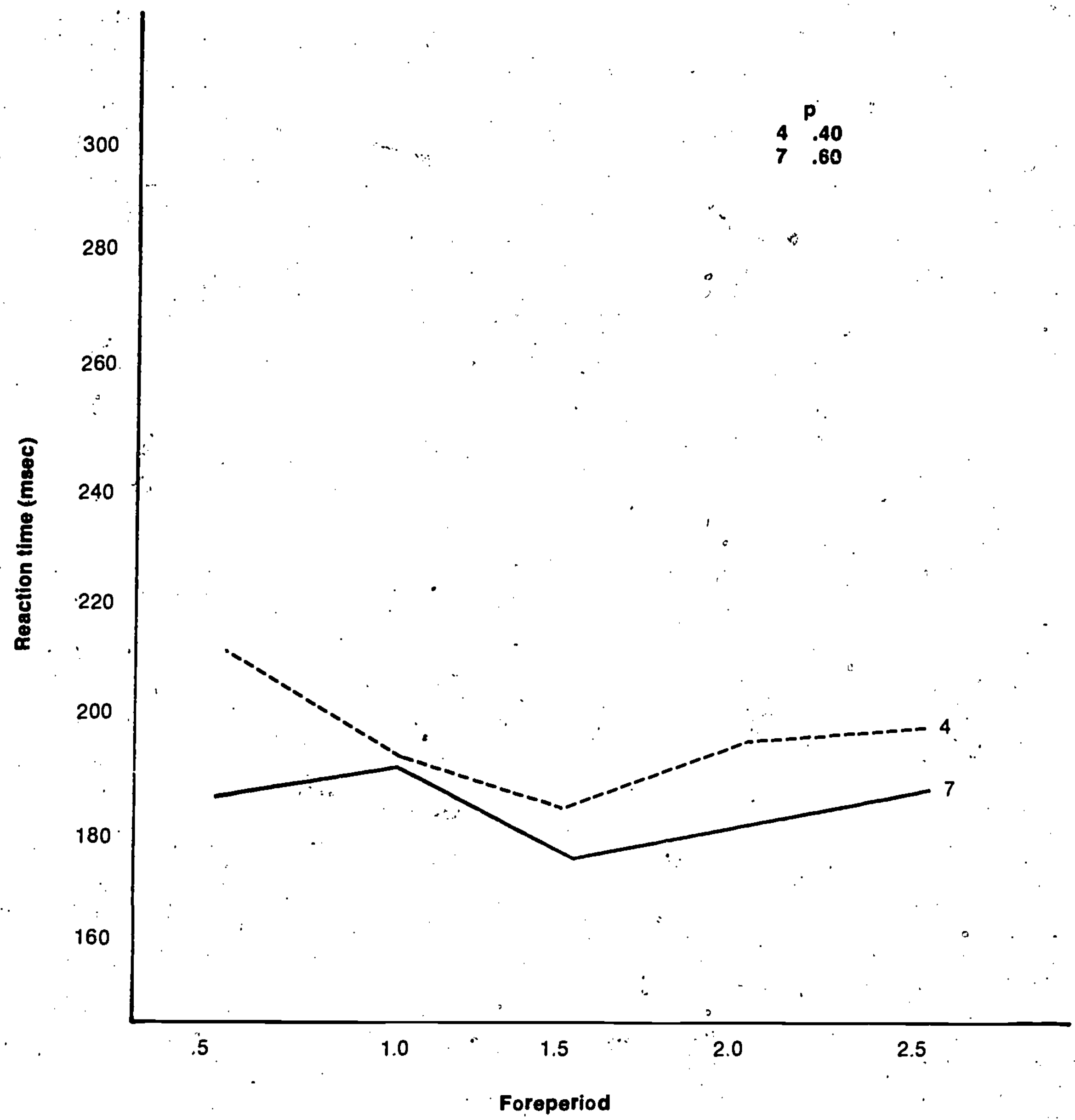

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Figure 5 – EXPERIMENT III: Mean RT for ranges with increased probability at 1.5 second FP.

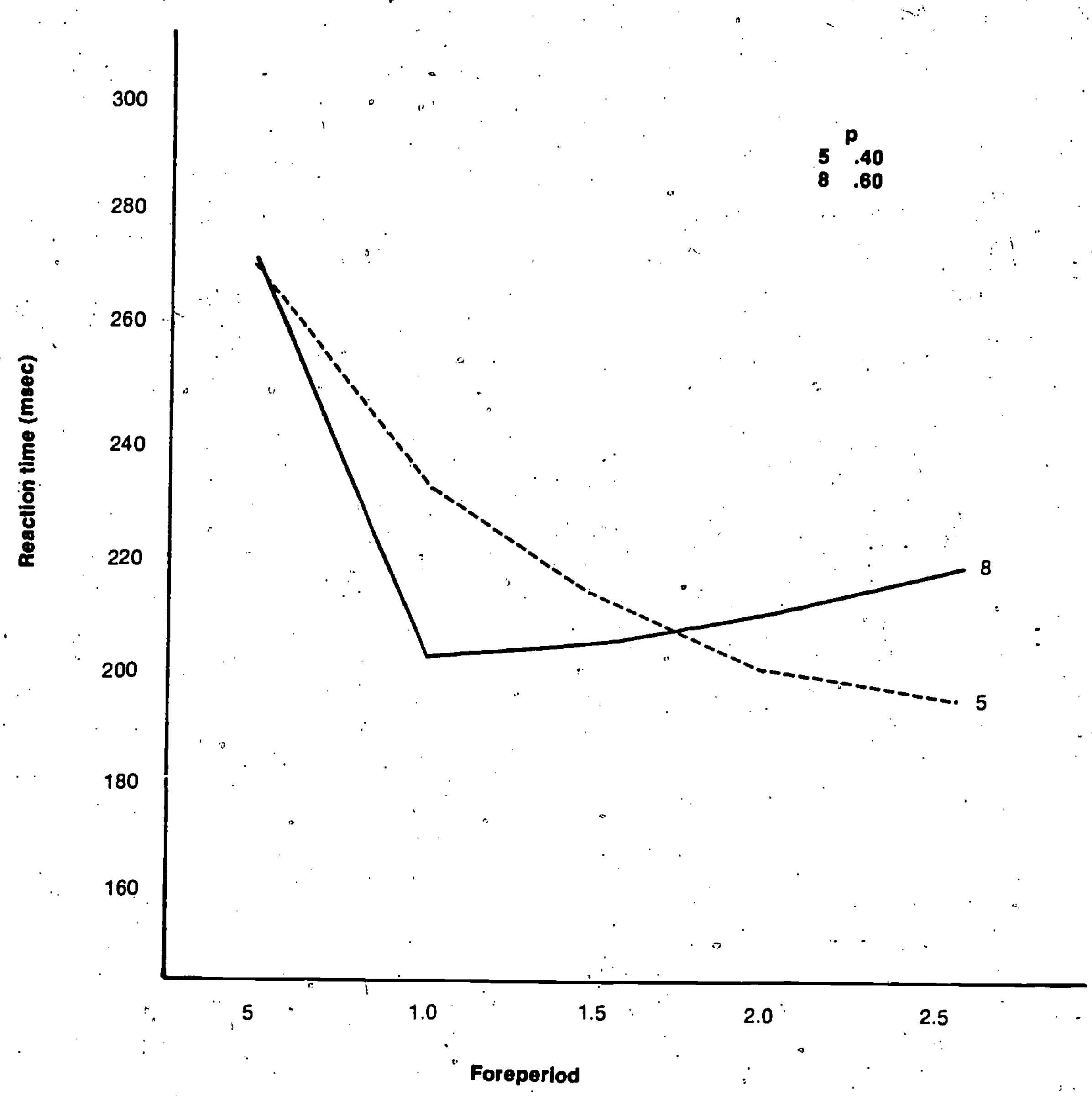

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Figure 6 – EXPERIMENT III: Mean RT for ranges with increased probability at 2.5 second FP.

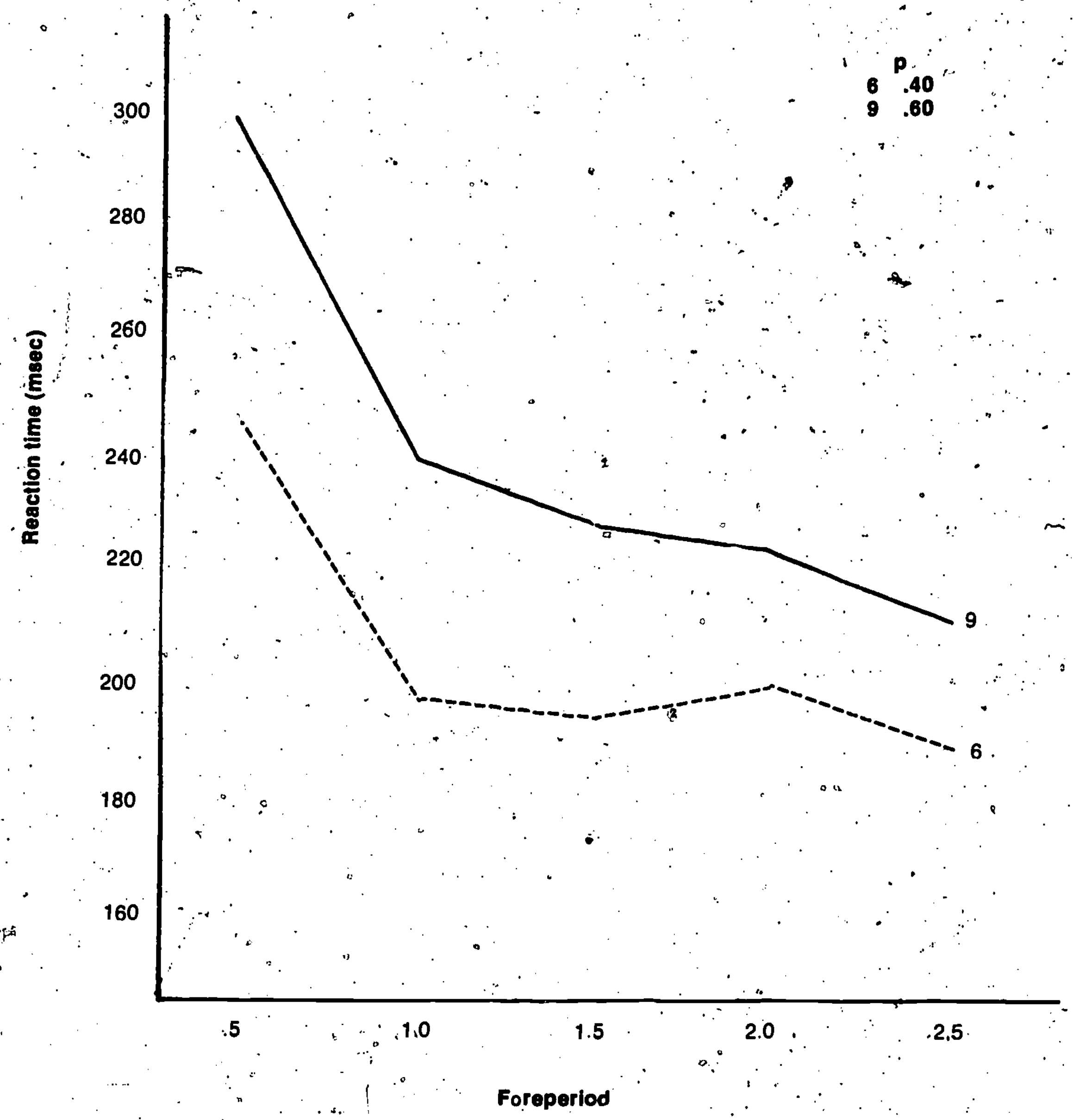

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Figure 7 - EXPERIMENT III: Mean RT for ranges with .40 probability at indicated interval.

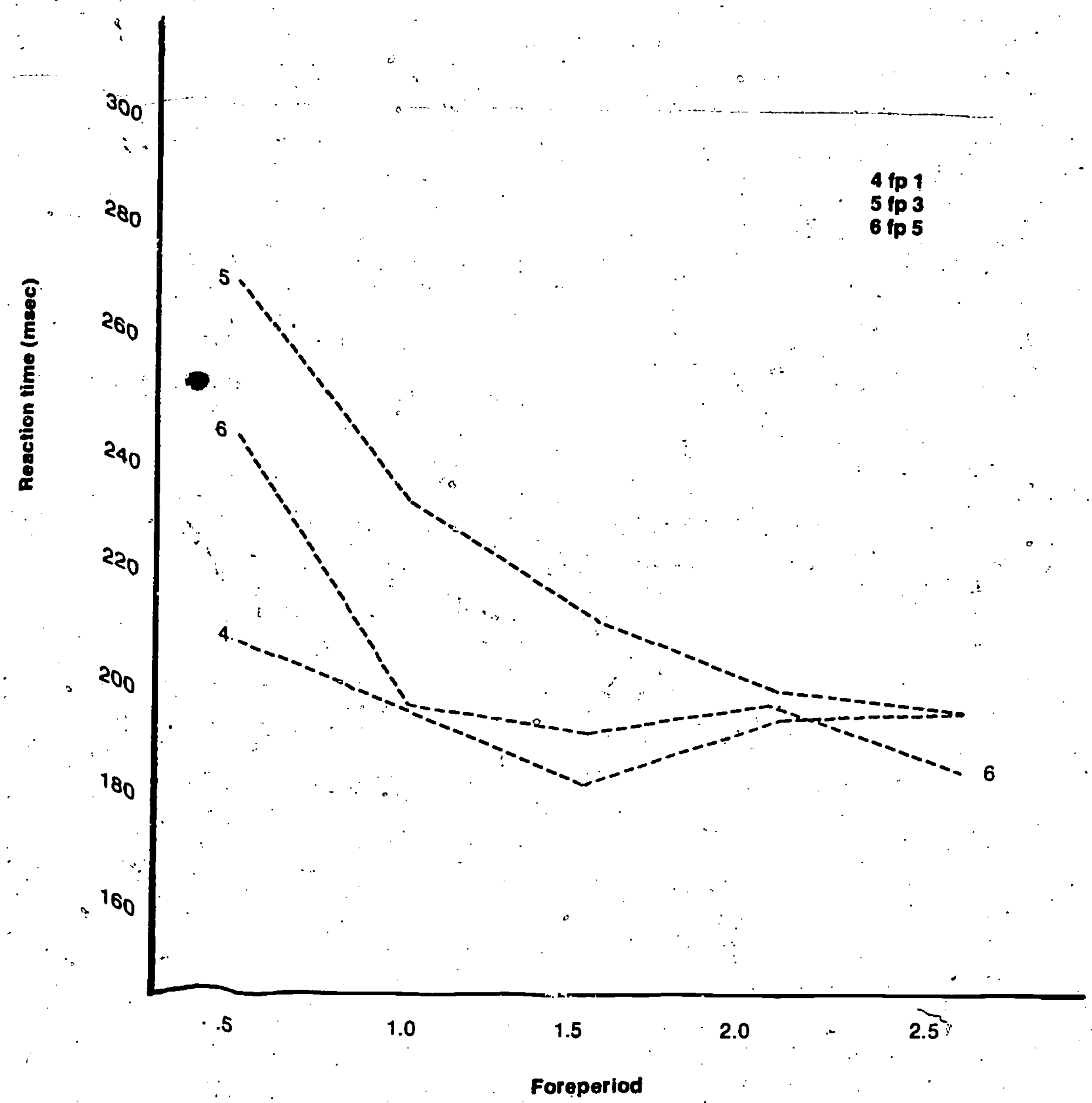
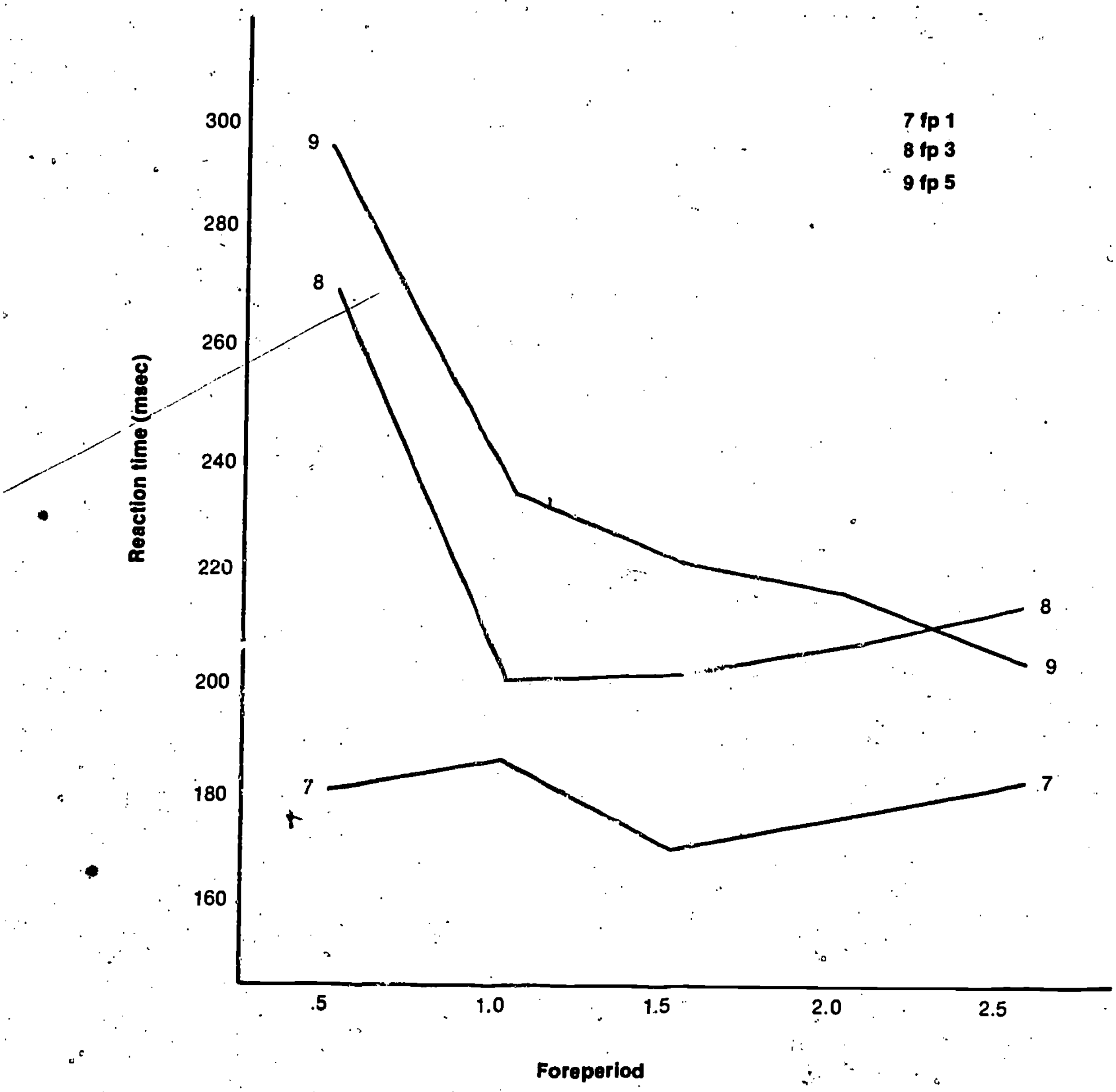


Figure 8 – EXPERIMENT III: Mean RT for ranges with .60 probability at indicated interval.



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Finally, individual comparisons for treatment groups revealed that for equal probability, illustrated in Figure 3, RT at the .5 second FP was slower than at any other. This finding was contrasted to that for groups 4 and 7, Figure 4 in which no significant differences were found among the intervals. For all other groups the RT was slowest at the .5 interval, with no differences observed among the others.

Experiment IV

Experiment IV was a pilot study designed to investigate the notion of j.n.d., but in order to accomplish this purpose it was necessary to vary range length as well. The ANOVA presented in Table VII revealed no significant differences between the groups, a significant overall effect of FP position, and a questionable interaction, which was further evaluated only because of the pilot nature of the study.

For the purpose of minimizing intersubject differences which were a function of the wide range of intervals employed it was decided to use mean RT differences. To compute this score the overall mean RT for all FPs to which the S was exposed was subtracted from the mean for the particular FPs. Individual comparisons for the significant interaction were conducted. For the 1.5–3.5 group the RT for the first FP was significantly slower than for any others; for the 8.3–17.3 range the first FP was significantly slower than the last FP only. For the 1.5–1.9 group and the 11.0–13.0 group there were no significant differences. It was interesting to note the patterns of the various groups shown in Figure 9. The variability of responses is greater for the 1.5–1.9 group than for the 11.0–13.0 group.

Table VII – ANOVA for mean difference RT for foreperiod ranges differing in j.n.d. and range length.

Source of variation	SS	df	MS	F
Total	180.31	79		
Between	.73	15		
Groups (A)	.14	3	.046	< 1
Error	.59	12	.050	
Within	159.58	64		
Position (B)	50.28	4	12.570	7.917 **
AB	33.08	12	2.760	1.74 *
Error	76.22	48	1.580	

** $p < .01$.
* $p < .10$.

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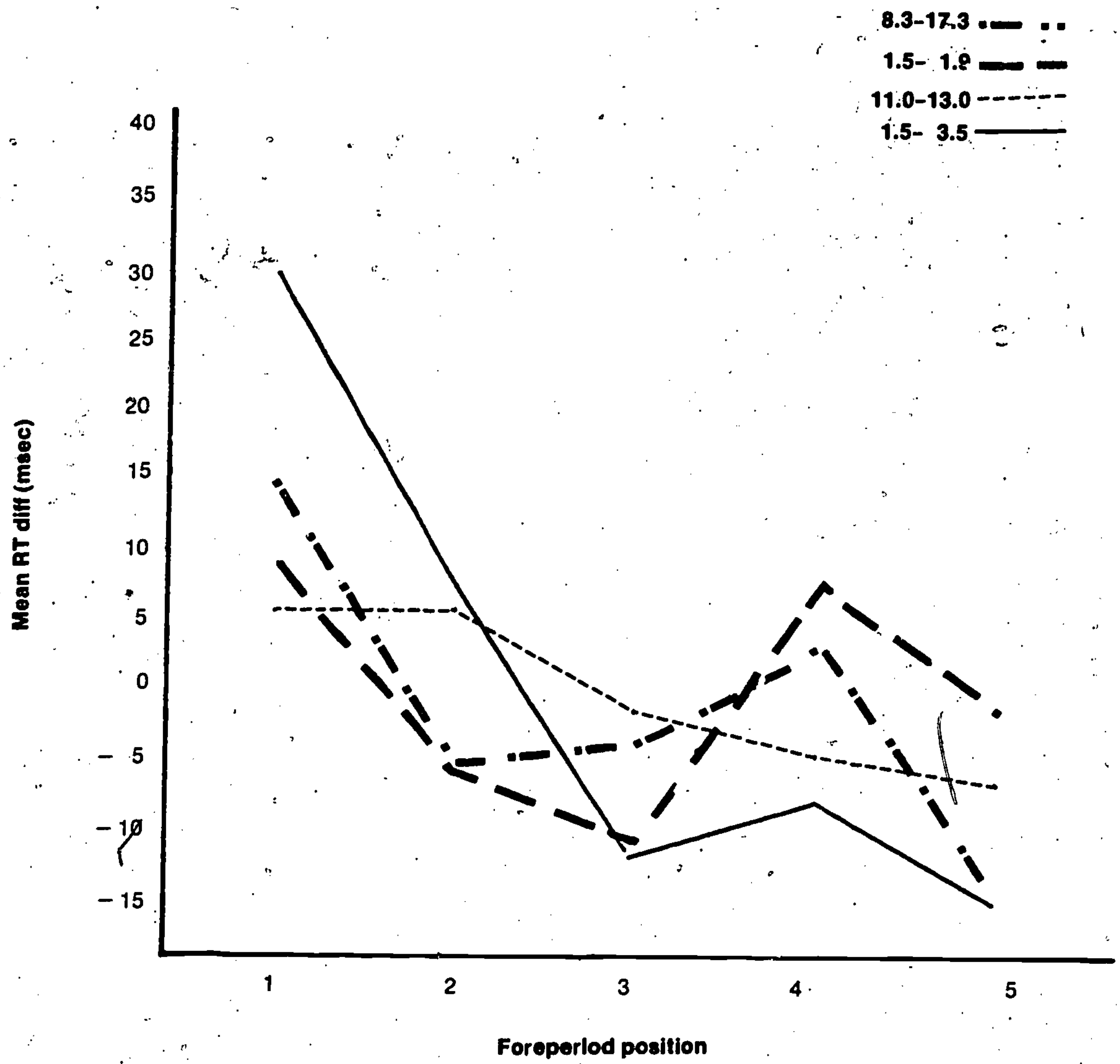
Figure 9 - EXPERIMENT IV: Mean RT at FP ranges differing in j.n.d. and range length.



DISCUSSION

The evidence presented in support of the TU-CP hypothesis suggested that the hypothesis is viable, but the data is inclusive. The minimal number of trials required of the Ss insured that they were still at the "learning stage". The fact that it was the first interval or intervals in most of the ranges that was effected, whether that interval was .5, 1.5, 2.5, 5.7, 8.3, or 12 seconds, suggested that perhaps the S had a strategy for dealing with the uncertainly. Certainly the research of BAILEY (1959) and BERGSRUND (1967), which demonstrated that RT and RT variability decreased over trials and that significant decreases in RT occur over trials, supports this notion. The Ss may have initially determined the average FP value so that shorter intervals, in relation to the mean, would have been associated with slow RT as a result. Subsequent strategy of S remains to be suggested since neither BAILEY (1959) or BERGSRUND (1967) provided analysis of practice and it was not possible in any of the reported experiments. Perhaps the strategy of dealing with uncertainty follows the sequence of mean, ends and then intermediate positions. This possibility remains to be investigated. The decrease in RT variability over trials does suggest, however, that some type of problem solving is proceeding.

In relation to the TU-CP hypothesis, four behavioral predictions were made, how does the evidence compare?

The absolute length of a FP would not matter but it's relative length, and thus its' position in a range of FPs, would affect RT.

Experiments I and II provide support for this as does the research of BAILEY (1959). Since Experiment II utilized long intervals the possibility of a refractory phase accounting for the increase in RT at shorter intervals did not seem possible.

The probability of a particular FP should affect RT to the extent that it changes the CP of that particular FP. Increasing the frequency of occurrence should decrease RT.

The results of BERGSRUND's (1967) study and Experiment III supported this prediction. In BERGSRUND's results the increase in probability had a more marked effect at the two second interval than at the four second interval. In Experiment III the early FPs were more markedly affected by changes in probability than later FPs.. This finding was reasonable because the early FPs in the range have more to gain from an increase since they were associated with such a low CP to begin with. Enhancing their probability marked decreases in RT resulted while the enhancement of the probability of later intervals markedly decreases probability of the earlier intervals and increases RT. For intervals later in the range, since the effect is on the CP, manipulation of intervals early in the range should have less of an effect. What is the possibility that there is a j.n.d. for increase or decrease in probability of occurrence? This might clarify some of the questions here.

If the S cannot extract probability information, i.e., if adjacent FPs do not exceed the required j.n.d., than no TU-CP effect should be observed.

The results of STADULIS (1967) study and the pilot study presented as Experiment IV lend support to this prediction. In addition the results provided by BERGSRUND (1967) with respect to the shifting of the 4 and 5 second interval RT and the fact that large numbers of his Ss had results differing from the overall average support the notion of varying j.n.d. In order to investigate this either j.n.d. could be determined and a set of time intervals custom designed for each S, or the inter-interval difference could be increased until all Ss, with sufficient practice, showed decreases in the predicted direction.

The Ss RT should more closely approximate CP in later blocks of trials.

Comparison of the studies presented here, which represent early learning, with the studies reviewed lend credibility to this prediction. Analysis of RT over practice periods would be necessary to further confirm this prediction.

CONCLUSION

There seems to be some support for the TU-CP hypothesis as an explanation of FP variability effects which have been reviewed. Four predictions which would arise from this hypothesis have been supported to some extent but further research is necessary. The likelihood of this hypothesis parsimoniously explaining various types of behaviors which require prediction should not be overlooked.

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LA MESURE DU TEMPS DE RÉACTION EN DISCRIMINATION DE DURÉE

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Un observateur (O) placé dans une tâche de temps de réaction (TR) simple où il doit réagir aussi rapidement que possible à un signal m_2 se produisant d millisecondes après un stimulus avertisseur m_1 possède deux sources principales d'information lui permettant de déclencher une réponse: 1) l'occurrence de m_2 et 2) l'estimation par chronométrage interne du temps d'arrivée de m_2 par rapport à m_1. Une certaine proportion des réponses, RE, utilisant l'information temporelle peuvent se produire avant ou en même temps que m_2 et sont alors désignées comme étant des réponses d'anticipation. Pour diverses raisons, ces réponses sont considérées comme nuisibles et certaines techniques ont été développées pour amener l'O à ne pas émettre de telles réponses. Les deux principales techniques sont l'utilisation de faux essais et la variation au hasard de l'intervalle d. Cependant, des études suggèrent que ces méthodes n'éliminent pas l'occurrence de RE (GORDON, 1967; KLEMMER, 1956). Par exemple, TR varie systématiquement avec l'étendue des valeurs d utilisées de même qu'avec la moyenne de ces valeurs (KLEMMER, 1956; NIKERSON, 1965).

Récemment, certains auteurs, (KORNBLUM, 1973; OLLMAN et BILLINGTON, 1972), ont proposé une approche par laquelle les TR des réponses d'estimation temporelle, RE, et ceux des réponses au signal m_2, RS, sont obtenus indépendamment en vue de déterminer la contribution des RE à la variance totale des TR au signal. Leur procédure expérimentale est une variation de la technique des faux essais en situation de TR simple. Dans une proportion des essais, le signal m_2 est omis et l'O doit alors émettre une réponse basée sur une estimation d'une durée donnée rapprochée de d. Donc, à partir de ces réponses d'estimation temporelle on peut déterminer les caractéristiques de distribution de TR des RE et par là corriger les distributions des TR des RS. Cependant la situation est encore ambiguë car, alors que les TR des RE sont clairement associés à l'opération d'un mécanisme interne d'estimation de durée, les TR des RS ne peuvent être considérés comme étant tous déclenchés par m_2 lui-même. Nous aimerions présenter un modèle de discrimination de durée qui selon nous, fournit une situation expérimentale très intéressante pour arriver à dissocier les TR à un signal interne de ceux à un signal externe.

Dans une tâche de discrimination de durée l'O doit discriminer un intervalle de durée $d_0 < C$, comme étant court, d'un autre de durée $d_1 > C$, comme étant long, où C est une valeur critère centrale relativement à d_0 et d_1. KRISTOFFERSON (1973) proposa l'existence d'un mécanisme par lequel un critère en temps réel de durée d_c, rapprochée de C, est déclanché au début de l'intervalle. Le jugement discriminatif serait alors posé par rapport à l'ordre temporel d'occurrence à un centre de décision, de la fin de l'intervalle à d msec. et de la conclusion du critère à d_c msec.

La figure 1 illustre le fonctionnement d'un mécanisme de critère en temps réel dans une tâche de discrimination de durée d'intervalles vides. À la fin du stimulus m_1 un signal interne t_1 marque le début de l'intervalle et, de la même façon, au début du stimulus m_2 un signal t_2 indique la fin du même intervalle. Simultanément, t_1 déclenche un critère interne de durée d_c dont la fin est identifiée par un signal interne, t_c. Dans un tel système on peut définir la stratégie de prise de décision suivante: si t_2 se produit avant t_c $(t_2 < t_c)$ une réponse R_0 est émise, et, une réponse R_1 est donnée quant t_2 apparaît après t_c $(t_2 > t_c)$. Si l'on suppose que t_2 et t_c sont des variables aléatoires avec une certaine fonction de distribution, la probabilité que t_2 soit enregistré avant t_c peut être définie comme $P(t_2 < t_c)$ et, de même $P(t_2 > t_c)$, la probabilité que t_c se produise avant t_2. Alors, $P(R_0) = (t_2 < t_c)$ et $P(R_1) = (t_2 > t_c)$ où $P(R_1)$ apparaît comme une fonction croissante de d.

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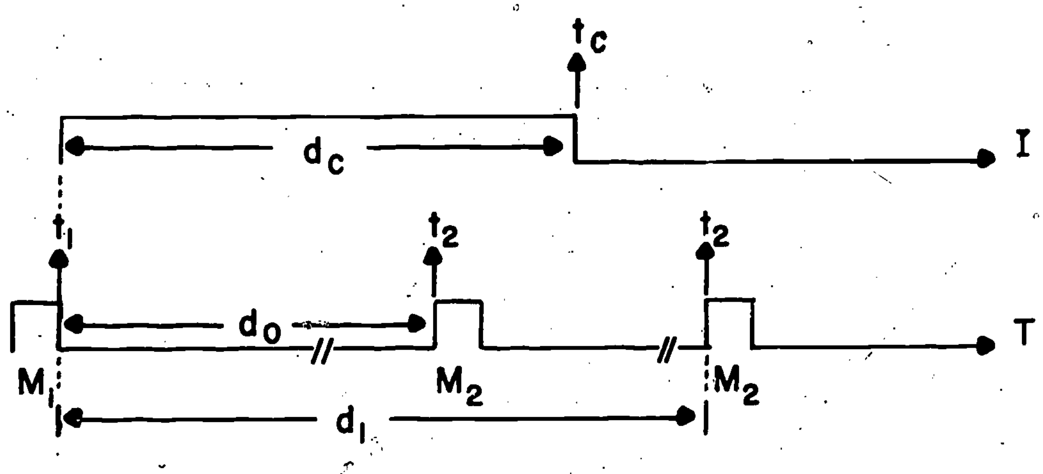
Figure 1 – Hypothèse de critère en temps réel.



$$t_2 \longrightarrow \text{V.A.} \; (\overline{t}_2, \; VAR(t_2))$$

$$t_c \longrightarrow \text{V.A.} \; (\overline{t}_c, \; VAR(t_c))$$

Les prédictions suivantes peuvent être faites quant aux TR des R_0, TR_0, et ceux des R_1, TR_1. Tout d'abord, l'on pose l'hypothèse que les TR sont le résultat d'une composante de mouvement, K, et d'une composante de discrimination, I. De plus I et K sont définies comme des variables aléatoires de moyenne et variance $\overline{I}$ et VAR (I) et, $\overline{K}$ et VAR (K) respectivement. Enfin, pour des valeurs de d où le niveau d'erreur est bas I et K sont considérées comme indépendantes. Alors, on peut définir en général,

$$CAR\,(TR) = VAR\,(I) + VAR\,(K)$$

et,

$$\overline{TR} = \overline{I} + \overline{K}$$

Pour TR_0,

$$VAR\,(TR)_0 = VAR\,(t_2) + VAR\,(K)_0$$

et,

$$\overline{TR}_0 = \overline{t}_2 + \overline{K}_0$$

De même pour TR_1,

$$VAR\,(TR)_1 = VAR\,(t_c) + (VAR\,(K)_1$$

et,

$$\overline{TR}_1 = \overline{t}_c + \overline{K}_1$$

Pour simplification, on pose K comme ayant une moyenne et une variance constantes pour un type de réponse donné.

Les réponses R_0 étant synchronisées avec un signal externe m_2 $\overline{TR}_0$ sera en fonction croissante de d ; et si l'on pose $\overline{t}_2 = d_i$, où i représente une valeur dans un groupe de durées à discriminer, la fonction $\overline{TR}_0$ vs d_i sera linéaire de pente 1. D'autre part, R_1 étant liée à t_c, $\overline{TR}_1$ sera constant pour toutes les valeurs de d. Pour les mêmes raisons VAR $(TR)_1$ sera constante puisque les R_1 sont indépendantes de d. Cependant VAR $(TR)_0$ ne sera pas spécifiée dans le présent modèle parce qu'elle dépend d'hypothèses spécifiques quant à la relation entre VAR (t_2) et d_i. Cependant, pour que ces prédictions tiennent l'on doit pouvoir supposer que les variations des TR ont leur origine dans le mécanisme de discrimination. Or, à mesure que d_i s'approche de d_c, P $(t_2 < t_c)$ et P $(t_2 > t_c)$ convergent vers .5 augmentant la possibilité qu'une compétition se produise entre les deux types de réponses. Une telle compétition pourrait brouiller la relation entre t_2 et TR_0 et, t_c et TR_1. En conséquence, le modèle sera évalué par rapport à des valeurs de d pour lesquelles le niveau d'erreur est inférieur à 10%.

Nous avons donc effectué une expérience où deux Os furent étudiés de façon extensive en situation de précision, sans accélération des réponses. et en situation de vitesse où le temps de réaction était mesuré.

MÉTHODE

Sujets

Deux sujets féminins adultes furent utilisés. Elles étaient volontaires, payées $3 par session et, sans expérience dans ce type de tâche.

Appareils

Les intervalles à discriminer étaient définis comme le silence intervenant entre la fin d'un éclair lumineux de 10 msec. et le début d'un son pur de même durée. Le signal visuel lumineux consistait en un point de 4mm apparaissant à 2 pi. de l'O. La source lumineuse était un «glow modulator» (Sylvania R11B1C) calibré à 50 ftL. Le stimulus auditif était un son pur de 2kHz dont l'enveloppe était contrôlée par un interrupteur électronique (Grason-Stadler), et l'amplitude fixée à 68dB. Les signaux auditifs parvenait à l'O par des écouteurs en réception binaurale. Donc, m_1 était un signal lumineux alors que m_2 était un signal sonore. La séquence son-lumière était précédée de 1 sec. par un signal avertisseur visuel et, suivie par un «feedback» identifiant la réponse correcte 2.5 sec. après la fin de m_2. Le signal avertisseur et le «feedback» était donnés à l'O par des petites lampes témoin faisant face au sujet. L'O effectuait sa réponse en pressant sur des boutons-pressions placés sur le bras droit du fauteuil. Dans la condition où le temps de réaction était enregistré, l'O gardait l'index et le majeur de la main droite constamment en contact avec les boutons. Les temps de réaction étaient mesurés à la milliseconde près à partir de la fin de m_1. Toutes les opérations de contrôles et de chronométrage étaient effectuées par un petit ordinateur PDP-8E (Digital Equipment).

Procédure

Les Os avaient à discriminer entre quatre intervalles divisés en deux groupes, l'un amenant une réponse R_0 et l'autre une réponse R_1. À chaque essai un de ces intervalles était présenté dans un ordre au hasard, chacun apparaissant un nombre égal de fois dans un bloc d'essais.

Dans la condition de précision, les quatre intervalles étaient: 100, 200, 300 et, 400 msec. Chaque session était formée de 3 blocs de 100 essais où chacun des intervalles était présenté 25 fois par bloc. Un grand nombre de sessions furent effectuées pour stabiliser le niveau de performance des Os. L'O 605 participa à 16 sessions et, l'O 503 à 24 sessions dont les 8 dernières forment les données expérimentales, soit 600 essais/stimulus pour chacun des Os.

Trois groupes de quatre intervalles furent utilisés dans la condition de vitesse, soit 100, 190, 310, 400 msec., 125, 190, 310, 375 msec., et 140, 190, 310, 360 msec. Donc, les valeurs intérieures ne changeaient pas alors que les valeurs extérieures étaient variées de façon à obtenir plusieurs points où la probabilité d'une erreur est faible. Les valeurs extérieures étaient changées en séries ascendantes et descendantes. Une séquence ascendante-descendante représentant un cycle, six cycles furent effectués avec l'O 605 et cinq cycles avec l'O 503 et, les résultats des deux derniers furent utilisés dans l'analyse des résultats. Enfin, avant d'entreprendre la variation systématique des intervalles, chaque O participa à plusieurs sessions d'habituation à la tâche de temps réaction. Ces sessions étaient au nombre de 10 pour l'O 605 et, 20 pour l'O 503.

Résultats

Les prédictions les plus fortes du modèle de critère en temps réel ont trait à l'allure des fonctions $\overline{TR}_0$ et $\overline{TR}_1$ vs d_i. Un examen visuel des figures 2 et 3 montre clairement que ces prédictions sont supportées. En effet, les $\overline{TR}_1$ montrent une stabilité remarquable, ce pour les deux Os. Ceci est un support important dans la démonstration de la synchronisation des R_1 à un événement unique dans le temps indépendant de d_i. De même, les $\overline{TR}_0$ sont de toute évidence une fonction croissante de d_i. Cependant, un ajustement de la meilleure droite par la méthode des moindres carrés donne une pente de .68 pour les deux Os ce qui est un peu plus faible que la valeur prédite de 1. D'autre part, l'ajustement linéaire rend compte de 96% de la variance pour O 605 et 85% pour l'O 503. En fait, dans les deux cas la principale déviation par rapport à la linéarité provient du point d = 100 msec.

Figure 2 - Temps de latence des réponses aux d_1 où P (R_0) et P (R_1) > .05.

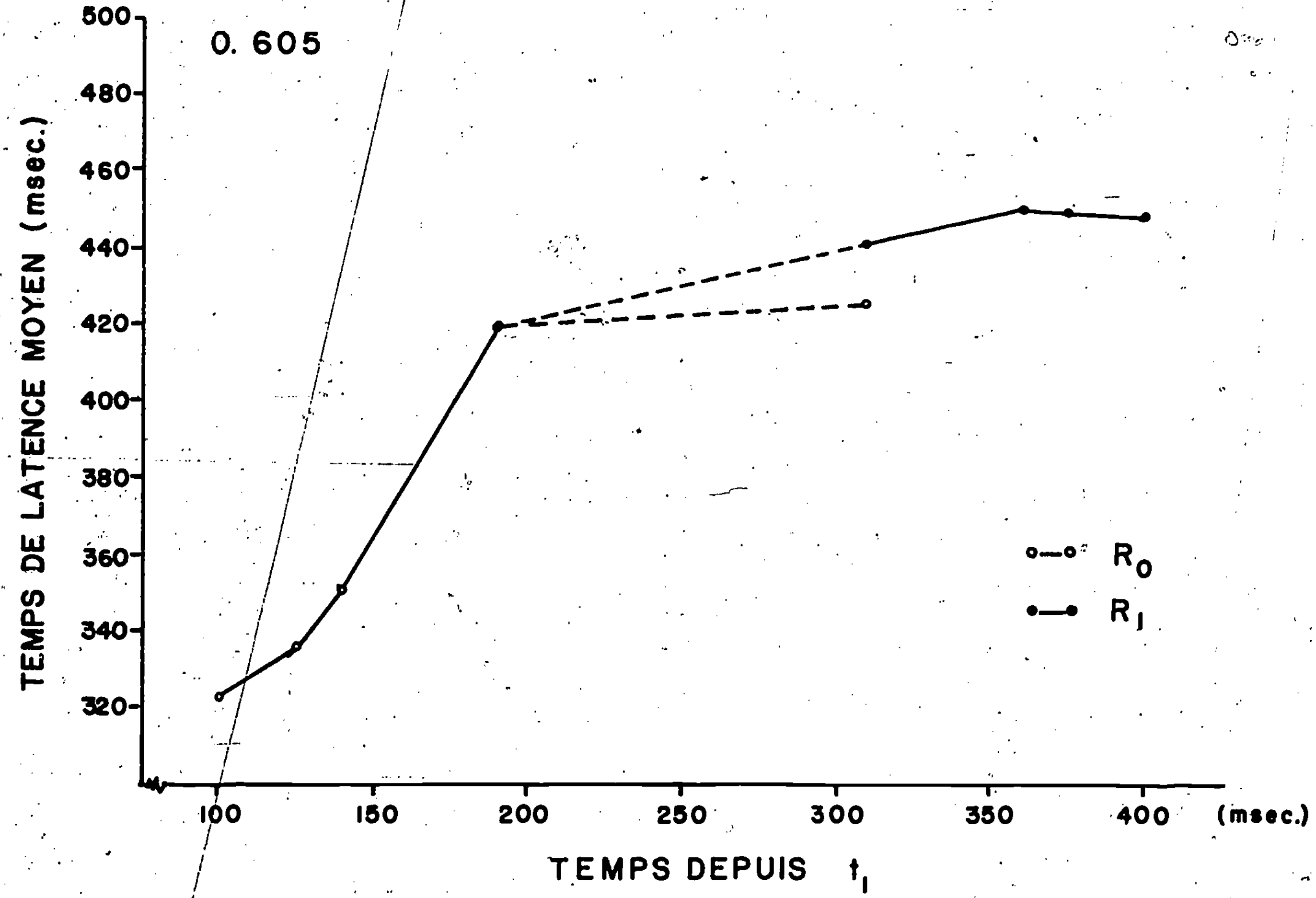
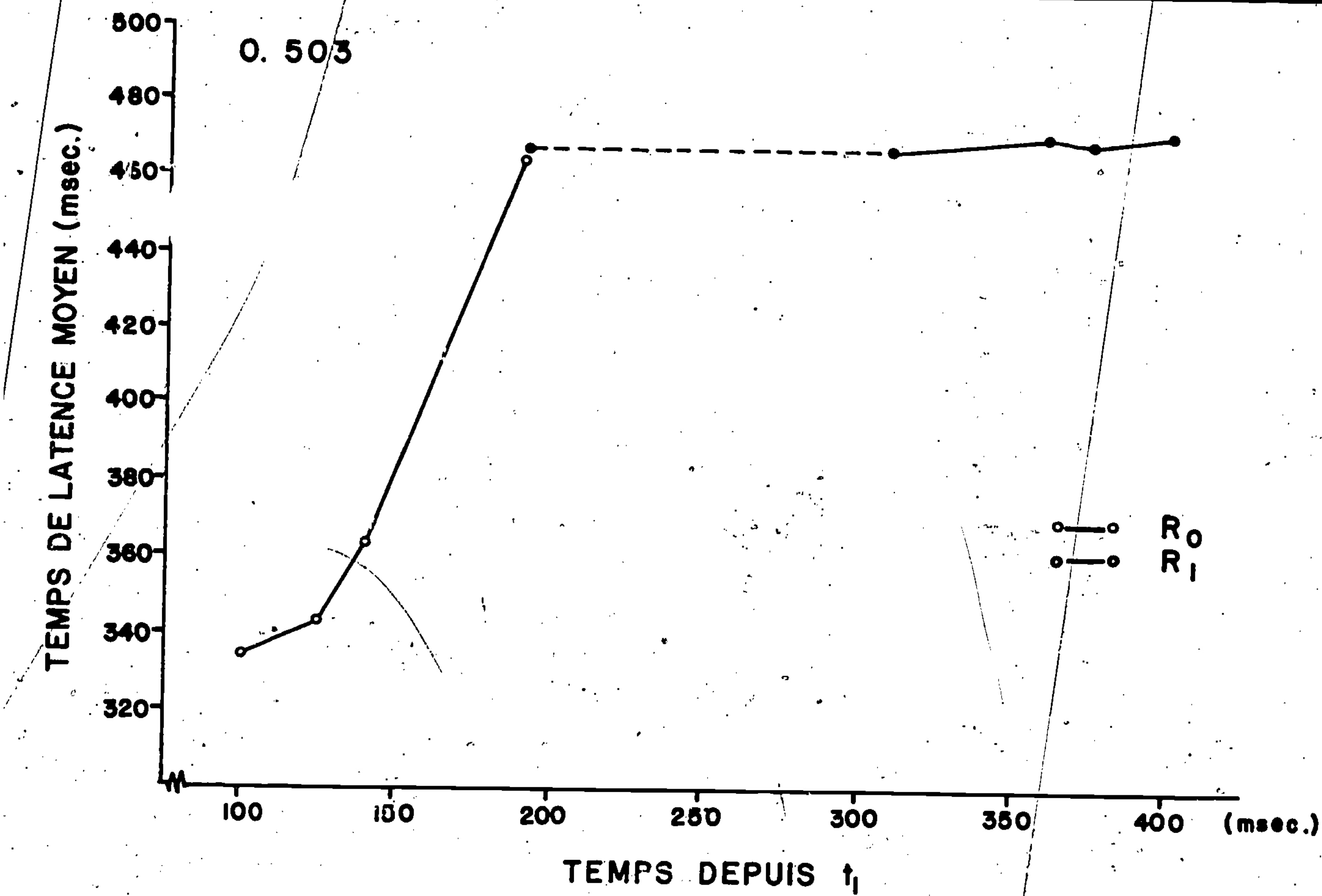


Figure 3 - Temps de latence des réponses aux d_1 où $P(R_0)$ et $P(R_1) > .05$.



Ces résultats peuvent être mieux appréciés par l'analyse des données présentées au tableau I. Chez les deux Os les $\overline{TR}_1$ sont à une milliseconde de la valeur moyenne pour les trois durées extérieures 360, 375 et 400 msec. D'autre part, VAR $(TR)_o$ et VAR $(TR)_1$ ne varient pas systématiquement en fonction de d_i. Elles peuvent être considérées comme constantes et, à l'intérieur du même O les valeurs de VAR $(TR)_o$ et VAR $(TR)_1$ sont très rapprochées. Enfin, il est intéressant de noter que l'O 605 montre des valeurs de $\overline{TR}$ et VAR (TR) plus faibles que celles de l'O 503.

Pour avoir une idée de la vitesse à laquelle l'O émet une réponse après t_2 ou t_c l'on doit se rappeler que TR est mesuré depuis t_1. Donc, une estimation du TR à t_2 ou t_c, RT, peut s'obtenir par soustraction de d_i à TR_o et, de d_c à TR_1. Le résultat de ces opérations est rapporté au tableau I. La transformation est directe pour RT_o et, la valeur obtenue pour la moyenne des trois courtes durées, 100, 125, 140 msec., est de 218 msec. pour l'O 605 et de 227 msec. pour l'O 503. Cependant, la chose est plus difficile pour RT_1 puisque nous n'avons pas de valeur objective pour d_c. Cependant, une valeur approximative peut être obtenue en utilisant les données de discrimination. En effet, si $\overline{t_2} = t_c$ la probabilité d'une réponse corrrecte est réduite à .5. Or, par définition, quand $P(t_2 < t_c) = P(t_2 > t_c)$, $P(R_o) = (R_1) = .5$; comme $\overline{t_2}$ peut être approximée par d_i, le point où $P(R_1) = .5$ fut évalué et défini comme étant égal à d_c. Les valeurs de d_c sont rapportées au tableau I, de même que les RT_1 correspondants. La moyenne de RT_1 pour les trois durées longues est de 201 msec. pour l'O 605 et de 242 pour l'O 503. Ces RT sont rapides considérant que nous sommes dans une tâche de temps réaction au choix. Donc, les présents résultats démontrent clairement l'emploi par l'O de deux sources différentes pour déclencher les deux types de réponses.

Les résultats présentés au tableau II montrent que l'O peut utiliser concurremment un signal interne et un signal externe pour émettre une réponse. En effet, en général la probabilité d'une réponse correcte n'est pas diminuée par l'exigence d'une réponse rapide. La stabilité des $P(R_1)$ pour les durées longues indique bien que les R_1 ont leur origine dans un événement unique dans le temps.

Tableau I – Moyenne et variance de la latence des réponses (en millisecondes) pour les valeurs de d_0 et d_3 pour Os 503 et 605.

d_i	$\overline{TR}$	VAR (TR)	$\overline{TR} - d_i$	$\overline{TR} - d_c$	d_c
100	335	2961	235		
125	343	2729	222		
140	364	2519	224		
$\overline{X}$		2736	227		
360	471	2926	111	247	224
375	469	1969	94	238	231
400	470	2717	70	241	229
$\overline{X}$	470	2537		242	
100	323	839	223		
125	336	373	211		
140	351	1039	211		
$\overline{X}$		934	218		
360	449	1109	89	204	245
375	448	1070	73	204	244
400	447	1451	47	195	252
$\overline{X}$	448	1210		201	

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Tableau II.- Probabilité d'occurrence d'une réponse R_1 en situation de précision et de vitesse pour Os 503 et 605.

Observateur	Condition			
	d_i	vitesse	d_i	précision
503	100	.0107	100	.0045
	190	.2686	200	.0622
	310	.9724	300	.6177
	400	.9793	400	.9261
605	100	.0035	100	.0045
	190	.1232	200	.1056
	310	.9159	300	.9200
	400	.9118	400	1.000

DISCUSSION

Nous avons donc démontré que de toute évidence un O peut dans une tâche de temps de réaction utiliser une information temporelle et non-temporelle pour effectuer une réponse. De plus, pour un même O la VAR (TR) est à peu près la même pour les TR_0 et les TR_1. Cependant certaines caractéristiques de la présente situation doivent être considérées pour pouvoir évaluer la généralité des présents résultats. Tout d'abord, l'utilisation de durées hétérogènes produit une situation analogue à celle où un signal avertisseur visuel précède un signal auditif. Or, il serait certes intéressant de voir les changements dans la VAR (TR) dans une situation où des intervalles sont présentés dans le même mode sensoriel. De la même façon, l'on peut se demander si l'égalité des VAR $(TR)_0$ et VAR $(TR)_1$ serait maintenue pour des durées de l'ordre de 1 sec. On peut supposer que la variance du système de chronométrage interne aurait alors augmentée se traduisant en une VAR $(TR)_1$ plus grande.

De plus, ces résultats mettent en doute la généralité des modèles courants de discrimination de durée (ALLAN et KRISTOFFERSON, 1974). En effet, tous ces modèles considèrent que la représentation interne d'un intervalle donné est le résultat d'une opération de chronométrage sur toute l'étendue de cet intervalle. Or, dans le présent travail il est apparent que le chronométrage se termine bien avant la fin des intervalles longs. Enfin, la poursuite de ce travail aura certainement des implications pour l'étude de l'interaction entre des processus efférents et dese processus afférents dans l'émission d'une réponse motrice.

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ATTENTION DEMANDS OF MOVEMENTS: A CRITIQUE OF THE PROBE TECHNIQUE

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In recent years much research has focused on the attention demands of information processing. More specifically, different authors have attempted to study the demands of individual processes within the information-processing model. For example, POSNER and KEELE (1969) found that response initiation was demanding while movement itself appeared not to require attention. Much of what we know about the attention demands of movement control was derived by using the secondary task technique and more specifically, the probe technique. With the latter technique the subject is asked to respond to an auditory signal (probe) while simultaneously performing a movement. The attention demands of different processes is inferred by having the onset of the probe occur at different points within the movement (e.g., the probe might be initiated simultaneously to the onset of movement). The subject's reaction time (RT) to the probe is then measured. If RT is delayed in comparison to a control condition where the subject simply reacts to the probe without producing the movement, then that process is said to be attention demanding.

As can be attested to by many researchers, the measurement of RT can be contaminated by many extraneous factors, other than those of interest. For example, if the subject tries to anticipate the onset of the signal, RT can be greatly diminished if the subject is correct, or greatly elevated if he is incorrect. In particular, a diminished RT to the probe would be interpreted as a decrease in the attention demands of the process in question. Obviously then, the experimenter tries to eliminate as many of these contaminating factors as possible.

When subjects are presented a series of mutually exclusive events, as they are with the probe technique, they will develop subjective probabilities for the occurrence of the different events, according to MOWBRAY (1964). For example, if the probe were presented sometime during every trial or movement (e.g., ELLS, 1973), the subject would become more and more certain that the probe would occur at the next instant in time as the required movement was completed. Typically, movements are made to some type of end point such that the nearer the subject moves towards this point the more certain he would be that the probe would occur in the next instant. Using catch trials (probe frequency of two-thirds) as POSNER and KEELE (1969) did, would diminish this changing probability effect to some degree, but indeed, regardless of the probe frequency adopted for a given experiment there will not be a match between the subjective and objective probabilities for event occurrence.

DRAZIN (1961) studied the effects of stimulus frequency and range of foreperiods on RT. He found that decreasing stimulus probability by increasing the number of catch trials increased the average RT. Applied to the probe studies this would predict that RT for trials with a probe frequency of two-thirds would be slower than with the probe on every trial. DRAZIN (1961) also found that regardless of the range of foreperiods used for a series of trials, the shortest foreperiod within a range produced the longest RTs (immediate foreperiod effect). Analogously, it would be predicted that RTs for probe positions early in a movement would be slower than RTs for later probe positions. Thus, the shape of the curve relating RT to probe position in a movement might be quite different depending on the probe frequency used, regardless of underlying attention demands of the movement.

In comparing probe RTs from the studies by POSNER and KEELE (1969) and ELLS (1973) with probe frequencies of two-thirds and three-thirds respectively, the former authors found probe RT to be elevated early and late in the movement (a V-shaped curve), while Ells found RT to be elevated only early in the movement (negatively accelerating curve). Thus both authors concluded that response initiation was attention demanding. However, there was no apparent reason for the difference in findings for attention demands at the end (target) of the movement. Experiment I of the present study was an attempt to clarify this discrepancy simply by varying probe frequency for iden[illegible]ar movements. Experiment II looked at a technique [illegible], supposedly nullified the immediate foreperiod effect.

EXPERIMENT I

Method

Subjects

Twenty-four male and female students from the University of Waterloo served as subjects for Experiment I. Subjects were randomly assigned to one of three groups; the groups differed only in the probe frequency during testing (⅓, ⅔, or 3/3). Thus there were eight subjects each in three independent groups.

Apparatus and task

The task and apparatus were basically the same for each experiment and therefore will be described extensively only once. The equipment consisted of a typical linear slide apparatus, two 1 000-second timers, three micro switches, a buzzer and a reaction time key. The slide was constructed of two 90 cm stainless-steel rods (1.7 cm diameter) mounted in parallel but offset such that one rod was higher and further forward than the other. The stand and end pieces were also made of stainless-steel. Each rod supported a ball-bushing sleeve and these were linked by a metal housing to form an almost frictionless slide. A handle attached to the front of the slide was grasped by the subject for movement production. A metal pointer attached to the handle was used to align the slide with a target. A plywood barrier in front and on top of the slide prevented the subject from seeing any of the apparatus except his handle. A moveable target (2 cm × 10 cm) was attached to the barrier.

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One clock was used to measure movement time (MT) and thus was attached to one micro switch which was initiated by the slide leaving the start position and a second switch, which was activated when the slide crossed a point one cm from the target (the second switch was so positioned in case the subject undershot the required movement). The second clock was used to measure the subject's RT to the auditory probe and thus was attached to a moveable reed switch, which could be placed anywhere in the movement and activated the clock and buzzer when the slide crossed over it. This clock was also attached to the RT key which stopped the clock and buzzer when the subject lifted his left index finger.

The subject's primary task was to move the slide from right to left to the designated target. He was instructed to be as accurate as possible in moving to the target and was given knowledge of results (KR) concerning MT and constant error about the target. In Experiment I the subject's task was to move either 41 cm in two sec. or 20 cm in one sec. The subject's secondary task was to lift his left index finger from the RT key as quickly as possible, if and when the buzzer sounded. Probe positions for the 41 cm movement were at 1, 14, 27 and 40 cm and 1, 7, 13 and 19 cm for the 20 cm movement. Depending on the condition the subject was in, the probe occurred on one-third, two-thirds or all of the trials.

Procedures

Subjects were brought into the testing room and a brief explanation of the primary (moving to the target) and secondary (reacting to the probe) tasks followed. It was emphasized that attention should be focused on the movement to the target. Following the instructions the subjects were given a few practice trials to acquaint them with the proper MT and procedures for a trial. In Experiment I subjects experienced the probe at each of the four probe positions, for each of the two movement distances. Once through these eight positions was termed an experimental cycle. Each subject completed four experimental cycles. In addition, each subject completed two control cycles during which the experimenter completed the movement to the target (the subject just watching) and the subject simply reacted to the probe. It should be noted that different groups of subjects received a different total number of trials (probe + catch trials) depending on the probe frequency. For example, the subjects who received the probe on every trial had 48 total trials [(4 + 2 cycles) × 8 = 48 total trials]. Subjects in the two-thirds probe frequency condition received 72 total trials [(4 + 2 cycles) × 8 = 48 probed trials + 24 catch trials = 72 total trials]. Subjects in the one-third condition received 144 total trials.

Design

The design for Experiment I was a probe Frequency × experimental and control Cycles × movement Length × probe Position, 3 × 6 × 2 × 4 arrangement, with repeated measures on all factors except the first. However, for analysis purposes the control and experimental Cycles were separated. This design allowed for a comparison of the effects of probe Frequency and probe Position on probe RT. It was expected that there would be significant main effects of probe Position and probe Frequency, as well as a Position × Frequency interaction. Of major concern was the expectation that the different probe frequencies would produce different shaped curves relating probe RT to probe Position.

Results

Experimental Cycles

Analysis of the four experimental Cycles revealed that probe RT increased as probe frequency decreased from three-thirds to one-third. RT for the three Frequency conditions was 252 (3/3), 274 (2/3) and 314 msec. (1/3) respectively, producing a significant Frequency main effect with $F(2,21) = 3.58$, $p < .05$. As well, RT decreased with practice over the four experimental Cycles, with $F(3,63) = 14.47$, $p < .01$. Probe RT was slower for the probe Positions at the beginning and end of the movement than for the two middle positions, with $F(3,63) = 10.25$, $p < .01$. Of major interest however was the significant interaction between probe Frequency and probe Position with $F(6,63) = 4.62$, $p < .01$. It can be seen from Figure 1 that the curves of probe Position plotted separately for each probe Frequency tend to be V-shaped except for the three-thirds probe Frequency condition. For each frequency probe RT was elevated for the probe Position at the beginning of the movement. Probe RT decreased for the two middle Positions and then increased again for the probe Position near the target, except for the three-thirds Frequency in which probe RT continued to decrease below the level of the middle Positions. A trend analysis of these three conditions revealed the one-third and two-thirds Frequencies to have only a significant quadratic component, with $F(1,63) =$ 12.62 and 16.45 respectively, $p < .01$, whereas the three-thirds condition had only a significant linear component with $F(1,63) = 28.70$, $p < .01$. A significant probe Frequency × Cycles interaction, $F(6,63) = 2.39$, $p < .05$ indicated that although all three probe Frequencies showed a decrease in probe RT with practice this effect was much more pronounced for the one-third condition. Although there was a significant probe Frequency × Cycles × probe Position interaction, with $F(18,189) = 1.84$, $p < .05$ there was no consistent trend within this effect.

Control Cycles

Only the main effects of probe Frequency, Cycles and probe Position reached significance for the control cycles. The former two were indentical trends to the experimental Cycles. Probe RT was elevated only for the first probe position and declined after that within the probe Position main effect. Figure 1 shows the three control condition curves plotted separately for each probe Frequency. It can be seen that control RT is generally 50-100 msec. faster than probe RT during the experimental Cycles.

Discussion

In studying the attention demands of movement control POSNER and KEELE (1969) found that attention was elevated during response initiation and as the subject approached the

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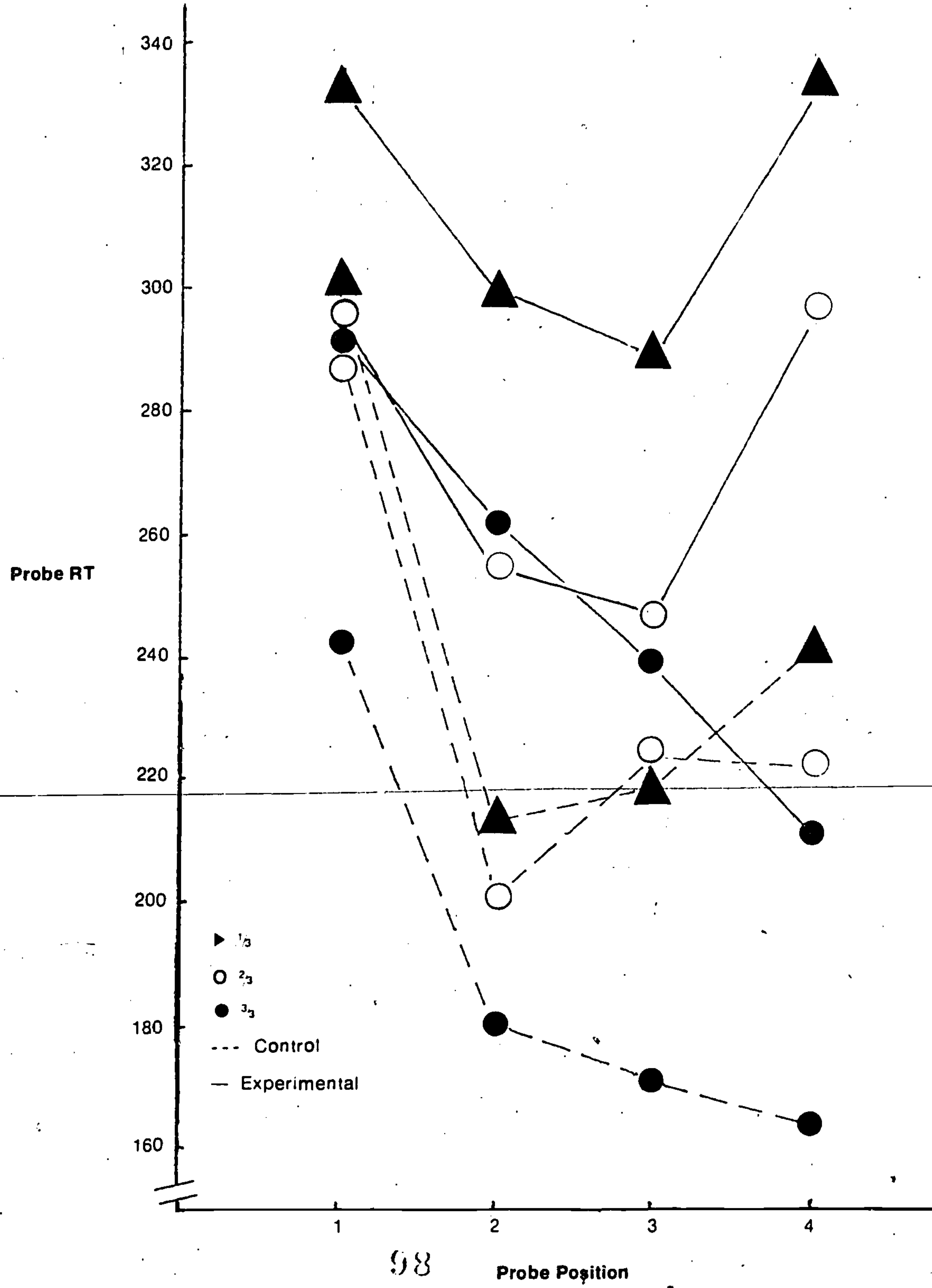
Figure 1 - Mean probe RT as a function of probe position plotted separately for each probe frequency.



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target at the end of the movement. During the middle of the movement probe RT was only elevated slightly above the control condition. Similarly, ELLS (1973) found response initiation to be attention demanding, however he did not find the same elevation in probe RT as the subject approached the target. A reason for this difference was not immediately apparent. There was some speculation that the difference may have been due to a difference in MT as MT in Ells' study was 200-300 msec. shorter than in Posner's and Keele's study. This shorter MT may have lent to some type of preprogramming strategy, (SCHMIDT & RUSSEL, 1973), which, if true, would be expected to lower attention at the target since termination of the movement at the desired spot would have been programmed before the movement began. However, Ells' movement times were 300-400 msec., which are somewhat long for a preprogramming-strategy explanation to be feasible.

Not considered was the difference in probe frequency between the two studies. Ells' subjects experienced the probe on every trial, while Posner's and Keele's subjects received the probe only on two-thirds of the trials. That this difference might be important is evidenced by the fact that DRAZIN (1961) found differences in stimulus frequency to affect the shape of the RT curve of foreperiod length plotted against RT. Instead of considering time into a movement Drazin dealt with the passage of time into a foreperiod. With a stimulus probability of 1.0 (similar to a probe frequency of three-thirds) he obtained a negatively accelerating curve representing time into a foreperiod plotted against RT. In addition, with a stimulus probability of 0.5 (between probe frequencies of one-third and two-thirds) the curve was V-shaped. These two shapes are identical to the shapes found by POSNER and KEELE (1969) and ELLS (1973). In addition, these shapes were duplicated in the present study using probe frequency of one-third, two-thirds and three-thirds, the latter two duplicating the probe frequencies used by POSNER and KEELE (1969) and ELLS (1973). By drawing an analogy between time into a foreperiod and time into a movement it becomes apparent that probe frequency is an important factor in drawing conclusions about the attention demands of movement control. In this regard, it is extremely important that the appropriate control condition is used since, as can be seen from Figure 1 the shapes of the control curves also change with probe frequency. Part of the assumption in using the probe technique is the fact that the slower the probe RT the greater the attention demands of the process being studied. In the present study probe frequency also affected the average probe RT. Thus it is apparent that in order for studies to be comparable probe frequency must be considered. If this is not done conclusions regarding underlying processes will be difficult to make since different studies using different probe frequencies will not be comparable. It is suggested therefore that in the future, researchers adopt a consistent probe frequency.

It was thought that the shorter movement distance (20 cm) would be more attention demanding than the longer distance (40 cm). A typical finding in motor short-term memory research (e.g., STELMACH and WILSON, 1970) has been that shorter movements have been more detrimentally affected by lack of space in the central processor. This has been taken as evidence that short movements are more attention demanding than long movements. However, in the present experiment there was no difference in probe RT for the 20 and 41 cm movement lengths. These two distances may not have been short or long enough, however, to produce a difference in probe RT.

If indeed anticipation of the onset of the probe can have such a great effect on the shape of the attention demand curve, then it may be desirable to eliminate the expectancy effect as much as possible. With the probe occurring on every trial there is a change in the probability that the probe will occur at the next probe position, as the movement is completed toward the target. If, for example, there are four probe positions, then the probabilities that the probe will occur at a certain position, given that it has not yet occurred at a preceding position are 0.25, 0.33, 0.50, and 1.0. That is, if the probe has not occurred at the first three positions it *must* occur at the last position. A technique to prevent this probability change was developed by NAATANEN (1970). The above effect depends on the fact that the subject will experience the probe an equal number of times at each position. By systematically decreasing the number of stimuli at each foreperiod (or probe position) and adding a sufficient number of catch trials, Naatanen held the stimulus probabilities constant across foreperiods. Within 54 total trials the absolute stimulus frequencies for three foreperiods was 18, 12, and 8. Thus, the probability that the stimulus would be delivered at each foreperiod was:

$$\frac{18}{54} = \frac{1}{3}, \quad \frac{12}{54-18} \text{ or } \frac{12}{36} = \frac{1}{3}, \quad \frac{8}{54-18-12} \text{ or } \frac{8}{24} = \frac{1}{3}$$

plus 54-18-12-8 = 16 catch trials.

Using this technique Naatanen was able to eliminate the immediate foreperiod effect, since the shortest foreperiods did not produce the longest RT. This technique was adopted in Experiment II to see what effect it would have on the shape of the attention demand curve. It is important that subjects are able to distinguish among the various probe positions within a movement. Changing the frequency of occurrence of each position cannot be effective unless a distinction is made among the positions. Therefore it would be best to use a long movement distance.

EXPERIMENT II

Method

Subjects

Four students from the University of Waterloo served as subjects for Experiment II.

Apparatus and Task

The apparatus and task were identical to Experiment I with a few minor exceptions. A single movement length of 50 cm was used with a desired MT of 1 000 msec. The four probe positions were at 1, 17, 33 and 49 cm.

Procedures

Basic procedures were the same for Experiments I and II. In Experiment II subjects experienced the probe at each of the four probe positions, but unlike Experiment I, the absolute frequency at each position was not equal. An attempt was made to produce a probe probability of .025 at each probe position. It should be noted here that the exact desired probability is not always easily obtained, since half trials are not possible and a very large number of trials is not always feasible. Each subject completed two cycles of 64 trials each, with a five minute rest between cycles. During 64 trials the subject experienced the probe in the first position 16 times ($\frac{16}{64} = 0.25$), the second position 12 times

$$\frac{12}{64-16} = \frac{12}{48} = 0.25 ,$$

the third position 9 times.

$$\frac{9}{64-16-12} = \frac{9}{36} - 0.25 ,$$

and the fourth position 7 times

$$\frac{7}{64-16-12-9} = \frac{7}{27} = 0.26$$

with an additional 20 catch trials. Presentation of probe positions was randomized over trials. Therefore, over 2 cycles subjects completed 128 trials.

On each trial the subject's RT to the probe, if it occurred, was recorded. In addition the subject was given knowledge of results concerning target accuracy and MT.

Results

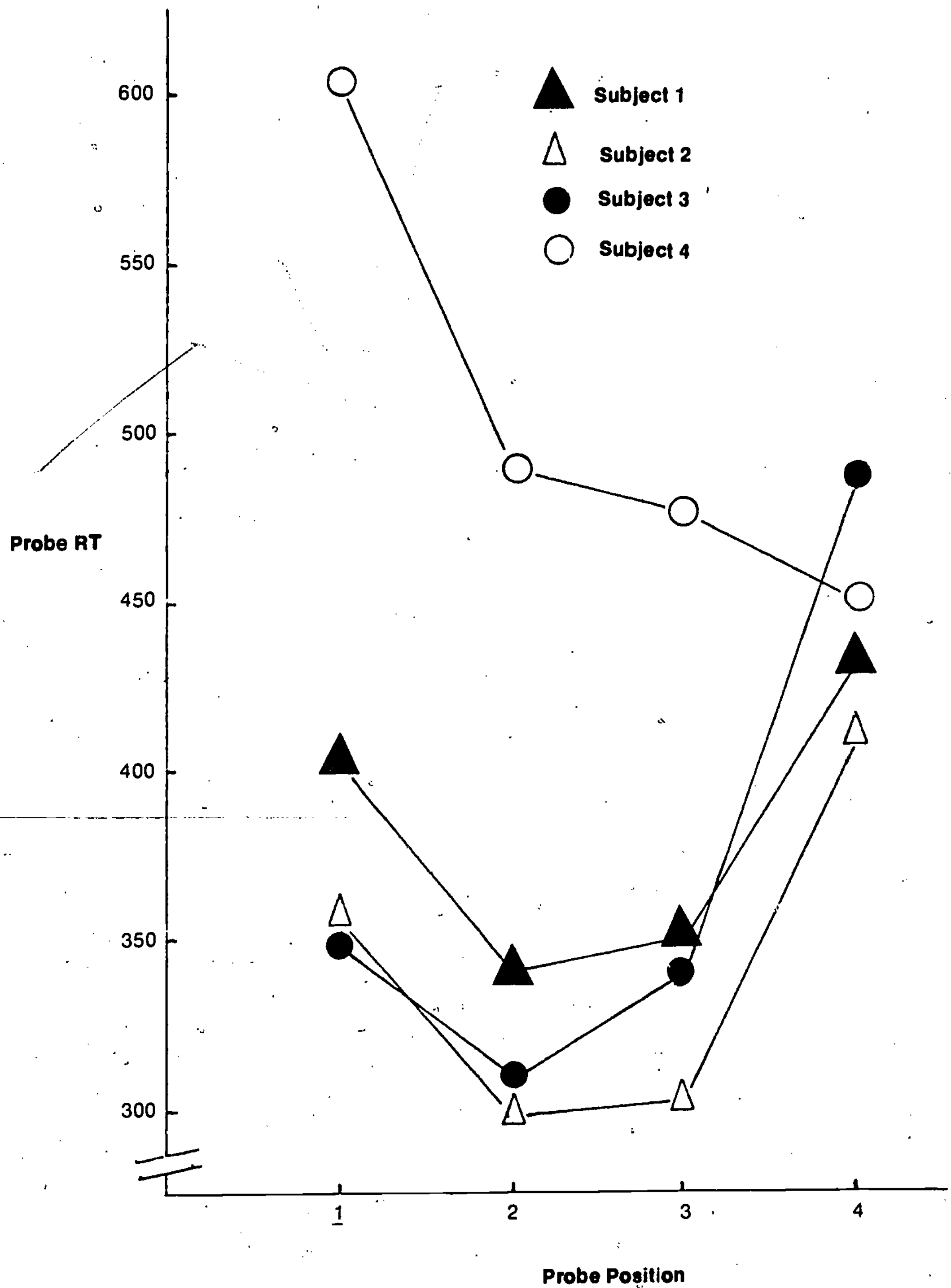
Mean RT was calculated separately for each probe position and for each subject (Figure 2). It can be seen that three of the four subjects produced probe position curves very similar to the curves in Figure 1 for probe frequencies of one-third and two-thirds. That is, probe RT was elevated at the beginning and end of the movement. A fourth subject produced a negatively accelerating curve similar to the curve in Figure 2 for the three-thirds condition.

Discussion

The former three curves are very similar to those obtained by Naatanen (1970), since his results demonstrated that the longest foreperiods produced the longest RT, although this was not true of every subject. Some subjects continued to produce the longest RT with the shortest foreperiod (immediate foreperiod effect). In the present study the longest RT was associated with the target probe position, analogous to the longest foreperiod.

If we can assume that this technique indeed minimizes the immediate foreperiod effect it seems safe to suggest that response initiation does cause an increase in probe RT, and that the elevated RT is not simply an artifact of the probe frequency. That is, response initiation is attention demanding. It is somewhat puzzling why probe RT at the target probe position is so elevated. This effect is very similar to that found in Experiment I for the two-thirds and one-third probe frequencies. Indeed, inspection of the curves in Figures 1 and 2 reveals very few differences. Even with an equalization of probe occurrence frequencies there is no guarantee that subjective frequencies follow the same pattern. This is evident in Figure 2 by the individual differences present. It would seem therefore, that equalizing probe occurrence frequencies has little advantage over the simple technique used in Experiment II.

Figure 2 - Mean probe RT as a function of probe position plotted separately for each subject.



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EFFECT OF THE COMPLEXITY OF A PREVIOUS RESPONSE UPON REACTION TIME TO A SUBSEQUENT STIMULUS[1]

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When a response is executed to each of two stimuli separated by interstimulus intervals (ISIs) of 500 msec or less, the reaction time to the second stimulus (RT_2) is usually found to be abnormally prolonged. The reason for this phenomenon is not entirely clear, although two prominent explanations have been contending over the past 25 years. On the one hand are those who attribute this delay in RT_2 to a single-channel mechanism in the brain, of limited capacity, which links stimulus reception to response execution (WELFORD, 1952; 1959; 1967; DAVIS, 1956; 1959; 1962; 1965; POULTON, 1972). Such a mechanism has been hypothesized to be restricted to dealing with only one stimulus event at a time. A subsequent stimulus (S_2) arriving prior to completion of the processing of the preceding stimulus (S_1) is believed to be held in short-term memory (POULTON, 1972), and admitted into the channel only after S_1 has been read out.

A rival explanation proposes that delays in RT_2 are simply a consequence of Ss' lack of expectancy for the arrival of S_2 (HICK, 1948; POULTON, 1950; ELITHORN and LAWRENCE, 1955; ADAMS, 1962; 1964; NICKERSON, 1965). Expectancy theorists contend that when a very long, short, or infrequent ISI occurs, the S is not ready to respond, and thus RT_2 becomes prolonged. This position also connotes that a S can be a multichannel processor of closely paired stimuli provided that the S is practiced in the testing situation, and is able to optimally anticipate the arrival time of S_2.

Although opinion presently seems to favor the single-channel explanation (BERTELSON, 1966; SMITH, 1967; WELFORD, 1967) since a S's expectancy for the arrival of S_2 can account for only part of the delay observed in RT_2, a truly discriminating test of the two hypotheses is not in evidence. Previous studies undertaking such an endeavor have chosen to vary the statistical structure of the ISI for the purpose of making some intervals more likely to occur than others (ADAMS, 1962; BORGER, 1963; DAVIS, 1965). Expectancy theorists have argued that if a particular ISI occurs more regularly than another one, the S will be more expectant at that ISI and consequently show accompanying decreases in RT_2. Conversely, single-channel proponents have contended that delays in RT_2 are caused only by the absolute value of the ISI, and not the relative frequency of how often a particular interval occurs within a series of ISIs. Unfortunately, these deductions have not been adequately tested since crucial investigations have been seriously questioned as to data interpretation and experimental validity (DAVIS, 1956; 1965; 1966; HICK and WELFORD, 1956; KARLIN, 1965; ANNETT, 1965; SMITH, 1967).

In light of the criticisms lodged against previous studies which have attempted to discriminate between single-channel and expectancy explanations for delays in RT_2 when the ISI is small, the present investigation introduced an additional factor which could possibly clearify which theory more adequately accounts for the empirical data. In earlier studies, complexity of the serial responses was totally neglected as a test variable, as simple key releasing and pressing, or short lever movements were predominently used to indicate occurrence of signaling stimuli. However, response complexity would seem to be an important variable in serial response investigations as evidence has been garnered indicating that reaction time (RT) becomes inflated for more complicated movements (HENRY, 1960; GLENCROSS, 1972; 1973). If this inflation in RT can be assumed to reflect additional internal processing necessary to initiate the appropriate response, single-channel and expectancy theories would have differing deductions concerning the effect that an initially complex response should have on the magnitude of RT_2. Whereas single-channel theorists would predict inflated RT_2 values because the single-channel would be occuppied by the additional time required to process S_1, indicated by a longer RT_1, expectancy theorists would contend that RT_2 should be unaffected by such increases in RT_1 since RT_2, according to their viewpoint, varies because of Ss' uncertainty as to S_2s arrival time. The latter proponents do not recognize the degree of processing required for S_1 to be related to RT_2. Thus, in the serial response testing situation, if the movement complexity of the first response is increased, while the probability of a particular ISI occurring on any trial is held constant, i.e., expectancy of S_2s arrival held constant, inflation of RT_2 would more easily be accounted for in terms of single-channel theory. This would connote sequential processing in that the increased processing of S_1 was delaying the access of S_2 to the limited mechanism. Conversely, if no change in RT_2 occurred by varying the complexity of the initial serial response, multichannel processing would seem to be evident and an expectancy explantion for the phenomenon, more tenable, since the processing of S_2 could probably occur concurrently with that of S_1.

The present study attempted to test which theory best accounts for variation in RT_2 when the complexity of the initial response in a serial task was varied. Response sequences included: (a) executing a simple response following a simple response (SS), (b) executing a simple response following a complex response (CS), (c) executing a complex response following a simple response (SC), and (d) executing a complex response following a complex response (CC). Additionally, ISIs within each sequence were varied by 100, 200, 400, and 800 msec in a constrained random order. This provided for each ISI to occur an equal number of times in each response condition, thus controlling Ss' expectancy of S_2 across blocks. Comparisons of interest were SS with CS, and SC with CC.

1. This research was done in partial fulfillment for the degree of Doctor of Education in Physical Education at the University of North Carolina at Greensboro under the direction of Dr. Pearl Berlin.

SECONDARY PROBLEM

A secondary problem of the present study was to examine individual differences in Ss' ability to execute fast, consecutive responses to successive stimuli. If an individual has a fast RT to a single stimulus, does he/she also respond quickly to both initial and successive stimuli in a serial task? An earlier study (KROLL, 1969) demonstrated that Ss who differred on simple unpaired RT, and RT_1, did not show differences in the absolute magnitude or pattern of response latencies to S_2. This finding, as Kroll indicated, seriously conflicted with single-channel theory since the ability to respond quickly on RT_1 should theoretically clear the channel faster, allowing the processing of S_2 to commence, thus eventuating in smaller delays in RT_2. Consequently, Kroll suggested that the ability to execute fast, serial responses may be a unique skill factor rather than a general capacity of responding within a particular individual.

Thus, in addition to examining the effect of response complexity and ISI on RT_2, an attempt was made to replicate and generalize Kroll's findings by analyzing differences between relatively fast and slow responders in simple non-serial RT, and their RT_2s across differing serial response sequences and ISIs.

METHOD

Subjects

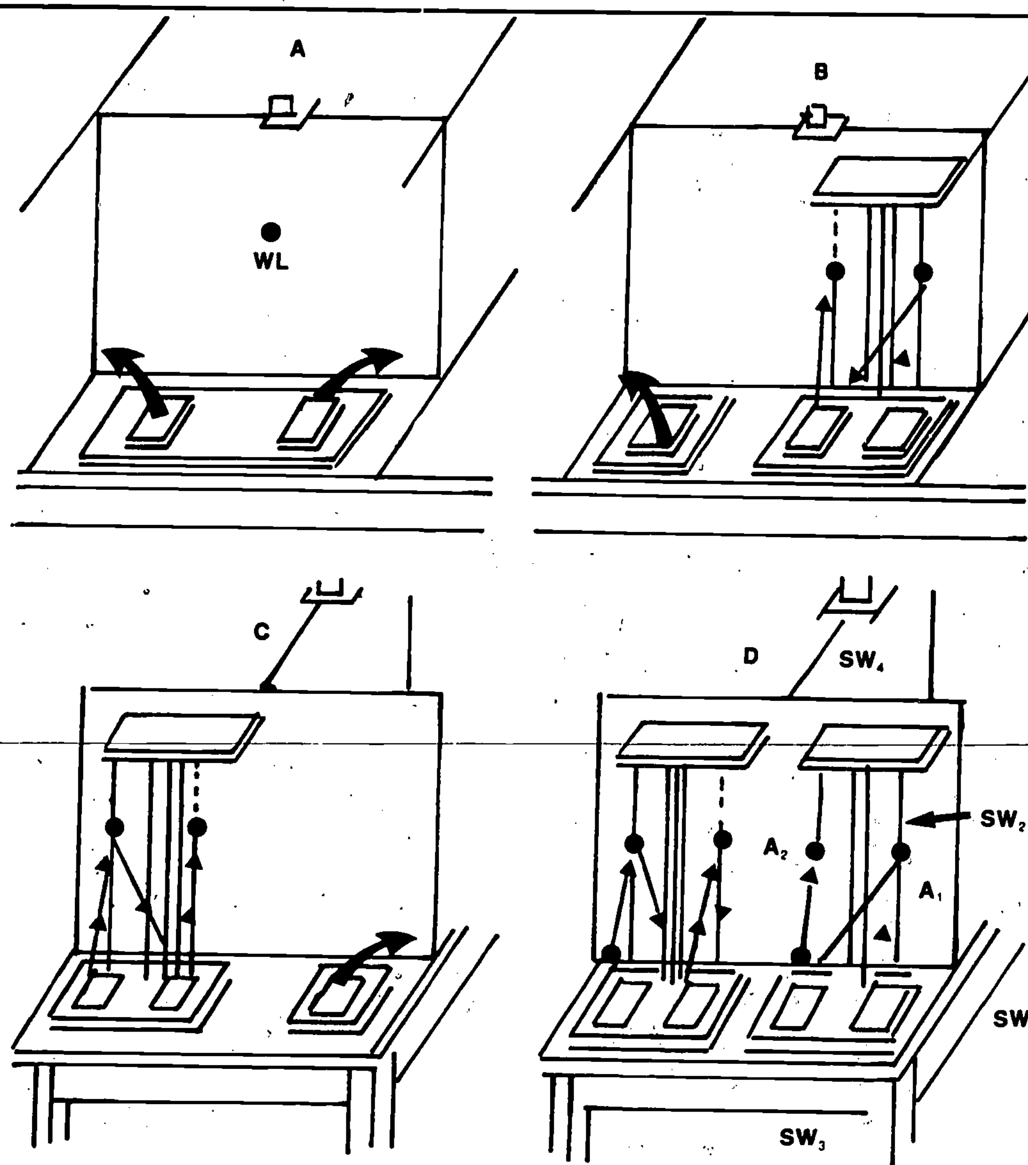
Data for this study were generated from 24 female, right-handed volunteers who were in attendance at the University of North Carolina at Greensboro. Their ages ranged from 18-33 years.

Responses

The complex response (CR) consisted of the motor pattern that HENRY (1960) adapted from HOWELL (1953). It entailed a S, while seated at a table upon which the test apparatus was located, to move her arm in a zig-zag fashion. At the sound of a stimulus buzzer lasting 30 msec the S moved her hand, as quickly as possible off of a RT switch (SW_1), reaching forward 30 cm, and upward 15 cm to strike a tennis ball with the back of her hand, closing dummy switch (SW_2), reversing direction to go diagonally back to another dummy switch (SW_3) on the baseboard, located parallel and 30 cm to the left or right of SW_1, and then reversing direction again and going upward 15 cm and forward 30 cm to pull down another tennis ball which was attached by a string to dummy switch (SW_4). Figure 1 contains illustrations of the apparatus and movement pattern selected for the CR.

The simple response (SR) consisted of the S lifting her index finger off of a RT key at the sound of the stimulus buzzer (see Figure 1).

Figure 1 - Experimental apparatus and response conditions.



A = Simple-Simple
B = Simple-Complex
C = Complex-Simple
D = Complex-Complex
A₁ = First Tennis Ball
A₂ = Second Tennis Ball

SW₁ = Switch
SW₂ = Dummy Switch
SW₃ = Dummy Switch
SW₅ = Dummy Switch
WL = Warning Light

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Procedures

Five experimental sessions were required for each S. Although every effort was made to order these for consecutive days and similar daily times, laboratory availability and Ss' schedules did not always coincide. However, no S completed the five sessions over a period longer than eight days, and all performed daily within two hours of the time of their initial visit.

Sessions 1 and 2 were utilized for obtaining estimates of each S's RT for each response task, i.e., CR and SR performed separately. Such measures were necessary for dividing the 24 Ss into two groups of 12 Ss, with one being relatively fast in non-serial RT when compared to the other.

For each of the first two sessions, 50 CR and 50 SR RT trials for each hand were administered to each S. These 200 trials were grouped into 4 CR and 4 SR blocks. Each one consisted of 25 trials including 5 randomly placed catch trials, i.e., trials upon which the stimulus buzzer did not occur. The eight response blocks were assigned to Ss in a random order on each of the first two sessions.

A trial began with the illumination of a red warning signal located 26 cm above the table top upon which the apparatus was located, and directly in front of the seated S. This signal initiated a preparatory interval which occurred in a constrained random order from 1-4 seconds. The stimulus buzzer then signaled, and the S executed the appropriate response called for by the particular block. Ten seconds were allowed between the end of one trial and the beginning of the next, while a two minute rest period was given between blocks. The dependent variable was the mean RT for each S, in each response condition, for each of the first two sessions.

During Sessions 3-5 each S was required to perform four different blocks of trials in which responses were executed in a sequential fashion (Figure 1). Additionaly, auditory stimuli signaling the initiation of each response were separated by ISIs of 100, 200, 400, and 800 msec. These were varied in a constrained random order within each of the four blocks. Block 1 entailed executing the SR following the SR (SS). Block 2, executing the SR following the CR (CS), Block 3, executing the CR following the SR (SC), and Block 4, executing the CR following the CR (CC). Each block consisted of 45 trials, containing 5 randomly placed catch trials for the second response. In all blocks, and over all trials, the left hand responded to the first stimulus (S_1), while the right hand responded to the second stimulus (S_2). As in Sessions 1 and 2, trials were initiated by the red warning light, which was followed by a preparatory interval of 1-4 seconds. Blocks were also assigned randomly to each S during each of these sessions. Ten seconds were permitted between trials, and a two minute rest period given between blocks. The dependent measures analyzed were the RTs to initial (S_1) and successive (S_2) stimuli, i.e., RT_1 and RT_2, within ISIs, response blocks, and sessions.

During all sessions, Hunter Interval Timers, model 111B, were used to set preparatory, interstimulus, and stimulus duration intervals. RTs were measured by clocks manufactured by Lafayette Electronics, model 54014.

RESULTS

Non-serial RTs for CR and SR and Speed Grouping

A repeated measures MANOVA, using mean session, right hand RTs was performed to determine whether latencies for CR and SR decreased from Session 1 to 2, $F(2,22) = 9.58$, $p < .01$. Session 2 values, when simultaneously considered were found to be faster than those for Session 1. CR RT was reduced by 24 msec, while SR RT decreased by 12 msec. Table I presents CR and SR RTs for the first two sessions.

Table I - Reaction Times for Each Task During Each Session[a].

	Response	Hand	Mean	SD
Session 1	Simple	Right	153	25
	Simple	Left	153	24
	Complex	Right	219	30
	Complex	Left	224	34
Session 2	Simple	Right	141	29
	Simple	Left	138	28
	Complex	Right	195	31
	Complex	Left	202	34

[a] All values in msec.

Correlation coefficients between the derived canonical variable and each dependent variable were respectively .99 and .46 for CR and SR RTs. Since CR latencies weighed more heavily as a discriminator between sessions, its median value on Session 2 was calculated and used as the criterion for dividing Ss into relatively fast and slow groups. However, a possibility still existed that such a division based on CR times alone would prove inadequate when SR times for Session 2 were simultaneously considered, since Ss who exhibited relatively small CR latencies need not necessarily show fast SR times. Thus, a discriminant analysis using both SR and CR measures as predictors of group affiliation was run. The results confirmed the assignment of all Ss to their respective CR RT groupings. Table II contains RT data on each response task for each of the two groups.

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Table II - Reaction Times for Fast and Slow Groups on Session 2 ª.

Group	Response	Hand	Mean	SD
Fast N = 12	Simple	Right	123	15
	Complex	Right	171	16
Slow N = 12	Simple	Right	160	29
	Complex	Right	219	23

ª All values in msec.

Analysis of RT_2

An ANOVA for repeated measures was run to determine the effect of initial response complexity and ISI on RT_2. Fast and slow groups of Ss were nested across the four response sequence blocks, four ISIs, and three sessions. The dependent variable was mean RT_2 for each S in each condition.

Response Blocks

RT_2 for the four serial response blocks was significant, $F(3,66) = 208.23$, $p < .01$. A Neuman-Keuls test revealed the four treatment means to be significantly different, p .01 (Table II). As deduced from single-channel theory, RT_2 was significantly prolonged when the initial response was more complex, i.e., CS > SS, and CC > SC. Variation of response blocks in the serial task accounted for a majority of the observed variance in RT_2, $w^2 = 57\%$.

Table III - RT_2s for Fast and Slow Groups. — Within Response Blocks and ISI Conditions ª.

Response Blocks		ISI 100 Fast	100 Slow	200 Fast	200 Slow	400 Fast	400 Slow	800 Fast	800 Slow	Group Mean	Block Mean
Fast	SS	200		171		147		171		172	187
Slow	SS		234		193		177		200	201	
Fast	CS	314		292		319		276		300	317
Slow	CS		342		313		350		328	333	
Fast	SC	226		190		178		202		199	226
Slow	SC		279		234		231		264	252	
Fast	CC	344		325		350		300		330	357
Slow	CC		415		370		392		356	383	
Group Mean		271	318	245	278	249	288	237	287		
ISI Mean		295		262		269		262			

ª All values in msec.

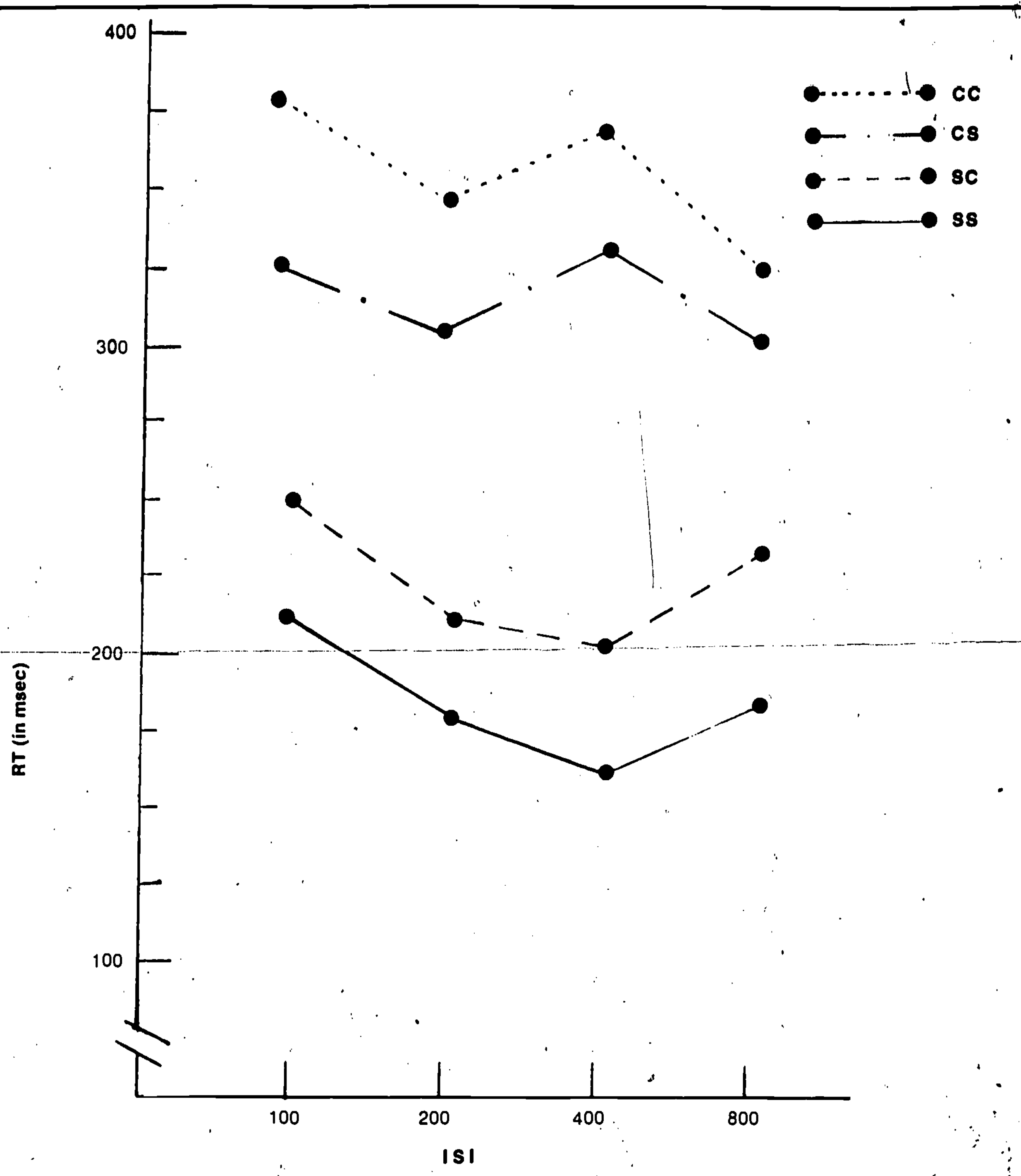
ISI

The factor of ISI was also found to be significant, $F(3,66) = 22.10$, $p < .01$. However, a Neuman-Keuls post-hoc test revealed that a difference existed only between the 100 msec ISI, and those at 200, 400, and 800 msec, $p < .01$ (Table 3). Since each ISI had an equal probability of occurring within a response block, this finding seemed to support single-channel theory since RT_2 was longest at the shortest ISI. However, it is not clear why RT_2 did not decrease as ISIs increased from 200 to 400 msec, and from 400 to 800 msec. The percentage of variance in RT_2 found to be attributable to ISI was small, $w^2 = 2\%$.

Response Blocks × ISI

An unanticipated result was the finding of a significant interaction between response blocks and ISI, $F(9,198) = 19.70$, $p < .01$. As seen in Figure 2, the significant interaction seems to be a consequence of the differing patterns among blocks at the 400 msec ISI. CS and CC sequences paralled one another, as did SS and SC Such a finding of inflated RT_2 values at the 400 msec ISI for sequences with an initially complex response may indicate that the single-channel processing mechanism was occupied because of movement monitoring when S_2 arrived. In contrast, the SS and SC sequences probably showed a decreasing pattern at this interval since by 400 msec the initial response was completed when S_2 arrived, and attention could be exclusively devoted to the processing of the next response. This interaction accounted for a small part of the variation of RT_2, $w^2 = 2\%$.

Figure 2 - Graphic illustration of the response blocks × ISI interaction.



Non-serial RT, RT_1, and RT_2

In order to determine whether relatively fast and slow non-serial RT groups remained intact when RT_1 was examined, a second identical ANOVA was run using RT_1, i.e., initial paired RT in the serial task, as the dependent variable, $F(1,22) = 23.81$, $p < .01$. This indicated that groups differed significantly in the anticipated direction on RT_1 (Table IV).

Table IV – RT_1s for Fast and Slow Groups. — Within Response Blocks and ISI Conditions *.

Response Blocks		ISI									
		100		200		400		800		Group	Block
		Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Mean	Mean
Fast	SS	118		121		123		123		121	136
Slow			149		149		153		154	151	
Fast	CS	170		170		173		174		172	194
Slow			215		210		216		221	216	
Fast	SC	145		133		134		135		137	155
Slow			164		173		175		177	172	
Fast	CC	178		171		173		178		175	198
Slow			221		223		218		222	221	
Group Mean		153	187	149	189	151	191	153	194		
ISI Mean		170		169		171		174			

* All values in msec.

The variance analysis using RT_2 as the dependent variable was also significant, $F(1,22) = 11.78$, $p < .01$. On both ANOVAS group classification did not interact with any other factors, thus fast and slow responders in a non-serial RT task, in contrast to Kroll's (1969) findings, remained so across all conditions for RT_1 and RT_2. For RT_2, $w^2 = 5\%$.

DISCUSSION

Does the complexity of the initial response affect RT_2?

From the data generated in the present study, RT_2 was significantly delayed in sequential response conditions in which the CR was required as the initial response, i.e., CS > SS, and CC > SC. This effect was found across and within as in th present investigation an increase in initial response complexity associated with it, the longer will be the occupation of the single-channel, and the greater the delay in RT_2.

Do individuals having fast RT to a single stimulus also have fast RT_1s and RT_2s?

The finding that Ss grouped into RT speed categories based on single measures of RT generated during Sessions 1 and 2, maintained their relative group positions across all response blocks, ISIs, and sessions when RT_2s were compared was contrary to Kroll's results. Inspection of RT_1s for each group demonstrated similar findings. In contrast to Kroll's conclusions, the present findings seem to be in accord with single-channel theory as speedier processing of S_1 seemed to free the channel faster for subsequent processing of S_2. Consequently, a general, rather than specific, RT speed factor for executing fast responses, separately or consecutively seemed to exist in the Ss used in this study.

A possible, although not probable, explanation for the disparity in results may be offered in terms of learning. Kroll allowed four days of practice in a single response situation, and six days in a dual one. Additionally, response complexity was not a factor in his study, hence each S had more practice time on the SS block, which was exclusively used. The overall trend in the present study was for the two groups to merge on RT_2 from Session 3 to Session 5. However, even in Session 5 the two groups differed significantly. Subsequent research investigating differing RT_2 patterns between fast and slow groups of Ss over an extended time period would seem to be needed to adequately resolve these conflicting results.

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SPECIFIC AND NON-SPECIFIC FATIGUE EFFECTS ON THE TIMING PERFORMANCE OF WELL-PRACTICED SUBJECTS

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The problem of performing or learning motor skills under conditions of physical fatigue has occupied the attention of practitioners for many years. Investigators of fatigue effects have typically employed a simple transfer paradigm in which a portion of subjects are fatigued during Day 1 acquisition trials and then are switched to non-fatigue practice (i.e.. control conditions) on Day 2 (SCHMIDT, 1969). If fatigue depresses the performance of experimental subjects on Day 1 only, then it is considered a *performance variable*. However, should decrements persist after transfer to non-fatigue practice on Day 2 then fatigue is concluded to be a *learning variable* as well. That is. practice under fatigue conditions is assumed to distort mechanisms which govern learning as well as performance.

Research in this area has indicated that fatigue is principally a performance variable; practice in a state of physical fatigue results in immediate motor performance impairment but motor learning is largely unaffected (ALDERMAN, 1965; CARRON, 1969; COTTEN, THOMAS, SPIETH, & BIASIOTTO, 1972; COTTEN, SPIETH, THOMAS, & BIASIOTTO, 1974; PACK, COTTEN, & BIASIOTTO, 1974; SCHMIDT, 1969). Exceptions are reported only in studies in which fatigue has been vigorously manipulated (BARNETT, ROSS, SCHMIDT, & TODD, 1973; CARRON, 1972; CARRON & FERCHUK, 1971; GODWIN & SCHMIDT, 1971). In such experiments extremely high levels of fatigue, usually induced both before and between acquisition trials, have been found to depress learning as well as performance.

A basic requirement of the performance-learning transfer design is the introduction of fatigue during acquisition of a motor skill. One limitation to this paradigm is that it prevents generalization of fatigue effects to the performance of well-practiced subjects. Therefore, the purpose of the present investigation was to determine whether either specific or non-specific fatigue is capable of altering the performance of subjects given greater opportunity to learn a motor task. An absence of post-fatigue performance decrement would suggest that the command of motor performance factors contributes to sustained performance under conditions of fatigue.

METHOD

Subjects

Subjects were right-handed male undergraduate student volunteers (N = 24) from the basic instruction program. None had experience on the experimental task.

Preliminary Testing

After recruitment, subjects were assigned to one of three treatment conditions (N = 8). Control subjects (C) received no pre-experimental tests, while specific fatigue (SF) and non-specific fatigue (NF) subjects were given preliminary exercise tests to prescribe an appropriate fatigue treatment for the experiment.

The potential for specific exercise in the SF group was determined using a tensiometer (Pacific Scientific Co.) and aircraft cable apparatus. Subjects performed three maximal static contractions with the right shoulder horizontal flexors, while lying supine on a strength table. Following a brief rest, a submaximal static contraction was held at a tension equivalent to 25% of the highest maximal trial. Contraction time (endurance) was measured (sec) to the point where subjects could not maintain (±2 tensiometer scale units) the required force level. Fatiguing specific exercise for the SF treatment was then defined as 90% of the endurance time (SF group $\bar{X}$ = 125 sec) held at 25% of the subjects' maximal force level (SF group X = 14.5 lb).

The capacity for non-specific exercise (treadmill running) was determined in the NF subjects through measurement of the maximal oxygen uptake (VO_2max). The VO_2max measurements were taken using an open circuit system consisting of a Parkinson-Cowan CD-4 dry gas meter, a Warren Collins Triple J breathing valve, 1.5 liter plastic-aluminum collection bags and Beckman OM-11 and LB-2 respiratory gas analyzers; work was done on a Quinton 24-72 treadmill. The protocol consisted of a 5 min. walk at 3.5 mph, followed by continuous running beginning at 5.0 mph on the level and increasing in 2 mph increments every 2 min to 8.9 mph. Thereafter, further increments were given by increasing grade from zero in 2% increments every 2 min until exhaustion. Fatiguing non-specific exercise was defined for the subsequent experiment as the workload (NF group $\bar{X}$ = 8.6 mph and 0.6% grade) estimated to elicit 90% of the VO_2max (NF group $\bar{X}$ = 45.84 ml/kg-min) continued for 7 min.

Apparatus

A microswitch and a hinged masonite target (12 cm square) were mounted on top of a large table. The microswitch and target were separated by a distance of 86 cm and were mounted along a line parallel to and 30 cm from the edge of the table. The subject was seated perpendicular to the movement line facing the apparatus, with the microswitch on his right and the target on his left. A .01 sec timer (Standard Type S-1, 6 v. dc clutch, 1-sec sweep) was connected to and placed on top of a Reaction-Movement Timer (Lafayette Instruments #63017) which was mounted on the table. The sweep hand and face of the .01-sec timer were in full view of the subject while the Reaction-Movement Timer was turned so the digital time displays were visible only to the experimenter. With the target in the vertical position a set of contact points were "closed" so that by depressing the microswitch a trial cycle could be initiated. After a 4-sec delay the sweep hand began moving from the 12 o'clock position in a clockwise direction and simultaneously time began to accumulate on the digital displays of the Reaction-Movement Timer. Releasing the microswitch stopped the reaction time display and knocking over the target "opened" the contacts and stopped both the sweep hand and the total response time display.

Procedure

As each subject arrived at the lab on Day 1, he was seated in front of the apparatus centered between and a comfortable arm's length from the microswitch and target. The position of the chair was then recorded on a floor tape and noted on the subject's score sheet for reference on subsequent test days. The subject was then told that his task on each trial in the experiment was to visually track the movement of the sweep hand. Then, moving his right arm in a right-left horizontal direction from the microswitch to the barrier, he was to attempt to knock down the target and stop the sweep hand at the precise moment it completed half a revolution (500 msec). After visually observing the end location of the sweep hand in relation to half a revolution, the subject was instructed to return the barrier to the vertical position, reset the sweep hand by depressing a lever located at the base of the .01-sec timer, and await the next "Ready" command from the experimenter. These commands occurred every 15 sec on each test day and signalled the subject to depress the microswitch with his right index finger and prepare for the next movement of the sweep hand. The experimenter reminded each subject that stopping the sweep hand in a position beyond half a revolution meant his response was "too slow" while stopping it prior to half a revolution indicated the response was "too fast." If there were no questions, the subject was encouraged to do as well as possible on each trial and the experiment was begun. Response times were recorded to the nearest msec on each trial.

Subjects were randomly assigned to one of three independent treatment conditions (N = 8). All subjects were given four consecutive days of practice (50 trials/day) on the timing task under non-fatigue conditions. However, on Day 5 motor performance was preceded in two-thirds of the subjects by one of two types of fatiguing activity. Specific fatigue was induced in the SF group by a static contraction involving the right arm and non-specific fatigue was imposed in the NF group by a treadmill run, as prescribed from the preliminary testing. Control subjects (C) received no fatigue treatment. For Group SF, 15 sec elapsed between cessation of the static exercise and beginning of motor performance trials. Subjects in Group NF required 40 sec to move from the treadmill and begin Day 5 performance trials.

RESULTS

Variable Error

The consistency of the subjects' responses at the end of Day 4 and immediately following fatigue treatment on Day 5 was determined by calculating variable error (VE) on the final two blocks of five trials on Day 4 and on the initial two blocks on Day 5 (Figure 1). There was an increase in variability in the performance of Groups SF and NF on the first block of trials following fatigue on Day 5 (D_5B_1). An analysis of variance revealed a significant Groups × Blocks interaction, $F(6,63) = 2.25$, $p = .05$. Separate ANOVA on each of the four blocks indicated a significant VE difference among groups only on $D5B_1$, $F(2,)21) = 3.47$, $p < .05$.

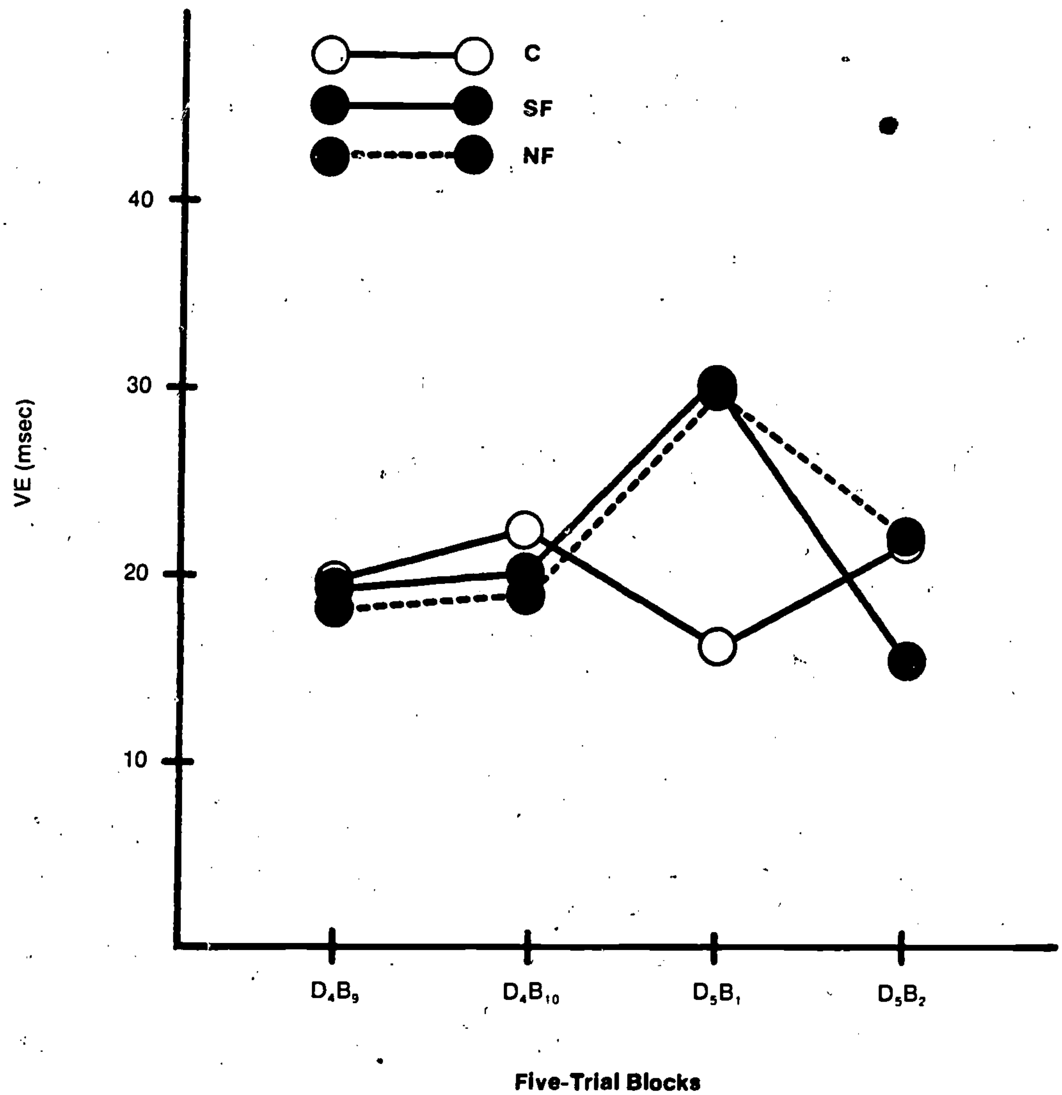
Constant Error

Constant error (i.e., the average deviation of responses from 500 msec with respect to algebraic sign, abbreviated CE) was calculated on the same blocks of trials as that of VE in order to determine response bias. Decrements due to a speeding up or undershooting of the 500 msec criterion were reflected by a negative CE whereas a slowing down or overshooting resulted in positive CE shifts. An inspection of block means for the three groups revealed slight undershooting throughout and an analysis of CE var[illegible]ndicated a non-significant Groups × Blocks interactio[illegible]3) = 1.36, $p > .05$. However, large CE shifts present [illegible] experimental fatigue treatments on Trial 1 of Day 5 (D_5T_1), were obviously masked in the five-trial mean on D_5B_1. Therefore, CE was calculated on D_5T_1 and D_5T_2 and compared with the last block on trials on Day 4 (D_4B_{10} to determine the extent and direction in which fatigue shifted the subjects' responses (Figure 2). Of particular interest was the opposite directional CE shift in initial post-fatigue performance of the two experimental conditions. While treadmill activity (Group NF) appeared to induce a speeding up or undershooting of the timing response, local static exercise (Group SF) caused at least temporary slowing down or overshooting. An analysis of variance of the scores of the last block of trials on Day 4 (D_4B_{10}) and the first post-fatigue trial on Day 5 (D_5T_1) revealed a significant Groups × Trials interaction, $F(2,21) = 5.50$, $p < .05$. However, this difference diminished by the second post-fatigue trial on Day 5 (D_5T_2), and an analysis of CE variance on D_4B_{10} and D_5T_2 yielded non-significant F ratios for both main and interaction effects.

DISCUSSION

The results of this study extended the well-documented finding that fatigue is a performance variable (ALDERMAN, 1965; CARRON, 1969; COTTEN, THOMAS, SPIETH, & BIASIOTTO, 1972; COTTEN, SPIETH, THOMAS, & BIASIOTTO, 1974; PACK, COTTEN, & BIASIOTTO, 1974; SCHMIDT, 1969) to a population of well-practiced subjects. Although only temporary, decrements in the post-fatigue

Figure 1 - Variable error (msec) in response times of the three groups on the final two five-trial blocks on Day 4 and the initial two blocks on Day 5.



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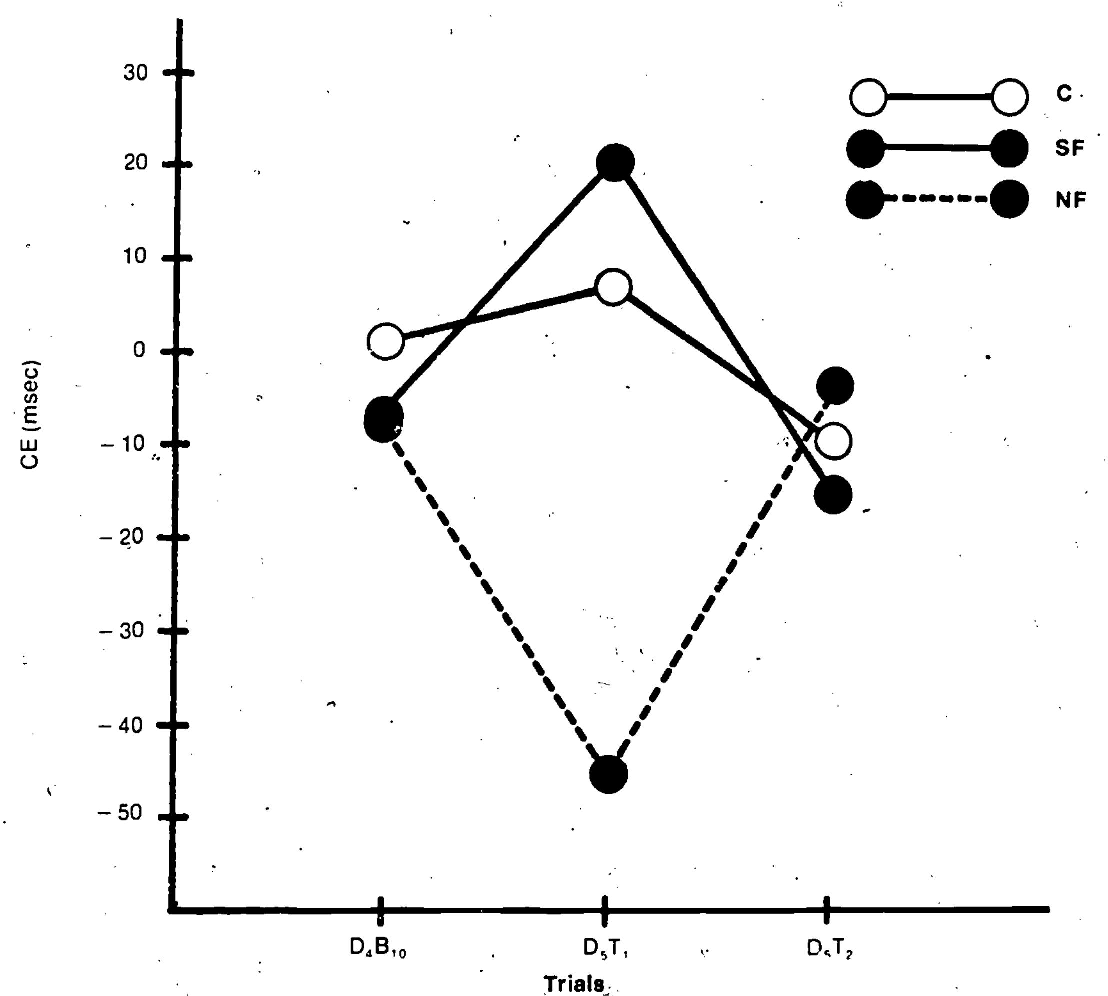
performance of both specific and non-specific fatigue subjects were significantly greater than that of non-fatigue controls.

The finding of increased VE in Groups SF and NF on D_5B_1 suggested at least transitory distortion of the timing mechanism which quickly diminished by D_5B_2. Of further interest was the opposite directional shifts in CE for the two fatigue groups on D_5T_1. Such a finding suggests support for the existence of separate fatigue mechanisms for specific and non-specific activity; localized static work producing a slowing down of timing responses while generalized rhythmic exercise acts to increase the speed of responses. If such is the case it might be predicted that subjects with high muscular endurance would be able to resist the trend toward overshooting in post-fatigue timing performance while subjects having a high aerobic capacity would be better able to prevent undershooting shifts.

Further research is needed to determine the results of combining muscular and cardiovascular endurance training with motor performance practice in reducing fatigue effects. Recent studies by BENSON (1968) and COCHRAN (1975) lend support to the notion that practicing while fatigued improved the subjects' resistance to performance decrement in tasks of jumping, juggling, and dynamic balance. Potential negative evidence has come from BARNETT, ROSS, SCHMIDT, and TODD (1973) who reported that subjects practicing a limb movement-speed task under fatigue conditions on Day 1 had slightly slower post-fatigue movement times on Day 2 than subjects who practiced the task under non-fatigue conditions on Day 1. However, incomplete learning of the motor task on Day 1 in the latter study may prevent generalizations to the post-fatigue performance of subjects given sufficient opportunity to practice the task before combining motor performance with physical overload.

Finally, it should be noted that the physiological measures used in the present study to ensure high fatigue levels provided a more homogeneous treatment effect than many methods previously reported. Thus, support was suggested for the observation made by CARRON and FERCHUK (1971) that "...if physical fatigue is of sufficient intensity and duration, a point should be reached where subjects can no longer properly attend to the task and motor... performance should suffer (p. 63)."

Figure 2 - Constant error (msec) in response times of the three groups on the final block of five trials on Day 4 and on the first and second post-fatigue trials on Day 5.



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STRATEGIES AND ENCODING OF LOCATION IN SHORT-TERM MOTOR MEMORY

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The accuracy of reproduction of a movement seems to be improved when the subject employs some cognitive strategy during the encoding of the criterion movement, e.g. NACSON, JAEGER and GENTILE, 1972; ROY, 1975. The procedures used to block central activity during the encoding phase, thus the use of cognitive strategies, have been shown to seriously decrease recall, e.g. SCHMIDT and ASCOLI, 1970. This provides indirect evidence that the subject spontaneously provides organization of the movement information. This active organization by the subject appears to be an all-pervasive event whose occurrence is seldom acknowledged or controlled.

It remains to be investigated what is the nature and availability of these strategies. Furthermore, it still remains to be established if there exist some conditions under which the reproduction of movement is based on the kinesthetic information. That is, the subjects' means of recall depend mainly on the sensations of the movement.

WILBERG (1969) has shown that increasing the intensity of torque pressure did not improve the accuracy of recall of the position of a handle. It might be that increase in intensity of the kinesthetic sensations does not necessarily increase the information concerning the form, pattern, or qualitative aspects of the movement. The kinesthetic pattern of information can perhaps be enhanced by a procedure whereby the subject focuses attention explicity on the sequences of sensation themselves by attempting "to frame" them according to some prior instructions. The recent literature indicates that the cues of location and distance are encoded differently, e.g. KEELE and ELLS, 1972; LAABS, 1973. Some authors (GUNDRY, 1975) have postulated that the location cues provide qualitative sensory information such as that concerning the angle of the movement. The present study investigated the encoding of location cues when prior instructions are given to focus on the kinesthetic sensations provided by the angle of the arms at a given location. It was thus supposed that the location information would be easier "to frame" than the quantitative information which is presumed to underlie the sensory action of distance cues (GUNDRAY, 1975).

The specific question was: is the subject's precision of reproduction of the final location of a movement greater when the subject utilizes assigned instructions of maximize attention on the kinesthetic sensations of the angle of movement, or when no instructions are given? To determine whether the utilization of such instructions demands the availability of central capacity, a condition was also evaluated where the subjects received the same prior instructions but during the encoding phase were required to perform a secondary mental task. Finally, to eveluate the duration of the effectiveness of the above procedures, for all conditions reproduction measures were obtained immediately after the criterion movement was executed and after a 30-second retention interval without interpolated activity.

METHOD

Subjects

Three groups each of ten right-handed students from the Department of Physical Education, with a mean age of 21.66 yrs (range: 18–26 yrs, SD = 2.2 yrs), were chosen from a sample of 40 who had participated in a pre-test. The latter consisted of five trials on a localization task similar to the experimental task. To control inter-subject variability, the groups were made equivalent by distributing among the three groups an equal number of students whose scores on the pre-test represented the various degrees of dispersion in terms of the constant error (CE) and variable error (VE). For each group there was an equal number of males and females.

Apparatus

It consisted of a half-circle (perimeter = 140 cm, radius = 45 cm), cut off on the surface of a rectangular wooden table. At the midpoint of the cord describing the arc and underneath the surface, a pivoting arm was attached to a near frictionless pivot. A nail, attached perpendicular to the arm, extended to the outside through the cut off of the half-circle and hooked to it was a lever (37 cm) which rested over the surface. The lever could be held wherever it was most convenient depending on the subjects' arm length. A measuring tape was glued along the border facing the experimenter. Twenty mechanical stops, easily raised and lowered were located every 5 cm between 10 and 115 cm along the opposite border. The first 10 stops of the right half were the departure points while the other 10 were the final points.

Procedure

The subject was first blind-folded and then seated, the center of his body in front of the center of the arc. Instructions were given through earphones which also eliminated auditory cues. The left arm was extended, always resting on the table, at approximately 75° from the frontal plane. With his right arm, the subject moved the lever towards his body until reaching a mechanical stop determined at one of the five movement distances (45, 50, 55, 60, 65 cm). The final position was held for 3 seconds before returning to the initial position. After the appropriate retention interval (0" or 30"), the subject attempted to reproduce the movement without the aid of a mechanical stop. The starting point for the reproduction movement was always different from that of the criterion movement. Three practice trials were given, and then 20 experimental trials, 10 at each retention interval. Six different final points were used but 10 measures were taken from the same location. The errors were calculated only from these 10 trials (5 at each RI). The order in which the different movements were executed was randomly assigned.

Group I, GS, was instructed to focus on the sensations of the angle formed by the moving right arm and the resting left arm. For group II, GS+, an identical procedure was followed except that the subject was also asked to count backwards by three while moving to the criterion position. Group III, GC, served as a control and followed the same procedure but was not given any instructions for recall. The experimental design was thus a 2 × 3 factorial (instructions × retention interval) with repeated measures in the last factor.

RESULTS

Absolute errors (AE), constant errors (CE) and variable errors (VE) from five measures at each RI were calculated. No significant sex differences were obtained for any of these scores. The scores for males and females were thus analyzed together. The means and SD's for each group as a function of AE, CE and VE at 0" and 30" retention interval (RI) are presented in Table I.

Table I - Mean absolute (AE), constant (CE) and variable (VE) and standard errors for the control (GC) and experimental groups (GS, GS+).

		Retention intervals			
		0"		30"	
Group		M	SD	M	SD
	AE	1.70	1.60	2.60	1.49
GC	CE	.82	2.24	− .57	3.06
n = 10	VE	2.21	.81	2.72	1.14
	AE	2.92	2.13	3.23	2.51
GS	CE	1.82	3.21	− 1.71	3.83
n = 10	VE	2.13	.46	3.51	1.33
	AE	2.88	2.23	5.29	4.00
GS_+	CE	− .55	3.72	− 5.02	4.37
n = 10	VE	3.41	1.05	3.42	1.87

In terms of AE (Figure I) the only significant difference was for the GS_+ scores at 0" and 30" RI, $t = 2.23$, $p < .053$.

A significant difference, $F(2/29) = 3.72$, $p < .05$ was evidenced in the CE's (Figure 2) at 30" RI but none at 0". Tukey tests indicated that the significant difference occurred only between GS_+ and GC. Also, t-tests indicated significant differences between the CE at 0" and 30" for GS, $t = 4.16$, $p < .05$; for GS_+, $t = 6.50$, $p < .05$, and GC, $t = 2.24$, $p < .05$.

Finally, for the VEs (Figure 3) a significant difference $F(2/29) = 7.73$, $p < .05$, was obtained at 0" but none at 30" RI. Tukey tests revealed that the differences were between GS and GS_+, and between GS and GC. A significant within-group difference between 0" and 30" RI was only revealed for GS, $t = 2.66$, $p < .05$.

Figure 1 – Means of absolute errors (AE).

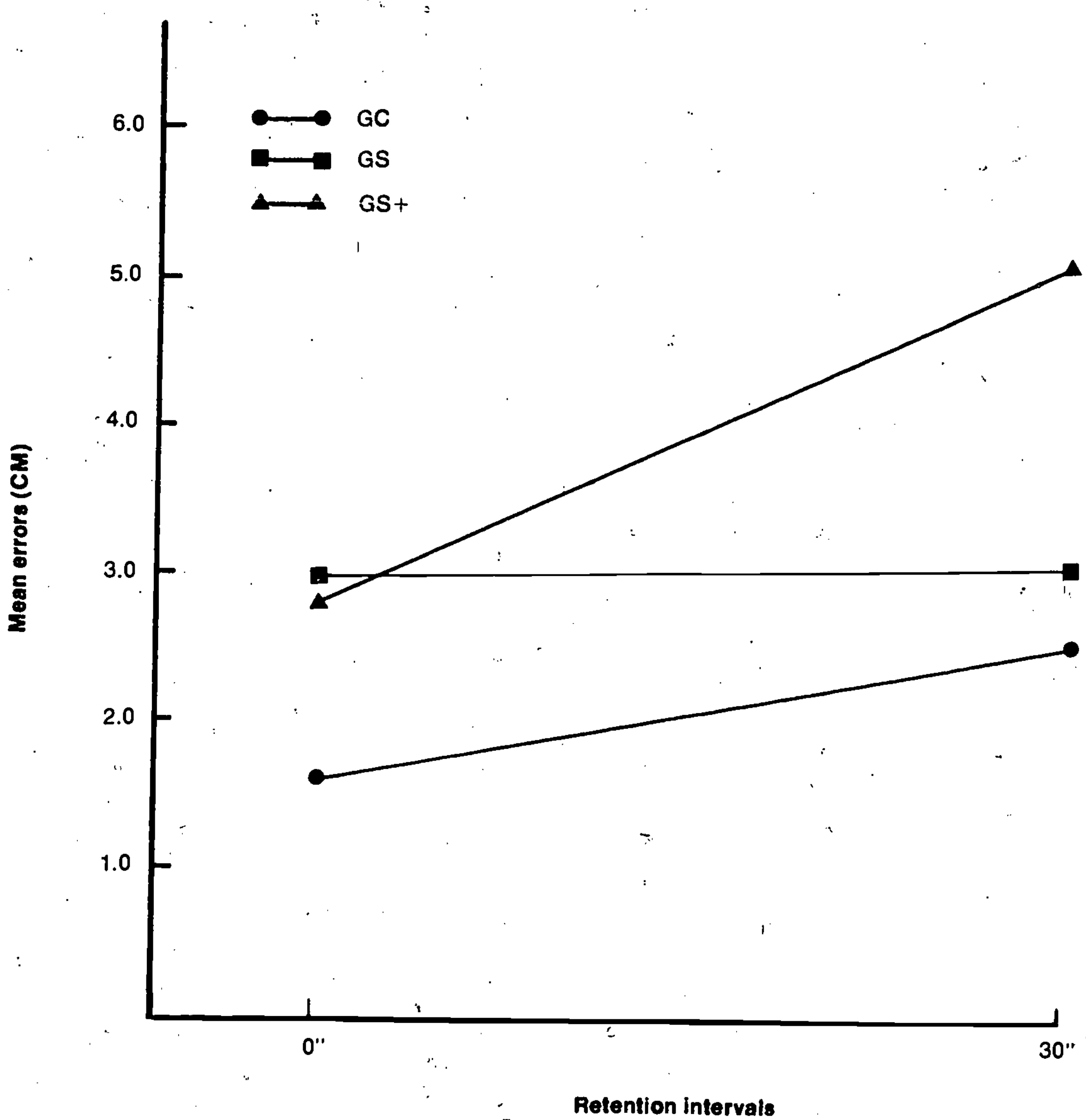

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Figure 2 - Means of constant errors (CE).

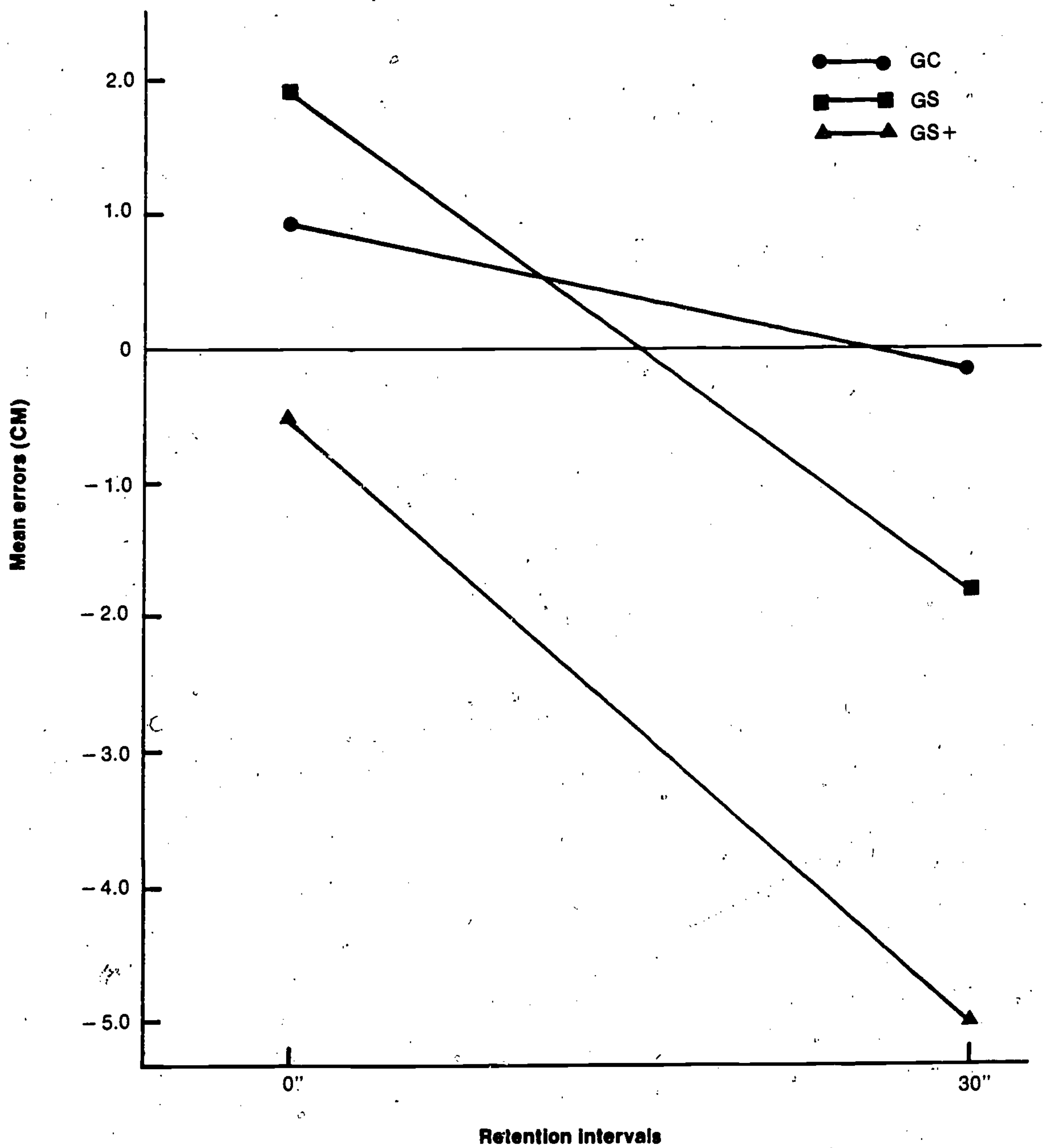
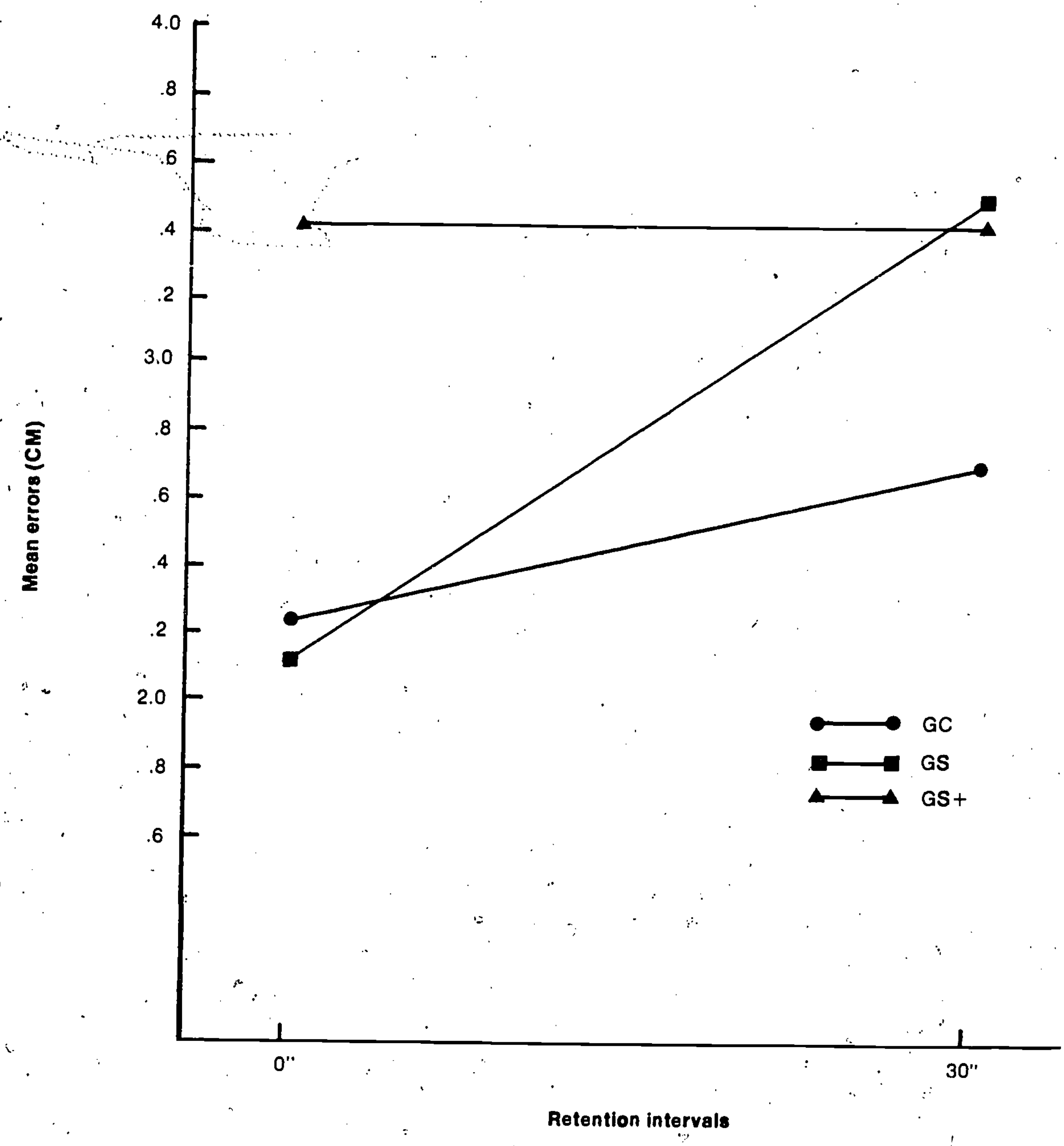


Figure 3 - Means of variable errors (VE).



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DISCUSSION

The first question concerned the effectiveness of the instructions that focus on the kinesthetic sensations of the angle of movement. It was hypothesized that the group given such instructions, GS, should manifest greater or equal accuracy of reproduction after 0" and 30" than the group control, GC. In terms of the constant error, CE, the results did not support the hypothesis. At 0" retention interval, RI, no significant differences were found; after 30", GS and GC did not differ significantly from each other and only the group with instructions plus mental activity, GS+, made significantly more errors than the GC. In terms of the variable error, VE, at 0" RI, GS+ made significantly more errors than GC and GS, which did not differ from each other; at 30", all groups are statistically equivalent. Thus, the weakest postulate of the hypothesis, equivalence of GS and GC, is supported only in terms of the VE at 0". The instructions did not seem to help "frame" the kinesthetic sensations as manifested by a greater accuracy of retention over time.

The second question, concerned the necessity of available central capacity for the utilization of kinesthetic cues. The large margin of error of the GS+ both in terms of VE and CE (particularly after a 30" RI) compared to the other groups, seems to indicate that kinesthetic information has to be attended to in order to be encoded in short-term memory. The set created by the prior instructions proved inadequate to permit access in short-term memory of the non-attented kinesthetic information. Different procedures would seem necessary to evaluate whether kinesthetic information would have access to short-term memory when it is an unattended channel. This last possibility has been postulated for other kinds of sensory information by NORMAN's (1968, 1969) memory model.

One important finding concerns the greater accuracy and lesser variability manifested by the GC. This indicates that the individual ways the subjects used for encoding the information were more effective than the instructions provided to the other two groups. These findings contrast with those obtained by ROY (1975). The group which had to retain the distances predetermined by a yoked subject, of actively produced movements, was significantly more accurate than an analogous group that was given no encoding strategy. Several reasons may account for this difference. First, ROY (1975) used a strategy of a cognitive nature, while in the present study the instructions put the emphasis on the peripheral kinesthetic sensations. Second, if indeed distance and location have different retention characteristics, it might also be the case that they require strategies of different nature to facilitate encoding. Third, ROY (1975) assessed the effects of strategy by the AE. This measure indicated for this study almost no significant effects, except for a marginally significant loss of retention for GS+ between recall at 0" and 30". Given the controversy surrounding the meaning and appropriateness of the various error measures, the comparison between ROY's (1975) findings and those of this study has to be taken cautiously.

The present results tend to support the recent findings of MARTENIUK and DIEWERT (1975) concerning the appropriateness of LAABS' (1973) model. Although the CE indicated for all groups a significant tendency to underestimate the movement after the 30" unfilled RI, the CE indicated also no significant differences at 0". The mean of the positions to which the subjects moved over all 20 trials was slightly below the criterion position (M = 73.5 cm, criterion position = 75 cm). Thus, the tendency to underestimate can be said to represent an adaptation level towards the average of all the movements presented. Also, the VE indicated that GS+ was equally variable at 0" and 30", suggesting that mental activity at the time of encoding prevented the formation of a trace. GS's VE was equivalent to GS' at 0"; but, after 30", it is equivalent to GS+. Thus, if the subjects in GS were trying to retain a sensation, the latter almost totally decayed after 30". However, GC, having the freedom to rehearse during the unfilled RI, by whatever means it employed to encode the information, showed a tendency towards less variability, thus less decay, after 30".

In conclusion, instructions to focus on the kinesthetic sensations of angle did not prove more effective as an encoding strategy to remember positions than when no instructions were given. Also whatever was encoded through the instructions, decayed over the 30" unfilled RI, thus it seems to be unrehearsable information. The use kinesthetic sensations during an initial encoding of a position appears to require the subjects' complete attention. Finally, further investigations will have to be made towards determining what are the forms or patterns that, for different movements, the kinesthetic information takes. This information may indicate what it is the subject attempts to organize to encode in memory.

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ENCODING AND RESPONSE STRATEGIES FOR DISTANCE

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One of the most important considerations in the reproduction of movement distance is the range effect the tendency to overshoot small distances and undershoot large distances. Recently the range effect has received increased attention, the result being a more precise understanding of this phenomenon. Most evidence suggests that the range effect is largely independent of the short-term memory system. There is little change in the range effect, as measured by constant error (CE), over an unfilled delay interval (KEELE & ELLS, 1972; MARTENIUK, 1973; HALL & LEAVITT, 1975). Nevertheless, PEPPER & HERMAN (1970) and LAABS (1973) have reported some conflicting evidence; a CE-shift in the negative direction over a simple delay interval, primarily being associated with long distances.

Interpolated activity has been a concern of numerous studies investigating the recall of distance information. LAABS (1973) reported that inhibiting the rehearsal of distance information by an interpolated activity had no effect on distance reproduction over that produced by an unfilled delay interval. In opposition to these findings, MARTENIUK (1973) found that an activity blocking rehearsal produced a significant decrease in response performance. When an interpolated motor act is inserted during a delay interval, strong assimilation tendencies are produced in the direction of the interpolated task (PEPPER & HERMAN, 1970; LAABS, 1973). These assimilation tendencies are augmented if the reproduction phase closely follows the interpolated motor act. Moreover, PEPPER & HERMAN (1970) and CRAFT & HINRICKS (1971) have all demonstrated reproduction errors proportional to the magnitude of the interpolated movement. A final consideration involves the memory trace strength of the criterion movement. STELMACH & KELSO (1975) contend memory trace strength is a determiner of error shifts at recall.

Several investigators have demonstrated differences between the reproduction of short and long distances. There is a large positive shift in CE for short movements when rehearsal during a delay interval is inhibited. A corresponding change for long movements does not occur (STELMACH & WILSON, 1970; KEELE & ELLS, 1972). MARTENIUK (1973) suggests that short movements may be much more dependent on the availability of central processing capacity than long movements.

Several factors influencing distance reproduction appear to be related to encoding processes. WILBERG & GIROUARD (1975) have demonstrated that the range effect can be substantially altered by visual information that is associated with the criterion movement. For the kinesthetic condition, kinesthetic reproduction was assimilated toward visual information. In contrast, for the visual plus kinesthetic condition the range effect was normal. Recently SHEA (1974) has shown that verbal information encoded with a motor response also alters reproduction performance. Therefore, other variables related to encoding processes such as instruction presentation may relate something about the role of encoding strategies on distance recall.

The manner in which the criterion movements are presented also deserves consideration. Criterion movements actively produced and defined by the subject seem to accentuate the range effect (produce more undershooting) as compared to movements that are experimenter-defined (for example, utilizing physical stops) (TANNIS & WILBERG, 1974).

Another important variable for distance reproduction appears to be response requirements. HALL & LEAVITT (1975) have shown that recall of distance information is superior at certain movement angles and suggest that these results are related to response programming and execution processes. Response strategies may also be a factor in the reproduction of distance. This ascertion could be tested by varying the response strategies the subject would be required to employ in executing the experimental task.

The purpose of the present experiment was to investigate encoding and response strategies for distance by varying the presentation of the task instructions and the response requirements. The range effect was employed as the context within which these variables were investigated to determine their influence on the well documented tendencies associated with this phenomenon. The experimental paradigm is based on that employed by BUCKOLZ (1974).

METHOD

Subjects

The subjects were 6 volunteers who were students at the University of Alberta.

Apparatus and Task

A meter bar (not calibrated) mounted on a dexicon frame served as the base over which the distances were produced by the subjects. A plastic cursor (7.2 × 4.3 × 2.2 cm.) with a metal handle 5.0 cm. high was employed for making the various distances. The cursor was attached to a 10-turn potentiometer whose output, after being passed through a voltage/amplifier box, was fed into a digital multimeter (Fluke 8000A). Therefore, when the cursor was moved, the distance traversed was recorded by a change in the digital output of the multimeter. The digital output was in mv. and the voltage divider/amplifier box was set at a constant value (1:1 ratio) throughout the experiment.

The subject sat comfortably in front of the apparatus and moved the cursor horizontally from his left to right with the right hand. The range used on the meter bar was 65.0 cm., all distances being made within that range. On the edge of the dexicon frame adjacent to the experimenter was mounted a plastic distance marker, calibrated in mm., and a metal bar (5.0 mm. diameter) with a wooden slider (8.0 × 2.0 × 4.0 cm.). These components were utilized in the presentation of the criterion distances.

Design

The experiment consisted of two tests. Test One consisted of a single treatment condition, movement length, with two levels: short (5.0 cm.) and long (25.0 cm.). Subjects received 15 trials for each condition. The design for Test Two was a 2 X 2 X 3 factorial with repeated measures on all factors. The first factor consisted of two levels of movement length: short (5.0 cm.) and long (25.0 cm.). The second factor had two levels of instruction: instructions for the type of response strategy to be employed in reproducing the criterion distance were given to the subject either before or after the presentation of the criterion distance. The last factor consisted of three levels of response strategy: reproduction of a distance just less than the criterion distance (1 jnd), accurate reproduction of the criterion distance, and reproduction of a distance just greater than the criterion distance.

Test One served two functions: to give the subjects experience in an unfamiliar testing situation and to act as a control condition for Test Two. The conditions used in Test Two were based upon previous and pilot research. Retention interval were not manipulated since it was found to have no significant effect on performance in the present design.

Procedure

The subjects were tested in an isolated lab and were blindfolded. On each trial, the subject had to reproduce the criterion distance, location information being made irrelevant by the use of 12 possible starting positions. The general procedure involved presenting the subject with a criterion distance by having him move the cursor until he contacted a physical stop. This position was held by the subject for approximately 2 seconds and then he released his grasp of the handle. The cursor was then repositioned to a different starting position and immediately a command was given to reproduce the required response. After the reproduction, the distance was recorded to the nearest mm.

The instructions as to which type of response strategy to follow were given to the subject just prior to the presentation of the criterion distance or as the cursor was being repositioned for the distance reproduced. The instructions were simple two word phrases. If an instruction was forgotten by the subject, the trial was repeated at a later time. The initial instructions stressed the importance of performing the required response strategy to the best of the subject's ability, therefore hopefully eliminating any tendency to overcompensate in the just less than and just greater than conditions.

Data Analysis

There were four dependent measures examined in the present research; constant error (CE) or mean algebraic error, variable error (VE), the standard deviation of the algebric error (AE) or unsigned error, and average variation (AV), the standard deviation of the mean absolute error.

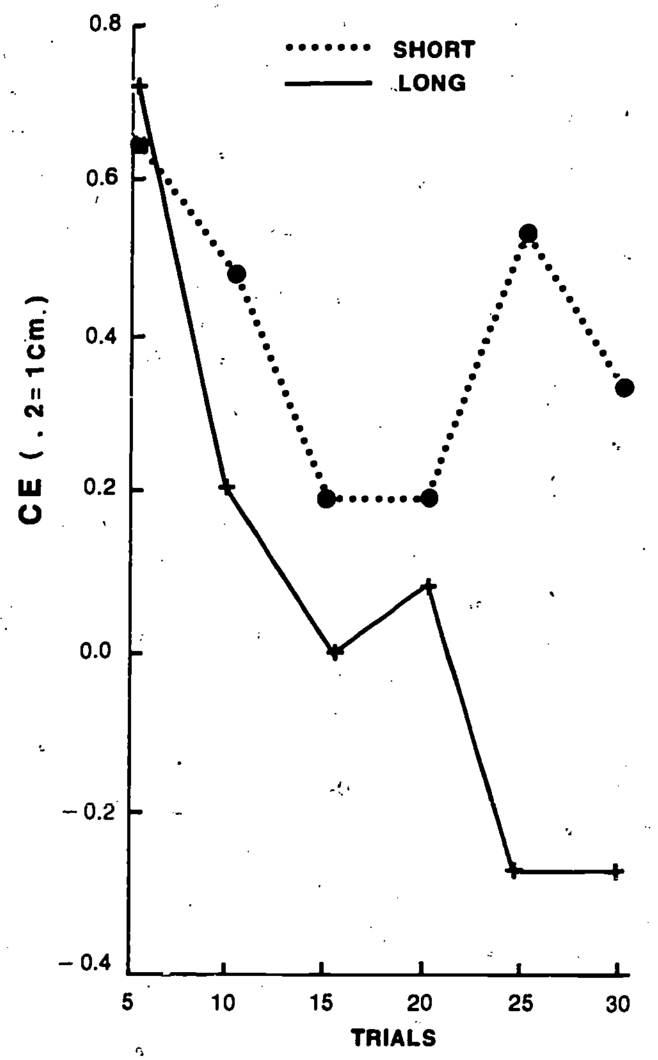
RESULTS

Although four dependent measures were employed in the analysis of the data, CE only was examined in detail in the present paper[1]. The main effects for VE, AE, and AV were also reported but discussed in brief.

Test One

CE for movement length was not significant ($p > .05$) with the short condition being 12.95 mm. and the long condition 6.30 mm. Since this result was not expected, CE was examined over trials. As indicated in Figure 1, an order effect for long lengths was produced with an increasingly negative trend in CE over trials. AE for movement length was significant, $F(1,84) = 8.59$, $p < .01$. For the short length the AE was 16.13 mm. while for the long length it was 29.25 mm. The short length (11.17 mm.) was also significantly different than the long length (33.26 mm.), $F(1,84) = 22.25$, $p < .01$, for VE. Finally, the results for AV followed the same pattern, $F(1,84) = 16.33$, $p < .01$, the short length (9.70 mm.) have the smallest error (long length, 26.26 mm.).

Figure 1. CE over trials in Test One

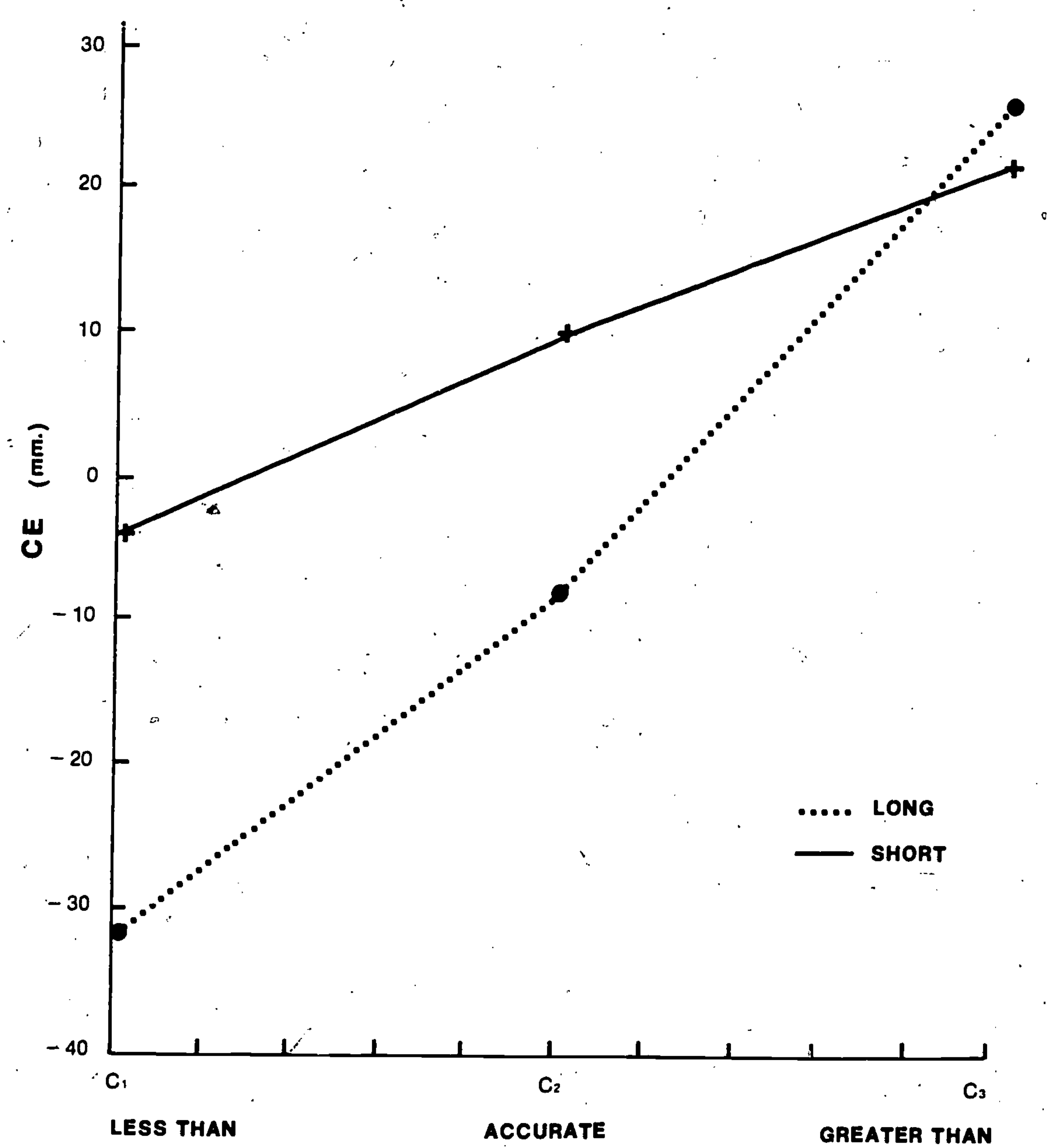


1. Further analysis of the data will appear in a future paper.

Test Two

Movement length for CE was significant in this test, $F(1,105) = 25.63$, $p < .01$; the short length (5.86 mm.) demonstrating the overshooting tendency and the long length (−4.92 mm.) the undershooting tendency. Response strategy for CE also proved significant, $F(2,140) = 91.42$, $p < .01$. Further analysis with the Scheffé test indicated that the three response strategies of less than (−18.48 mm.), accurate (0.56 mm.), and greater than (24.13 mm.) were significantly different from each other ($p < .01$). As shown in Figure 2, the movement length by response strategy was significant, $F(2,140) = 15.74$, $p < .01$. While a gradual CE-shift from undershooting to overshooting occurs for the short movement lengths over the corresponding response strategy conditions, that is a large positive CE-shift for the long movement lengths between the accurate and greater than response strategies.

Figure 2. The Movement Length X Response Strategy Interaction for Test Two



For CE, the instruction condition failed to reach the conventional significance level and no other interactions were significant ($p > .05$).

In order to obtain a clearer understanding of the relationship between movement length and response strategy, the distributions of the CE scores for the three response strategies for both the short and long lengths were constructed. The three response strategy distributions for the short movement length are very similar (Figure 3) with the scores being concentrated aroung the subject determined zero point for each strategy. The distributions for the long movement length are each very different and are generally characterized by a wider dispersion of scores (Figure 4).

Figure 3. Distribution of CE scores of the short movement length for the response strategy conditions

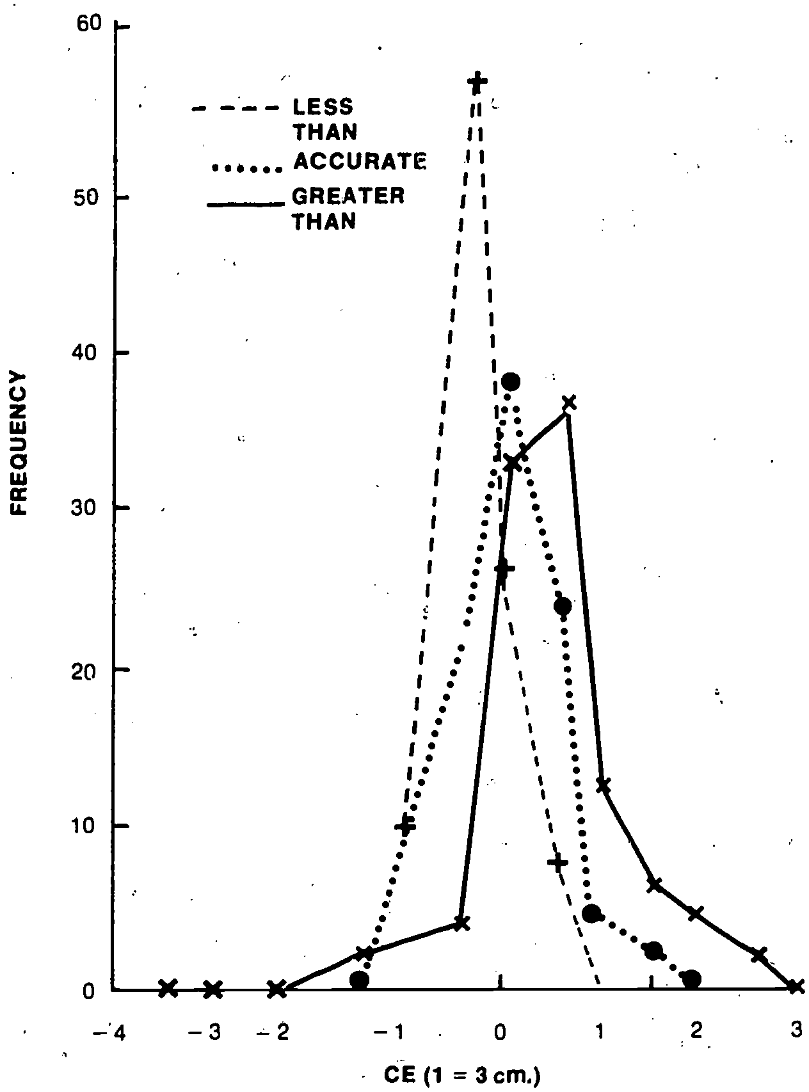


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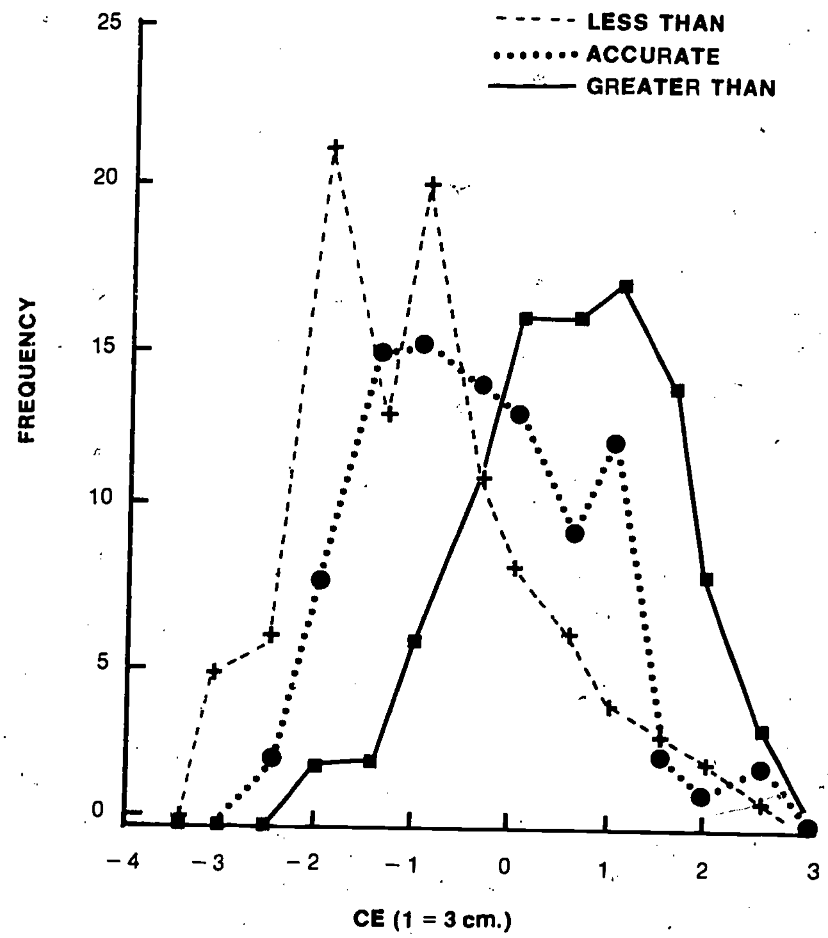
Figure 4. Distribution of CE scores of the long movement length for the response strategy conditions



Movement length for AE, VE and AV was significant in each case, the respective ANOVA values being $F(1,105) = 152.19$, $p < .01$; $F(1,105) = 63.01$, $p < .01$; and $F(1,105) = 50.08$, $p < .01$. Table I gives the error scores for the two movement length conditions and compares Test One with Test Two.

Finally, instruction presentation was significant for AE, $F(1,105) = 6.78$, $p < .05$ and VE, $F(1,105) = 5.54$, $p < .05$. In both cases instruction before the criterion distance (AE = 24.99 mm; VE = 21.97 mm.) resulted in a better performance then instruction following the criterion distance (AE = 29.67 mm; VE = 27.56 mm.).

Table I – Mean CE, AE, VE and AV for movement length in Test One and Test Two (in mm.)

		TEST ONE	TEST TWO
CE	SHORT	12.95	5.86
	LONG	6.30	−4.92
AE	SHORT	16.13	16.51
	LONG	29.25	38.16
VE	SHORT	11.17	13.16
	LONG	33.26	36.37
AV	SHORT	9.70	10.42
	LONG	26.26	25.02

DISCUSSION

The comparison of Test One and Test Two shows similar performance patterns, the tendencies usually associated with the range effect being produced in both tests. The exception is for CE in Test One; however, Figure 1 indicates that by trial thirty the expected undershooting for the long lengths was occurring. In addition, the group results are biased by the consistent significant overshooting of the long lengths by two subjects over the first twenty trials. These findings support the contention of BUCKOLZ (1974) that performance patterns described by the range effect are just general descriptors and may not be useful in attempting to predict individual performance. A large number of trials, in the present study over thirty is usually required for subjects to determine the experimental movement range and produce the characteristic central tendencies.

Since Test One and Test Two demonstrate very similar patterns for movement length over the four dependent measures, Test One was considered to be the control condition against which Test Two could be compared. The most important result of this comparison was that the range effect appears to be independent of instruction presentation and response strategy as defined in the present study.

Corresponding with previous research (PEPPER & HERMAN, 1970; LAABS, 1973), short distances were more accurately reproduced than long distances. In addition, as indicated by the movement length X response strategy interaction performance accuracy decreased most for the long distances at the "greater than" response strategy. The tendency for the long distances to show large non-linear CE-shifts over the response strategy conditions indicates that the information from large distances is not as available for the accurate formation and execution of response strategies as is the information from short distances. This difference may be a consequence of the variable encoding of distance information, or may be linked to the central processing capacity for movement length information (MARTENIUK, 1973).

Subjects were able to produce the required response strategies indicating response strategy formation is independent of the range effect. Since subjects can be under-estimators or over-estimators, tendencies in distance recall data that appear to correspond with range effects must be due to the response strategy adopted by the subjects. The distributions for the CE scores in the present study provide some indication of how subjects approached the task of distance reproduction for various response strategies. The "accurate" response strategy condition was considered the control condition corresponding to the response approach utilized normally by subjects in producing the range effect.

When reproducing short distances, subjects appear to approach the task in much the same manner regardless of the type of response strategy being employed. The somewhat decreased variable performance for the "less than" condition suggests subjects were better able to establish, and consistently incorporate in their response strategy, a zero error point when making reproductions under this condition. With respect to long distances, the three difference distributions suggest the subjects approached the task of distance reproduction in a separate manner under each response strategy. There is also a definite difference between the nature of reproductions for short and long distances regardless of strategy. Presently it is not possible to account for the nature of the various distributions but further analysis and testing now being conducted will hopefully provide some answers.

Initial analysis for the instruction conditions indicates distance reproduction performance is more accurate and precise if the response instructions are given before, rather than following the presentation of the criterion distance. Presenting the instructions before the criterion distance probably facilitates the encoding of information to be utilized for making the reproductions. Further analysis should provide a clearer understanding of the instruction variable.

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THE REPETITION EFFECT IN SHORT TERM MOTOR MEMORY RETRIEVAL

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In order to understand the process of learning and performing motor skills, it is necessary to understand the process by which skills are stored and retrieved from memory. Most researchers in the field agree that memory storage is divided into at least two areas: a short term or primary memory (PM) storage area of limited capacity but high accessibility, and a long term or secondary memory (SM) store of unlimited capacity but less accessibility (SHIFFRIN and ATKINSON, 1969). Others propose a third area of storage, that of an immediate memory or selective attention (SA) store (FALMAGNE, 1965; NORMAN, 1969; SCHUTZ, 1972). SA, which is thought to have a capacity of only one program, usually contains the program for the response having the highest subjective probability of occurrence.

Reaction time experiments afford an opportunity for establishing an exact quantitative theory, and for this reason have been utilized by many researchers as a measure of search, retrieval, and recognition time in PM and SM (KEELE, 1969). SCHUTZ (1972, 59) suggests that:

> When a response is called for by presentation of a certain stimulus, the following progression of events takes place:
>
> 1. the stimulus is perceived;
> 2. the stimulus is categorized as being one of a number of possible stimuli;
> 3. hte name (or number, or code) of the required response to the perceived stimulus is determined;
> 4. the response program (RP) is searched for, found, and discharged from a memory storage area to the motor effector system;
> 5. the neural pathways carry out the instructions released by RP and elicit the required response.

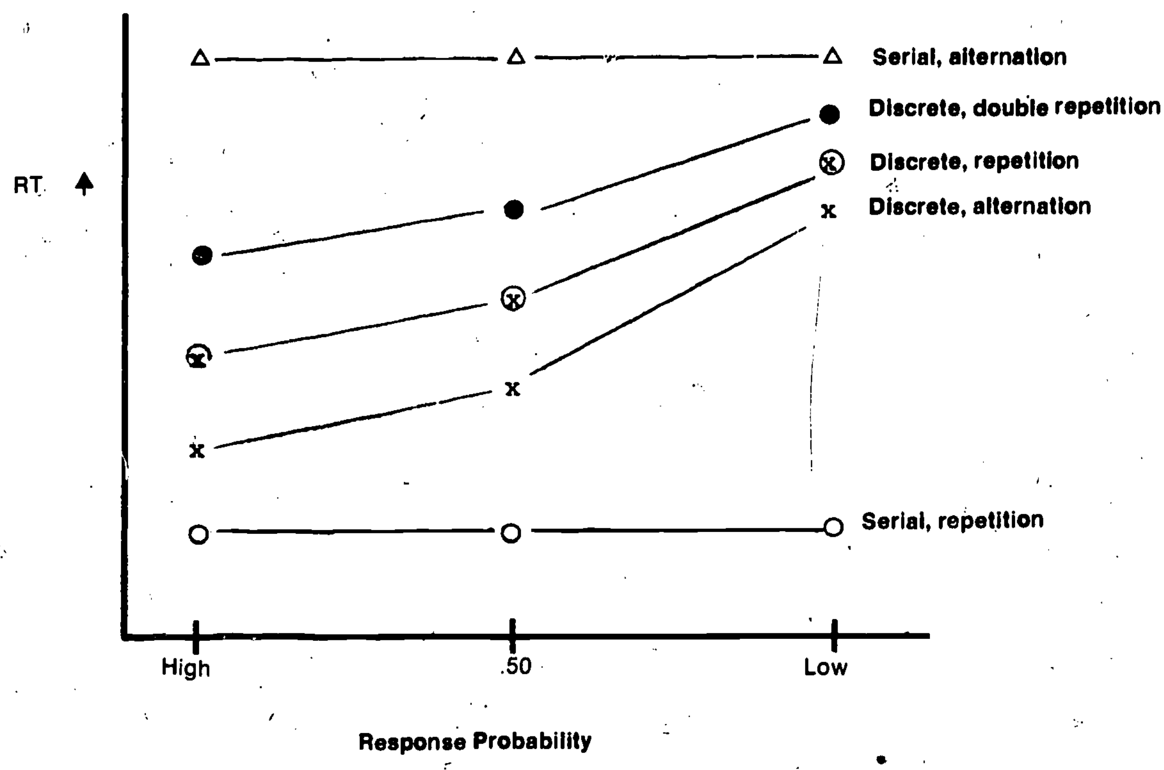
Stage 4 can be further broken down into the search and retrieval time for each memory store. It is assumed that when a stimulus is presented, the template corresponding to the stimulus can be in a SA state, or in a PM state, or in a SM state; these states being mutually exclusive. Then once the stimulus is perceived and categorized, and the name of the required response code determined, the response program (RP) is searched for, first in SA, which takes time t_1. If not found there, PM is searched, which takes time t_2; then if not found in PM, SM is searched, taking time t_3. Thus it should take a shorter time to search and retrieve an RP if it is in SA. The problem to which this study is directed then is to determine if the above model can account for a specific set of experimental results established in CRT studies; namely, those to do with the repetition effect, ITI, and probability.

Sequential effects have been found in serial reaction time experiments such that, under some conditions, response to a signal which is the same as the preceding signal is faster than if it is different (BERTELSON, 1961; HALE, 1969). Bertelson termed this the 'repetition effect'. Under other conditions, the opposite has been found; the response to a signal which is different from the preceding signal being faster than if it is the same (WILLIAMS, 1966). Generally, the repetition effect takes place at inter-trial intervals (ITI) of less than 1 second, while a negative repetition effect, or alternation effect takes place at ITIs of over 1 second (KIRBY, 1972). If the subject has time to prepare himself for the more probable stimulus by placing the appropriate RP in SA, this would explain the alternation effect in a discrete 2-choice reaction time task. That is, due to what is termed the 'gamblers fallacy', people tend to think an alternation is a more probable event than a repetition in an equal probability situation (JARVICK, 1951). On the other hand, at extremely short ITIs, the subject has no time to prepare for the next stimulus, and the previous engram might still be in SA, thus mediating the repetition effect.

Response probability also affects CRT, as shown by the general agreement that the higher the response probability, the faster the reaction time (BERTELSON, 1965; KORNBLUM, 1967; MOSS *et al.*, 1967). This effect appears to be confounded with the repetition effect, as the more probable the stimulus, the more frequent repeated S-R pairs occur. The above explanation of memory search and retrieval could also account for the effects of probability on CRT. That is, in the discrete task, the subject prepares for the more probable stimulus by placing the appropriate RP in SA. However, using the same argument as above, probability should have no bearing on RT in the serial self-paced task, as the subject has no time to prepare.

Extrapolating from Schutz's model, the interacting effects of ITI and probability should then be as shown in Figure 1.

Figure 1 - Hypothesized response probability by repetition effect interaction.



That is, in discrete task, probability of occurrence is inversely related to RT, and further alternation is responded to quicker for a repetition.

In a discrete CRT task the subject has sufficient time between trials to prepare himself for the next S-R pair. Although the probability of occurrence of any stimulus is independent of the previous one, it is theorized that the subjective probabilities formulated by the subject do not exhibit this independence. If response A is required on trial n, the subject assumes that the probability of B being required on trial n + 1 is higher than it would be if B had been required on trial n. Therefore, given equal average probabilities of response requirements, a subject will, on the average, be more likely to put into SA that RP not retrieved on the previous trial. However, in unequal probabilities, the more probable a repetition, the less of a difference in RT between alternated and repeated S-R pairs. The converse findings that CRTs are shorter for repeated S-R pairs than for changed S-R pairs in a self-paced serial CRT task is explained thusly.

In a self-paced serial CRT task the stimulus for trial n + 1 occurs so quickly after the response made on trial n, that a subject rarely prepares himself for any particular stimulus or response. It is possible that when a response is found, whether it is in SA, PM, or SM, it must be put in SA before it can be discharged. It could also be hypothesized that immediately following the elicitation of a response, the RP is put into SA so it is available for comparison with various visual and kinesthetic feedback messages. In either case, the RP of the immediately preceding response is in SA for a short interval of time following the discharge of that response. With very short ISI (ITI), the RP is still in SA on presentation of the next stimulus, and if it is a repeated S-R pair, the correct RP will be in SA, thus resulting in a shorter search time.

Furthermore, this search time should be at a minimum. Thus there should be no difference, whether that S-R pair was a single, double, or more than twice repeated. Also, since search time is at a minimum, increasing the probability of the S-R pair should have no effect on RT.

In summary, two hypotheses, which are logical deductions based on Schutz's model, were tested:

1. In the serial self-paced task there is a RE which asymptotes after one repetition, while in the discrete task there is a negative repetition effect (which does not asymptote at one repetition).

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2. Probability of occurrence has no effect in the serial self-paced task, while probability of occurrence is inversely related to RT in the discrete task.

METHODS AND PROCEDURES

Sixteen subjects completed 480 RTs in each of the following conditions, latinized over four days.

1. 480 trials at short ITI, P(a) = .33 P(b) = .67
2. 480 trials at long ITI, P(a) = .33 P(b) = .67
3. 480 trials at short ITI, P(a) = .5 P(b) = .5
4. 480 trials at long ITI, P(a) = .5 P(b) = .5

Apparatus

The apparatus consisted of a subject's console and an experimenter's console. The subject's console was as described by GOODMAN (1975) and consisted of two stimulus lights mounted above two response keys. The experimenter's console consisted of a programmer (to pre-set the sequence of 480 trials with a known probability), a reaction time interface and a digital printer.

Response Task

The subjects were seated in front of the apparatus, and asked to respond as quickly as possible to the stimulus light by depressing the appropriate response key. The time from onset of the light until depression of the key was the subject's RT for that trial. In the serial self-paced task, the stimulus light came on approximately 380 mseconds after the response to the previous stimulus, while in the discrete task there was a ITI of approximately 1 600 mseconds.

Experimental Design

The experimental design gave rise to 18 means of the dependent variable (median RT) for each subject. That is the median RT of each of alternations, repetitions and double repetitions within each probability level (.67, .50, .33) and each ITI (serial, discrete) was used as the dependent measures. The design was then a 3-way ANOVA with repeated measures on all three factors.

RESULTS

Figure 2 illustrates the ITI by probability effect. The effect of probability was significant; however, the interaction effect (P x ITI) was non-significant. This was not as predicted — probability was predicted to have an effect in the discrete task but not in the serial task. Both tasks behaved as reported in the literature with RT being inversely related to probability. The repetition effect is illustrated in Figure 3. The main effect of condition failed to reach significance, although there is a trend showing a repetition effect.

Again the interaction effect (ITI by card) failed to reach significance. The results were not as predicted, whereby an AE was predicted for the discrete task and a RE for the serial task. Rather, both tasks exhibited a repetition effect.

Figure 2

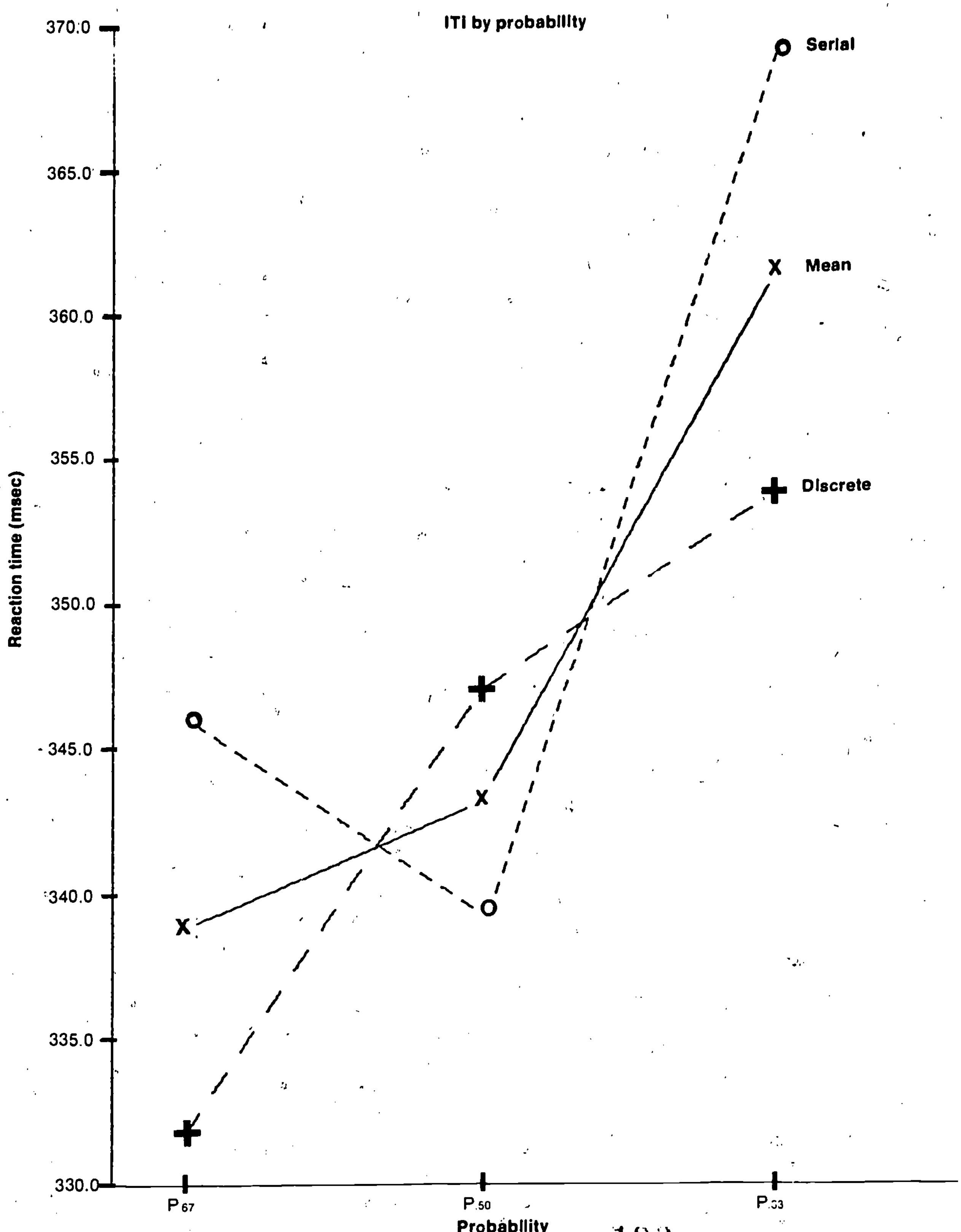
ITI by probability
Serial
Mean
Discrete
Reaction time (msec)
370.0
365.0
360.0
355.0
350.0
345.0
340.0
335.0
330.0
P_{67}
$P_{.50}$
$P_{.33}$
Probability

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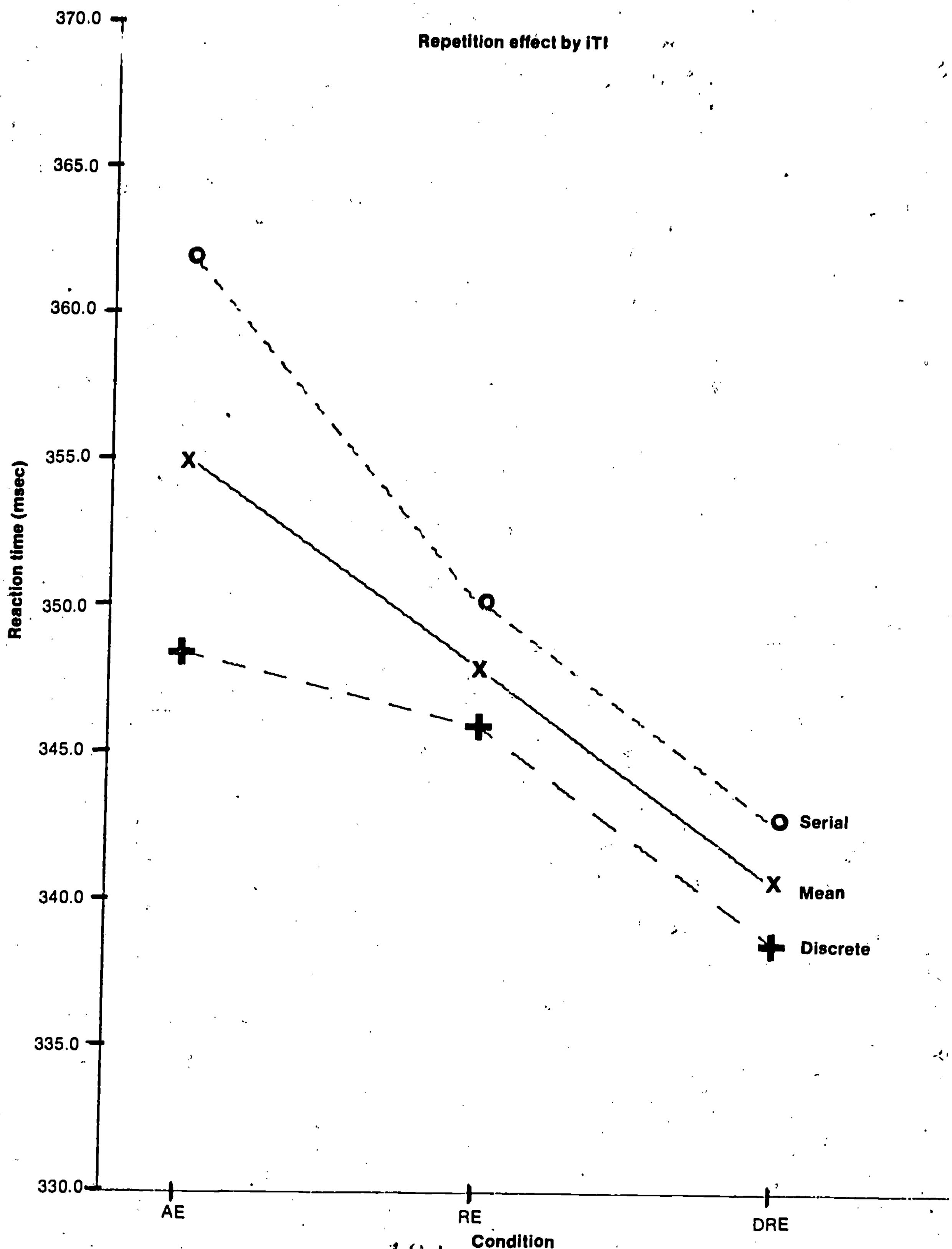
Figure 3



Repetition effect by ITI
370.0
365.0
360.0
355.0
350.0
345.0
340.0
335.0
330.0
Reaction time (msec)
Serial
Mean
Discrete
AE
RE
DRE
Condition

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DISCUSSION

Neither of the two predicted interacting effects of ITI × P or ITI × R were supported. This would logically lead one to accept the two null hypotheses, until shown otherwise, that there are no differences among any of the experimental conditions. However, this researcher is reluctant to accept the experimental findings on a number of counts. Firstly, the high invalid or error rate casts doubts on any findings. Secondly, the fact the the ITI in the serial self-paced task was approximately 380 mseconds might enable the subject to treat the task as a discrete task. Thirdly, the difference between the high and low probabilities might not have been of a great enough difference. Fourthly, and perhaps most importantly, in a 2-choice RT task, the subject's response strategy might be simplified. For instance, a binary search operation might take place, where the response engram is checked, a match would elicit one response program, whereby a no-match would elicit the alternate response program. If such was the case, there would be too small a difference in search and retrieval time to detect a difference between matched and not matched response program search and release times.

CONCLUSION

Under the tenuous assumption that the empirical results of this investigation are valid, Schutz's model is refuted. Since the basic premise of this model is a 'state of preparation', whereby the expected RP is placed in SA, and the results indicate that stimuli are not selectively prepared for, the model is incompatible with the results. Indeed a two-state stochastic model seems most inappropriate if there is only a one-state memory (long term memory storage being neglected).

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PROPRIOCEPTIVE ENCODING IN PRESELECTED AND CONSTRAINED MOVEMENTS *

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Current research in motor control and memory has been directed toward the identification of various movement cues potentially available to mediate retention. Force, timing, extent (distance) and position (location) information arising from a movement are a few potential cues which could be encoded into short term memory. These particular cues are thought to project from sensory origins (e.g. joints, tendons, muscles) to higher centers where they are encoded, stored and later recovered for reproduction purposes. Thus, the role of sensory feedback is thought to have a major function in movement retention (ADAMS, 1971; ADAMS, MARSHALL and GOETZ, 1972, STELMACH, 1973).

Another important contributor to movement retention not necessarily exclusive of peripheral information is prior organization of a movement. A number of recent studies have demontrated that a planned or preselected movement is better reproduced than a constrained movement (JONES, 1974; MARTENIUK, 1973; STELMACH, KELSO and WALLACE, in press). In the preselected condition the criterion movement is defined by the subject and thus has the ability to predict the consequences of the movement prior to initiation. The above findings have been interpreted as support for the corallary discharge hypothesis (TEUBER, 1974; SPERRY, 1950) by STELMACH, KELSO and WALLACE (in press). This hypothesis states that in preselected movement production the central nervous system sends information from motor to sensory centers preparing them for the sensory consequences of the movement. Thus, corallary discharge in unique to active, preselected movements and possibly allows the central nervous system to efficiently encode the proprioceptive information. The foregoing interpretation is less extreme than proposed by a number of other investigators (FESTINGER and CANON, 1965; JONES, 1974; LASHLEY, 1917; 1951; MacNEILAGE and MacNEILAGE, 1973) who have suggested that when the central nervous system can predict the characteristics of the motor act no afferent information may be necessary.

Two experiments were performed to determine whether proprioceptive encoding is important for both constrained and preselected reproduction. It is our position that preselected movements may be more output oriented than constrained since with prior organization the subject knows the response characteristics prior to movement initiation. Thus, the prediction of interest here is that preselected movement should benefit less from increased peripheral input than constrained. There are a number of ways to augment sensory input (vision, audition, proprioception). In these experiments, it was chosen to augment proprioceptive information by varying the time at the movement endpoint. It follows that increasing the time at the criterion movement endpoint should facilitate reproduction accuracy. Since there is limited data available on the benefits of endpoint duration, it was necessary to substantiate whether one could achieve facilitory effects by this manipulation prior to comparing preselected and constrained movement.

Experiment I was conducted to substantiate whether endpoint duration influences reproduction accuracy. In this experiment, subjects rested on the CM endpoint of a constrained movement for less than one sec., 2 sec. and 5 sec. and reproduced the CM immediately or after a filled or unfilled 15 sec. retention interval. After Experiment I was conducted showing that endpoint duration increased reproduction accuracy a second experiment was performed. In Experiment II, both preselected and constrained movements were compared to determine whether endpoint duration would similarly benefit reproduction of the two response modes.

EXPERIMENT I

Method

Subjects

Thirty-six right-handed female volunteers were recruited from the University of Wisconsin. The subjects were assigned by systematic rotation to three experimental groups.

Apparatus

Two hardened, stainless steel rods (1.3 cm × 1.8 m.) were mounted horizontally and parallel to each other 8 cm. apart on a wooden frame. A ball bearing sleeve (Thompson Ball Bushing) ran on each rod and were connected with an aluminum plate making up the main frame of the slide. The freely moving slide had a vertical, 11.2 × 3 cm. handle. A pointer attached to the experimenter's side of the slide moved along a metric scale so that the subject's criterion and reproduction movements could be recorded. A movable peg allowed the experimenter to control the starting positions for the subject's movements. An adjustable mechanical stop allowed the experimenter to control the end position of the subject's criterion movement. A cardboard shield attached to the subject's chair blocked the subject's view of the apparatus and her arm, while a sponge chin rest connected to the shield prevented extraneous head movements. The timing of events was controlled by a Hunter programmed timer.

Procedure

The subject was seated facing the slide such that the entire movement range (0 – 70 cm.) could be easily completed. Before beginning the experimental trials, the subject was

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instructed to grasp the handle while the experimenter passively presented the movement range twice in a right or left manner (subjects view). Each trial commenced with an instruction for the subject to "Grasp the handle correctly", "Ready" and "Move" to the mechanical stop which defined the criterion target location. The subject was instructed not to anticipate where the stop might be on any trial. After remaining on the target location for the appropriate duration the command "Release" cued the subject to remove her hand from the handle and immediately place it by her side, while the experimenter returned the slide to the appropriate starting position. The subject attempted to reproduce the criterion movement (CM) endpoint either immediately, after a 15 sec. unfilled retention interval or after 15 sec. of interpolated verbal processing activity. During the 15 sec. unfilled retention interval the subject was instructed to concentrate on the CM enpoint. Within 15 sec. filled retention interval the subject was told to count backwards by threes as quickly and as accurately as possible from a three digit number which was presented verbally by the experimenter immediately after the subject released the handle. The subject was instructed not to repeat the digit but rather to immediately make the subtraction and continue backwards. After 15 sec. of this activity the commands were given to "Grasp the handle" and "Recall" the CM endpoint. All subjects received practice to familiarize them with each retention interval condition. The subjects were instructed to produce both CM and RM in a rapid, smooth manner.

The procedures for the immediate release (IR), 2 sec. release (TR) and 5 sec. release (FR) conditions were identical as described above with the exception of exposure time on the CM endpoint. In the IR condition, subjects released the handle in less than 1 sec. after encountering the mechanical stop which defined the CM endpoint while TR and FR subjects rested on the CM endpoint for 2 and 5 sec., respectively.

In order to render distance cues unreliable 24 starting position combinations for the CM and reproductions movements (RM) were used with the former being either 15, 17, 19, 21, 23, or 25 cm. to the left of the zero point on the slide (subject's view). The RM starting position was either +5 or +15 cm. from the CM starting position. These combinations were randomly assigned to each of the three retention intervals.

Criterion movement endpoints were assigned to three target sectors, short (24-38 cm.), medium (40-54 cm.) and long (56-70 cm.) in increments of 2 cm. Thus, within each target sector there occured 8 CM endpoints for a total of 24 trials per retention interval. Assignment of these CM endpoints to each retention interval was random with the restriction (due to the starting position combinations) that the CM and RM be a minimum 5 cm. long. This allowed the subject to complete each movement in the designated right to left manner.

Design

The three endpoint duration conditions received 24 trials under each of three retention intervals (immediate, 15 sec. unfilled and 15 sec. filled). The order of presentation of the three retention interval blocks was counterbalanced across subjects. For analysis purposes, reproduction errors of the eight targets within each target sector were collapsed for constant (CE) and absolute (AE) error inspection, thus creating a 3 × 3 × 3 (Groups × Retention Intervals × Target Sectors) analysis of variance. The Groups factor was the only between-subject variable. A measure of within-sector consistency (VE') was obtained within each target sector. This measure was defined as the standard deviation of the constant errors within each target sector.

Results and Discussion

The means and standard deviations of reproduction errors for Groups, Retention Intervals and Target Sectors are presented in Table I.

Table I – Means and Standard Deviations for Groups, Retention Intervals and Target Sectors.

Main effects		Immediate release			2 sec. release			5 sec. release		
		CE	AE	VE'	CE	AE	VE'	CE	AE	VE'
Groups										
	M	2.13	4.35	3.83	.60	3.62	3.42	.65	2.95	2.98
	SD	3.60	2.33	1.74	3.18	1.60	1.37	2.15	1.07	1.02
Retention intervals										
Immed.	M	2.15	3.94	3.18	.31	3.29	2.76	.48	2.87	2.51
	SD	3.00	1.54	1.07	3.10	1.43	.93	2.45	1.05	.89
15 sec.	M	2.10	3.78	3.36	.13	3.32	3.21	.58	2.82	2.93
unfilled	SD	2.93	1.85	1.23	2.84	1.37	.93	2.14	1.14	.95
15 sec.	M	2.14	5.32	4.96	1.36	4.25	4.29	.89	3.16	3.52
filled	SD	4.70	3.06	2.15	3.55	1.81	1.66	1.86	1.03	.98
Target sectors										
Short	M	2.22	4.55	3.99	.12	4.23	3.69	– .20	2.93	3.10
	SD	4.32	2.92	1.52	3.79	1.46	1.18	2.19	1.04	.94
Medium	M	3.26	4.58	4.05	1.26	3.68	3.27	1.34	3.09	3.15
	SD	2.37	1.85	1.73	3.27	1.70	1.38	1.84	1.19	1.11
Long	M	.90	3.91	3.46	.42	2.94	3.29	.80	2.82	2.71
	SD	3.54	2.08	1.93	2.28	1.39	1.53	2.16	.99	.97

Note: Means are given in cm. CE refers to constant error, AE is absolute error, and VE' is within-sector consistency.

The Groups main effect for AE and VE' is significant, $F(2,33) = 4.90$, $p < .05$ and 5.27, $p < .01$, respectively. Tukey's *post hoc* test reveals a definite superiority of the FR condition over the IR condition for AE and VE' (ps of .05 and .01), however, the TR condition is not significantly different from either of these groups. For CE, the Groups main effect is nonsignificant, $F(2,33) = 2.07$.

The Retention Intervals main effect is also significant for AE and VE', $F(2,66) = 15.77$ and 5.27, $p < .01$, respectively, while CE is nonsignificant, $F(2,66) = 2.27$. *Post hoc* analysis of AE and VE' reveal an identical pattern with no differences occurring between the immediate and 15 sec. unfilled retention interval. Introducing verbal processing activity during the 15 sec. retention interval results in a significant increase in AE and VE' ($p < .01$).

The Target Sectors main effect is significant for AE, VE' and CE, $F(2,66) = 5.08$, 3.73 and 5.74 ($p < .05$). Post hoc analysis reveals that greater positive errors are associated with the medium target sector (40–54 cms.). Reproduction of targets within the short sector (24–38 cms.) results in greater absolute and variable error.

The Groups × Retention Interval interaction is only marginally significant for AE and VE', $F(4,66) = 2.13$ and 2.29, $p < .10$. A test of simple main effects for both dependent measures reveals that the groups differ only in the filled retention interval with the FR condition superior to the IR condition. While this finding would suggest that the FR condition is being less affected by verbal processing activity than the IR condition, the results should be accepted with caution due to the marginal significance. Additionally, the Groups × Retention interval interaction for CE is nonsignificant, $F(4,66) = 1.00$.

The Retention Intervals × Target Sectors interaction is significant for CE only, $F(4,132) = 30.84$, $p < .01$. A test of simple main effects indicates that the reproduction of target sectors is different in each retention interval ($p < .01$). In the immediate and 15 sec. unfilled retention intervals greater positive errors are associated with the medium and long target sectors. However, a classical range effect (ELLSON and WHEELER, 1947) is suggested in the 15 sec. filled retention interval with the short and medium targets being overshot while the long targets were undershot.

EXPERIMENT II

Method

Subjects

Forty-eight right-handed female volunteers were recruited from the University of Wisconsin. The subjects were randomly assigned to the three endpoint duration conditions.

Apparatus

Identical to Experiment I.

Procedures

The procedures were identical to Experiment I except that in the preselected conditions, the subject's CM endpoints were selfdefined. The subject was instructed however to disperse his movements throughout the entire movement range and avoid making a series of similar responses on succeeding trials. Any consistent pattern of movements (e.g. short. medium, long) was also to be avoided. In the preselected conditions, each trial commenced with the instruction for the subject to "Grasp the handle". covertly "Select" and "Move" to her desired CM endpoint. The command "Select" was given to insure that the subject preset the movement prior to initiation. After the appropriate endpoint duration (IR. TR or FR) and retention interval manipulation (immediate. 15 sec. unfilled, 15 sec. filled) the subject was instructed to "Grasp the handle" and "Recall" the CM endpoint.

In the constrained mode, the subject's CM endpoints were identical to those she had chosen earlier in the preselected mode. The order of constrained trial presentation was also analogous to the preselected movement trials. The commands given were identical to those used in Experiment I.

In order to render distance cues unreliable 12 starting position combinations for the CM and RM were used with the former being either 15, 19, 23 cm. to the left of the zero point on the slide. As in Experiment 1, the RM starting position was either +5 or +15 cm. from the CM starting position. These combinations were randomly assigned to each of the three retention intervals. The presentation order of the three retention intervals was randomized rather than presented in blocks (Experiment II) with the restriction that a retention interval could not appear more than twice in row.

Design

The three endpoint duration conditions received 12 trials under each of the three retention intervals (Immediate. 15 sec. filled). Subjects in each endpoint duration condition performed 36 trials under the preselected mode followed by 36 trials under the constrained mode. For analysis purposes, the CM endpoints chosen under the preselected mode were categorized into short (15-32.5 cm.), medium (33-50.5 cm.) and long (51-68.5 cm.) target sectors. Thus, a 3 × 2 × 3 × 3 (Groups × Modes × Retention Intervals × Target Sectors) factorial design was used with the Groups factor as the only between subject variable. As in Experiment I. reproduction errors within each target sector were collapsed for inspection of CE, AE, and VE'.

Results and Discussion

An examination of the CM dispersions of the three preselected conditions was necessary to establish whether the groups chose similar movements as a function of target sectors and retention intervals. No differences were found ($F < 1$) and allowed for the comparison of reproduction errors. The means and standard deviations of reproduction errors for groups, modes. retention intervals and target sectors are presented in Table II.

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significantly different from each other at or beyond the .05 significance level. For CE, a significant increase in positive errors results when verbal processing activity is introduced during the 15 sec. retention interval ($p < .05$).

Table II - Means and Standard Deviations for Groups, Modes, Retention Intervals and Target Sectors.

Main effects		Immediate release			2 sec. release			5 sec. release		
		CE	AE	VE'	CE	AE	VE'	CE	AE	VE'
Groups										
	M	.09	3.18	3.10	.03	2.69	2.66	.22	2.51	2.44
	SD	2.50	1.53	1.62	2.11	1.08	1.16	1.92	1.07	1.11
Modes										
Pre	M	.35	2.90	3.08	.05	2.46	2.45	.28	2.49	2.37
	SD	1.90	1.30	1.61	1.99	1.01	1.05	1.92	1.08	1.01
Con	M	− .16	3.47	3.14	.01	2.93	2.88	.15	2.51	2.51
	SD	3.15	1.76	1.63	2.18	1.15	1.26	1.92	1.07	1.15
Retention intervals										
Immed.	M	.16	2.67	2.48	.10	2.25	2.18	.18	2.32	2.07
	SD	2.10	1.30	1.14	1.69	.81	1.05	1.79	.99	.87
15 sec.	M	− .18	3.22	3.06	− .10	2.81	2.62	− .02	2.52	2.54
unfilled	SD	2.50	1.42	1.55	2.36	1.18	1.10	1.88	1.05	1.17
15 sec.	M	.31	3.67	3.77	.10	3.02	3.19	.50	2.67	2.71
filled	SD	3.00	1.86	2.16	2.27	1.25	1.32	2.07	1.18	1.32
Target sectors										
Short	M	− .34	3.61	3.33	− .71	3.04	2.92	− .74	2.88	2.84
	SD	3.00	1.72	1.66	2.33	1.20	1.36	2.11	1.22	1.47
Medium	M	.79	3.12	3.14	.68	2.55	2.58	.80	2.51	2.58
	SD	2.40	1.35	1.50	1.97	.99	1.02	1.86	1.03	1.01
Long	M	− .16	2.81	2.85	.14	2.49	2.48	.60	2.14	1.92
	SD	2.20	1.51	1.68	2.03	1.06	1.09	1.78	.97	.86

The Groups main effect for AE and VE' is significant, $F(2,45) = 8.65$ and $F(2,45) = 8.39$, $p < .01$, respectively. Tukey's *post hoc* test indicates that the IR conditions are significantly worse that the TR ($p < .05$) and the FR conditions (p .01) for both AE and VE' measures. For CE, the Groups main effect is nonsignificant, $F < 1$.

The Modes main effect is significant for AE and VE', $F(1,45) = 15.02$, $p < .01$, and $F(1,45) = 6.71$, $p < .05$, respectively. A clear superiority of the preselected (PRE) over constrained (CON) modes is evident.

The retention intervals main effect is significant for AE, VE' and CE, $F(2,90) = 23.92$, $F(2,90) = 35.16$, and $F(2,90) = 3.16$, $p < .01$, $p < .01$, $p < .05$ respectively. For AE and VE', Tukey's test reveals that all three retention intervals are

The target sectors main effect is significant for AE, VE', and CE, $F(2,90) = 11.07$, $p < .01$, $F(2,90) = 10.38$, $p < .01$, and $F(2,90) = 14.45$, $p < .01$, respectively. For AE, Tukey's test indicates that short targets are more poorly reproduced than medium ($p < .05$) and long targets ($p < .01$). For VE, short and medium targets are reproduced more poorly than long targets ($p < .01$ and $p < .05$, respectively). For CE, short targets evidenced greater undershooting relative to medium and long targets.

Of considerable interest is the groups by modes interaction since it might reflect differences in the PRE and CON modes relative to the endpoint duration manipulation. The groups by modes interaction is significant only for AE, $F(2,45) = 3.43$, $p < .05$. A simple main effects analysis of the two response modes as a function of the IR, TR, and FR conditions was performed. This analysis reveals that PRE-IR reproduction error is marginally greater than PRE-TR ($P < .10$). For the constrained mode however, CON-IR is significantly worse than both CON-TR and CON-FR ($p < .05$) which are not different from each other. Examining this interaction further reveals a superiority of PRE location over CON location at the IR and TR conditions. However, at the FR condition, reproduction of PRE and CON location is not significantly different for AE. The failure of a significant groups by modes interaction for VE' suggests that the PRE and CON modes are similarly effected by the endpoint duration manipulation.

The findings for both AE and VE' measures support those in Experiment I that constrained movements are affected by the endpoint duration manipulation. The lack of a significant endpoint duration by modes interaction for VE' and a marginal superiority of the PRE-TR over PRE-IR for AE suggests that preselected movement is also affected by the endpoint duration manipulation. Since the time at the CM endpoint is assumed to be critical for proprioceptive encoding it appears that the above findings point to the importance of peripheral information for both constrained and preselected location reproduction.

GENERAL DISCUSSION

The present experiments sought to examine whether reproduction of constrained and preselected movements was equally dependent on peripheral information. The main variable of interest was the exposure time at the CM endpoint which was thought to be crucial for proprioceptive encoding. In constrained movement production the blindfolded subject's major source of information regarding the CM endpoint arises from the proprioceptive modality. Since these movements should be more input oriented, it was hypothesized that endpoint duration should benefit the encoding of proprioceptive information and facilitate reproduction accuracy. The AE and VE' results from both Experiment I and II clearly support this position. Using the same rationale as presented here, DEL REY and LICHEN (1971) failed to find an endpoint duration effect for constrained movement reproduction. However, endpoint duration in their study varied from 2 to 10 sec. and it could be argued that 2 sec. at the CM endpoint was sufficient for proprioceptive encoding in constrained movements and that further exposure time was not influential. This interpretation is strengthened in light of the AE and VE' results of Experiment II which suggests that the crucial interval for proprioceptive encoding is between 0 and 2 sec.

In preselected movement production, a corollary discharge (TEUBER, 1974; SPERRY, 1950) from motor to sensory centers may occur which prepares the latter for the sensory consequences of the motor act. As hypothesized by STELMACH *et. a.* (in press), this operation may allow for better proprioceptive encoding. The prediction in Experiment II was that preselected movements, being aided by the corollary discharge mechanism, should be more output oriented and not benefit from increased exposure at the CM endpoint. However, the significant increase in reproduction consistency (reflected by VE') and the marginal increase in reproduction accuracy (reflected by AE) for preselected movements as a function of endpoint duration certainly suggests that peripheral information is also important for preselected movement reproduction. If corollary discharge occurs in preselected movement production it may be that some time is still required in order to encode the proprioceptive information. Additional AE data of Experiment II indicates that resting on the CM endpoint of a constrained movement for 5 sec. may compensate for the lack of prior response organization and augment the memory trace to a degree comparable to that of preselected movements. However, response consistency (as reflected by VE') of preselected movements appear to be superior to constrained regardless of the endpoint duration.

Another interpretation of the data is warranted which incorporates a rehearsal explanation of the endpoint duration effect. It might have been that subjects in both preselected and constrained conditions rehearsed the terminal location of the movement during endpoint duration. This rehearsal interpretation could explain the benefits of endpoint duration on preselected reproduction and would not necessarily predict a presentation mode by endpoint duration interaction. The above interpretation would suggest that endpoint duration allows for more rehearsal at the endpoint rather than for more encoding time in both constrained and preselected movements and thus can explain the benefits of endpoint exposure on both response modes. However, it cannot explain the superiority of preselected over constrained reproduction at a *given* endpoint duration since rehearsal time is equal for both response modes.

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ON THE LOCUS OF THE RANGE EFFECT IN A SHORT-TERM MOTOR MEMORY PARADIGM

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The range effects (RE), that is, the tendency to overshoot or undershoot a criterion movement, has been the object of careful considerations recently in the short-term motor memory literature (see, for example: STELMACH, 1974) and valuable information has been gained on this problem.

For example, it is now a well-documented fact that if a series of movement extents are used, small ones will tend to be overshot and large ones will tend to be undershot (PEPPER & HERMAN, 1970; TRUMBO, MILONE & NOBLE, 1972; WILBERG & GIROUARD, 1975) but more importantly, such tendencies will be little affected by the short-term motor memory (STMM) system. In other words, using constant errors (CE) as an index of RE, there is little change in CE over an unfilled retention interval (ASCOLI & SCHMIDT, 1969; BURWITZ, 1972; KEELE & ELLS, 1972; MARTENIUK, 1973; SALMELA, 1972) although contradictory evidence has been reported by PEPPER and HERMAN (1970) and LAABS (1973).

Several factors are known to affect RE. If a motor interpolated task is inserted in a retention interval, then strong assimilation effects are found in the direction of the interpolated act (PEPPER & HERMAN, 1970; LAABS, 1973) and especially if the interpolated act is inserted very close to the reproduction phase (PATRICK, 1971; STELMACH & WALSH, 1973). The memory trace strength of the to-be-reproduced (TBR) movement has also been found a potent variable, in that a stronger trace appears more apt to resist the effect of an interpolated act (STELMACH & KELSO, 1975).

The method used to present the TBR movements represents also an important variable. Subject-defined movements appear to produce more undershooting (that is accentuate the RE during the reproduction phase) than experimenter-defined movements (for example, using a tone or a physical stop to indicate the endpoint) (TRUMBO, WHITTAKER, NOBLE, 1972; TANNIS & WILBERG, 1974). Results provided by TRUMBO, MILONE and NOBLE (1972) tend to suggest that response execution mechanisms play a minor rôle in RE tendencies as compared to the response classes themselves. Finally, one must remember that the series of movement extents, if used as a within — S variable, may by itself, represent an important source of response biasing (POULTON, 1973, 1974).

The last three factors (method of presentation of the TBR movements, response or movement classes, and set of stimuli or TBR movements) seem to indicate that the encoding processes of the TBR movements represent a common source of effects. One way of testing such assertion is to present the TBR information in two modalities, at the same time, such as in the kinesthetic (K) and visual (V) modalities, but varying independently the values or extent of the information within each modality. The resulting effects, if any, on CE at recall may thus say something about the relative rôles of the K and V codes on the RE observed.

In a recent experiment (WILBERG & GIROUARD, 1975), we found that RE for movement information can be substantially altered by V information provided at the same time as the TBR movements. We used three types of K:V ratios: 2:1, 1:1, and 1:2 in presenting the information to S such that V extents appeared half as long, equal to, or twice as long as the K extents. Ss reproduced either in the K or in the K + V modality. In K reproduction, K information was assimilated toward V information while in V + K reproduction, RE was much as normal. However, since K:V ratios were used as a main factor in a completely crossed design, it implied that some V extents were used for which there were no equivalent K extents. Perhaps the results obtained were partly due to the fact that V information was over-emphasized.

The purpose of this experiment was therefore to try to replicate the findings of the previous experiment but using this time an equal pairing of K and V extents. The purpose of using K — V disparity was to determine whether the RE found was mostly determined by V or K information and thus provide an insight into the locus of the RE.

METHOD

Apparatus and task

The apparatus consisted of a 4.0 by 98 cm. wooden ruler, used as a track, mounted on a wooden frame. A metal cursor, with a small knob 3.5 cm. high and .75 cm. in diameter, was used to fit metal edges on each side of the track and was employed by the Ss for making simple linear movements. The cursor was hooked up to a 10-turn potentiometer whose output, after being passed through a voltage divider/amplifier box, was fed into an oscilloscope (Statham, model 700-170). Therefore, when an S moved the cursor, he could see the spot (1.6 mm. diameter) on the scope moving in the same direction according to one out of five possible K:V ratios: 4:1, 2:1, 1:1, 1:2, and 1:4. For example, when a ratio of 1:1 was used, the spot was moving the same length as that of the cursor; while a ratio of 1:2 meant that the spot moved twice as far as the actual physical movement executed by the Ss. The scope used had a screen 35.5 cm. wide by 28 cm. high and was situated about 1.2 meters in front of S, at eye level.

The S sat confortably in front of the apparatus and moved the cursor horizontally from his left to right, all Ss being right-handed. The range used on the ruler was 35.5 cm., that is, any movement used took place within that range.

Subjects and design

The Ss were 8 undergraduate students (4 males and 4 females, $\bar{X}$ = 19.63 y.a., SD = 2.33) who volunteered for this experiment. Each S received all treatment conditions (36) in a 3 × 3 × 2 × 2 completely crossed factorial design with repeated measures on all factors. Each treatment condition was replicated 3 times by every S.

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The first factor consisted of three levels of V information: short (3.5 cm.), medium (7.0), and long (14.0 cm.). The second factor had three levels of K information: short (3.5), medium (7.0), and long (14.0 cm.). The last two factors, with two levels each, were: reproduction modality (K + V or K) and retention interval (0 or 15 sec.). Thus, as an example, if a given treatment condition involved a movement extent of 14 cm. associated with the spot moving only a distance of 3.5 cm., then a ratio of 4:1 was being used. However, as said before, K:V ratios were not treated as a factor since all the necessary information was already contained in the first two factors of the design.

Procedure

Ss were tested in an isolated room where only the experimenter (E) and the S were present. On each trial, S had to reproduce the distance moved during the execution of the criterion movement, location information being made unreliable by changing the starting location during the reproduction phase. All criterion distances were presented in K + V modalities. In the case of the reproduced distances in the K modality, the oscilloscope was simply turned off. Ss did not know in advance (i.e., until the scope was effectively turned off) whether the reproduction modality was going to be K + V or K. When it was in the K + V modality, the same type of relationship between K and V existed, as the one used during the execution of the criterion movement. A blackout cloth extended from a frame above the apparatus to cover Ss shoulders, completely eliminating any visual cues as to the position of his arm, hand, or of the cursor while permitting a clear view of the scope. Ss were not explained the mechanism of the apparatus (i.e., the values of the K:V ratios) until the completion of all test sessions. Instruction emphasized the reproductions of the distances moved by the hand (K information) but at no time were Ss allowed to close their eyes or move their eyes away from the scope during a trial in order to avoid the somewhat confounding effect of K:V disparity.

The general procedure involved presenting S with a criterion movement by having him move the cursor until he hit a physical stop. S held this position for about 2 sec. E then activated the clock (in the case of the 15 sec. retention interval) and repositioned the cursor to a different starting point, S's hand always staying on the cursor. Immediately or after the completion of the 15 sec. retention interval, E gave the command to reproduce. Errors in reproduction were then recorded to the nearest mm. During the unfilled retention interval, Ss were asked to concentrate on the distance just moved. For each trial V extent, K extent, and reproduction modality were randomly selected. Concerning the retention interval, half the Ss went through all the immediate reproduction trials first, followed by the 15 sec. trials while the other half (each group having an equal number of males and females) had the opposite sequence.[1]

1. In addition to the extents reported here (i.e.. 3.5 - 7.0 - 14.0 cm.). two other sets of V and K extents (2.5. 5.0, and 10.0 and 4.5, 9.0. 18.0 cm.) were also used, in a random fashion. with all Ss but only the first set was analyzed.

Analysis of error scores

Constant error (CE) or mean algebric error, variable error (VE), the standard deviation of the algebric error, and average variation errors (AV), the SD of the mean absolute error, were each submitted to a separate analysis of variance (ANOVA).

Results

Concerning CE, only the K extent main effect was significant, $F(2,14) = 39.02$, $p < .01$, and results appear in Table I. This is the basic RE generally observed which indicates that a short K extent is overshot while a long one is undershot (PEPPER & HERMAN, 1970; TRUMBO, MILONE & NOBLE, 19‾ ?: WILBERG & GIROUARD, 1975). We will use through the remainder of this paper, these response set data as a base line for the discussion.

Table I - Mean constant, variable, and average variation error as a function of kinesthetic extents (in cm.).

	Kinesthetic extents		
	Short	Medium	Long
Constant error	1.09	0.45	− 2.03
Variable error	1.17	1.33	2.48
Average variation	0.95	0.99	1.96

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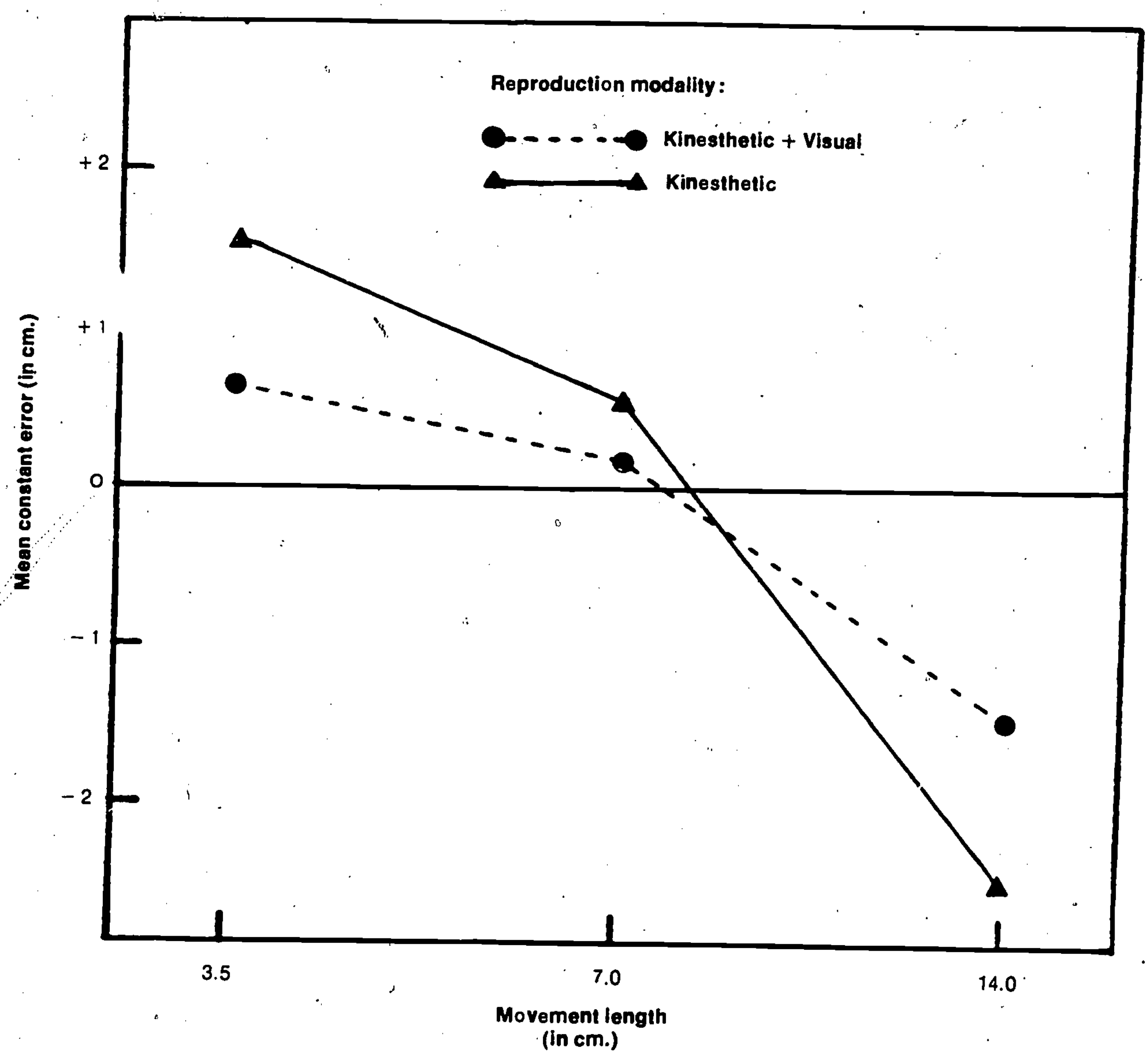
No other main effects were significant. The K extent by reproduction modality interaction was significant $F(2,14) = 9.00$, $p < .01$; (see Figure 1) and shows the RE is more pronounced in the K than in the K + V reproduction modality. Finally, the three-factor interaction involving V extent, K extent, and reproduction modality was significant, $F(2,14) = 9.14$, $p < .01$. No other interactions reached the level of significance.

Figure 1 - Interaction between reproduction modality and criterion movement lengths to be reproduced.



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Concerning VE and AV, only one main effect was significant in both analyses and this is again K extent, $F(2,14) = 24.44$, $p < .01$ for VE, and $F(2,14) = 15.02$, $p < .01$ for AV. Results are illustrated also in Table I. No other main effects nor interactions were significant concerning VE and AV.

The significant three-factor interaction involving K, V, and reproduction modality indicated that in fact those three factors are interrelated in a complex manner. However, unlike the previous experiment (WILBERG & GIROUARD, 1975), the present interaction was hard to interpret and no particular trend was immediately apparent.

In order to get a clearer picture, we reanalyzed the data concerning CE. In the V + K reproduction modality, data were computed using, this time, the visual dimension as the basis for measurement. For example, if an S had a movement of 7 cm. with a V information of 3.5 cm. and his reproduction score was 8 cm. (indicating a CE of + 1.00 cm. on the K side), it was divided by 2 such that his reproduction score became 4 cm. (thus, indicating a CE of + 0.5 cm. on the V side). As before then the first factor of interest was again V extent, (hereafter called primary information) and the second factor was K extent, hereafter called secondary information.

In the K reproduction modality, scores were not retransformed but simply reordered such that the first factor, or primary information, was K and the second factor, or secondary information, was V. In summary, when we say that the first factor (or primary information) had 3 levels, (i.e., short, medium, long), it implies that the dimension is V in the case of K + V reproduction modality and K in the case of K modality.

The ANOVA revealed that both the primary extent, $F(2,14) = 15.85$ $p < .01$, and the secondary extent $F(2,14) = 4.05$ $p < .05$, were significant. In addition, both two-factor interactions, namely the primary extent by reproduction modality interaction, $F(2,14) = 26.60$ $p < .01$, and the secondary extent by reproduction modality interaction, $F(2,14) = 12.44$, $p < .01$, were significant. Both interactions are illustrated in Figure 2 and 3 respectively. No other main effects or interactions were significant.

Figure 2 - Interaction between reproduction modality and primary criterion lengths to be reproduced. Primary criterion lengths are measured on the visual dimension in the case of the visual + kinesthetic modality and on the kinesthetic dimension in the case of the kinesthetic modality.

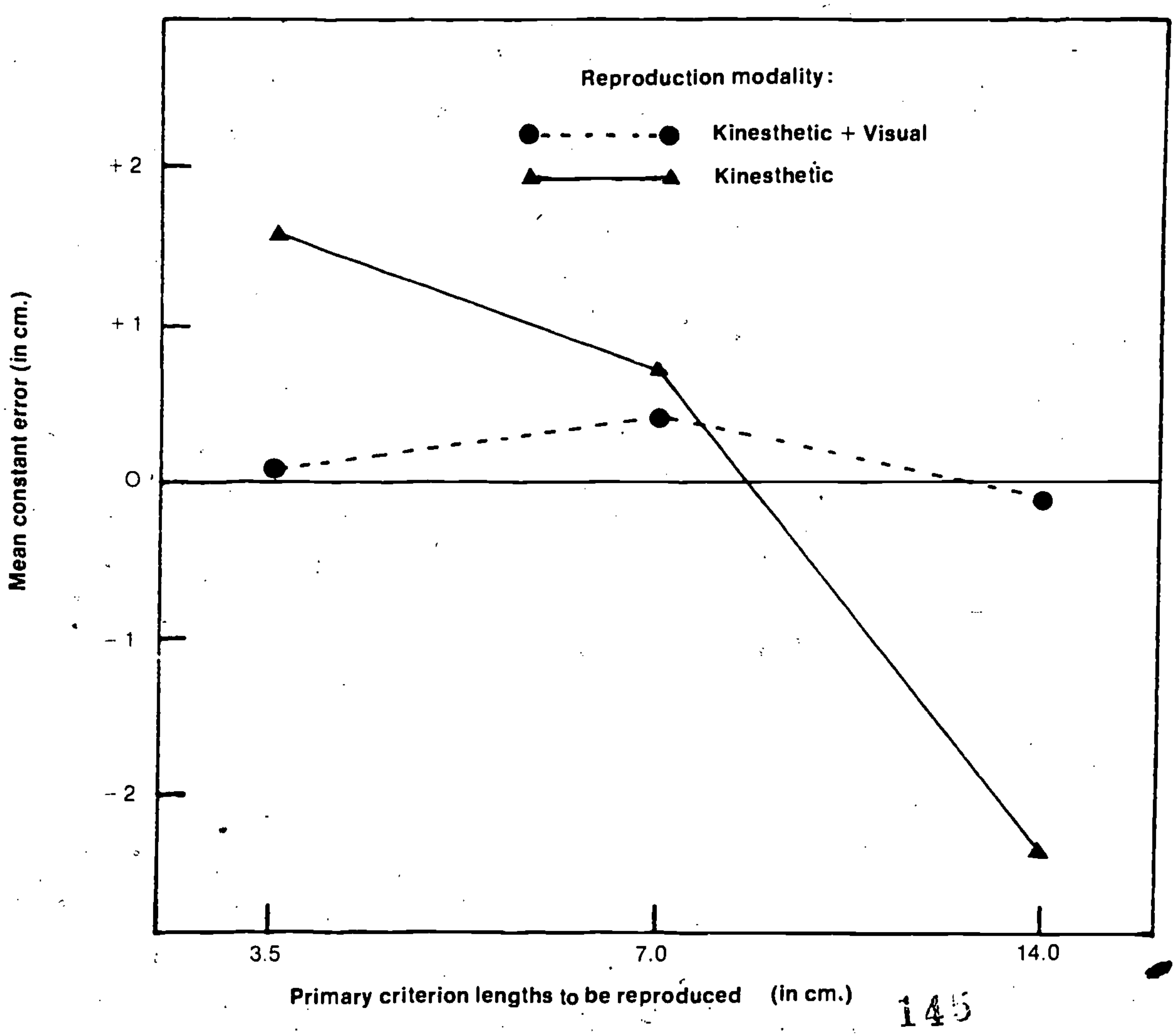

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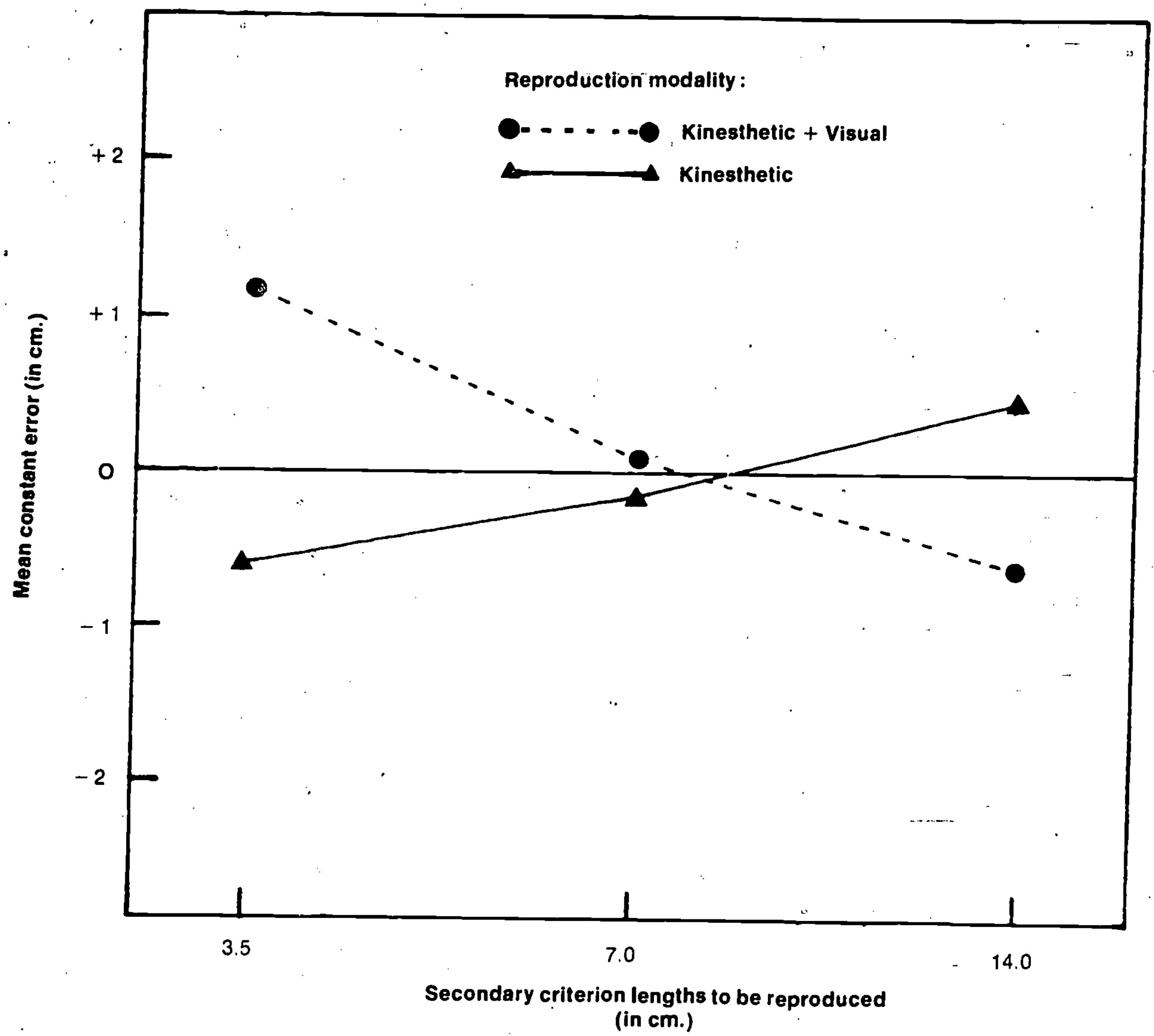
Figure 3 - Interaction between reproduction modality and secondary criterion lengths to be reproduced. Secondary criterion lengths are measured on the kinesthetic dimension in the case of the visual + kinesthetic modality and on the visual dimension in the case of the kinesthetic modality.



DISCUSSION

Taken together, results of the present study agree fairly well with those of the previous study (WILBERG & GIROUARD, 1975), showing a strong effect of the V code on the RE. In addition, the effect seems to resist memory effects since there was no decay, especially in the case of VE, as a function of the 15 sec. retention interval.

That the RE depends on the reproduction modality is illustrated by the fact that it is much more pronounced in the K than in the K + V modality (see both Figures 1 and 2) and this would be in agreement with results reported by STELMACH and KELSO (1975). In Figure 2 for example, when V is the primary dimension in the K + V reproduction modality, then RE is almost non-existent while normal and accentuated RE is found when K is the primary dimension in the K modality. A rushed conclusion would be that most RE occurs due to K. This, however, may not be the case. Consider the secondary information by reproduction modality interaction (Figure 3).

In the K + V reproduction modality, we found again the normal RE. When K is short as a secondary dimension, then V information is overshot and when K is long, then V is undershot. This should not come as a surprise, however, since instruction emphasized K information. What is surprising, however, is the fact that in the K reproduction modality, the pattern is simply reversed: where V was short at the time of presentation, then K information is undershot at recall and when V was long, K is overshot. Consistent with previous findings (WILBERG & GIROUARD, 1975), RE can be reversed by an assimilation process with V information.

Results would be in agreement with KLEIN and POSNER (1974) who found that the *mere presence* of V information disrupts the acquisition of K information and it does not depend at all on whether or not Ss will have to pay attention to V information. Vision seems to dominate K at the level of central attention and it seems that when V and K provide conflicting information, performance might be mainly under V control (e.g., KLEIN & POSNER, 1974, p. 406).

The present study would also be in agreement with results reported by ANNETT (1970) who found that when amplified V information is removed (i.e., when Ss have to reproduce in the K modality only after being presented with K-V information with approximately a ratio of 1:2), performance is marked by gross overshooting, which represents what happened in the present study when V was long.

An interesting question with the present results is to ask whether Ss stored V, K, or both codes for the purpose of recalling the information after the retention interval. One possibility might have been that a K code only was stored and that V information had its full assimilation effect during the reproduction phase by a sort of reconstruction process using visual imagery for instance. Another possibility might have been that information was stored directly by using V codes.

The first possibility can be discounted, we believe, on the grounds that if such had been the case, then we would have observed a significant memory effect, at least in the case of K reproduction and using VE as an index. K-distance information is generally affected by an unfilled retention interval (POSNER, 1967; LAABS, 1973). Since we found no memory effect, especially in terms of VE and AV, and since V codes have been found stable over time (e.g., POSNER, 1967), we have a basis for infering that a V code was at least stored.

We cannot imply, of course, that a K code was not stored or used by Ss. It was either a V code or both V and K codes and since we found normal RE for K information in the K + V modality, the possibility that a K code was stored or used in conjunction with a V code remains.

It seems, therefore, pertinent to conclude that RE can, to a large extent, be affected by encoding processes. STELMACH (1974) has argued that the biasing effect in STMM was peripheral. However, based upon the present results, and based also on the fact that RE is dependent on whether the TBR movement is subject-defined or experimenter-defined (TRUMBO, WHITTAKER & NOBLE, 1972; TANNIS & WILBERG, 1974), the conclusion seems warranted that an important source of RE has a central, encoding-related locus.

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PERFORMANCE MOTRICE: INFORMATION ET RETOUR D'INFORMATION

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LA STRATÉGIE PERCEPTIVE ET LA PERFORMANCE SPORTIVE

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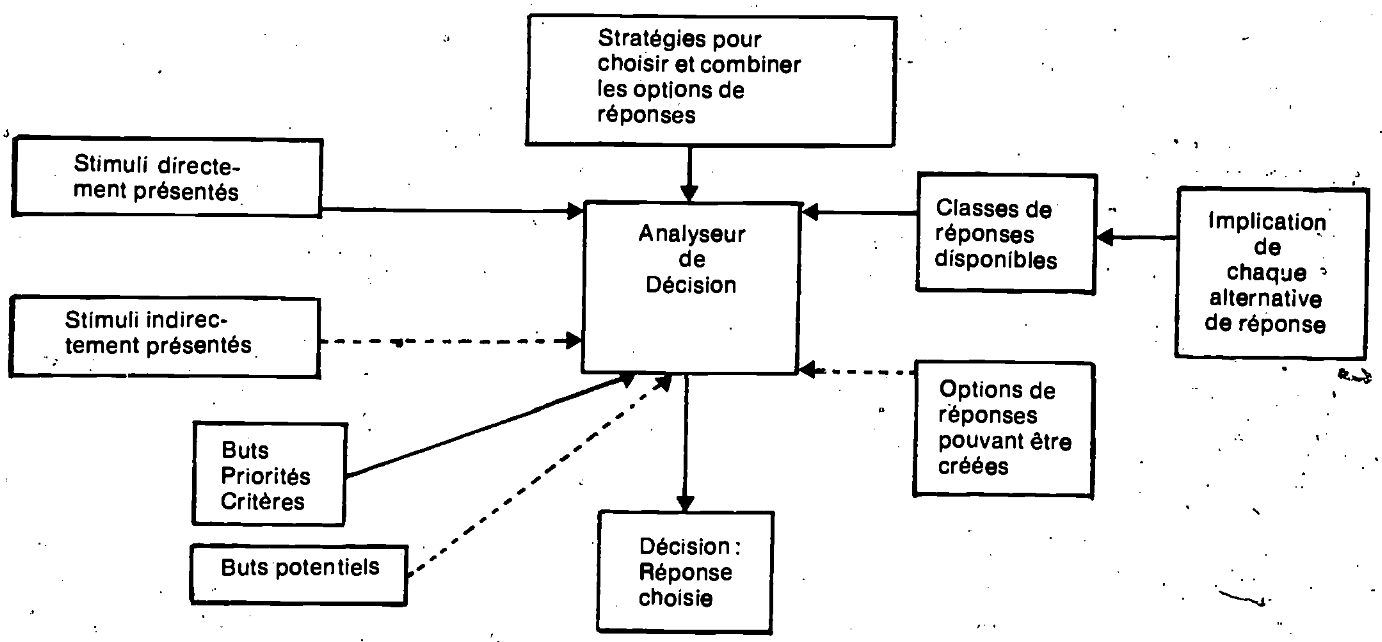
La prise de décision reflète un comportement sélectif, où un choix est impliqué. Elle est issue de l'analyse de l'information et par le fait même, dépend des informations captées et de la qualité de l'analyse de ces informations. Ainsi, les facteurs influençant tout le processus d'analyse de l'information ont un effet sur la prise de décision.

Certaines variables influencent le processus de prise de décision et MILLER (1962) en identifie plusieurs dans une figure type.

Figure 1 – Variables influençant la décision *.



* Tiré de Miller, 1962.

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De ces variables, quelques-unes sont pour nous d'une importance capitale dans leurs implications et corollaires:

1. *La complexité du stimulus.* La complexité du stimulus modifie grandement l'analyse de l'information et la décision qui en découle.
2. *Les catégories de réponses.* Les catégories de réponses possibles sont déterminantes puisque nous ne pouvons choisir une réponse qui n'est pas dans notre répertoire.
3. *La capacité du sujet.* Le sujet aura d'autant plus de réticences à choisir une réponse qu'il n'est pas efficace au niveau de la réalisation de cette réponse.
4. *Le désir d'efficacité ou de réussite.* Le sujet recherchant l'efficacité maximale devant une situation devra peser les conséquences de chacune des possibilités, avant d'en choisir une. «La sélection d'une réponse peut dépendre, en grande partie, de la connaissance permettant la conceptualisation de l'issue et du résultat de cette réponse dans le contexte d'une situation particulière» (MILLER, 1962).

   Un autre aspect de ce paramètre est représenté par l'évaluation subjective de la probabilité du succès d'une réponse dans la réalisation d'une tâche. Ces aspects sont directement dépendants de l'expérience du sujet dans la tâche qu'il doit accomplir.
5. *Les issues possibles, les priorités du sujet.* Chaque tâche peut comporter plusieurs issues possibles, mais le choix de la réponse dépendra directement des priorités que le sujet s'est fixées.

Il existe d'autres approches pour l'étude de la prise de décisions complexes (EDWARDS, 1965; PITZ, 1968-69; BROADBENT, 1971). Elles consistent essentiellement dans l'élaboration de modèles de recherche d'information basés sur les paramètres influençant l'analyse. Les trois principaux modèles sont:

a) les accumulateurs avec une mémoire parfaite;

b) les accumulateurs avec une mémoire défectueuse. et

c) les critères comparatifs: le modèle «random walk». (BROADBENT, 1971).

À ce niveau, plusieurs chercheurs ont tenté d'établir pour l'homme des stratégies optimales quant au nombre d'informations qu'il prélève.

EDWARDS et SLOVIC (1965) ont trouvé que les humains sont capables de déterminer des stratégies optimales pour minimiser le coût d'une réponse, par un prélèvement d'informations «utiles», i.e. par le maintien d'un ratio **rendement/coût** élevé. Par contre, PRUITT (1961) montre que si le sujet fait une mauvaise prédiction avant la présentation, il aura besoin de beaucoup plus d'informations que le niveau optimal habituel. Selon PITZ (1968), le sujet, à partir de la description d'une tâche, émet des prévisions sur le moment où une décision devrait être prise. Les performances subséquentes sont, en partie, dépendantes de ces prévisions.

Dès maintenant, nous pouvons donc réaliser la complexité des processus impliqués dans la prise de décision, ainsi que les nombreuses questions pouvant être soulevées à ce propos. Dans le contexte sportif, les variables influençant la prise d'information et la prise de décision sont pratiquement inconnues, pourtant ces processus sont d'une importance capitale.

En performance motrice, nul ne peut échapper à la problématique de la prise d'information visuelle, celle-ci étant la pierre d'angle de toute activité perceptivo-motrice (BARD, 1973; FLEURY, 1973). Partout où la réponse motrice est instantanée et fonction de la prospection visuelle, il devient primordial de préciser les stratégies d'investigation visuelle optimales, permettant la facilitation de la prise d'information.

Le but de cette étude, à multiples facettes, est donc d'identifier et d'analyser les repères informatifs nécessaires à une réponse adéquate, à l'aide de certains paramètres de la prospection visuelle.

Nous traiterons de trois (3) problèmes particuliers:

a) de l'effet de la complexité de la situation sur la prise de décision;

b) de l'influence du contexte sur la prise de décision;

c) de la densité et de la localisation des fixations en fonction du contexte (avec ou sans alternative), du type de solution (premier ordre: impliquant le joueur seulement; deuxième ordre: impliquant le joueur et ses partenaires) et du niveau d'expérience du sujet (expert ou non-expert).

L'exploration oculo-motrice a deux (2) fonctions principales:

a) recueillir les informations et

b) établir des relations entre ces informations,

pour résoudre adéquatement le problème proposé.

Les paramètres utilisés dans l'étude de la prospection visuelle sont, entre autres:

a) les durées et le nombre de fixations oculaires;

b) la localisation de ces fixations.

La durée et le nombre des fixations oculaires

Dans la plupart des tâches de prospection oculaire, un observateur fixe environ trois (3) fois par seconde. Toutefois, des études ont montré que les durées de fixation sont dépendantes des exigences de la tâche ainsi que du niveau d'entraînement des opérateurs-sujets. SCHOONARD *et al.* (1973) enregistrent les mouvements oculaires d'inspecteurs entraînés qui recherchent des défectuosités dans des circuits intégrés de petites dimensions. Après un entraînement de quelques mois, la durée moyenne des fixations est de 200 millisecondes, temps très proche du minimum de temps de fixation de l'œil. Les fixations les plus longues semblent porter sur les parties les plus difficiles à évaluer. Les résultats obtenus avec des observateurs moins bien entraînés révèlent des durées de fixation plus longues. Lors de comparaisons entre des joueurs de basketball experts et non-experts, BARD et CARRIÈRE (1975) notent que le nombre et la durée moyenne de fixation diminuent significativement avec la pratique et l'expérience. Les résultats de WHITE et FORD (1960), enregistrés lorsque des opérateurs recherchent un point sur un écran de radar, révèlent des durées de fixation de 300 millisecondes.

Dans des tâches où les sujets cherchent un élément parmi plusieurs, la durée de fixation sur un élément est déterminée systématiquement par la relation entre les caractéristiques de l'élément et les caractéristiques de la cible recherchée.

GOULD et SCHAFFER (1965) ont trouvé que la durée et le nombre de fixations varient significativement en fonction de la complexité de la tâche.

En résumé les durées de fixations sont influencées par

- les exigences spécifiques d'une tâche donnée,
- l'expérience des sujets et
- la complexité de la tâche.

La localisation des points de fixation

La zone privilégiée par l'observateur, lors d'une présentation, est influencée par au moins trois (3) facteurs :

- les exigences spécifiques de la tâche ;
- l'information que le sujet possède en rapport avec la tâche et
- l'expérience du sujet.

WHITE et FORD (1960) ont démontré que, dans une tâche de vigilance sur radar, la plupart des fixations apparaissent à mi-chemin sur la ligne de recherche du radar, plutôt qu'au milieu de la présentation visuelle. Le centre et les limites extrêmes de la présentation sont négligés. MOURANT et ROCKWELL (1972) ont montré qu'en conduite automobile, selon les tâches proposées (conduite en ville ou sur autoroute), les points de fixation varient de façon significative.

Le deuxième facteur influençant la localisation des fixations est l'information donnée au sujet sur la tâche. Dans une de ses expériences, WILLIAMS (1967) présente des diapositives contenant 100 formes géométriques. Ces éléments varient en forme, couleur et taille. Chaque élément contient deux (2) chiffres en son centre. Lorsque le sujet ne connaît préalablement que le numéro de la cible, ses fixations oculaires se répartissent presqu'également sur toute la présentation. Lorsque le sujet connaît en plus la couleur de l'élément critique, on note des fixations oculaires sélectives sur les éléments de cette couleur. Toutefois, une connaissance sur la forme ou la taille de l'objet ne produit pas autant de sélectivité au niveau des fixations sur les éléments de même forme ou de même taille. Lorsque le sujet connaît la couleur, la forme et/ou la dimension de la cible, il fixe les éléments surtout d'après les couleurs. Il semble que certaines couleurs ressortent plus que la forme de l'arrière-fond d'une présentation. Ceci peut s'expliquer par le rôle de la vision périphérique déterminant la prochaine fixation, la sensibilité au niveau de la reconnaissance de la couleur ne décroissant pas autant en périphérie que l'acuité de la forme.

Vérifiant le rôle de l'information préalable sur la prospection visuelle, YARBUS (1967) trouve que les sujets varient la localisation de leurs fixations en fonction des instructions reçues. Pour cette expérience, avant chaque présentation, l'expérimentateur informe le sujet du type de questions qui lui seront posées après la présentation du stimulus. Cet auteur trouve que les patrons de fixations changent en terme de localisation et de séquence selon les directives. Les sujets concentrent leurs fixations sur les zones pouvant leur permettre de répondre aux questions.

L'expérience des sujets, troisième facteur pouvant influencer la localisation des fixations, fut traité par GOULD et SCHAFFER (1965). Ces auteurs rapportent que les sujets, ayant participé intensivement à des expériences tachistoscopiques, ont 50% moins de fixations que les sujets n'ayant jamais eu cette expérience.

Les différences individuelles ressortent principalement de l'étude de SCHOONARD *et al.* (1973). Cette étude est réalisée avec des inspecteurs entraînés à détecter des défectuosités dans des circuits électroniques.

Comparant la prospection de radiologistes et d'étudiants en médecine et d'internes, KUNDELL (1972) trouve des stratégies de recherche différentes entre les groupes. Le patron de prospection semble dépendre des connaissances théoriques plutôt que d'un entraînement formel.

Dans une étude ultérieure, KUNDELL (1974) rapporte que les radiologistes et les profanes ne fixent qu'une portion sélective de l'image. Les fixations, tout en étant différentes pour les deux groupes, reflètent les priorités des sujets. Il existe une forte corrélation entre les régions décrétées importantes par les sujets et la localisation de leurs fixations. Les sujets regardent les régions susceptibles de contenir le plus d'informations, comme l'ont démontré MACKWORTH et MORANDI (1967) et ANTES (1973), mais selon leur expérience propre et l'utilisation qu'ils comptent faire de ces informations.

L'influence de l'expérience est aussi mise en lumière par MOURANT et ROCKWELL (1972) alors qu'ils trouvent des différences significatives entre les automobilistes expérimentés et les débutants qui suivent des cours de conduite. Ces derniers concentrent leurs fixations dans des régions plus réduites à mesure qu'ils prennent de l'expérience. Ils regardent plus en avant et à droite que les expérimentés et regardent leur rétroviseur moins souvent.

EXPÉRIENCE I

Dans une première étude sur la prise d'information et de décision dans des situations-problèmes ne contenant qu'une seule solution, BARD et CARRIÈRE (1975) ont démontré que des sujets expérimentés sont plus rapides (accumulent moins de fixations) que des sujets non-expérimentés, pour la solution des mêmes problèmes.

Néanmoins, dans la réalité sportive, l'athlète est plus souvent confronté avec des problèmes à solutions multiples, il fait le plus souvent face à plusieurs alternatives. Le but de la première expérience de cette série est de vérifier si les résultats obtenus précédemment se renouvellent ou se modifient dans des situations plus complexes, pour des sujets expérimentés aussi bien que non-expérimentés.

Protocole expérimental

Sujets

Trente (30) sujets de sexe masculin participent à la première expérience. L'âge moyen du groupe est de 21.3 ans. Quinze d'entre eux sont fortement impliqués dans l'activité sportive faisant l'objet de notre étude (de 3 à 7 ans de compétition intercollégiale et interuniversitaire en basket). Les 15 autres ont peu d'expérience en basketball (connaissance théorique et pratique limitées, contrôlées lors d'une entrevue avec le sujet et durant la période de familiarisation).

Tâche

Une série de 74 diapositives est présentée au sujet. Chacune des diapositives illustre, sous forme de schéma, une situation d'attaque typique au basketball. L'ordre de présentation des diapositives est établi aléatoirement pour chaque sujet. Des directives standardisées sont lues individuellement au sujet. Un signal préparatoire est donné avant chaque essai (2 secondes avant la présentation de la diapositive). À l'apparition d'un stimulus le sujet doit donner verbalement, le plus rapidement et précisément possible, la réponse choisie. La diapositive disparaît et le chronomètre électronique s'arrête dès que le sujet verbalise sa réponse. Pour chaque situation les réponses possibles sont:

a) lancer au panier;

b) dribbler;

c) passer à un partenaire démarqué et spécifique;

d) s'en tenir au statu quo, aucune action n'étant possible.

L'expérimentation est précédée d'une période de familiarisation de 74 essais. Une mise au point de l'appareillage est faite après chaque série de cinq (5) essais. L'expérimentation se fait en deux sessions entre lesquelles le sujet prend une heure de repos.

Appareillage et matériel

Les mouvements oculaires des sujets sont enregistrés au moyen d'un NAC Eye Mark Recorder, d'Instrumentation Corporation. Cet appareil utilise la technique de réflexion cornéenne. On filme:

a) la scène telle que vue par le sujet;

b) un V lumineux qui se superpose à la scène et dont la localisation correspond à la région fixée par le sujet (précis à ± deux degrés d'angle visuel).

Les diapositives sont présentées sur un écran à projection arrière. Les projecteur, tachistoscope, détecteur de vibrations vocales et chronomètre électronique sont reliés à un enregistreur à quatre (4) canaux.

Schème expérimental

Cette étude comprend trois (3) variables indépendantes:

1) la complexité de la tâche;

2) le niveau d'expérience des sujets;

3) le type de solution contenue dans la présentation.

- La *complexité* est définie opérationnellement, comme le nombre d'inputs codés possibles, i.e. le nombre de messages possibles dans l'ensemble du stimulus. Trois (3) niveaux de complexité sont identifiés:
  - a) un niveau où une solution possible est contenue dans la présentation;
  - b) un niveau où la présentation contient deux solutions possibles;
  - c) un niveau où il y a trois solutions possibles.
- L'*expérience* des sujets. Cette variable comprend deux niveaux:
  - a) le sujet fortement impliqué dans l'activité (de 3 à 7 ans d'expérience) et
  - b) le sujet profane en la matière (celui qui n'a aucune expérience de compétition représentative, mais qui connaît l'activité).
- Le *type de solution* contenue dans la présentation. Cette variable comprend elle aussi deux niveaux:
  - a) une solution de type 1, n'impliquant que le porteur de balle (dribble, lancer);
  - b) une solution de type 2, impliquant d'autres joueurs que le porteur de balle (passe).

Deux (2) variables dépendantes sont identifiées:

1. le temps de décision total;
2. le nombre de fixations oculaires.

Résultats

Le tableau I présente les moyennes pour le temps de décision et le nombre de fixations obtenues dans l'expérience I.

Tableau I – Temps de décision et nombre de fixations (moyennes) obtenus dans l'expérience I.

		Complexité 1	Complexité 2	Complexité 3
Solution de type I	Experts	T.D. = .842 N.F. = 3.892	T.D. = .823 N.F. = 3.544	T.D. = .795 N.F. = 3.265
	Non-experts	T.D. = 1.298 N.F. = 5.758	T.D. = 1.047 N.F. = 4.364	T.D. = .928 N.F. = 3.846
Solution de type II	Experts	T.D. = 1.038 N.F. = 4.771	T.D. = .800 N.F. = 3.517	T.D. = .771 N.F. = 3.224
	Non-experts	T.D. = 1.424 N.F. = 6.309	T.D. = 1.118 N.F. = 4.821	T.D. = 1.081 N.F. = 4.521

L'obtention d'une corrélation de .79 entre le temps de décision et le nombre de fixations nous permet de ne retenir que le nombre de fixations pour le reste des analyses.

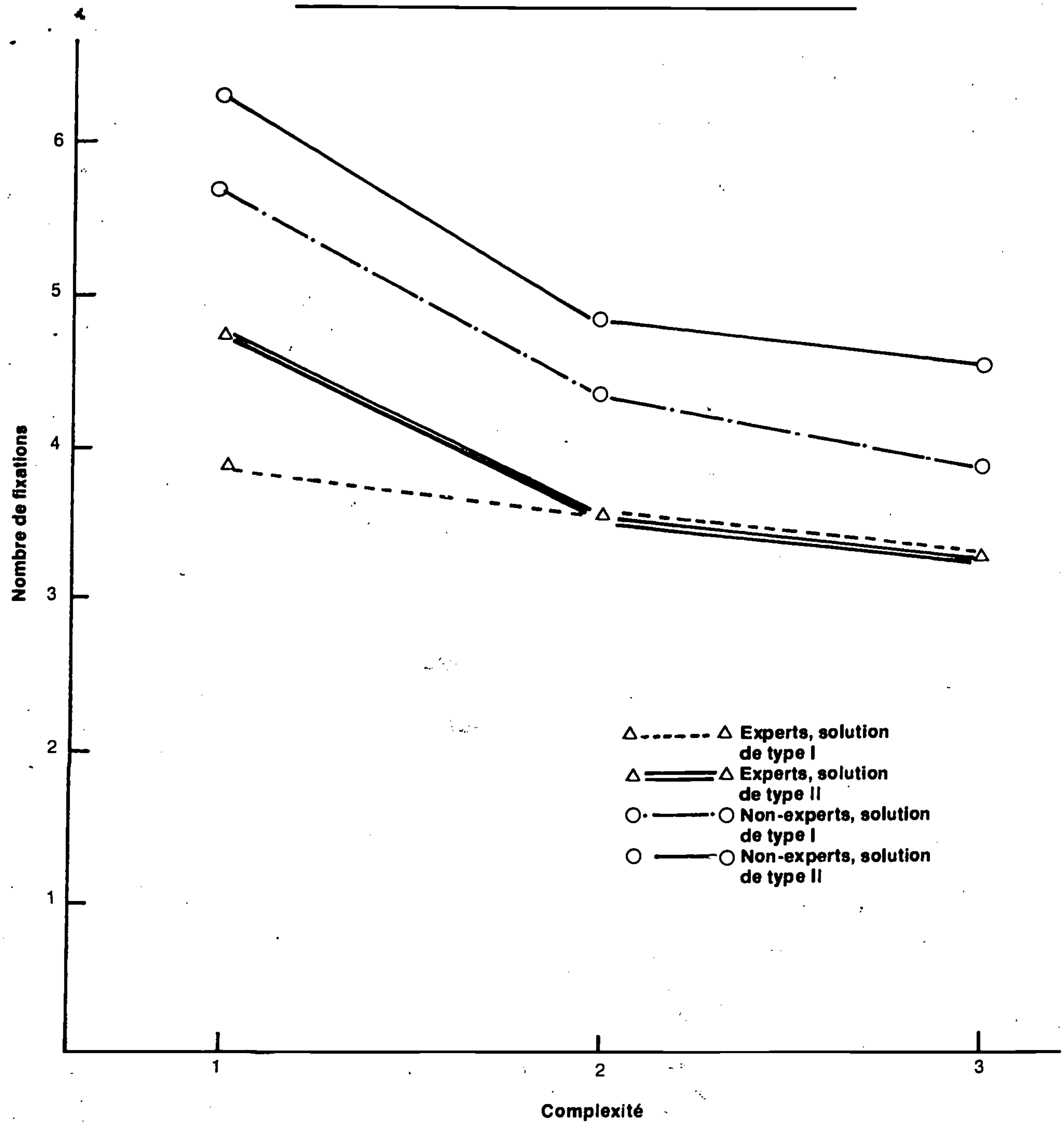
Une analyse de variance à trois (3) dimensions sur le nombre de fixations révèle une différence significative entre les trois (3) niveaux de complexité, $F(1,2218) = 120.985$, $p < .001$; entre les deux niveaux d'expérience, $F(1,2218) = 18.173$, $p < .001$; entre les deux niveaux de type de solution, $F(1,2218) = 18.173$, $p < .001$. La figure 2 fait ressortir :

— que les sujets experts ont moins de fixations que les sujets non-experts ;

— que le type de solution présentée affecte la prise de décision (plus petit nombre de fixations pour les solutions n'impliquant que le porteur de balle) ;

— que l'augmentation du nombre de choix facilite la prise de décision.

Figure 2 - Nombre de fixations (moyenne) en fonction du type de solution, du niveau d'expérience et du niveau de complexité.



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EXPÉRIENCE II

Ayant établi l'influence de la complexité de la solution sur la prise d'information et de décision, nous avons planifié une deuxième expérience où les mêmes situations-problèmes (à solution unique) sont présentées dans deux contextes différents. Dans le premier contexte, sans alternative (CSA), le sujet est informé que toutes les situations problèmes sont à solution unique; dans le deuxième contexte, avec alternatives (CAA), les situations-problèmes peuvent présenter 1, 2 ou 3 solutions et le sujet en est aussi informé. Seules les situations à solution unique furent analysées dans la présente expérience.

Protocole expérimental

Sujets

60 sujets, de sexe masculin, participent à la deuxième expérience. 30 d'entre eux font aussi partie de l'expérience I (CAS). Le tableau II illustre la répartition des sujets.

Tableau II – Répartition des sujets dans les différents groupes expérimentaux.

	CONTEXTE SANS ALTERNATIVE DANS LA SOLUTION	CONTEXTE AVEC ALTERNATIVES DANS LA SOLUTION
Experts	15	15
Non-experts	15	15

Les 30 nouveaux sujets (CSA) furent sélectionnés selon les mêmes critères que pour l'expérience I.

Tâche

Pour le groupe CAS, voir expérience I. Pour le groupe CSS, une série de 42 diapositives est présentée au sujet, illustrant, comme dans l'expérience I, des situations typiques d'attaque au basketball. Le protocole et l'appareillage utilisés sont les mêmes que dans l'expérience I.

Schème expérimental

Dans cette expérience, deux variables indépendantes sont introduites:

- le contexte (CSA, CAA);
- l'arrangement spatial (dispositif 1 et 2), défini en termes de proximité ou d'éloignement d'éléments spécifiques (joueur de centre et ailier gauche) par rapport au porteur de balle et au panier.

Résultats

Le tableau III présente les moyennes pour le temps de décision et le nombre de fixations obtenues dans l'expérience II.

Tableau III - Temps de décision et nombre de fixations (moyennes) obtenus dans l'expérience II.

		Contexte sans alternative		Contexte avec alternatives	
		Dispositif 1	Dispositif 2	Dispositif 1	Dispositif 2
Solution de type I	Experts	T.D. = 0.878 N.F. = 2.73	T.D. = 0.905 N.F. = 3.03	T.D. = 0.870 N.F. = 4.15	T.D. = 0.816 N.F. = 3.65
	Non-experts	T.D. = 1.176 N.F. = 4.63	T.D. = 1.100 N.F. = 3.60	T.D. = 1.27 N.F. = 5.27	T.D. = 1.329 N.F. = 6.24
Solution de type II	Experts	T.D. = 1.026 N.F. = 3.89	T.D. = 0.943 N.F. = 3.58	T.D. = 1.008 N.F. = 4.70	T.D. = 1.068 N.F. = 4.84
	Non-experts	T.D. = 1.280 N.F. = 5.36	T.D. = 1.289 N.F. = 5.46	T.D. = 1.321 N.F. = 5.85	T.D. = 1.528 N.F. = 6.76

Une analyse de variance multivariée, à quatre (4) dimensions, sur le temps de décision et le nombre de fixations, démontre une différence significative pour 3 des 4 facteurs:

1. les deux contextes, $F(2,822) = 31.409$, $p < .001$;
2. les deux niveaux d'expérience, $F(2,822) = 66.923$, $p < .001$;
3. les deux niveaux de type de solution, $F(2.822) = 13.735$, $p < .001$.

La figure 3 fait ressortir d'abord que le contexte sans alternative favorise la rapidité de décision des sujets et réduit leur nombre de fixations. De plus, le contexte affecte davantage les sujets profanes que les sujets experts. Ce résultat pourrait s'expliquer par une plus grande flexibilité perceptuelle des sujets experts, i.e., une habileté à s'adapter plus rapidement à de nouvelles situations perceptuelles. La figure 4 illustre bien le fait que les sujets experts ont moins de fixations que les sujets non-experts, et enfin que tous les sujets sont plus rapides dans les situations à solution de type 1 (lancer ou dribble) que dans les situations à solution de type 2 (passe à un partenaire).

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Figure 3 – Temps de décision en fonction du type de solution, du niveau d'expérience et du contexte.

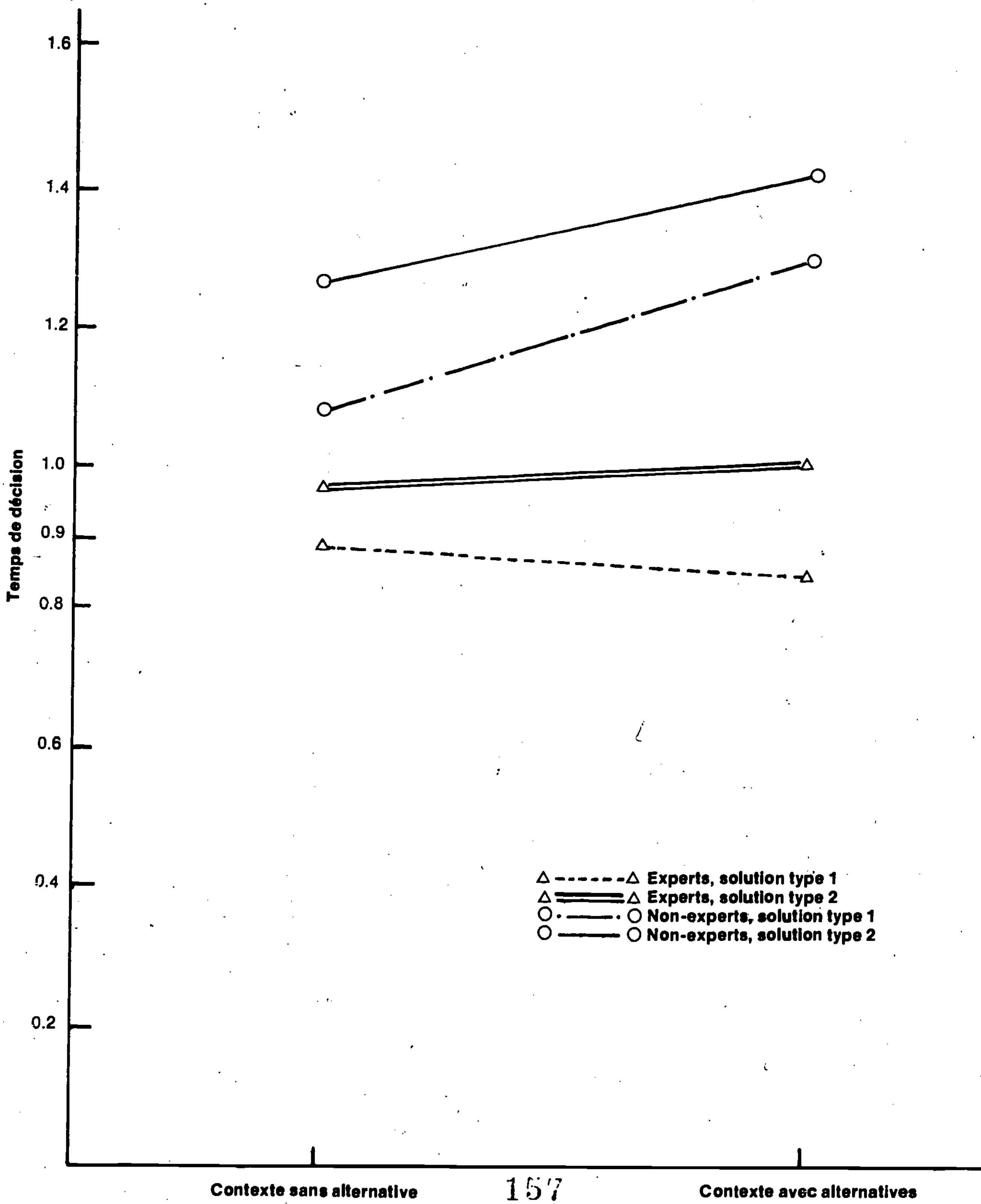

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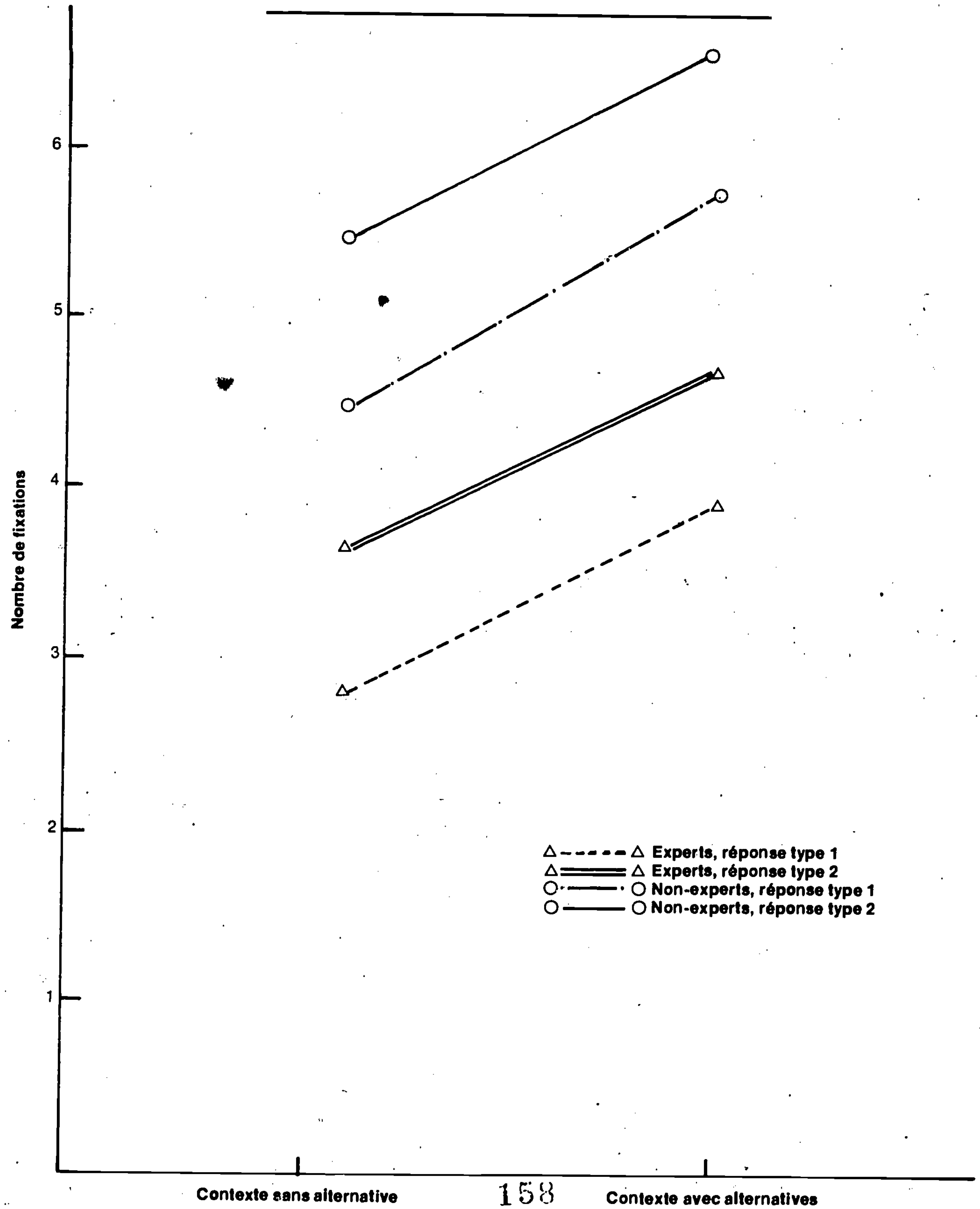
Figure 4 - Nombre de fixations en fonction du type de solution, du niveau d'expérience et du contexte.



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EXPÉRIENCE III

Sachant que la répartition des fixations reflète la structure spécialisée des mécanismes d'analyse centraux face à une tâche donnée (JUST et CARPENTER, 1975), nous avons décidé de poursuivre notre étude avec l'analyse de la localisation des fixations en regard du niveau d'expérience des sujets et du type de solution possible.

Seules les données du contexte sans alternative (CSA) de l'expérience II ont été utilisées.

Pour la bonne compréhension des résultats, nous allons dans le tableau IV illustrer la signification de la codification numérique des éléments.

Tableau IV - Signification de la codification numérique des éléments.

1	2	3	4	5	6	7	8	9	10	11	12
PORTEUR DE BALLE	ARRIÈRE GAUCHE DÉF.	AILIER GAUCHE	AILIER GAUCHE DÉF.	CENTRE	CENTRE DÉF.	AILIER DROIT	AILIER DROIT DÉF.	ARRIÈRE DROIT	ARRIÈRE DROIT DÉF.	PANIER	ESPACE VIDE *

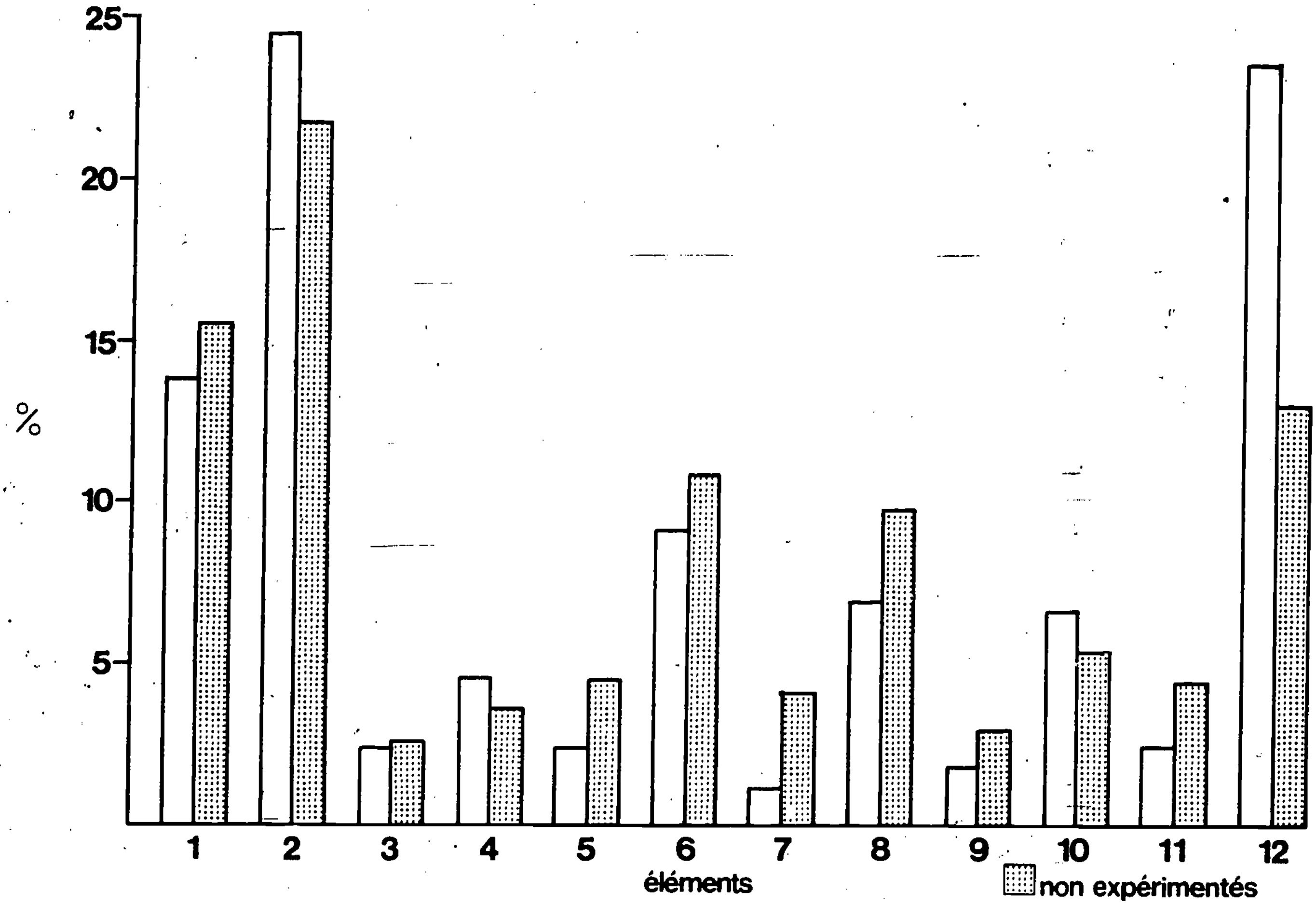
* Espace pertinent comprenant soit :
— l'espace entre le porteur de balle et le panier (solution de type I) ;
— l'espace entre le joueur démarqué et le panier (solution de type II).

Résultats

La distribution pondérée des fixations selon le niveau d'expérience des sujets apparaît dans le tableau V et la figure 5.

On relève, en général, peu de différence entre experts et non-experts.

Figure 5 - Distribution des fixations (en%) en fonction de chaque élément selon le niveau d'expérience



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Il faut noter cependant la densité double de l'élément 12 (espace vide pertinent) pour le groupe expérimenté en comparaison du groupe non-expérimenté (23.6 et 12.9% respectivement).

Tableau V - Distribution des fixations (en %) en fonction de chaque élément selon le niveau d'expérience.

	Fixations											
	1	2	3	4	5	6	7	8	9	10	11	12
Experts	13.32	24.11	2.38	4.59	2.38	9.04	1.12	7.01	1.96	7.85	2.59	23.62
Non-experts	15.23	21.58	3.55	3.60	4.48	10.75	4.08	9.69	3.02	6.44	4.66	12.92

Chi deux: 245.130 degrés de liberté 11 significatif à .001

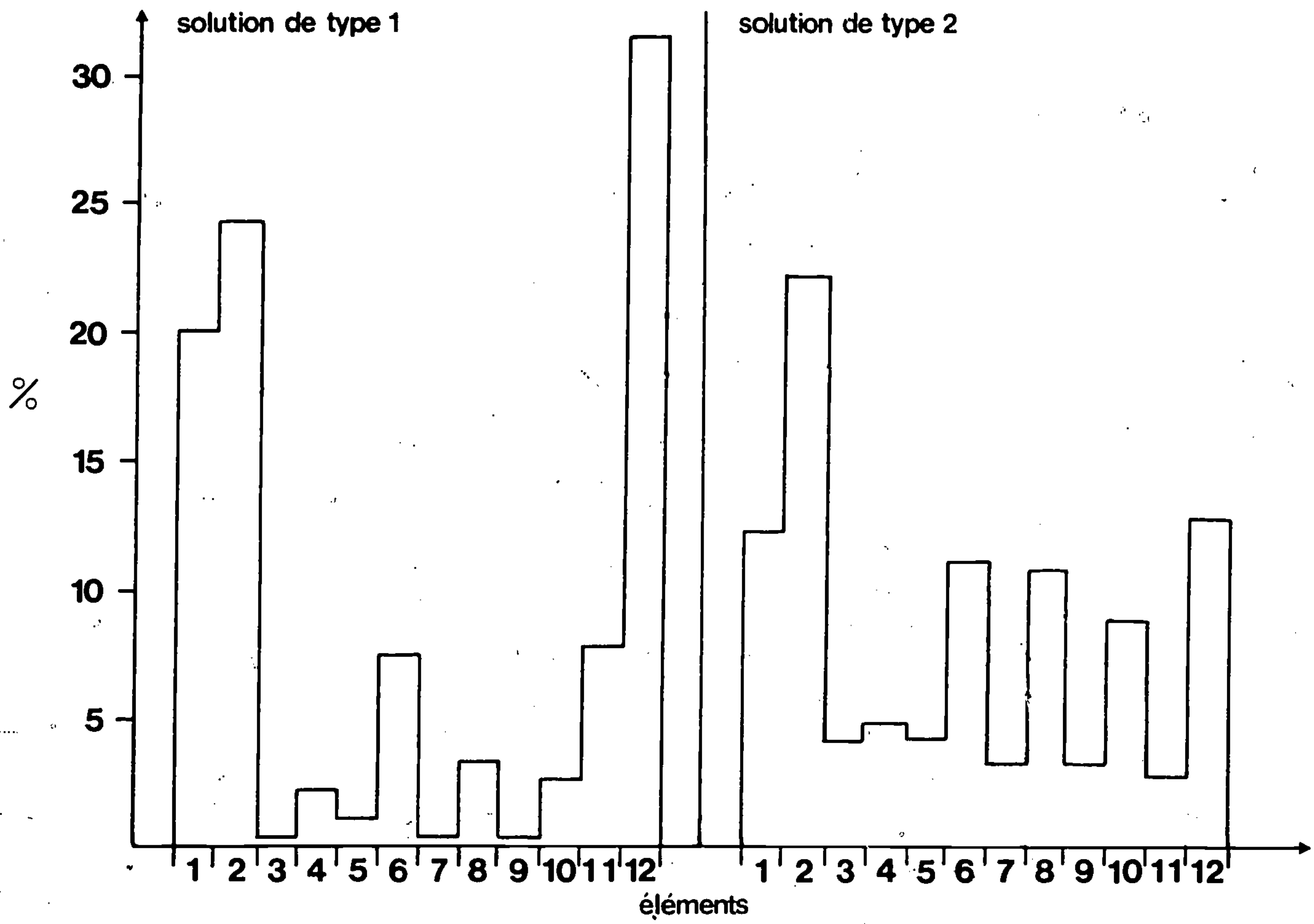
Le tableau VI et la figure 6 présentent la distribution pondérée des fixations selon le type de solution contenue dans la présentation.

Tableau VI - Distribution des fixations (en %) en fonction de chaque élément selon le type de solution.

	Fixations											
	1	2	3	4	5	6	7	8	9	10	11	12
Solution[1] de Type I	19.97	24.07	0.22	2.31	1.07	7.31	0.73	2.70	0.45	2.59	7.26	31.33
Solution[2] de Type II	12.37	22.16	4.08	4.66	4.49	11.01	3.57	10.68	3.34	8.68	2.49	12.47

1. Chi deux: 122.834 degrés de liberté 11 significatif à .001.
2. Chi deux: 209.978 degrés de liberté 11 significatif à .001.

Figure 6 - Distribution des fixations (en %) en fonction de chaque élément selon le type de solution.



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On peut voir que le type de solution affecte le patron de prospection visuelle des sujets. Dans une solution de type 1, trois (3) éléments sont privilégiés (1,2 et 12). Dans une solution de type 2, six (6) éléments sont privilégiés (1, 2, 6, 8, 10 et 12).

Discussion

Nos résultats, en général, ont souligné les différences existant entre les experts/non-experts en regard des temps de décision et du nombre de fixations. Ceci vient appuyer les études récentes de SCHOONARD *et al.*, (1973) et de MOURANT et ROCKWELL (1972).

Cependant, il ne semble pas y avoir de différence importante dans le patron de fixations. La différence semble donc quantitative et qualitative plutôt que structurale. La seule caractéristique spécifique que nous pouvons relever est la densité différente que l'on retrouve pour l'élément 12.

Peut-être pourrions-nous rapprocher ce fait du phénomène que KUNDELL (1974) appelle « la priorité donnée par le sujet à un élément, en regard de l'exploitation qu'il peut en faire ». Il est en effet plus difficile au non-expert d'exploiter efficacement cette zone libre, comme le pourrait l'expert, pour qui cet espace devient source de solution.

Figure 7 - Distribution des fixations (en %) pour les réponses « dribble » en fonction de chaque élément, selon le niveau d'expérience.

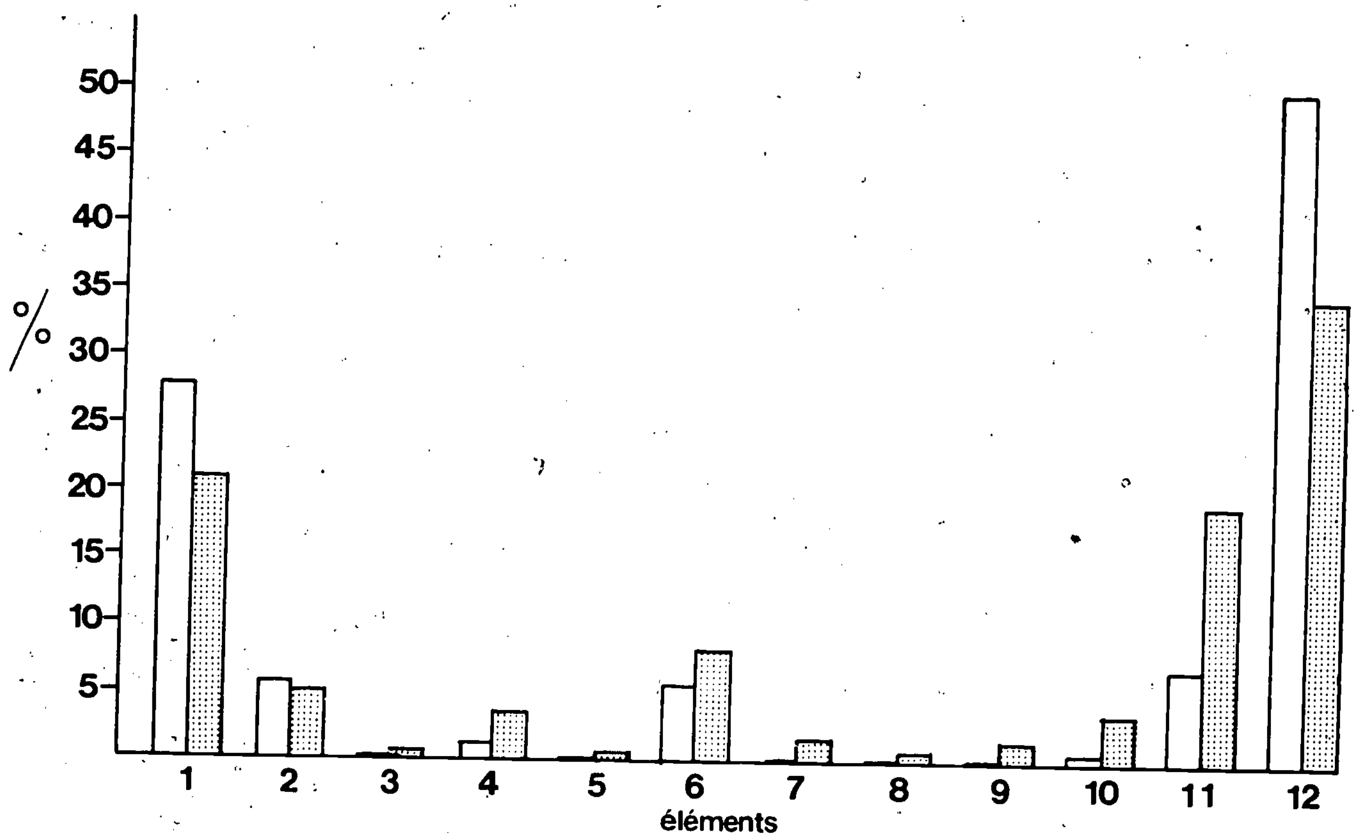

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Figure 8 - Distribution des fixations (en %) pour les réponses «lance», en fonction de chaque élément, selon le niveau d'expérience.

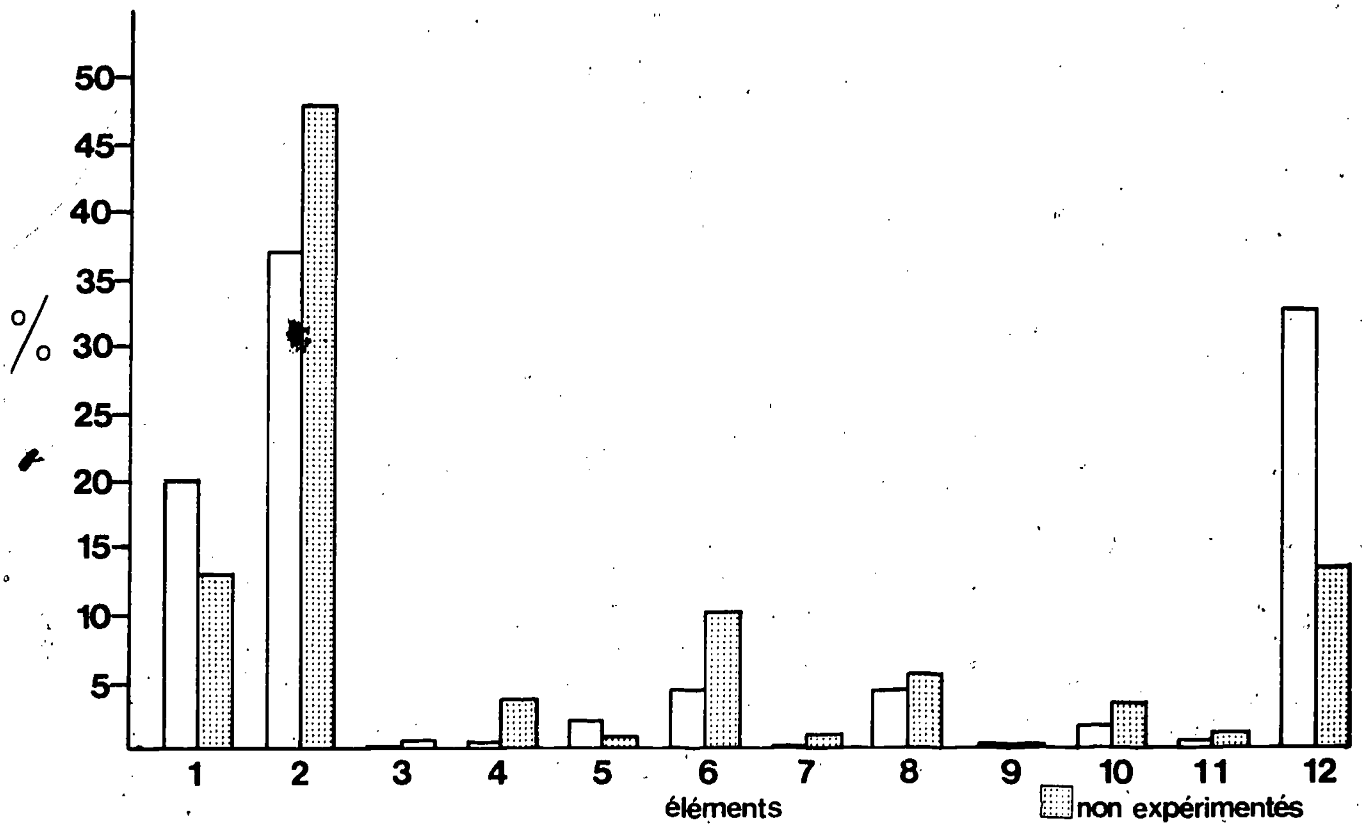

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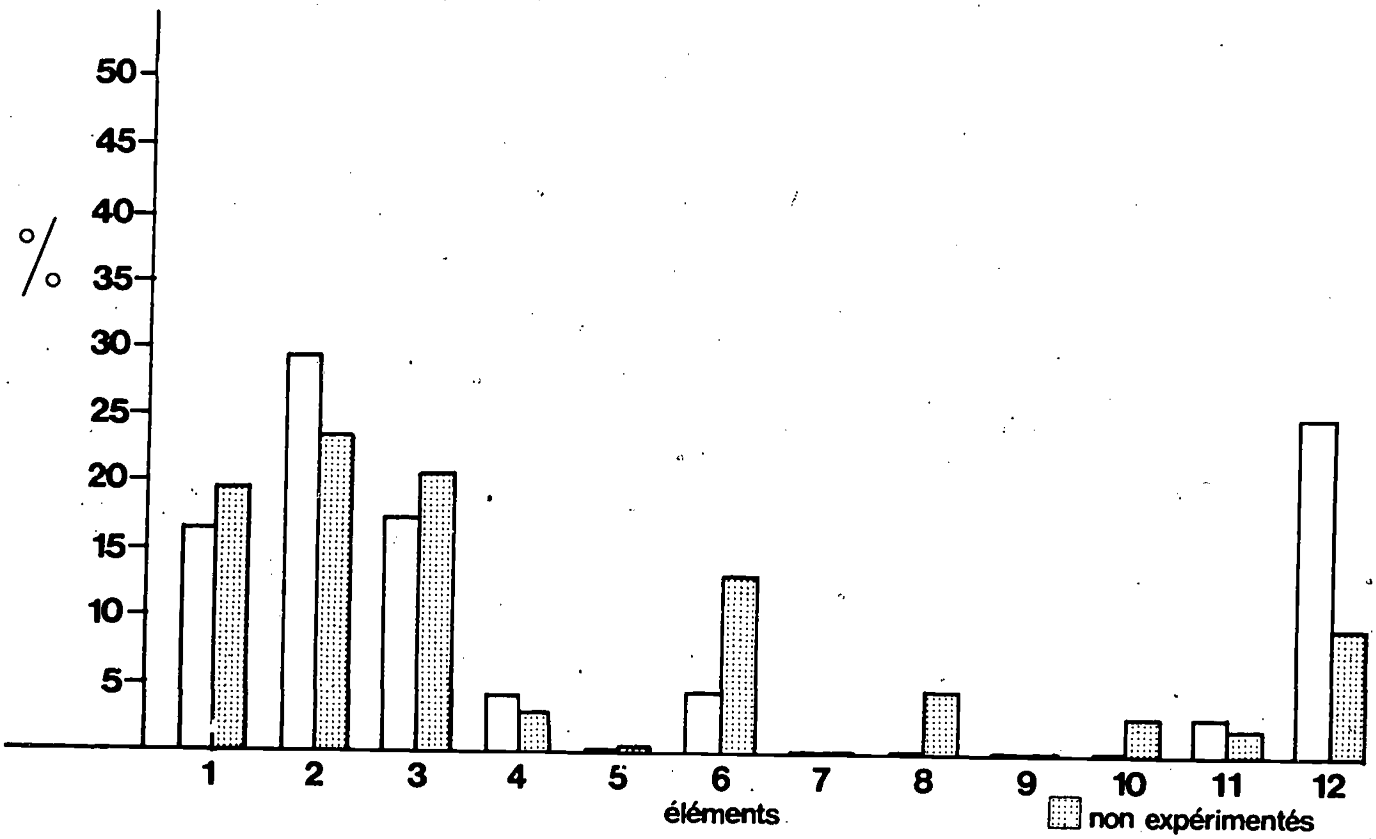
Figure 9 - Distribution des fixations (en %) pour les réponses « passe à l'ailier gauche » en fonction de chaque élément, selon le niveau d'expérience.



Les figures 7, 8 et 9 illustrent bien l'uniformité structurale que nous mentionnons. On ne peut relever aucun élément significatif oublié par un groupe et privilégié par l'autre. Mais, un fait est certain, si dans le patron de recherche du non-expert existe déjà cette tendance à favoriser l'élément douze (12), il nous faut l'exploiter au maximum, plutôt que d'espérer créer des éléments prioritaires nouveaux, que nous ne retrouvons nullement chez l'expert. La familiarité avec les caractéristiques de l'objet de la prospection peut devenir une nécessité pour l'utilisation efficace des mécanismes de prospection, déjà existants, que le sujet a développés. (KUNDELL, 1972). Si cela est vrai, l'exposé clair et précis de ce qui peut être utile dans l'amélioration des patrons de prospection serait beaucoup plus rentable qu'un entraînement spécifique et séquentiel à la prospection.

On pourrait cependant tenter d'accélérer le schème de prospection du non-expert par la réduction maximale de la redondance que nous y détectons.

Une double constatation ressort de l'utilisation de différents types de solution. D'une part, les solutions impliquant le joueur seul amènent une plus grande rapidité de décision et un nombre moins important de fixations, pour les experts comme pour les non-experts. Ceci vient supporter les résultats mis en évidence par BARD et CARRIÈRE en 1975. D'autre part, les sujets semblent privilégier les solutions de premier ordre.

Il appert de l'expérience I (tableau VII) que les sujets privilégient certaines solutions lorsqu'ils sont placés devant un choix (72 vs 28% et 75 vs 25% en faveur des solutions de type 1).

Cette priorité donnée à une solution vient à l'encontre du postulat de l'indépendance entre les alternatives. Comme MORRISON et SLOVIC (1962), nous affirmons que le sujet pondère les indices, faisant varier sa décision, sous l'influence de différents facteurs.

Tableau VII – Distribution des types de solution choisis par les sujets selon les niveaux de complexité.

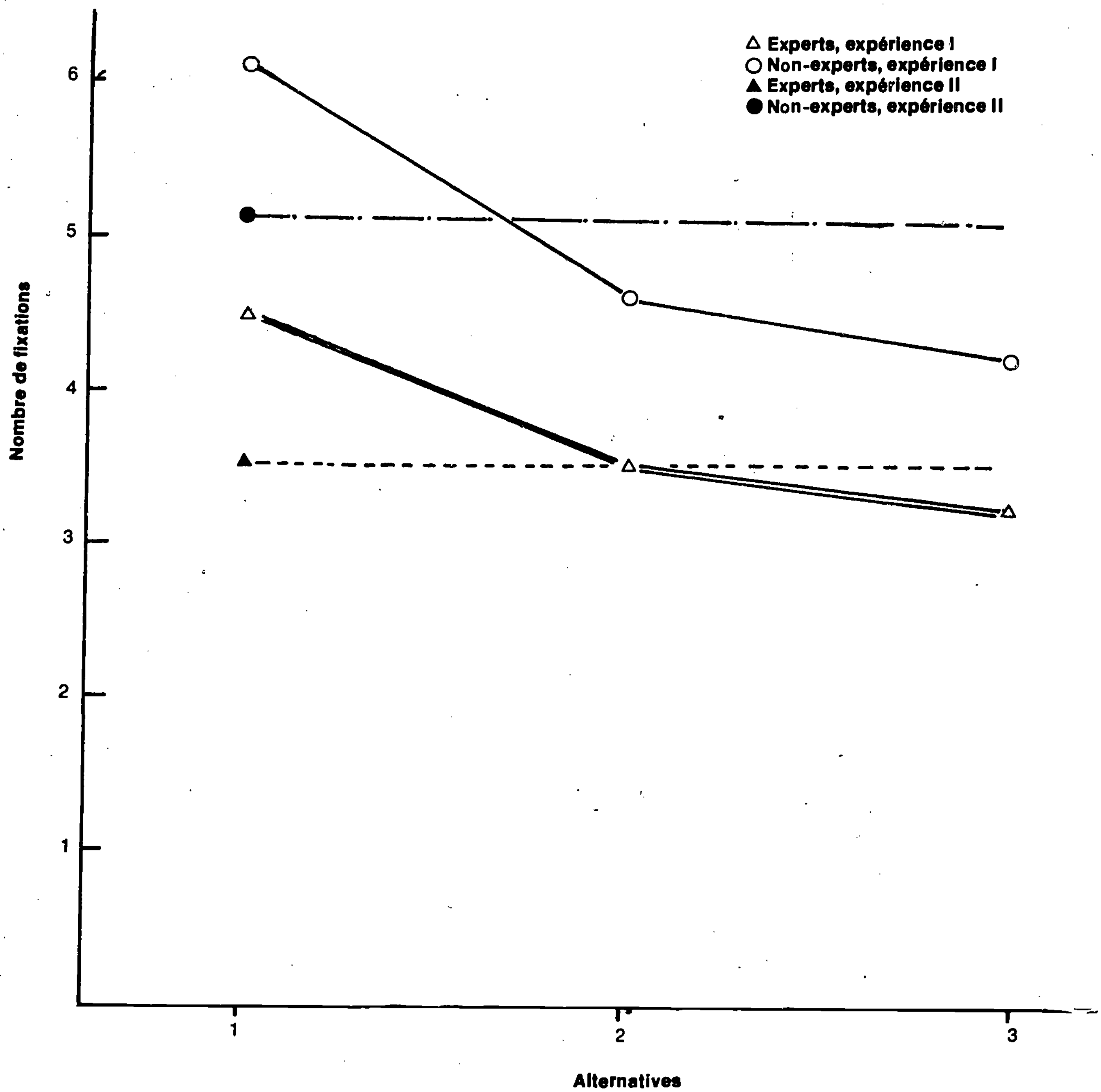
		Solutions	
		Type 1	**Type 2**
Complexité	2	72%	28%
	3	75%	25%

Nous ne pouvons encore, face à ce phénomène, préciser les influences. Cependant trois (3) facteurs pourraient se partager l'effet de prédilection pour le premier ordre de solution :

- *l'économie*, le besoin réduit d'indices pour la solution de premier ordre;
- *l'auto-considération*, le besoin d'exploiter d'abord sa propre habileté;
- *la simplicité de relation*, le lien direct, existant entre le sujet et l'objectif visé, prendrait le pas sur la création d'un lien indirect. (BERNARD, 1962).

Pour ce qui est du contexte, (figure 10) l'expérience II fait ressortir clairement que tous les sujets sont plus rapides dans leur décision et ont moins de fixations lorsque le contexte ne présente pas d'alternative (CSA), comparativement aux mêmes situations (donc même diapositives) présentées dans un contexte avec alternatives (CAA).

Figure 10 – Nombre de fixations chez les experts et les non-experts dans expériences I et II.



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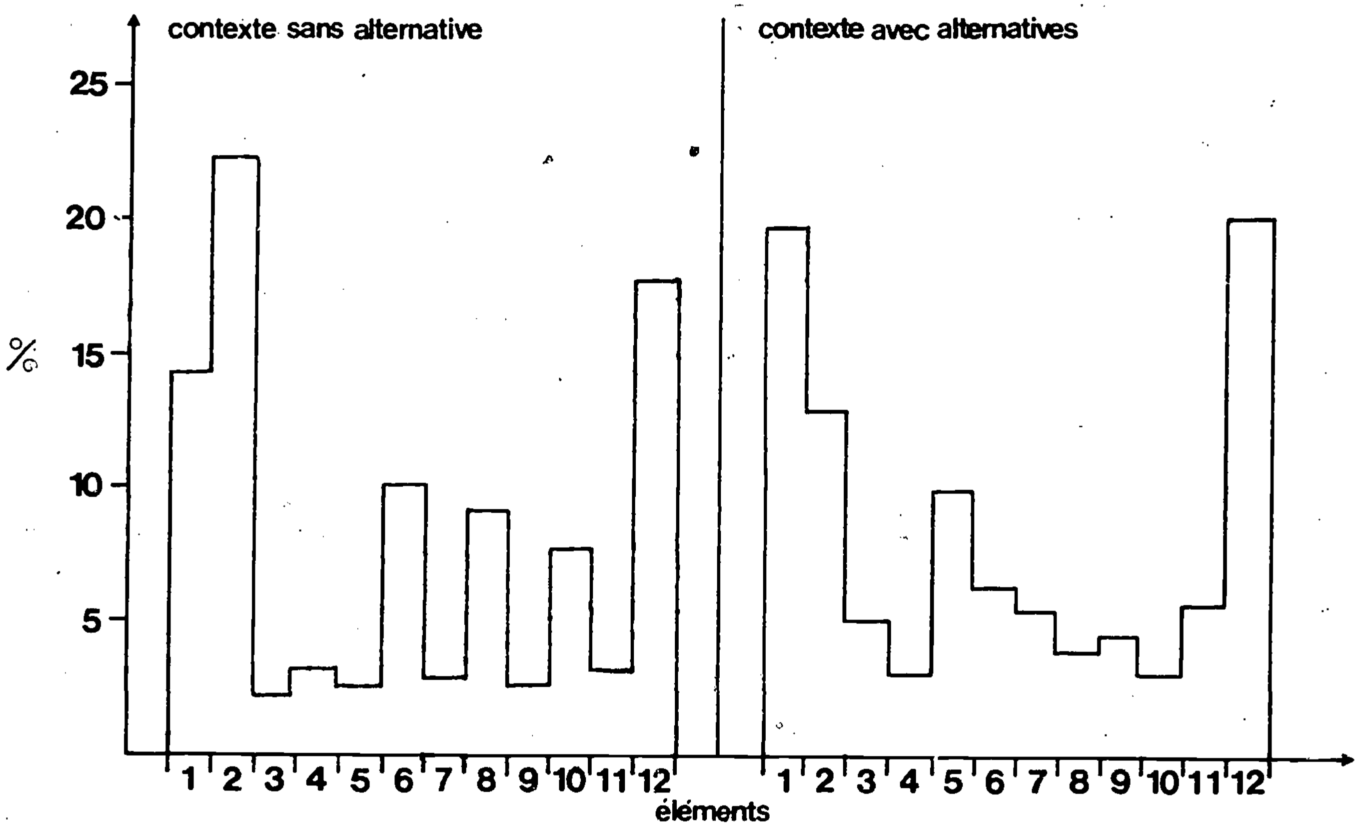
Si nous admettions que notre étude est similaire aux études sur des temps de réaction à choix multiple, nous pouvions aisément prévoir, à cause de la différence dans la probabilité d'apparition des stimuli, des temps de décision plus longs dans un contexte impliquant une ou des alternatives. (TEICHNER, 1974; LAMB et KAUFMAN, 1965). Toutefois, il nous semblait important, dans le cadre de notre étude, de ne pas assimiler totalement nos expériences à des expériences de temps de réaction à choix multiple et de voir comment, en prospection visuelle, le nombre des fixations était affecté par le contexte.

Comme l'analyse du nombre des fixations révèle des différences parallèles à celles obtenues pour les temps de décision, nous devons conclure avec PRUITT (1961) que le sujet, faisant une mauvaise prédiction avant la présentation, aura besoin de beaucoup plus d'informations que le niveau optimal habituel le laissait supposer. L'uniformité caractérisant la distribution des fixations dans un contexte avec alternative (figure 11) tranche avec la sélectivité caractéristique du contexte sans alternative, exception faite des éléments 1 et 12, toujours privilégiés.

Figure 11 – Distribution des fixations (en %) en fonction de chaque élément selon le contexte.



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Notre apport à la problématique du caractère exhaustif ou terminal du processus cognitif va du côté de l'aspect terminal du processus. Notre travail fait ressortir que, même si le sujet fait face à une ou plusieurs alternatives, il s'en tient à la solution qu'il a trouvée, sans prolonger sa recherche au-delà. L'amélioration de sa performance pour les niveaux de complexité 2 et 3 n'étant due qu'à la disponibilité d'un nombre plus important d'informations pertinentes.

Comparativement au contexte sans alternative, le nombre de fixations du non-expert, lorsqu'il est en présence d'alternatives, est moindre. Il semble donc que l'alternative représente pour le non-expert une situation beaucoup moins stressante, parce que plus riche en informations. Pour l'expert, l'alternative n'apporte pas d'avantage, puisque de toute façon il va directement à l'information pertinente et n'utilise pas toute l'information disponible.

Conclusions

1. Tous les sujets (experts et profanes) sont sélectifs dans leur prise d'information.
2. Les experts sont plus rapides, parce que moins redondants.
3. Les solutions de type 1 (impliquant le joueur seul) sont privilégiées pour tous les sujets.
4. L'alternative favorise la prise d'information.
5. La seule différence structurale du patron de prospection visuelle expert/non-expert réside dans l'utilisation accrue de l'espace vide comme indice significatif dans la prise de décision.

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DE L'INFLOW À L'OUTFLOW LORS DE LA REPRODUCTION D'UN MOUVEMENT D'ADDUCTION HORIZONTALE DU BRAS *

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ÉNONCÉ DU PROBLÈME

La présente étude se situait dans le cadre d'un programme de recherche sur la kinesthésie, vue comme un des systèmes dont dispose l'opérateur humain pour fournir un rendement optimal. Notre modèle de ce système kinesthésique ainsi que les postulats en découlant (NADEAU, 1975) vont nettement dans la ligne de l'outflow ou du guidage central de l'efférence (GCE) tel qu'exprimé récemment par JONES (1974a, 1974b). Bref, nous présupposons une voie unidirectionnelle mécanismes idéo-moteurs → déplacement(s) segmentaire(s) au sein de ce système.

La séquence mouvement-critère (passif ou actif) → reproduction (passive ou active) nous est apparue une technique valide pour amorcer une vérification de ce modèle au niveau comportemental. Pour le moment, il s'agissait d'obtenir un patron de la performance du système à travers les conditions de mouvement suivantes: stimulation passive → reproduction passive (SR-RP), stimulation passive → reproduction active (SP-RA), stimulation active avec butée → reproduction active (SA_B-RA), autostimulation → reproduction active (A-RA).

À notre connaissance, deux études ont déjà fourni de l'information sur le comportement du système kinesthésique à travers les conditions SP-RA, SA_B-RA, A-RA (JONES, 1972, 1974a). Les résultats de celles-ci ont montré une similitude entre SP-RA et SA_B-RA ainsi qu'une nette supériorité en A-RA (erreur absolue en 1972, erreur variable en 1974a). À la suite d'autres manipulations de l'intervalle de rétention (vide ou avec tâche intercalée) et du feedback proprioceptif (surcharge musculaire), JONES (1974a) concluait que le GCE pouvait être une condition nécessaire et suffisante pour des opérations de *rehearsal* au sein de la mémoire motrice à court terme (MMCT). Même si nous considérons la MMCT uniquement comme une des composantes du système kinesthésique, la notion du GCE demeure très pertinente à notre modèle.

Dans la ligne d'un modèle outflow, il ne faut pas omettre de citer l'expérience de TAUB et BERMAN (1968). Au moyen de la destruction progressive de l'afférence spinale chez le macaque, ces chercheurs démontrèrent clairement que le contrôle et l'apprentissage de plusieurs comportements moteurs (réponse d'évitement au moyen de l'avant-bras, marche quadrupédique, obtention de nourriture par la pression d'un levier, grimper, etc.) existaient en l'absence de feedback périphérique. Ils ont eux-mêmes avancé l'idée d'un contrôle central de l'efférence, soit par un programme moteur central, soit par un système hiérarchisé de feedback purement central (TAUB et BERMAN, 1968, pp. 188-190).

PAILLARD et BROUCHON (1968) ont étudié l'estimation intersegmentaire (mouvement-critère avec le bras gauche et reproduction avec le bras droit) tout en distinguant la phase dynamique (mouvement comme tel) de la phase de maintien de la position finale d'un mouvement. Leurs résultats (expérience 1) montrèrent:

a) aucune différence significative entre le maintien passif et le maintien actif de la position finale tant au plan de la précision (médiane des erreurs constantes) que de la variabilité (écart quartile);

b) une supériorité nettement significative du mouvement actif sur le mouvement passif, ceci en regard de la précision (médiane des erreurs constantes) et de la variabilité (écart quartile).

Ils conclurent tout d'abord qu'une information kinesthésique pertinente pouvait être tirée du mouvement actif. Par la suite, après avoir examiné leurs résultats à la lumière de données neurophysiologiques (récepteurs de la capsule articulaire, récepteurs cutanés, récepteurs tendineux, faisceaux neuromusculaires, outflow moteur), ils considéraient que la supériorité du mouvement actif pouvait s'expliquer tout aussi bien par une intervention périphérique axée sur l'activité motrice fusoriale (information sur l'accélération et décélération d'un mouvement) que par une intervention centrale axée sur l'outflow moteur (GCE).

MOUNTCASTLE et POWELL (1959) démontrèrent l'importance des récepteurs de la capsule articulaire dans le repérage des mouvements passifs chez le macaque. Il s'agirait de récepteurs positionnels assimilables à des détecteurs d'angles absolus. Selon ces travaux électrophysiologiques, cette information périphérique sur la position d'un segment corporel se rendrait au cortex par les voies suivantes: capsule articulaire et ligaments → faisceau cunéatus → noyau cunéatus → faisceau lemniscal médian → noyau VP du thalamus → gyrus postcentral.

En fonction du type de mouvement, COULTER (1974) a enregistré des modifications des potentiels évoqués lemniscaux chez le chat. Lors du mouvement passif, aucun changement significatif d'amplitude des potentiels ne fut noté. Par contre, lors du mouvement actif, une diminution nettement significative de l'amplitude des potentiels évoqués fut enregistrée. De plus, on enregistra une diminution significative et progressive de l'amplitude des potentiels évoqués avant qu'un mouvement actif soit initié, celle-ci pouvant débuter jusqu'à 150 msec. avant l'initiation du mouvement. Selon COULTER (1974), ces résultats, à la suite de plusieurs autres, suggéraient l'idée d'une modulation centrale de l'afférence périphérique (au niveau des noyaux de la colonne dorsale) parallèle au mouvement actif et d'une action conjointe de ce mécanisme et des mécanismes contrôlant l'état d'attention.

En somme, les conditions de mouvement influencent le système kinesthésique, de telle sorte qu'il devient possible d'obtenir de l'information sur son fonctionnement à travers

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les caractéristiques des conditions qui entraînent un meilleur rendement. Dans la ligne des travaux de JONES (1972, 1974a), nous désirions savoir si le système kinesthésique se comportait de manière similaire chez cinq petits échantillons de sujets à prime abord différents (adultes normaux, enfants normaux, enfants aveugles, enfants sourds, enfants déficients mentaux légers), ceci à travers quatre conditions de mouvement. Nous nous attendions à retrouver une tendance commune caractérisée par une amélioration de la performance de SP-RP à A-RA.

MÉTHODE

Appareil

Nous avons utilisé le KINADEL comme instrument principal (voir NADEAU et LORTIE (1974) pour une description détaillée). Ce kinesthésiomètre se trouvait à l'intérieur d'une petite chambre noire de 8 pi. × 8 pi. × 8 pi. (figure 1). Le sujet prenait place sur le siège et son bras droit était placé sur le levier. On ajustait la hauteur du siège de manière à obtenir un angle droit entre le tronc et le bras du sujet. De manière à fixer la tête du sujet, nous exigions de ce dernier qu'il place ses yeux dans la lunette d'un tachitoscope suspendu utilisé dans d'autres expériences pour la présentation de stimuli visuels (figure 1). Le système du levier étant muni de plusieurs roulements à billes, le sujet pouvait dans cette position exécuter aisément un mouvement d'adduction horizontale du bras. Le sujet ayant son bras fixé par le poignet et près de l'épaule, laissait celui-ci reposer de tout son poids sur le levier. Pour assurer une liberté totale au cours des mouvements, le levier possédait une articulation sur roulements à billes à son extrémité proximale, et une autre du même type à son extrémité distale (figure 2).

Figure 1 - Vue d'ensemble du kinesthésiomètre et de la position du sujet.

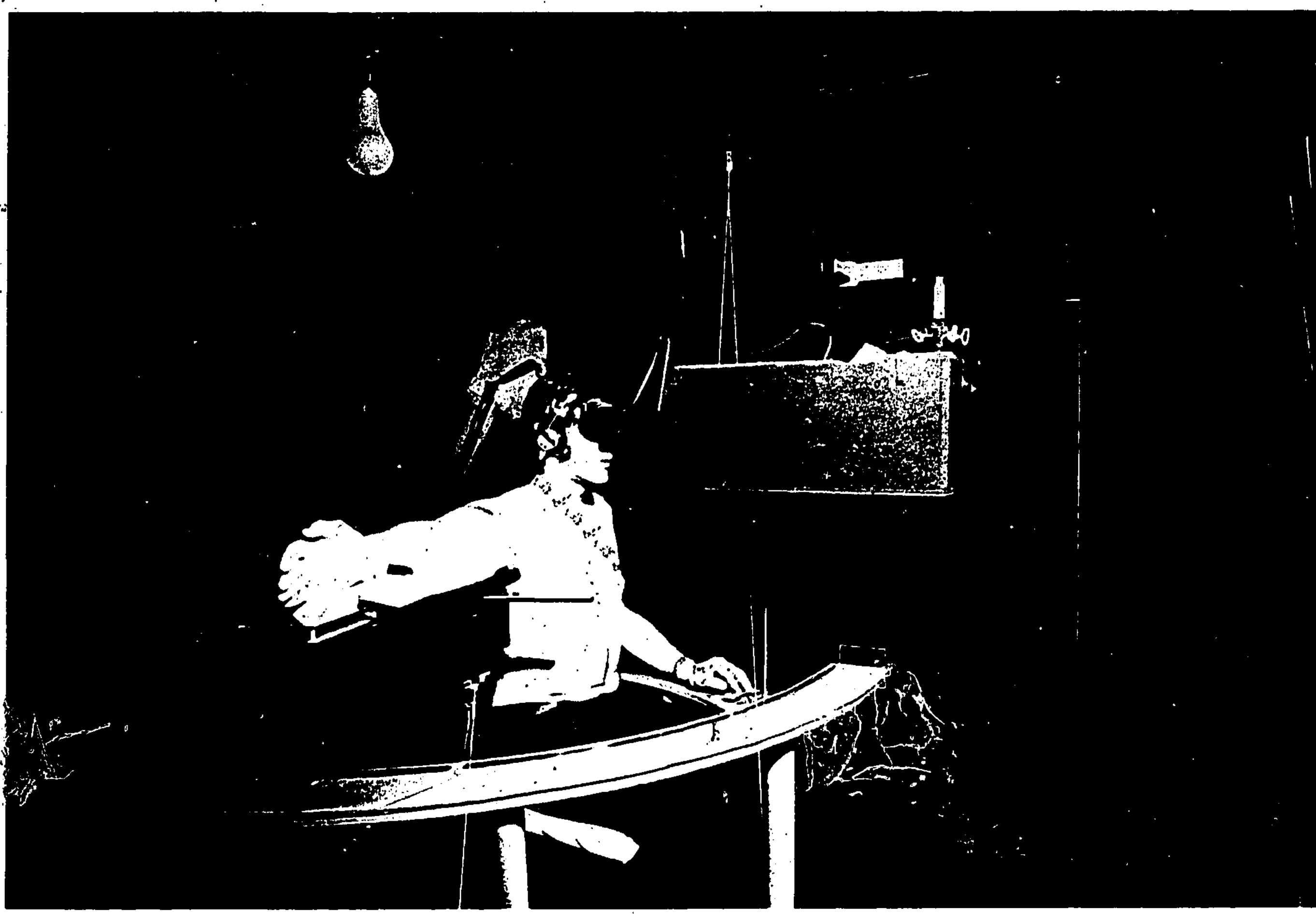

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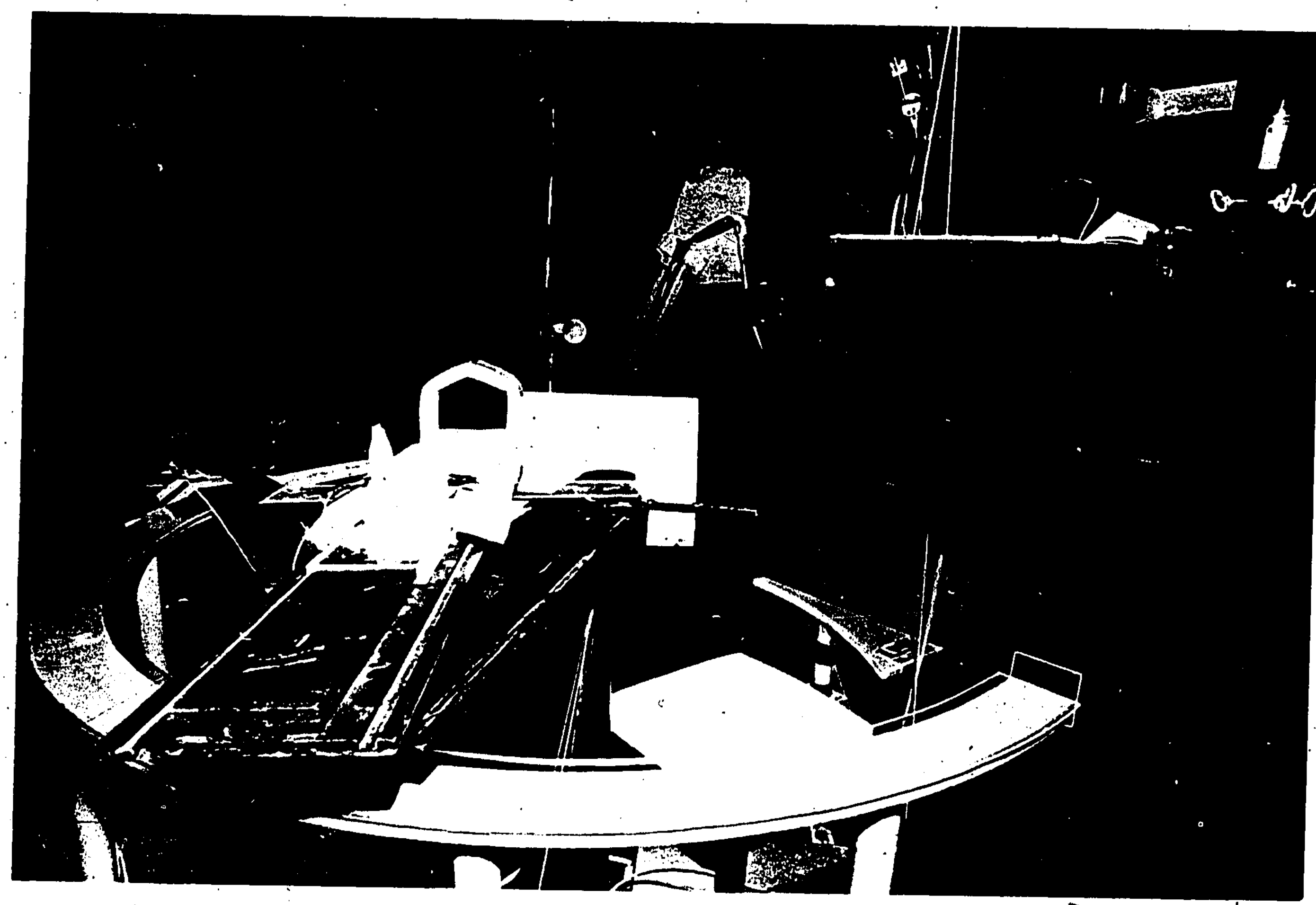
Figure 2 - Vue des articulations proximale et distale au niveau du levier du kinesthésiomètre.



L'extrémité distale du levier se déplaçait sur un arc de cercle de 34½ po. de rayon. Le levier était réuni par un long excentrique à un petit chariot sur une rampe horizontale à l'extérieur de la chambre noire (figure 3). Au moyen de ce chariot, l'expérimentateur pouvait exécuter les adductions et abductions passives, déterminer les positions-critères et les positions de départ des reproductions en insérant une ou deux butées dans la rampe horizontale. Le sujet portant une paire d'écouteurs, l'expérimentateur pouvait communiquer avec lui de l'extérieur de la chambre.

Un potentiomètre linéaire se trouvait au niveau de l'axe de rotation du levier et était relié à un voltmètre digital HP 2401C et à une imprimante HP H007-5050A (figure 4). Les positions-critères, les positions de départ des reproductions ainsi que les positions atteintes par le sujet se lisaient au centième de volt près, pour être ensuite transformées en degrés (1cV = .298°).

Figure 3 - Vue d'ensemble du stimulateur du kinesthésiomètre.

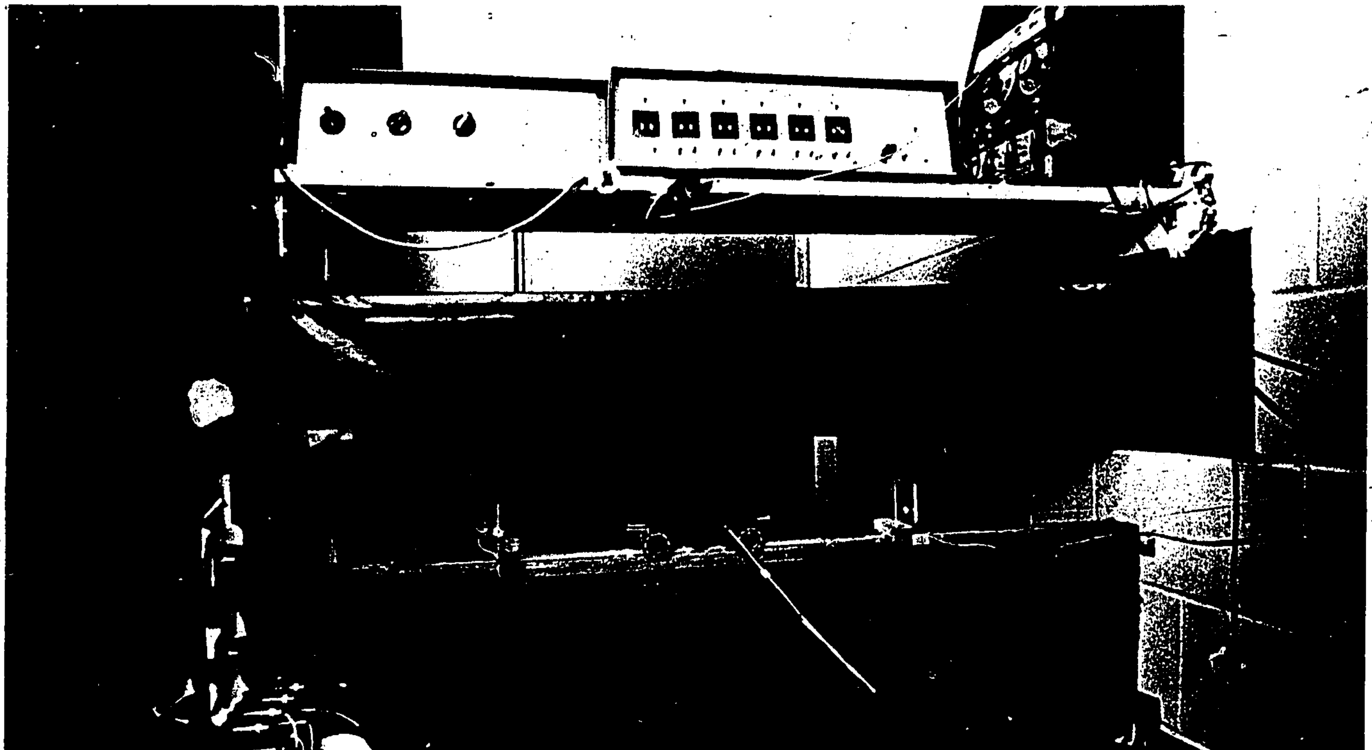


Figure 4 - Vue du voltmètre et de l'imprimante utilisés pour cette étude.

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Plan de l'expérience

Nous avons choisi un plan factoriel avec blocs aléatoires (KIRK, 1968, pp. 131-150, 237-243), effets fixes et mesures répétées sur tous les facteurs. Chaque sujet constituait un bloc. Trois facteurs ou variables indépendantes furent manipulés : les conditions de mouvement à quatre niveaux (stimulation passive → reproduction passive (SP-RP), stimulation passive → reproduction active (SP-RA), stimulation active avec butée → reproduction active (SAB-RA), autostimulation → reproduction active (A-RA)) ; les positions de départ de la reproduction à trois niveaux (5° derrière le départ du mouvement-critère, 2° devant le départ du mouvement-critère, 5° devant le départ du mouvement-critère) ; les séances de testing à cinq niveaux (5 séances séparées l'une de l'autre par un intervalle de sept jours).

En ce qui a trait aux variables dépendantes, nous avons fait appel à l'erreur constante ou algébrique ainsi qu'à l'erreur variable (SCHUTZ et ROY, 1973). Pour nous, l'erreur constante se rapporte à la précision du système kinesthésique tandis que l'erreur variable nous renseigne sur la justesse ou fiabilité de ce système. Dans cette perspective, l'analyse des résultats pour le facteur **conditions de mouvement** se fera à partir de l'erreur variable ; l'analyse des résultats pour le facteur **positions de départ de la reproduction** se fera en regard de l'erreur constante.

Au plan des techniques statistiques utilisées, nous suivions la démarche appropriée à notre plan d'expérience (KIRK, 1968, pp. 131-150, 237-243 ; LANA et LUBIN, 1963) :

a) test de non-additivité de Tukey pour savoir s'il y avait une interaction blocs × traitements ;

b) analyse de la variance avec le calcul des rapports F conventionnels et conservateurs ;

c) T^2 de Hotelling dans le cas d'une discordance entre le F conventionnel et le F conservateur.

Procédure

Les sujets participèrent à six séances de testing séparées l'une de l'autre par un intervalle de sept jours et d'une durée maximum d'une heure quinze minutes. La première séance en était une de familiarisation. Les cinq séances suivantes permirent d'obtenir un nombre satisfaisant de données sur les éléments étudiés.

Au début de chaque séance, le sujet devait se dévêtir jusqu'à la taille. On procédait ensuite à l'ajustement de la hauteur du siège de manière à obtenir un angle droit entre le tronc et le bras droit du sujet. Le sujet recevait comme instructions de reproduire le plus exactement possible la position finale (*location*) du mouvement-critère, et ceci lui était rappelé avant chaque bloc d'essais.

Pour les conditions SP-RP, SP-RA et SAB-RA, le mouvement-critère consistait en une adduction horizontale de 50 degrés exécutée à une vitesse voisine de 50°/sec. Pour la condition A-RA, chaque sujet s'entraîna au cours de la séance de familiarisation afin de réaliser une adduction horizontale de 50° (± 10°) à une vitesse voisine de 50°/sec. Les tableaux XI et XII fournissent les distances parcourues par chaque sujet lors de l'autostimulation dans la condition A-RA. Il fut difficile pour les sujets de respecter à la fois le 50° et la vitesse (ils déplaçaient leur bras à une vitesse voisine de 100°/sec.). Si nous attribuons une valeur de 0° à la position atteinte par le sujet lors d'une abduction horizontale maximale, sans rotation du tronc, nous pouvons dire que le mouvement-critère correspondait approximativement à un déplacement articulaire de la position 40° à 90° dans les conditions SP-RP, SP-RA, SAB-RA, et de la position 40° à ?° dans la condition A-RA.

L'expérimentateur qui manipulait le stimulateur avait reçu un entraînement préalable lui permettant :

a) de réaliser une adduction passive de 50° à une vitesse très voisine de 50°/sec. ;

b) de réaliser une abduction passive en un temps approximatif de 3 sec., ceci malgré la variation de la position finale lors des différents essais dans la condition A-RA.

À l'intérieur de chaque séance, les niveaux du facteur **conditions de mouvement** étaient répartis au hasard quant à leur ordre de présentation. Chaque niveau formait un bloc de dix-huit essais. À l'intérieur de chaque bloc de dix-huit essais, les trois niveaux du facteur **positions de départ de la reproduction** étaient présentés au hasard et un nombre égal de fois. À la fin de chaque bloc d'essais, le sujet bénéficiait d'une période de repos de deux à trois minutes. En somme, un sujet faisait 72 essais par séance, pour finalement atteindre 360 essais pour l'ensemble de l'expérience.

La procédure d'un essai comprenait les moments suivants :

a) présentation du mouvement-critère (adduction passive, adduction active avec butée, adduction active sans butée) ;

b) marquage de la position finale du mouvement-critère pendant 3 sec. ;

c) abduction passive réalisée en un temps approximatif de trois secondes ;

d) reproduction du mouvement-critère (passive ou active).

Dès que le sujet réalisait que son bras avait atteint la position de départ de la reproduction, il devait immédiatement initier sa reproduction. De plus, le sujet recevait comme consigne de ne pas porter attention à l'abduction passive. Les expérimentateurs n'ont jamais mentionné aux sujets les changements de la position de départ de la reproduction ainsi que le maintien d'un mouvement-critère de 50°. Au cours de l'entraînement A-RA lors de la séance de familiarisation, l'expérimentateur se limitait à signaler au sujet que la longueur et la vitesse de l'adduction horizontale convenaient aux exigences de l'expérience.

Lors de la reproduction passive dans la condition SP-RP, le sujet relâchait le bouton sur l'accoudoir du kinesthésiomètre lorsqu'il croyait que son bras passait à la position finale du mouvement-critère. Cette opération avait pour effet d'arrêter instantanément l'horloge digitale du voltmètre et ainsi éliminer la participation de l'expérimentateur. Dans la condition SAB-RA, deux ressorts avaient été accrochés au petit chariot du stimulateur de manière à éviter un contact trop violent contre la butée qui marquait la position finale du mouvement-critère. Pour éviter que le sujet déploie plus de force pour tendre les ressorts, l'expérimentateur accompagnait l'adduction active et ainsi se chargeait de pousser le chariot contre la butée.

Sujets

La réalisation complète de la présente étude suppose la participation des petits échantillons suivants : six adultes normaux, six enfants normaux (11 à 13 ans), six enfants demi-aveugles (11 à 13 ans), six enfants sourds (11 à 13 ans) et six enfants déficients mentaux légers (11 à 13 ans). La présence d'enfants plutôt que d'adultes dans le cas des échantillons spéciaux repose sur des raisons pratiques. Bref, le présent rapport concerne les résultats obtenus avec les six adultes normaux et les six enfants demi-aveugles, le testing n'étant pas encore complété au sein des autres échantillons.

Dans le cas des adultes normaux, il s'agissait d'étudiants sous-gradués volontaires, droitiers manuels et ne présentant aucun handicap physique apparent. Chaque sujet reçut $20 pour sa participation aux six séances de testing.

Dans le cas des enfants demi-aveugles, il s'agissait d'écoliers d'une institution spécialisée avec laquelle il fut possible de conclure une entente. Ils étaient tous droitiers manuels et ne présentaient pas de handicap physique apparent. Sans être rémunérés, ils bénéficiaient tout de même d'un avant-midi de congé par semaine pour la durée de l'expérience. Tous étudiaient en braille et peuvent être considérés comme aveugles quant à la vue de leurs segments corporels. De manière à sonder un peu leur motivation, ils subirent à l'école l'épreuve de Fraisse (FRAISSE, 1963, pp. 103-104), épreuve qui fut d'ailleurs appliquée à plusieurs enfants de la même institution. Les résultats de cette épreuve ne servirent que secondairement à la sélection de ces sujets; l'âge et la prévalence manuelle représentaient les premiers critères. Pour être complets, nous avons aussi demandé à nos six adultes normaux de subir cette petite épreuve et les résultats de chaque échantillon apparaissent au tableau X.

RÉSULTATS

Tests de non-additivité

Pour les adultes normaux (groupe V), l'application du test de Tukey ne faisait pas apparaître d'interactions blocs × traitements (erreur constante: $F = .00078$; $d1 = 1, 295$; $p > .25$; erreur variable: $F = .694$; $d1 = 1, 295$; $p > .25$). Il en était de même pour les enfants demi-aveugles (groupe DV) en regard de l'erreur constante ($F = .00038$; $d1 = 1, 295$; $p > .25$) et de l'erreur variable ($F = .166$; $d1 = 1, 295$; $p > .25$). Bref, les résultats obtenus rencontraient le présupposé principal de notre plan d'expérience.

Conditions de mouvement

L'analyse de la variance sur l'erreur variable dégageait un effet principal au sein de ce facteur chez le groupe V ($F_{conv.} = 222.136$; $d1 = 3, 295$; $p < .001$ – $F_{cons.} = 11.295$; $d1 = 1, 5$; $p < .05$ – $T^2 = 8859.351$; $p < .001$) et chez le groupe DV ($F_{conv.} = 90.143$; $d1 = 3, 295$; $p < .001$ – $F_{cons.} = 4.584$; $d1 = 1, 5$; $p > .05$ – $T^2 = 248.579$; $p < .001$). Un test de Duncan permettait de conclure à une différence nettement significative entre le niveau SP-RP et les trois autres niveaux de ce facteur, ces derniers accusant une similarité entre eux. Cette tendance existait chez les deux groupes (tableau I) ainsi que chez chaque sujet (tableau II, tableau III). Aucune interaction significative liant ce facteur à un autre n'apparaissait. Notre hypothèse initiale face à ce facteur ne se vérifiait qu'en regard d'une tendance commune aux deux échantillons.

Tableau I – Erreurs variables (degrés) obtenues selon les conditions de mouvement.

Groupe	Conditions de mouvement SP-RP	SP-RA	SAB-RA	A-RA
V	10.401	2.814	2.959	2.587
DV	13.903	5.466	5.449	5.902

Tableau II – Erreurs variables (degrés) obtenues pour chaque bloc du groupe V selon les conditions de mouvement.

Bloc	Conditions de mouvement SP-RP	SP-RA	SAB-RA	A-RA
1	8.522	2.382	2.509	1.850
2	8.452	3.432	3.334	2.363
3	9.846	3.142	2.651	2.105
4	11.585	2.047	2.150	2.399
5	10.762	3.099	3.824	3.638
6	13.239	2.783	3.285	3.166

Tableau III – Erreurs variables (degrés) obtenues pour chaque bloc du groupe DV selon les conditions de mouvement.

Bloc	Conditions de mouvement SP-RP	SP-RA	SAB-RA	A-RA
1	12.015	4.741	4.398	7.733
2	12.021	5.890	4.521	5.148
3	16.611	5.071	5.385	5.571
4	12.485	5.905	5.996	5.703
5	14.277	6.286	7.324	6.010
6	16.009	4.900	5.072	5.250

Positions de départ de la reproduction

Pour le groupe V, l'analyse de la variance sur l'erreur constante ne mettait pas en évidence d'effet principal au sein de ce facteur ($F_{conv.} = 4.676$; $d1 = 2, 295$; $p < .01$ – $F_{cons.} = .158$; $d1 = 1, 5$; $p > .05$ – $T^2 = 36.231$; $p > .01$). Pour le groupe DV, toujours en tenant compte de l'erreur constante, l'effet principal apparaissait ($F_{conv.} = 7.541$; $d1 = 2, 295$; $p < .01$ – $F_{cons.} = .256$; $d1 = 1, 5$; $p > .05$ – $T^2 = 178.051$; $p < .01$). Un test de Duncan permettait de différencier le niveau D_1 (−5°) des deux autres (2°, 5°), ces derniers présentant un effet similaire (tableau IV). Malgré l'absence de différences statistiquement significatives au sein du groupe V, le tableau 4 indique une légère diminution de la sousestimation à travers les niveaux de ce facteur.

Par ailleurs, l'examen détaillé des tableaux V et VI permet de constater l'effet de ce facteur au sein de chaque sujet. À travers les niveaux du facteur (de derrière à devant le départ du mouvement-critère), la sousestimation diminue progressivement, et la surestimation augmente progressivement. Aucune interaction significative liant ce facteur à un autre apparaissait.

Séances de testing

Les deux analyses de la variance ne dégageaient pas d'effets principaux au sein de ce facteur (erreur constante du groupe V: $F_{conv.} = .323$; $d1 = 4, 295$; $p > .05$ – $F_{cons.} = 022$; $d1 = 1, 5$; $p > .05$; erreur variable du groupe V: $F_{conv.} = 1.699$; $d1 = 4, 295$; $p > .05$ – $F_{cons.} = .115$; $d1 = 1, 5$; $p > .05$; erreur constante du groupe DV: $F_{conv.} = 1.988$; $d1 = 4, 295$; $p > .05$

Tableau IV – Erreurs constantes (degrés) obtenues selon les positions de départ de la reproduction.

Groupe	Départ de la reproduction – 5°	3°	5°
V	– 5.750	– 4.444	– 3.125
DV	– 0.066	2.858	3.907

Tableau V – Erreurs constantes (degrés) obtenues pour chaque bloc du groupe V selon les positions de départ de la reproduction.

Bloc	Départ de la reproduction – 5°	2°	5°
1	– 7.482	– 5.222	– 4.112
2	– 6.869	– 5.687	– 4.296
3	– 4.470	– 4.060	– 3.698
4	– 3.149	– 1.674	0.551
5	– 3.005	– 1.954	0.534
6	– 9.528	– 8.066	– 7.731

Tableau VI – Erreurs constantes (degrés) obtenues pour chaque bloc du groupe DV selon les positions de départ de la reproduction.

Bloc	Départ de la reproduction – 5°	2°	5°
1	– 5.751	– 3.120	– 2.520
2	0.082	2.418	4.428
3	– 3.402	0.184	1.140
4	– 1.125	2.590	3.112
5	0.971	3.442	3.349
6	8.831	11.634	13.937

- $F_{cons.} = .271$; d1 = 1, 5 ; $p > .05$; erreur variable du groupe)V : $F_{conv.} = 1.075$; d1 = 4, 295 ; $p > .05$ – $F_{cons.} = .073$; d1 = , 5 ; $p > .05$). Il est donc permis de croire que le système inesthésique accusait une performance comparable d'une éance à l'autre.

ıutres résultats

ıien que l'erreur constante ne nous intéressât pas tellement u départ pour l'analyse des effets du facteur conditions de ıouvement, les résultats obtenus avec cette variable ne euvent être omis. Au sein du groupe V, nous obtenions un ffet principal ($F_{conv.} = 253.571$; d1 = 3, 295 ; $p < .001$ – F_{cons} 12.893 ; d1 = 1, 5 ; $p < .05$ – $T^2 = 287.384$; $p < .01$). Un test ə Duncan montrait que la condition SP-RP entraînait une ərformance significativement différente de celles obtenues ans les autres conditions, ces dernières s'avérant similaires ıbleau VII). Au sein du groupe DV, nous obtenions aussi un fet principal ($F_{conv.} = 417.220$; d1 = 3, 295 ; $p < .001$ – $F_{cons.}$ 21.215 ; d1 = 1, 5 ; $p < .01$). Un test de Duncan montrait :

Tableau VII – Erreurs constantes (degrés) obtenues selon les conditions de mouvement.

Groupe	Conditions de mouvement SP-RP	SP-RA	SA$_B$-RA	A-RA
V	– 27.821	1.799	1.334	0.261
DV	– 22.552	15.103	14.793	1.589

a) que la performance dans la condition SP-RP était significativement différente de celles obtenues dans les trois autres conditions ;

b) que la performance dans la condition A-RA était significativement différente de celles obtenues dans les trois autres conditions ;

c) que les performances dans les conditions SP-RA et SA$_B$-RA étaient similaires (tableau XII).

Aucune interaction de ce facteur avec d'autres n'apparaissait à la suite de cette analyse. Bref, pour ce qui est de l'erreur constante, le groupe DV ne se comportait pas exactement comme le groupe V.

Un examen détaillé des tableaux VIII et IX nous indique :

a) une sousestimation appréciable et systématique de la position finale du mouvement-critère dans la condition SP-RP ;

Tableau VIII – Erreurs constantes (degrés) obtenues pour chaque bloc du groupe V selon les conditions de mouvement.

Bloc	Conditions de mouvement SP-RP	SP-RA	SA$_B$-RA	A-RA
1	– 30.843	4.884	2.963	0.573
2	– 29.475	2.563	3.755	0.689
3	– 26.522	4.480	4.635	1.103
4	– 23.857	– 0.997	– 1.003	0.162
5	– 26.410	– 0.364	– 0.096	0.970
6	– 29.816	0.228	– 2.248	– 1.930

Tableau IX – Erreurs constantes (degrés) obtenues pour chaque bloc du groupe DV selon les conditions de mouvement.

Bloc	Conditions de mouvement SP-RP	SP-RA	SA$_B$-RA	A-RA
1	– 22.155	3.377	3.782	– 0.194
2	– 16.893	14.220	11.814	0.096
3	– 27.420	9.367	12.115	3.165
4	– 19.794	13.764	8.943	3.189
5	– 29.616	20.823	16.595	2.546
6	– 19.439	29.066	35.508	0.735

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b) une légère surestimation de la position finale dans les conditions SP-RA, SAB-RA, A-RA chez le groupe V;

c) une surestimation appréciable et systématique de la position finale dans les conditions SP-RA et SAB-RA chez le groupe DV;

d) une précision nettement supérieure (légère surestimation) dans la condition A-RA chez le groupe DV.

Il y a lieu de signaler ici qu'il s'agissait d'effets généralisables à tous les sujets d'un même groupe.

D'autre part, l'analyse de la variance sur l'erreur variable au sein du facteur positions de départ de la reproduction n'entraînait pas d'effet principal à la fois chez le groupe V ($F_{conv.} = 5.818$; $d1 = 2, 295$; $p < .01$ — $F_{ons.} = .197$; $d1 = 1, 5$; $p > .05$ — $T^2 = 24.011$; $p > .01$) et chez le groupe DV ($F_{conv.} = .279$; $d1 = 2, 295$; $p > .05$ — $F_{ons.} = .009$: $d1 = 1, 5$; $p > .05$).

DISCUSSION

Après avoir examiné deux des échantillons, nous avons obtenu un comportement similaire du système kinesthésique à travers les quatre conditions de mouvement (erreur variable et erreur constante). Notre hypothèse se trouve donc partiellement vérifiée. Quant aux résultats des autres échantillons, ils feront l'objet d'une prochaine publication.

Pour les conditions SP-RA, SAB-RA et A-RA, nos résultats sur l'erreur variable ne vont pas dans le sens de ceux présentés par JONES (1972, 1974a). Par contre, pour ces mêmes conditions, ce sont nos résultats sur l'erreur constante (en regard de la tendance) qui rejoignent ceux de JONES (1974a) sur l'erreur variable. Il est possible que le changement de la longueur du mouvement-critère dans la condition A-RA ait entraîné une variabilité aussi élevée que dans les conditions SP-RA et SAB-RA à l'intérieur desquelles la longueur du mouvement-critère ne changeait pas au cours des essais. Nous soutenons ce point de vue même si JONES (1974a) n'a pas obtenu l'effet net de la longueur des mouvements. Même si le sujet ignorait que la longueur du mouvement-critère demeurait inchangée dans les conditions autres que A-RA, l'établissement d'un critère par le système, s'il en était ainsi, devenait une opération plus difficile dans la condition A-RA. D'autre part, les différences méthodologiques entre les deux études pourraient représenter une autre source d'argumentation; mais nous ne désirons pas soulever ce point avant d'avoir réalisé les épreuves de contrôle adéquates. Bref, si nous considérons le système kinesthésique comme un étalon de mesure, nous pouvons dire qu'il fut également fiable (erreur variable) dans les conditions SP-RA, SAB-RA et A-RA, mais plus précis (erreur constante) dans la condition A-RA.

Reste maintenant à suggérer une explication à la fois partielle et plausible du comportement du système kinesthésique à travers nos conditions de mouvement. Sur ce point, toute notre argumentation repose sur deux présupposés théoriques:

a) l'impossibilité pour le système d'utiliser un feedback périphérique lors de mouvements suffisamment rapides (ROY et MARTENIUK, 1974);

b) l'existence d'unités gnosiques (KONORSKI, 1967) ou de mécanismes idéo-moteurs (GREENWALD, 1970) qui représenteraient les niveaux supérieurs du système kinesthésique et justifieraient un mode d'opération outflow pour un rendement optimal de ce système.

Pour admettre le premier présupposé face à la présente étude, il faut évidemment classer comme rapides des mouvements dont la vitesse est de 50°/sec. et plus.

Selon un modèle inflow (c'est-à-dire l'idée d'un feedback articulaire émanant de la reproduction qui serait comparé à une trace sensorielle laissée à la suite du mouvement-critère), la performance dans la condition SP-RP se devait d'être nettement supérieure à celle obtenue, ceci tout aussi bien sur l'erreur variable que sur l'erreur constante. Disons pour le moment qu'en présence de mouvements rapides, un modèle inflow pur basé uniquement sur l'exafférence (notion introduite par von HOLST, 1954) ne peut rendre compte du fonctionnement optimal du système kinesthésique. En définitive, il semble peu probable, dans de telles conditions, que l'information articulaire puisse laisser une trace sensorielle pertinente.

Par contre, nos résultats montraient une amélioration importante de la performance (fiabilité et précision) lorsqu'une RA suivait une SP. De plus, le fait d'introduire une SAB avant une RA ne provoquait pas de changement par rapport à la condition SP-RA. Plus encore, une autostimulation suivie d'une RA entraînait à nouveau une amélioration de la performance sur le plan de la précision. Rappelons que cette dernière amélioration apparaissait chez les deux groupes examinés, mais n'était statistiquement significative ($p < .01$) que chez le groupe DV. Dans le cas du groupe V, on peut facilement prétendre que la performance dans la condition A-RA (.261°) se situait près de la limite de précision du système. De plus, les valeurs obtenues pour les conditions SP-RA et SAB-RA (tableau VII) étaient nettement plus près d'une valeur-limite chez les V. Se cache-t-il derrière cela des caractéristiques particulières au système kinesthésique des aveugles? ou des effets attribuables au développement (maturation) du système kinesthésique? Il ne sera possible de répondre à cette question qu'en présence des résultats des autres échantillons à tester.

D'autre part, le comportement du système kinesthésique à travers les conditions SP-RA, SAB-RA et A-RA fournit de l'appui à un modèle outflow basé sur le lien direct entre des mécanismes idéo-moteurs (planification et anticipation de l'action) et les déplacements segmentaires. Dans la condition SP-RA le sujet tirait certainement de la SP des éléme[illegible] davantage compatibles avec une RA (NADEAU, 1974) [illegible] telle condition peut entraîner dans le système des opé[illegible]s de reconstruction permettant l'estimation de l'exaff[illegible]ce. Ceci nous conduit à prétendre que le sujet produi[illegible] un mouvement d'estimation, mais non une reproduction au sens strict. Dans la condition SAB-RA, le fait d'inclure un mouvement actif vers une position non-anticipée (sorte d'exafférence) n'ajoutait rien à la condition précédente. Contrairement aux idées de PAILLARD et BROUCHON (1968), le mouvement en soi ne semble pas constituer un élément pertinent pour le système kinesthésique. Il est donc possible de penser que le système opérait de la même manière que dans la condition SP-RA. Toutefois, en A-RA, le fait de permettre l'exécution d'un mouvement volontaire vers une position anticipée par le système entraînerait la rétention du mouvement; ce qui nous fait dire que le sujet reproduisait véritablement. Ici, nous rejoignons les idées de TEUBER (1972) et de COULTER (1974) que nous interprétons de la manière suivante: grâce à des mécanismes idéo-moteurs (activité supérieure), le système kinesthésique génère son propre input (plan d'action); l'output du système (exécution du plan) est accompagné d'une décharge corollaire efférentielle qui vient atténuer les afférences périphériques articulaires (ou réafférence selon von HOLST, 1954) tout en laissant une copie efférentielle (ou trace mnémonique du plan) utilisable à court terme par le système. Ces suppositions donnent donc un statut particulier à l'anticipation de l'action, et par le fait même prédisent un rendement optimal du système kinesthésique si cette condition est rencontrée. D'ailleurs, ROY et DIEWERT (1975), au moyen d'une procédure particulière, rendirent une condition SA$_{B}$-RA comparable à une A-RA. En somme, nous acceptons l'idée de JONES (1972, 1974a, 1974b) à l'effet que le guidage central de l'efférence (ou la décharge corollaire des physiologistes) serait la condition à la fois nécessaire et suffisante pour qu'il y ait rétention de mouvements rapides, ceux d'ailleurs qui caractérisent bien les opérations motrices dominantes chez l'humain.

Ajoutons finalement que le comportement du système kinesthésique face à la variation de la position de départ de la reproduction indique une sorte de couplage distance-position déjà obtenu par NADEAU (1974). Même si les résultats de HAGMAN et FRANCIS (1975) montraient qu'il fut possible d'axer l'attention du sujet sur un indice particulier par des instructions appropriées, nos sujets ne faisaient pas appel uniquement à la position finale du mouvement (voir les tableaux IV, V et VI). De plus, l'absence d'interaction conditions de mouvement × positions de départ de la reproduction attribue de la généralité à l'idée précédente. Nous pensons qu'il y a lieu, dans un contexte comportemental, de clarifier davantage l'idée d'une réafférence périphérique articulaire qui devient de plus en plus difficile à insérer dans nos interprétations.

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APPENDICE

Tableau X – Erreurs variables obtenues à l'épreuve de Fraisse.

Bloc	Normaux (cm)	Demi-Aveugles (cm)
1	1.227	1.806
2	1.410	2.088
3	1.438	2.457
4	1.450	2.777
5	1.479	3.425
6	1.984	4.076

Tableau XI – Distance parcourue (degrés) lors de l'autostimulation dans la condition A-RA (groupe V).

				Séances		
Bloc		1	2	3	4	5
1	X̄	48.938	57.961	61.769	67.662	65.808
	s	9.331	3.822	6.225	5.125	3.511
2	X̄	52.266	63.292	69.549	58.772	66.255
	s	8.897	5.950	6.326	6.545	6.971
3	X̄	64.236	69.765	66.951	67.149	49.418
	s	5.099	5.529	2.844	3.247	4.611
4	X̄	36.240	45.180	46.935	44.303	43.59[illegible]
	s	4.472	5.143	4.527	2.543	3.998
5	X̄	36.505	27.399	40.362	39.336	36.297
	s	3.486	13.660	4.383	4.974	4.055
6	X̄	52.945	46.207	62.746	61.239	53.160
	s	4.377	3.636	2.223	3.242	4.243

Tableau XII – Distance parcourue (degrés) lors de l'autostimulation dans la condition A-RA (groupe DV).

				Séances		
Bloc		1	2	3	4	5
1	X̄	49.518	42.928	42.813	38.326	38.012
	s	10.931	4.808	4.547	4.440	6.546
2	X̄	53.143	60.991	54.468	61.570	62.381
	s	8.731	7.488	3.464	6.629	3.306
3	X̄	57.348	51.140	48.309	46.968	47.481
	s	9.057	9.246	10.457	9.791	8.570
4	X̄	48.177	54.037	60.527	53.193	60.709
	s	7.682	7.263	7.145	0.442	5.993
5	X̄	51.885	57.464	52.564	72.662	57.592
	s	10.127	8.178	5.973	6.598	8.414
6	X̄	74.963	70.444	74.848	62.061	64.666
	s	7.827	4.351	4.761	4.499	4.905

KNOWING WHICH MODALITY TO REPRODUCE IN THE MATCHING OF VISUAL AND KINESTHETIC INFORMATION

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Some years ago, CONNOLLY and JONES (1970) proposed a model to account for the asymmetry they observed in cross-modal matching of visual (V) and kinesthetic (K) information, whereby K-V performance is more accurate and less variable than V-K performance (CONNOLLY & JONES, 1970; JONES & CONNOLLY, 1970). They proposed that translation between the modalities occurs before storage in short-term memory although translation is ultimately dependent upon an integrated long-term store. In support of the model, Connolly and Jones appealed to the earlier findings of Posner and his associates (POSNER, 1967; POSNER & KONICK, 1966) that visual information is retained better than kinesthetic information, because the latter is apparently uncodable and therefore susceptible to decay over time. Thus by inference, if only visual information is rehearsable and K-V performance is better than V-K, translation between the modalities must occur at the beginning of the retention interval.

Although the Connolly and Jones modal provides a parsimonious explanation of the cross and intra modal data relating to visual and kinesthetic information, empirical evidence together with a number of issues concerning the model have appeared in the intervening years, which suggest caution in accepting the validity of their interpretation.

1. The rationale for the postulation that translation occurs before storage in short-term memory is only a *post hoc* explanation. No attempt has been made to manipulate the time at which the subject knows what modality reproduction will be in, despite the apparent concern for it.

2. The asymmetry observed in the cross modal matching of visual and kinesthetic information has not consistently been found (JONHSON, 1975), although the effect appears stronger with younger children (MILLAR, 1972), and may be dependent upon whether kinesthetic information is presented actively or passively (JONES, 1973).

3. Recent work relating to the retention of kinesthetic information suggests that location information at the very least is rehearsable (LAABS, 1973; MARTENIUK & ROY, 1972). Although location was not a reliable cue in the Connolly and Jones experiments, it was available in the work of MILLAR (1972), yet both have reported the asymmetrical finding.

We report two experiments which bear on the issue of whether subjects actively translate the modality information at the beginning of the retention interval. POSNER (1973) has suggested that the choice of a given sensory channel to rehearse will only affect the preservation of the other modalities, to the extent that they are susceptible to decay in the absence of rehearsal. Delaying knowledge of the reproduction modality until the end of the retention interval should create a conflict for rehearsal and thus a decrement in reproduction performance, if translation occurs at the beginning of the retention interval. This hypothesis was examined initially in the traditional cross and intra modal design, and secondly in a design where the presentation was [illegible] given both kinesthetically and visually (KV) with reproduction being KV, K or V.

EXPERIMENT 1

Method

Subjects

The subjects were 27 right-hand male and female volunteers from the University of Illinois. They were unpaid for their services.

Apparatus

A linear trackway, described in detail elsewhere (NEWELL, 1974; NEWELL & CHEW, 1974), consisted of two stainless steel rods (1.27 cm. diameter) set horizontal and parallel 3.81 cm. apart. A brass handle projected vertically from a near frictionless slide attached to the rods. Red lights (Light Emitting Diodes, Monsanto MV 10B) were mounted at the apex of the handle and at an adjacent position at the start. The lights could be controlled by the experimenter from a small battery system. Beneath the slide and hidden from the subjects view rested a metal bar with holes 6 11/16, 9 7/16 and 13 12/16 inches from the start position. A peg could be placed in the desired hole for presentation allowing the lever to slide until it reached this peg. Affixed to the posterior of the slide was a pointer which transversed an interval scale marked off in 1/16ths of an inch.

Lights in the experimental room were extinguished to eliminate visual feedback of the apparatus surrounding the subject (NEWELL & CHEW, in press). The experimenter sat on the posterior side of the apparatus behind a black partition and enclosed by black felt cloth. Auditory feedback from the moving slide was eliminated by piping white noise through earphones worn by the subject, when the slide was away from the start position.

Procedure

Upon entering the testing room the subject was seated with the right shoulder opposite the start position and an arm's length from it. The subject was told that the task was to reproduce a series of different line lengths either visually or kinesthetically, having been originally presented with a visual or kinesthetic distance. The subject was instructed that he/she would be told the reproduction mode at one of three times, before the presentation (early), immediately after the presentation (middle) or just before it was time to respond (late), and that this would vary from trial to trial. The subjects were given 4 practice trials which included each cross and

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intermodal pair. All subjects randomly received every possible combination of the 3 line lengths, 4 feedback conditions and 3 instruction times, totalling 36 trials. Reproduction began 10 sec. after the original presentation and the onset of white noise was the signal to respond. There was a 45 sec. interval between the starting signal for each of the 36 original presentations. The arrangement for each feedback matching condition was:

V-V The lights on top of the lever and the start position were lit and the experimenter moved the lever to a criterion distance and held it there for 1 sec. Then the experimenter moved the lever back to the start position with the lights turned off. During reproduction the experimenter turned the lights on and moved the slide until the subject said "stop" when he/she thought the distance matched that of the original presentation.

V-K The presentation was exactly the same as in the V-V condition, however, the subject had to reproduce this distance kinesthetically by moving the lever the appropriate distance. The lights were turned out in the kinesthetic condition.

K-K For the K presentation, the subject moved the lever to a stop and held it there for approximately 1 sec. The experimenter returned the lever to the start position. During reproduction the subject grasped the lever and attempted to replicate the distance given during the original presentation without the aid of a stop.

K-V The presentation was the same as for the K-K presentation. The subject had to reproduce the distance visually by saying "stop" when the experimenter moved the lever the appropriate distance.

Results and discussion

The absolute error data (units $\frac{1}{16}$ in.) were subjected to a completely within-subjects 4 (feedback condition) × 3 (instruction time) × 3 (line length) variance analysis. The main effect of instruction time was non-significant, $F(2,52) < 1$. The absolute error means for the early, middle and late instruction times were 16.09, 16.39, and 15.46 respectively. Thus, knowing prior to the initial line length presentation or at the beginning of the retention interval which modality reproduction would be performed in, did not facilitate performance in comparison to delaying knowledge of the modality required for reproduction until the end of the retention interval. The feedback condition was significant, $F(3,78) = 5.09$, $p < .01$. *Post hoc* inspection of the means by the Newman-Keuls procedure revealed V-V (12.91) to have significantly smaller error than V-K (18.14) and K-V (18.31), and K-K (14.57) to have significantly smaller error than V-K. These findings substantiate crossmodal matching to be more difficult than intramodal matching, but provide no support for asymmetry in the cross modal matching of kinesthetic and visual information. In the latter regard, they conflict with the early work of CONNOLLY and JONES (1970) and JONES and CONNOLLY (1970), but support the more recent work of JOHNSON (1975). The main effect of line length was also reliably significant, $F(2,52) = 12.09$, p .01. A Newman-Keuls test showed the longest line length (19.08) produced significantly larger error than both the shortest (14.18) and middle (14.69) line lengths. No interactions where significant (all p's .05).

EXPERIMENT 2

Method

The same subjects were used as in Experiment 1. Additionally, the apparatus and general procedure employed were identical to Experiment 1 except for the following:

(1) the three line lengths used were 5 in., $7\frac{7}{16}$ in. and $12\frac{2}{16}$ in.;

(2) all subjects were given the line length under a KV presentation and were told whether reproduction would be KV, V or K prior to the initial presentation (early), at the beginning of the retention interval (middle), or at the end of the retention interval (late);

(3) all combinations of the 3 line lengths, 3 instruction times, and 3 feedback reproduction conditions were presented randomly to total 27 trials in all. Experiment 2 began approximately 5 minutes after the completion of Experiment 1.

Results and discussion

A 3 (instruction time) × 3 (feedback conditions) × 3 (line length) within subject variance analysis of absolute error was conducted. As with Experiment 1, the main effect of instruction time was non-significant $F(2,52) < 1$. The absolute error means for the early, middle and late instructions were 11.24, 11.74 and 12.14 respectively. The main effect of feedback conditions was significant, $F(2,52) = 3.30$, $p < .05$. A Newman-Keuls test indicated that KV reproduction (10.24) produced significantly ($p < .05$) smaller error than K (13.52), but that there was no reliable difference from the V condition (11.35). The implications are that the more feedback channels available the better the performance, and, that visual information is more useful than kinesthetic information. The main effect of line length was significant, $F(2,52) = 16.92$, $p < .01$. The absolute error means for the small, middle and long line lengths were 9.14, 12.09 and 13.88 respectively. All pairwise comparisons were significant at the .01 level, except the middle and long line lengths which differed at the .05 level. None of the interactions were reliably significant (all p's $> .05$).

GENERAL DISCUSSION

The important finding from these two experiments is the null effect of delaying knowledge of the sensory modality for reproduction until the end of the retention interval. Why no differences emerged between the instruction times is not clear and explanations offered can only be *post hoc*. Certainly the data seem contrary to the CONNOLLY and JONES (1970) notion that translation of the information between modalities takes place prior to storage in short-term memory, unless visual and kinesthetic information are not susceptible to decay in the absence of rehearsal (POSNER, 1973).

However, both location and distance information were reliable cues in these experiments which suggests that rehearsal would have faciliated reproduction performance.

One feasible explanation for the null instruction time effect is that subjects always used the same strategy regardless of when they knew in which modality reproduction would be performed. Post experimental interviews revealed a number of subjects always tried to maintain the criterion distance visually, by turning their heads toward the target location regardless of the mode of the original presentation. Whether the present instruction time findings were due to this could be examined by making location an unreliable cue.

The finding in Experiment 1 that intra modal matching of kinesthetic and visual information produces better performance than cross modal matching is consistent with previous experiments (CONNOLLY & JONES, 1970; JONES & CONNOLLY, 1970). However, no asymmetry was observed in the cross modal data and certainly more work is required to resolve the equivocal status of this issue with kinesthetic and visual information (CONNOLLY & JONES, 1970; JONES & CONNOLLY, 1970; JOHNSON, 1975; MILLAR, 1972). There are a number of procedural inconsistencies in these studies which may contribute to the conflicting findings.

The final result of interest comes from Experiment 2. Withdrawing visual feedback for reproduction of a KV presentation, produced a significant decrement in performance. The same effect did not occur for the V reproduction, which implies that it is visual information which is predominantly being used in a KV reproduction. These data are essentially consistent with some previous finding (NEWELL & CHEW, in press) and confirm the dominant rôle of vision in the reproduction of positioning movements (ADAMS & GOETZ, 1973).

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FEEDBACK AND FEEDFORWARD MECHANISMS SUBSERVING THE PERCEPTION OF MOVEMENT *

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Any discussion of motor control must, and usually does get around to addressing questions concerning the role of feedback in the control of movement. In fact very early theories of motor control (JAMES, 1890) as well as more recent ones (ADAMS, 1971; SCHMIDT, 1975) have been predicated almost entirely on feedback being the prevailing and dominant source of control. Feedback, as the term has been employed, carries a rather restricted meaning and refers largely, if not specifically, to the proprioceptive[1] consequences of movement. There is no doubt that proprioceptive feedback occurs and little doubt that it is vital to the regulation of most motor behavior. The most convincing case for its primacy is the decrement in the performance of deafferented animals and humans.

The fact that some movements are, or at least can be, performed with reasonable accuracy in the absence of proprioceptive feedback however, requires a re-evaluation of its role or at least a search for other mechanisms of control. Since the foregoing proposition (that some movements can be perf[illegible] with reasonable accuracy in the absence of propric[illegible] feedback) might be considered debatable, it will be [illegible] to review some of the evidence.

First of all, there is the observation that some movements are executed with such rapidity that proprioceptive feedback occurs too late to have any influence over their course. Reaction time to movement-produced stimulation has been estimated to be as low as 120 msec. (CHERNIKOFF and TAYLOR, 1952). Movements such as rapid striking motions are nevertheless often completed in less than even 120 msec. and could not possibly be under feedback control. The most frequently employed explanation for such performance is that rapid movements are preprogrammed responses that are run off much the way a computer executes a set of commands. The analogy may eventually prove to be a deficient one, but even so it would appear that even preprogrammed instructions to muscles would need some kind of check since incorrect instructions might be issued.

Clinical work by LASHLEY (1917) had shown that a patient totally deprived of afferents from the left knee was able to duplicate a given extent of movement at that joint as well as a normal person. The patient, as the result of a gunshot injury to the spinal cord, was left with complete anesthesia of the left knee joint, but had unimpaired motor functions above the knee. Lashley first conducted extensive diagnostic testing to ascertain that the patient had no sensibility to passive movement in the joint. LASHLEY found that the pattern and extent set by the first movement in a series was quite accurately duplicated on succeeding trials. He also found that the patient, when asked to make movements of varying extent, did so quite accurately. While the actual extents of the movements produced differed from that requested, the extents produced were ordered in non overlapping categories corresponding to the requested extents. Clearly the patient had some source of information about the movement other than proprioceptive feedback.

A similar line of evidence has been offered by TAUB and BERMAN (1968). These authors observed that surgically deafferented monkeys recovered reaching, grasping and general locomotor movements to preoperative levels of efficiency, even in the absence of vision. While there is question as to whether or not the deafferented animals learned new movements, the case made for improvement in performance of existing learned movements is convincing.

Evidence for the proprioceptive independence of movement even lower on the phylogenetic scale comes from the work of WILSON (1961) who found that wing beat frequency of locusts could continue largely unaltered in the absence of afferent feedback. Wilson suggests central patterns of motor responses may be genetically determined (at least in lower phyla) and not dependent on peripheral feedback.

The observation that reasonably accurate movements can be made in the absence of proprioceptive feedback has provoked some speculation as to the mechanism of control in such situations. The speculation that has achieved the greatest attention offers the following hypothesis: Along with the issuance of motor commands to the responding musculature there is signalled a corresponding copy of the command to an internal (CNS) comparator mechanism. Here the actual commands are compared to the intended commands. Any discrepancy or mismatch can then effect the issuance of new commands to reduce the discrepancy (BERNSTEIN, 1967 pp. 128-129). All this is hypothesized to happen independent of proprioceptive feedback. The mechanism of control suggested then, is an internal feedback loop. Control then, is presumed to be feedback based, but feedback as used here lies outside the more restricted implication of the term as applied to proprioceptive feedback models of control.

Although described as an internal feedback loop (apparently from the mechanism's presumed neural circuitry), such a control mechanism might more accurately be termed a "feedforward" control system since it is signalling information about an event that has yet to happen, the movement itself. In fact, MACKAY (1956) has described it as such.

Other investigators in discussing the same or related notions have employed varying terminology. HELMHOLTZ (1925) had very early, suggested a "sense of innervation." The terms "efference copy" and "reafference" were suggested by VON

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1. Proprioception is used here in the sense that SHERRINGTON (1906) intended and includes stimulation from muscles, joints and the vestibular mechanism.

HOLST and MITTLESTAEDT (1950) in describing how motor commands to the occulomotor system influences the stability of the visual image during eye movements SPERRY (1950) used the term "corollary discharge" in his reports on the optokinetic response produced by eye rotation in fish. SPERRY's meaning of the term "corollary discharge" as well as its presumed function in visual motor coordination differs little from that intended by VON HOLST's and MITTLESTAEDT's use of the term "efference copy." Both quite explicitly argue that internal feedback loops function to regulate motor bahavior and visual perception.

HIGGINS and ANGEL (1971) in a more recent investigation have revived the term "motor outflow" in explaining how movement errors in a step function tracking task could be corrected in less than a visual or proprioceptive reaction time. While the terminology employed in discussions of internal mechanisms of control varies, the central idea is the same — that internal feedback occurs in conjunction with, but prior to, a motor response.

The assumption (predicated in part on experimental evidence) that the internal feedback loop functions prior to proprioceptive feedback, makes the hypothesized mechanism more amenable to experimental testing. Some control functions should be observed to occur earlier than would be predicted on the basis of proprioceptive feedback. HIGGINS and ANGEL for example employed this very assumption to evaluate for the existence of central efferent monitoring. These investigators reasoned that if central feedback loops exists and if they function earlier than the more tardy proprioceptive feedback mechanisms, then movement errors should be amended in less than a proprioceptive reaction time. Using a step function tracking task these investigators found that errors in movement directionality were amended in less than subject's individually determined reaction times.

It is the presumed early occurrence of central feedback loops that allow for the strategy employed in the present report. If accompanying motor commands to muscles there is a corresponding discharge to perceptual mechanisms through internal feedback loops, then a performer should experience the movement before it has actually gotten underway.[2] To test this hypothesis subjects were administered a reaction time task for which the response was a thumb movement (flexion) of approximately 80 degrees and consuming approximately 100-150 msec. In addition to the stimulus to which subjects had to respond by moving the thumb (a 300 Hz tone), a second stimulus (10 μsec. light flash) was interjected at varying temporal locations in the course of the response. The flash was interjected anywhere from before the actual movement was underway until well after the movement was completed. The subject was then asked to report where in the course of the response the flash occurred. If subjects were aware of the movement before it had actually begun then one would expect reports of the flash occurring during the course of the movement when in fact the movement had not yet started.

2. Whether perceptual and control functions are one and the same is of course a debatable issue. For elaboration see thorough review and data by FESTINGER, BURNHAM, ONO, and BAMBER, 1967 and FESTINGER and EASTON, 1974.

METHOD

Subjects

Five right handed males ranging in age from 21 to 27 years (median age = 22 years) volunteered to participate in the present study. All subjects were naive as to the hypothesis under investigation.

Apparatus

Subjects sat at a table peering into a completely darkened viewing box constructed from plywood and anchored securely to the table top. The viewing box was approximately cubicle and measured roughly 46 × 51 × 51 cms. The front panel of the box (that side facing the subject) had an oval hole, the shape of a swim mask cut out at eye level. Into the hole was mounted a swim mask so that when a subject peered into the viewing box with his face firmly against the opening, the rubber edges of the mask blocked out all light. A small hole was cut in the rubber edging of the mask right below the nostrils to prevent breathing discomfort.

The rear panel of the box was constructed at a slight angle to the vertical (30 degrees, slanting away from the subject) so as to make its surface at nearly right angles to the subjects line of vision. This was necessary since in the seated position, and peering into the view box the subject's head was tilted slightly forward.

From the rear panel of the box was cut an opening 14 cm. in diameter into which was mounted the globe of a Grass (Model PS 22) photostimulator. The borders of the globe, where it fitted into the opening, as well as all other joints were well sealed leaving the interior of the box completely light free. The interior of the box was painted flat black to allow as little reflection as possible from photostimulator flashes.

Also located on the table top, just to the right of the view box, was a thumb lever that fastened onto the interphalangeal joint of the right thumb and which rotated through approximately 80 degrees from flexion of the thumb. Movement of the thumb lever rotated the shaft of a linear, precision potentiometer to which it was coupled and whose output voltage was proportional to the amount of rotation occurring in the lever.

A Grason Stadler, 45 ohm headset was worn by the subject over which a 300 Hz tone generated from a Wavetek (Model 132) function generator was delivered. The tone, initiated at the start of a trial and lasting for a randomly determined foreperiod, was abruptly terminated by switching logic controlled by Hunter (Model 111C) interval timers. Cessation of the tone was the stimulus to which the subject responded by rapidly flexing the right thumb.

A custom designed, integrated comparator and timing circuit allowed for the triggering of the photostimulator. Triggering could occur after any interval following the cessation of the tone. Flashes occurring before the movement started were triggered by having the switching logic shutting off the tone start a timer that operated the photostimulator after an interval less than a reaction time. Flashes occuring during the movement were triggered by having a voltage comparator circuit operate the photostimulator when the thumb lever passed a point yielding a voltage corresponding to the preset comparator voltage. Flashes occurring after the completion of the movement were triggered by having the voltage corresponding to the middle of the final third of the movement start a timer that operated the photostimulator after a timed interval. The timing and comparator circuitry then

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allowed for the presentation of the light flash (10 usec. in duration) at any point from well before the movement started till well after it was completed.

Electromyograms were recorded from the flexor pollicus brevis muscle of the responding thumb using surface electrodes. Two Beckman, mini (silver, silver chloride) recording electrodes were placed over the belly of the muscle approximately 2 cm. apart and secured with double backed adhesives. Resistances across the recording electrodes were kept under 3000 ohms. A third ground lead was attached to the right earlobe. Electrical activity from the muscle was conditioned using two cascaded Textronix (Model 122) low level preamplifiers. Recording the electromyograms allowed for the fractionation of the total reaction time (RT) interval into its premotor (PMT) and motor (MT) components.

All stimulus and response events were recorded using a Honeywell (Model 1508) Visicorder with a paper speed of 200 mm/sec. which allowed for resolution to the nearest 5 msec. A sample recording is shown in Figure 1.

Statistical Analysis

The independent variable in the present experiment was the temporal location of the light flash, the dependent variable the reported subjective estimate of when it occurred. The exact temporal location of the flash relative to the course of the movement however, could not be exactly predetermined. Rather its location was dependent in part upon the subject's RT, or movement time (MVT) both of which were variable. For example, a flash set to occur 100 msec. after the cessation of the tone would occur 50 msec. before the start of the movement if RT was 150 msec., but 100 msec. before the movement if RT was 200 msec. Similarly, flashes set to occur during the first, second, or final third of the movement would occur later after the start of the movement for slow movements than for fast movements. The values of the independent variable under which associated values on the dependent variable were obtained then, were not wholly under experimental control. Rather they were determined in part by the subject's response parameters.

The temporal location of the flash was computed in the following manner:

(1) RT, the interval between the cessation of the tone and the start of the movement, was subtracted from the flash delay, the interval between the cessation of the tone and the occurrence of the flash. If the flash occurred during the RT interval the result of the subtraction was a negative value whose magnitude represented (in msec.) how long before the movement started the flash occurred.

(2) If the flash occurred during the movement the result of the subtraction was positive, less than MVT, and indicated how long after the start of the movement the flash occurred.

(3) If the flash occurred after the completion of the movement, the result of the subtraction was positive and greater than MVT. For such trials MVT was subtracted from the difference, flash delay — RT, the resulting value indicating how long after the completion of the movement the flash occurred.

Each subject then, had 200 trials with varying flash locations and rendered a subjective estimate of flash location for each. The 200 flash locations for each subject were then grouped into twenty-five 20 msec. intervals. Intervals of 20 msec. were employed as compromise between obtaining sufficient measures to insure a reliable mean subjective estimate for each interval without obscuring the true relationship between the actual and subjective flash location by making the intervals too wide.

The mean subjective estimate was subsequently computed for each of the twenty-five flash location intervals. The number of flashes and consequently the number of subjective estimates occurring for each of the twenty-five intervals varied. Most intervals contained at least five observations per subject, a few as many as nineteen. A group mean was then computed for each of the twenty five intervals with each subject's contribution to the group mean weighted according to the number of observations comprising the individual subject means. The above descriptive analysis allowed for an assessment of the relationship between actual and subjective flash location. Correlation and regression analysis was performed to determine more precisely the form of the relationship.

Means and standard deviations were also computed for each subject's MVT, RT and its component delays, PMT and MT. Mean RT's and MVT's were determined to assess if perhaps subjective estimates bore any relationship to them.

Procedure

Subjects were first oriented to the apparatus and the experimental task. The orientation, which actually included a few practice trials, was useful since it permitted the adjustment and calibration of the thumb lever to suit the morphology and response parameters of each subject. Following this brief orientation, recording electrodes were applied after which the subject was returned to the apparatus for more precise instructions and the start of testing.

Subjects were told they would hear a tone through the headset at the start of each trial. The tone, they were told, would cease after a variable interval and that cessation of the tone was the signal for them to react as quickly as possible by depressing the thumb lever. The thumb movement was instructed to be made through the entire range of motion that their thumb could comfortably travel.

Instructions were given that a brief flash would occur some time after the cessation of the tone. Subjects were told to report, after their response, on a scale from one to five when they believed the flash to have occurred relative to the course of the movement. If they believed the flash to have occurred before the movement started they were told to report a "one." If they believed the flash occurred in the early part of the movement they were to report a "two," in the middle of the movement a "three," near the end of the movement a "four," and if they believed the flash occurred after the movement was completed they were to report a "five." Subjects were further instructed that if they had no notion of when the flash occurred to simply report that they could not estimate. Instructions were also given that if they felt equally inclined towards two adjacent values to report neither. If however they felt even slightly more inclined toward one of two adjacent values they should report the favored value.

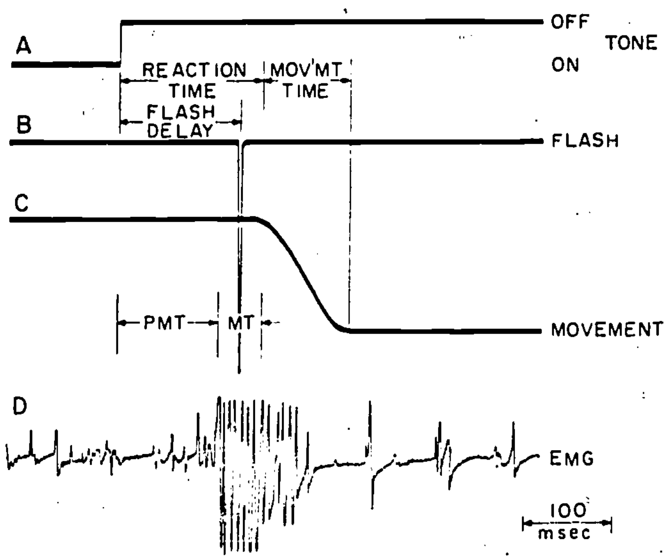
Following final clarifications, subjects were administered twenty practice trials followed by 200 test trials. Blocks of fifty test trials were separated by a five minute rest interval.

Each trial followed essentially the same sequence of events. The trial was initiated by the onset of the tone which remained on for a randomly determined interval of 2.0, 2.5, 3.0, or 3.5 sec. The subject responded to the cessation of the tone by depressing the thumb lever. A flash was delivered at any one of ten temporal locations in the response: 75, 100, 125, or 150 msec. after the cessation of the tone, or as the lever passed the middle of the first, second or final third of its excursion, or at 75, 100, or 125 msec. after the thumb lever reached the middle of the final third of its excursion. Flashes occurred at each of the ten temporal locations an equal number of times over the 200 test trials in a randomly permuted order.

RESULTS

A sample trial is depicted in Figure 1. The time course of the movement shown by trace C is very representative of the pattern of movements observed in all subjects as is the pattern of EMG activity (trace D) producing the movement. Figure 1 shows the flash occurring before the start of the moment very near the onset of EMG activity. The intervals corresponding to RT, MVT, and flash delay are shown near the top of the figure. The fractionated components of RT, PMT and MT, are shown near the bottom of the figure.

Figure 1 - Sample trial.



Mean RT, PMT, MT, and MVT along with corresponding standard deviations for each of the five subjects are presented in Table I. Subjects responded to the cessation of the tone with a mean latency of 171.1 msec. with a thumb movement that took on the average 109.5 msec. The obtained reaction times are not significantly at variance with other reported auditory RT's (e.g. Chernikoff and Taylor, 1952).

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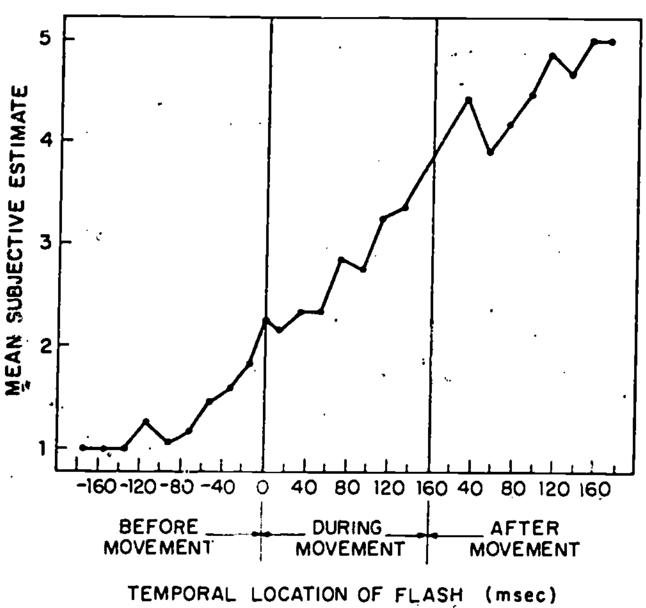
Table I - Means and Standard Deviations for RT, RT components and MT for Individual Subjects.

Subject	Reaction time: Premotor Mean	Premotor SD	Motor Mean	Motor SD	Total Mean	Total SD	Movement time Mean	Movement time SD
MT	118.3	33.4	46.6	[illegible]	164.9	32.9	102.7	11.8
RN	152.0	46.1	46.9	9.8	198.9	46.8	108.0	13.2
WV	111.9	32.9	36.3	10.8	148.2	29.7	108.3	11.6
MM	126.9	55.6	37.8	7.6	164.7	55.7	94.5	10.9
DD	123.2	33.7	55.8	13.8	179.0	32.2	134.0	13.9
Group	126.5	[illegible]5.3	44.7	7.9	171.1	19.0	109.5	14.8

Note.: Entries are in msec.

Group mean subjective estimates are plotted against flash location in Figure 2. Points are plotted such that early occurring flashes are located on the extreme left of the figure and proceed forward in time toward the right hand side of the graph. The abscissa is partitioned into thirds corresponding to, and accomodating flash locations occurring. before, during and after the movement.

Figure 2 - Group mean subjective estimates of flash location.



As can be seen from Figure 2 flashes occurring earlier than 132 msec. before the start of the movement were correctly and invariably estimated to have occurred before the start of the movement. Likewise, flashes occurring more than 152 msec. after the completion of the movement were correctly and invariably estimated to have occurred after the movement. More interesting however, is that flashes occurring approximately between 32 msec. before the movement and the actual start of the movement have a mean subjective estimate of greater than 1.5. This indicates that flashes occurring during this interval were more frequently estimated to have occurred during, rather than prior to, the movement. In fact, flashes occurring just as the movement was initiated (the zero scaling on the abscissa) have a mean subjective estimate of 2.23, indicating such flashes were at times estimated to occur beyond the initial segment of the movement.

If the flash locations that were correctly and invariably estimated (those with a mean subjective estimate of one or five) are omitted, the relationship for the remaining data points can be quite adequately described as linear ($r = .99$). That such is the case suggests two things. First subjects apparently did not scale according to classically observed phychophysical laws. Secondly, subjects show a rather good ability to scale, at least relatively, the location of the flash.

DISCUSSION

The present experiment was conducted to determine if subject's would, under the experimental conditions, estimate a movement to be underway before in fact it was. That they do, in fact in some cases more often than not, is clearly shown by the data. Whether they do so because of some perceptual consequences of internal feedback loops, or whether they do so out of an inability to scale with precision still remains an open question.

An argument could be made that subjects, perhaps because of information processing limitations, are simply unable to scale flash location with precision. As a result their subjective categories (i.e. 1, 2, 3, 4, and 5) may have substantial overlap. Such category overlap would help explain subjective estimates of two or greater being reported for flashes occurring before the movement had actually started.

The data, largely because of their descriptive nature, do not make for a strong argument in favor of early occurring central feedback loops with a perceptual function. What is needed, but missing from the present experiment is a control condition against which the reported data can be compared. Exactly what that control condition should be is debatable. What is needed is a similar scaling task where efference is absent. Such a condition might be achieved by conducting the trials as they were except passively moving the thumb through a similar motion. This arrangement would be essentially the same scaling task in the absence of efference but with proprioceptive estimates since proprioceptive feedback is presumed to occur later than central feedback could.

Passively moving the thumb however deletes from the task one of the subject's responsibilities — responding to the cessation of the tone. If the subjects scale imprecisely because of information processing limitations then the suggested control condition may not be appropriate. While it does meet the requirement of proprioception without efference if probably also is a less demanding task in terms of the information ot be processed.

Although it is difficult to make a statistical argument for internal feedback from the present data, a strong intuitive argument can be made from several considerations. It can be seen from Figure 2 that up to approximately 125 msec. before and after the movement subjects scaled flash location correctly and invariably. In other words it is between approximately 125 msec. before and after the movement that subjects' estimates contain any error. That is, it appears that perceptually the movement is extended in time. Further, the movement is extended perceptually almost equally before it starts as it is extended after it is completed. If subjects were relying only on proprioceptive feedback to formulate their subjective estimate of flash location, then one would expect the movement to be extended further after than before the movement. Proprioceptive feedback, after all, cannot occur before, but does continue after the cessation of the movement.

It should be noted however that there is muscular activity occurring before the actual movement begins. The mean motor time was found to be 44.7 msec. Muscle afferents could possibly be signalling feedback about the movement, although whether their activity has any perceptual consequences is a currently debated issue (GOODWIN, McCLOSKEY, and MATTHEWS, 1972; KONORSKI, 1967; OSCARSSON and ROSEN, 1963). Figure 2 reveals however that it is around 40 msec. before the movement is initiated that subjective estimates begin to be closer to two than to one.

Another intuitive argument can be advanced from investigating the slope of the least squares regression line fitted to the data. The predicted mean subjective estimate for flashes occurring just as the movement was being initiated (zero scaling on abscissa of Figure 2) was 2.0. The subjective category "two" included flashes whose mean temporal location corresponded to the initiation of the movement. If subjective estimates were proprioceptive based the mean flash location for the "two" category would be predicted to occur further into the movement.

Finally the results need to be considered in the light of what is known about information processing limitations of the human performer, especially since the task required vigilance to two or more signals. It is a well documented observation that the response to the second of two signals closely spaced in time will be longer than a normal RT. The added delay is presumed to be due to a psychological refractory period (WELFORD, 1952) and is inversely proportional to the separation of the two stimuli. The offset of the tone and the light flash in the present experiment is analogous to the "two closely spaced stimuli" situation of psychological refractory period experiments, although only one, the tone, required an overt response. If however, the psychological refractory period holds for the conscious registration of a stimuli, then flashes following closely behind the offset of the tone would be expected to be estimated as occurring later than they actually did. As psychological refractory experiments clearly demonstrate however, the longer the separation between two successive stimuli the shorter the delay to the second one. If in the present experiment subjects were estimating flashes to occur later than they actually did (which is analogous to their estimating movements to start earlier than they did) one would expect the perception of early occurring flashes to be delayed longer than later occuring flashes. That such was not the case can be seen from Figure 2. Subjects' estimate of the temporal location of the light flash did not vary inversely with the interval separating the two stimuli rather it varied proportionally.

In an experiment analogous to the present one, and reported in Boring's *History of Experimental Psychology* subjects had to estimate the relative temporal occurrence of two stimulus events. Subjects watched a pointer rotating continuously about a clock face, and reported its location upon the presentation of a brief tone. It was observed that when the tone occurred say when the pointer was a five, subjects reported it to have been at four. The interpretation led to what was called the "doctrine of prior entry" which can be summarized as follows: Due to information processing limitations which leave the subject unable to process two signals simultaneously, signals will be processed in serial order. Since the subject was instructed to listen for the tone and since the actual pointer location and the tone occurred simultaneously the tone was perceived as occurring first. The last pointer location processed before the tone then was the one reported as occurring with the tone.

If the analogy between that experiment and the present one is correct, then one might expect flashes occurring simultaneously with the start of the movement to be estimated as occurring earlier than they did since subjects were instructed to attend to the flash not the start of the movement. That such was not the case raises suspicions that subjects do get information about a movement before it actually begins.

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PERFORMANCE HUMAINE : ENTRAÎNEMENT ET TRANSFERT

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EFFECT OF PRETRAINING ON PERFORMANCE ERROR IDENTIFICATION *

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EFFECTS OF PRETRAINING ON PERFORMANCE ERROR IDENTIFICATION

Detecting critical flaws imbedded in the technique of the performer is an important, but exceedingly difficult instructional task. The teacher or coach who is unable to pinpoint discrepancies between the learner's response and the required response lacks a prerequisite pedagogical skill and is helpless in knowing how to proceed with instruction. The development of this important ability, therefore, should be a primary objective of the professional efforts of those responsible for training teachers and coaches.

Actually, little more is known about how students should be trained to observe and evaluate movement responses than was known 25 years ago when Robert KRETCHMAR (1949) urged researchers to determine which «visual habits» are best for observing complex movement configurations and to design and test training programs for the development of these habits. This embarrassing state of affairs stems from a tradition of neglect of research on the psychological phenomena associated with skill analysis. This study was designed to gather some preliminary data concerning the extent to which competency in performance error identification could be developed through short term training experiences and to explore the relationship between visual imagery and competence in error identification.

Evidence has been produced in a small number of studies which suggests that detection of errors in gymnastic skills (GIRARDIN & HANSON, 1967), the ability to recall details of previously presented film of sport skill performances (MOODY, 1967) and the ability to compare films depicting performances of cartwheels and batting responses with preestablished models of correct performance (BISCAN & HOFFMAN, 1975; HOFFMAN & SEMBIANTE, 1975) all are related to S's experience with the skills being evaluated. In only Osborne and Gordon's study (1972), where it was found that members of a college varsity tennis team were no more accurate in their evaluation of the tennis forehand than Ss who had never played nor received instruction in tennis, have the findings run counter to the experiential hypothesis. The indication from these studies was that competency in performance error identification would be subject to modification through systematic variation of a S's experience with a skill.

The nature of experience that might facilitate development of proficiency in performance error identification has not been indicated in earlier studies. For example, does experience in observing models of highly skilled performers, or experience observing a wide range of quality of responses develop this critical ability? In typical training approaches, it has been customary to adopt the former approach and focus the trainee's attention on loop films and other visual displays of expert performance.

The hypothesis guiding the conduct of this study was that visual experience with both common performance errors and models of highly skilled performances would be a more effective training experience than visual experience with highly skilled performances alone. Such an assumption, though untested, has undergird a series of projects in which investigators have identified and recorded on film, sport skill performance errors which have a high probability of appearing in a learner's repertoire (HIGGINS, 1970; HOMEWOOD, 1955; MABRY, 1965). The assumption would appear tenable in light of data from a host of studies (see GIBSON, 1953) which have indicated that familiarity with material gained prior to testing can improve accuracy in perceiving that material, and that practice in visually discriminating among members of a class of objects facilitates recognition of members of that class (ELLIOTT, WILLS & GOLDSTEIN, 1973). It follows that Ss who have had visual experience with performance errors as well as correctly modelled performance (the entire range of the class) are more likely to identify errors when they appear in the learner's response.

It has been proposed that in evaluating motor skill performances, the observer matches the learner's response with a memorial representation of acceptable performance (HOFFMAN, 1974), a process not unlike that involved in pattern recognition tasks. It is a widely held hypothesis that recall of pictorial material is mediated through visual images (PAVIO, 1971) and a small amount of evidence has suggested that Ss reporting more visual images can more accurately recall pictorial material than Ss who report less vivid imagery (MARKS, 1973). More specifically, Hoffman and Sembiante found significant correlations between S's reported vividness of the image of a previously presented model of a highly skilled batter and scores on a test where Ss were required to compare test responses with the model. In addition, significant correlations were found between Ss' reports of visual imagery control and scores on the test, suggesting involvement of a generic visualizing ability.

Perhaps the apparent involvement of visual imagery ability in a task which requires Ss to discriminate responses against a *specific stereotyped model* should not be too surprising. Whether vividness of the image of the criterion performance and control of imagery however, are related to performance on a test in which Ss are required to evaluate responses on the basis of a set of propositions which describe acceptable performance is another matter, and it was this question that was also examined in this study.

METHOD

Film Preparation

Training and test films used in this study were selected from a collection of 8mm films which depicted over 200 trials of the two-feet standing long jump as performed by children in

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grades K - 9 (side view). Films were examined using single frame, stop-action and projection rates of 6 and 18 f/s. Technique used by jumpers was evaluated on the basis of eight criteria statements which incorporated basic biomechanical features of skilled performance. The statements were formulated to include definitive spatial and temporal checkpoints to facilitate determination of presence or absence of specific criteria. Absence of a critical performance criterion in a filmed performance was interpreted as an error in technique. The criteria used are presented in Figure 1.

Figure 1. Characteristics of correct performance of the standing long jump.

PRELIMINARY PHASE	1. Upper arms are swung rearward so that they are at least parallel to the floor. 2. Feet remain side by side during preliminary phase. One foot does not slide or step in front of the other during this phase.
PROPULSIVE PHASE	3. Jumper takes off with two feet simultaneously. 4. Upper arms clearly move in the direction of the jump so that they are at least parallel to the floor and in front of the body.
FLIGHT PHASE	5. Both knees are flexed to at least right angles (90 d[illegible]es) at some point during the flight. 6. As the jumper descends, both upper arms clea[illegible]ackward so that they pass the vertical plane.
LANDING PHASE	7. Both knees flex during the landing phase to lower the thigh to a position where it is at least parallel to the floor. 8. Upper arms are positioned clearly forward of the vertical plane at some point following touchdown.

Films were selected for use on the basis of technical quality and the extent to which the performance unambiguously depicted conformance or nonconformance to specific criteria. All performances were authentic executions of the skill; none were staged. The films were evaluated independently by two judges who were permitted to view the films as often as desired. Following an initial viewing session, interjudge agreement was 95%. A replay of the disputed items increased agreement to 98%. Items on which agreement could not be reached were eliminated.

Subjects

Eight-six preservice physical education trainees, freshman to senior levels, were required to participate in the experiment as part of course requirements. Three Ss were lost due to schedule conflicts and termination of enrollment.

Mental Imagery Tests

The Vividness of Visual Imagery Questionaire (VVIQ) (MARKS, 1973) and the Gordon Test for Visual Image Control (GCT) (RICHARDSON, 1969) were administered two weeks prior to the experimental program. The VVIQ is a 16-item self-report questionaire which directs S to summon images for specific visual phenomena and to rate the vividness of the image on a scale of 1 ("perfectly clear and vivid as normal vision") to 5 ("no image at all"). Marks reported a test-retest reliability coefficient of .85 for the VVIQ.

The GCT contains 12 statements which require S to report his ability to visualize objects in a variety of changing contexts and thus "control" images from one instance to the next. JUHASZ (1972) has reported odd-even reliabilities for the GCT ranging from .88 to .95.

Procedure

Ss were randomly allocated to four groups which were randomly assigned to one of four conditions: Correct (Cr) N=21; Correct-verbal (Cv) N=19; Correct-error (Ce) N=21; Control (C) N=22. In order to provide common points of reference in communicating about the skill, all groups were given a brief orientation to the four major performance phases (preliminary, propulsive, flight and landing) which included visual demonstration.

Cr. Ss were given opportunity to study the eight performance criteria and were provided with multiple replays of four different performances which conformed to all of the criteria. An 8-item "phase test" which required Ss to match each of the criteria statements with the performance phase in which they occurred was administered and was followed by feedback. Ss also observed 14 different examples of correct performance and were required to indicate whether each example conformed or did not conform to the established criteria. In all cases the examples conformed to the criteria.

Cv. Ss were given opportunity to study only verbal descriptions of the performance criteria. No visual examples of correct technique were provided. In addition to the phase test, an 8-item verbal recognition test which required Ss to identify incorrectly formulated statements describing performance criteria was administered. Ss were also required to hand-copy the criteria statements onto paper and then to write the statements from memory. In order to control for warm-up effects that might have stemmed from watching movie films, Ss were shown an irrelevant film (children throwing) and required to answer selected questions concerning the performance viewed..

Ce. Ss were given opportunity to study the performance criteria along with multiple replays of four different examples of correct performance (same performances used for Cr). The phase test was administered. In addition, Ss studied verbal descriptions and filmed examples of performances that did not conform to the criteria. Ss were given practice in identifying errors in three performances which was followed by feedback, and the examples were replayed.

C. Ss were given practice in viewing an irrevelant film (throwing) and responded to questions regarding the performance. Ss were not given opportunity to read the criteria statements nor to view examples of performance.

Treatments were administered to Ss in groups ranging from 3 to 13. Ss sat 3.60 to 4.60 meters from a movie screen onto which films were projected so that the image was approximately 61 centimeters in height. Ss were informed that the purpose of the session was to help them improve their proficiency in skill analysis and they were encouraged to give their best effort. E worked from a prepared script to insure uniformity of comment and treatment for Ss within groups. All treatments concluded by requesting Ss to summon a mental image of a skilled performer executing the standing long jump and to rate the image in accordance with the scale used for VVIQ. Experimental treatments consumed between 30 and 35 minutes.

Error Identification Test

An error identification test which determined S's ability to discern whether or not performances of the skill conformed or did not conform to the established criteria was administered immediately following pretraining. The test included four written questions concerning each of 12 films depicting jumping performance. Each of the questions required a "Yes/No" response and was formulated with regard to whether the example conformed or did not conform to a specific criterion (i.e. "During the preliminary phase were the upper arms swung rearward so that they were at least parallel to the floor?"). The four questions used for each film were randomly selected from the eight possible criteria. Questions were not available to Ss until they had viewed each film twice; once at normal speed and again at 6 f/s. Ss had 30 seconds to respond to the four questions.

Results

The means for correct responses on the error identification test are presented in Table I. Although the data do not indicate large functional differences between the groups following the pretraining experiences, ANOVA indicated that the differences were significant $F(3,79)=6.01$ $p<.01$. Scheffe's test revealed that means for Cv and Ce were significantly higher than for C. Sixty of the original Ss were available for a retention test during the third week following pretraining. Scores remained relatively stable over the interval with the average (absolute) change in score per S equal to 2.55 points. As indicated in Table I, scores did not change significantly over the interval, although analysis of the retention test means showed that only Ce was significantly different from C $F(3,56)=4.60$ $p<.01$.

Table I - Means and Standard Deviations for Performance-Error Identification Tests

Group	n	Initial Test		n	Retention Test		t
		$\bar{X}$	SD		$\bar{X}$	SD	
Correct	21	34.81	2.25	16	34.25	1.91	.28
Correct-verbal	19	35.80	2.33	15	34.73	2.31	1.16
Correct-error	21	36.06	2.57	15	35.80	1.93	.32
Control	22	32.64	4.63	14	33.07	3.85	.62

Means for the visual imagery measures, presented in Table II, show Cr to have reported higher vividness on VVIQ than did other groups, but the differences failed significance F (3,78)=2.70. No differences were found between groups for GCT F(3,79)=1.15 or for vividness of image of a correctly performed jump F(3,79)=.86, all p>.05.

Table II - Means and Standard Deviations for Imagery Tests

Group	VVIQ[a]		Gordon Test		Jump Imagery[a,b]	
	X	SD	X	SD	X	SD
Correct	29.66	7.74	8.95	3.59	1.71	.71
Correct-verbal	31.88	7.29	8.00	5.04	1.94	.93
Correct-error	31.47	10.97	7.76	3.47	1.85	.85
Control	31.81	9.07	9.04	3.44	2.00	.77

[a] Low score represents high vividness report.

[b] Image of correctly executed jump reported by Ss immediately before taking performance error identification test.

Table III displays correlation coefficients between each of the imagery tests and scores on the error identification test. Although there were slight tendencies for VVIQ and GCT scores to be inversely related to error identification scores for Ce and Cv, none of the correlations were significantly different from zero p>.05.

Table III - Correlation Coefficients Between Imagery Ratings and Performance Error Identification Scores

Group	Imagery Ratings		
	VVIQ	Gordon Control	Jump Imagery
Correct	.267	.038	.119
Correct-verbal	.350	−.467	−.030
Correct-error	.305	−.295	.038
Control	−.246	.099	109
Total	.065	−.204	.048

DISCUSSION

Although data from this study have furnished some statistical support for the hypothesis, the actual differences between groups were not large. In fact, when one considers that 30-35 minutes of carefully programmed visual and verbal training which included practice in discriminating errors (with feedback provided), resulted in scores only 7% higher than controls who received no training at all, one might be tempted to conclude that the gains are not worth the effort. Such pessimism shoud be avoided however, until the problem has been more fully investigated.

First, the fact that the means for Ce were significantly higher than C on the retention test suggests that the changes brought about through pretraining were relatively stable. Secondly, differences between groups may have been minimized due to factors peculiar to the test. For example, Ss in the experimental groups presumably monitored all eight aspects of the performance since the four questions were not presented until after the test film had been viewed. The difficulty of accurately rating several categories of movement behavior has been pointed up by LANDERS (1969). Confusion, interference and consequent indecision may have been concomitants of attempting to observe and remember eight aspects of performance while being required to recall only four of these eight for test purposes. The controls, having no prior instruction regarding what to look for, may have encountered relatively less interference. Were Ss to have been questioned regarding the conformity of the test performances to all eight criteria, the experimental groups might have improved their scores relative to the controls. What does seem to have been pointed out, both by this data as well as by data from OSBORNE and GORDON (1972), is that the specialized skill of error identification is not easily developed in trainees, particularly on a short-term basis.

Many training programs, where film libraries and projection equipment are scarce, incorporate a predominately verbal mode of instruction in performance analysis. The rather surprising performance of Cv suggests that rehearsal of verbal material relating to critical features of performance (where the skill is a familiar one) may be more beneficial than dividing training time between verbal and visual examples as was done in Cr. One possible explanation may lie in the active role Ss had to assume in the Cv condition. If a visual model was used, it had to be generated on the basis of verbal stimulus alone. Perhaps translation of conceptual material to an imaginal form was a critical factor in Cv, although if such was the case, it was not manifested in the particular type of imagery tests employed in the study. Another level of explanation of this finding is that when S are required to rate performance on the basis of a list of statements, the image formed may not be a visual (pictorial) image but a set of verbal propositions. If this is the case, the extensive experience of Cv with verbal descriptions may have facilitated formulation of these propositions. Failure to retain the propositions would account for the finding of no significant differences between Cv and C on the retention test.

When the data were further analyzed to determine the reason for Cr's poor performance, it was discovered that this group responded "No" significantly fewer times than other groups $F(3,79)=17.02$ $p<.01$, indicating a tendency to rate test films as conforming rather than not conforming to the criteria. When the percentage accuracy of responses for test items in which the modelled performance was incorrect was compared to percentage accuracy for test items where the modelled performance was correct, a marked difference in accuracy was observed for Cr (See Table IV). A differential accuracy score (% accuracy for correctly modelled behavior minus % accuracy for incorrectly modelled behavior) was computed for each S. The mean differential accuracy score for Cr was significantly higher than for other groups $F(3,79)=13.90$ $p<.01$. Thus the poorer performance of Cr clearly had its basis in errors of overgeneralization (i.e. mistaking instances of incorrect performance for examples of correct performance).

Table IV - Percentage Accuracy for Correctly and Incorrectly Modelled Performance

Group	Number of «NO» Responses	%Accuracy Correct Performance	%Accuracy Incorrect Performance	Differential[a] Accuracy
Correct	16.25	82.39	60.13	22.26
Correct-verbal	21.46	72.91	76.65	−3.73
Correct-error	23.40	75.71	75.22	−.14
Control	23.28	69.37	67.61	−1.67

[a] %accuracy for correctly modelled performance minus %accuracy for incorrectly modelled performance.

Pretraining under Cr conditions apparently induced a set to "see" performances as conforming to the criteria when in fact they did not. The vulnerability of inexperienced observers to such sets in pretraining has been previously demonstrated by LEPPMANN and MEFFORD (1968). A general tendency for observers to rate correctly performed skills with greater accuracy than incorrectly performed skills has been observed by OSBORNE and GORDON (1972) which they labelled the "differential accuracy phenomenon". They did not find, however, that different amounts of previous experience with the skill or a "feedback-no feedback" condition during test administration differentially affected the magnitude of the differential accuracy phenomenon. Assuming that demonstration of correct technique is the dominant training approach used in institutions, the potential for this to create sets to see performance as correct deserves further investigation.

Finally, there was no indication that S's reports of vividness or control of imagery were related to competence in the criterion task. This may have been a function of the test which, unlike that used in an earlier study (HOFFMAN & SEMBIANTE, 1970), did not direct Ss to compare test items with a *specific* visual model, nor were S's instructed to summon an image of a specific performance. If visual imagery was used, it was more likely to have been a diffuse abstraction of the distinguishing features of correct performance rather than a concrete image called for in the imagery tests. Such an abstract schema would not have lent itself to a vividness report. No evidence was found in this study to suggest that a generic visual image control factor was related to competency in detecting performance errors.

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LE TRANSFERT ET LES PHASES DE L'APPRENTISSAGE MOTEUR

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L'influence des expériences ou apprentissages antérieurs sur un nouvel apprentissage, sans aucun doute, doit être inclus dans les concepts ou modèles explicatifs du processus d'apprentissage des habiletés motrices. La présente étude fut entreprise dans le but de contribuer à l'avancement des connaissances en ce domaine de recherche.

Nombre de théories, principes, et modèles pour tenter d'expliquer le transfert de l'apprentissage ont d'abord été développés dans le domaine cognitif et furent ensuite appliqués, à tort ou à raison, à l'apprentissage des habiletés motrices. Par exemple, pour deux tâches motrices apprises en succession, les concepts de la similarité des stimuli et/ou des réponses furent souvent utilisés pour prédire la direction et le degré de transfert (exemple: *Osgood Transfer Surface*). Les recherches poursuivant la vérification de telles généralisations ont cependant démontré des résultats plus ou moins inconsistants et ainsi n'ont pas vraiment contribué à une compréhension satisfaisante du transfert en apprentissage moteur. Les deux objectifs de la recherche réalisée consistaient:

a) à essayer de développer un modèle de transfert propre à la problématique de l'apprentissage des habiletés motrices,

b) à effectuer une première vérification expérimentale de sa valeur.

La plupart des études effectuées sur le transfert de l'apprentissage moteur utilisaient des tâches d'apprentissage qui dépendaient grandement de processus perceptuels et/ou cognitifs. Nombre de ces études ne concernaient que le transfert qui s'effectuait à la phase initiale d'apprentissage d'une habileté motrice. Les résultats de ces études démontrèrent, entre autres,

a) qu'un entraînement perceptuel, verbal, perceptuel ou verbal-moteur produisait normalement des effets de transfert positifs à la phase initiale d'apprentissage d'une nouvelle tâche qui est partiellement similaire aux tâches d'entraînement, et

b) que ces effets de transfert disparaissaient progressivement à mesure que le nouvel apprentissage avançait (ADAMS, 1954; BAKER & WYLIE, 1950; GAGNÉ &FOSTER, 1949a, b; GAGNÉ, BAKER & FOSTER, 1950; McALLISTER, 1953).

Considérant, d'une part, la nature perceptuelle, cognitive des entraînements ou des tâches d'entraînement employées dans ces études et, d'autre part, la nature perceptuelle, cognitive de la phase initiale d'apprentissage des habiletés motrices, les effets de transfert observés peuvent être anticipés et expliqués. La disparition des effets de transfert pendant l'apprentissage peut probablement s'expliquer par le peu de compatibilité entre les entraînements et les processus qui soustendent la performance motrice à une phase finale d'apprentissage.

Cette hypothèse, soulevée pour expliquer les résultats des études mentionnées, n'a pas encore été vérifiée. Aucune des études relevées dans le domaine du transfert de l'apprentissage moteur ne s'est intéressée à une comparaison des effets de transfert d'entraînements perceptuels ou cognitifs à ceux de transfert d'entraînements moteurs, et ce, en rapport avec une tâche reconnue comme sollicitant respectivement des processus perceptuels ou cognitifs et des processus moteurs aux phases initiale et finale d'apprentissage.

Des chercheurs comme GAGNÉ, FOSTER et CROWLEY (1948) ont cependant fait remarquer que les effets de transfert peuvent également apparaître à un stade avancé d'apprentissage d'une habileté nouvelle. FITTS et POSNER (1967) ont suggéré l'importance du transfert aux différentes phases d'apprentissage des habiletés motrices. Dans le domaine de la psychologie différentielle, FERGUSON (1954) a émis l'hypothèse que des aptitudes humaines différentes peuvent exercer des effets de transfert également différents, et ce, à des phases différentes d'apprentissage. De nombreuses études appuyèrent partiellement la position de FERGUSON, entre autres, celles de FLEISHMAN et ses collègues (BLIXT, 1970; FLEISHMAN, 1957; FLEISHMAN, 1960; FLEISHMAN & HEMPEL, 1955; FLEISHMAN & RICH, 1963; HINRICHS, 1970; NOMATA, 1971, PARKER & FLEISHMAN, 1961; REYNOLDS, 1952). Récemment des modèles qui tiennent compte des changements de niveau des aptitudes des sujets et des exigences des tâches pendant l'apprentissage d'une tâche nouvelle sont apparus dans la littérature (ALVARES & HULIN, 1972, 1973; BUSS, 1973; CORBALLIS, 1973; CORBALLIS & TRAUB, 1970). À cet effet, BUSS a proposé que plus deux tâches sont similaires, tel que déterminé par les *factor loadings*, plus les effets de transfert doivent être prononcés.

Il est aussi bien établi que les phases d'acquisition des habiletés motrices sont des considérations essentielles en apprentissage moteur, pouvant servir à trouver une explication au transfert de l'apprentissage moteur. En effet, la plupart des concepts ou modèles utilisés pour expliquer le processus d'apprentissage des habiletés motrices soulignent, avec peu d'élaboration, l'importance du transfert des apprentissages antérieurs et suggèrent l'importance des processus perceptuels et cognitifs à la phase initiale d'apprentissage, et l'importance des processus moteurs particulièrement à la phase finale d'acquisition des habiletés motrices (ADAMS, 1967; FITTS, 1964; GENTILE, 1972; KEELE, 1968; LA FAVE, 1972; MILLER, GALANTER & PRIBRAM, 1960; ROBB, 1974; RUDIK, 1963).

Nombre d'études publiées supportent l'importance du transfert des expériences ou apprentissages antérieurs lors de l'acquisition d'une nouvelle habileté motrice, de même que l'existence de changements au plan des processus employés, ou des exigences des tâches, pendant l'apprentissage des habiletés motrices. Cependant, il faut déplorer l'absence de connaissances suffisantes sur l'intégration théorique du transfert et des phases de l'apprentissage moteur.

Le problème soumis à l'étude de cette recherche consistait donc à déterminer si les entraînements d'une composante discriminatoire et d'une composante motrice associées à la performance dans une tâche motrice pouvaient produire des effets de transfert différents à des niveaux différents d'apprentissage de cette tâche.

MÉTHODES DE RECHERCHE

Sujets

À partir d'un groupe de 130 étudiants de l'Université du Québec à Trois-Rivières, tous volontaires, 55 sujets furent sélectionnés à l'aide d'une table de chiffres aléatoires et répartis, de la même façon, en quatre groupes de sujets: le groupe témoin (n = 14), le groupe d'entraînement de la composante discriminatoire (ECD, n = 18), le groupe d'entraînement de la composante motrice (ECM, n = 10), et le groupe d'entraînement de la composante non-pertinente (ECI, n = 10). Trois sujets furent éliminés.

Appareillage, tâche et critères d'apprentissage

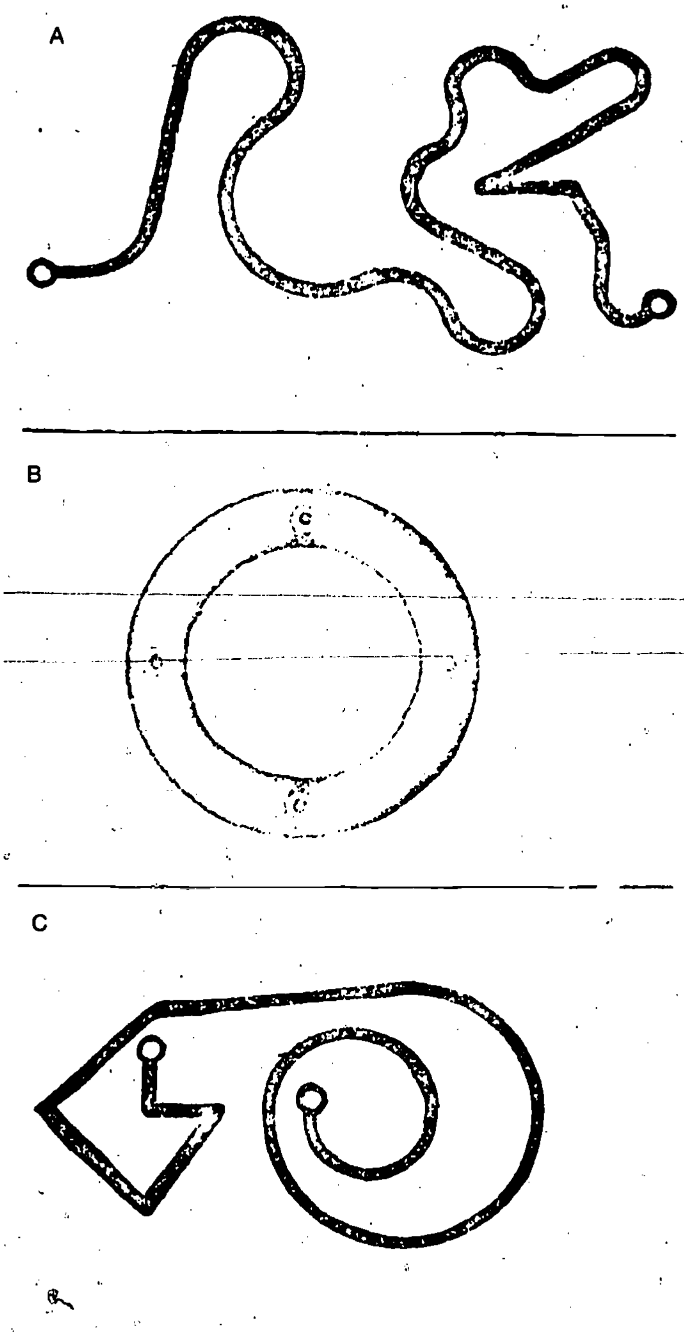
Le «Test du tourneur» de Bettendorff (Belgique), reconnu comme étant une tâche de coordination bi-manuelle, fut utilisé dans l'étude. Afin d'exécuter la tâche, le sujet devait à l'aide de manivelles déplacer une plaque, selon deux dimensions, dans le but de conserver la pointe métallique à l'intérieur d'un labyrinthe donné. Le temps total employé pour passer d'une extrémité à l'autre du labyrinthe (temps total) fut enregistré, au .01 de seconde près, au moyen d'un chronomètre digital et de deux relais reliés aux deux extrémités du parcours. Le temps total fut considéré représentatif de l'apprentissage de la séquence motrice de la tâche d'apprentissage. Le temps total passé à l'extérieur du tracé (temps d'erreur) fut aussi enregistré, au .01 de seconde près, au moyen d'un chronomètre digital relié au Test du tourneur. Comme l'erreur constante, après vérification, était presque égale à zéro le temps d'erreur fut considéré comme indicateur de l'apprentissage discriminatoire de la tâche d'apprentissage.

Procédures

La période d'apprentissage fut précédée d'une période d'entraînement visant l'acquisition des composantes discriminatoire et motrice chez le groupe ECD et chez le groupe ECM. Le groupe ECI a effectué la pratique d'une autre tâche pendant la période d'entraînement. Le groupe témoin fut seulement soumis à la période d'apprentissage, sans activité préparatoire.

À la fin de l'entraînement, le groupe ECD possédait les capacités d'exécuter, avec une précision quasi parfaite, le parcours du labyrinthe d'entraînement discriminatoire (figure 1, A), en ne plaçant pas d'accent particulier sur la vitesse d'exécution de la tâche. Le groupe ECM, à la fin de son entraînement, pouvait exécuter le parcours du labyrinthe d'entraînement de la séquence motrice en 35 secondes au moins (figure 1, B). Le labyrinthe utilisé pour la tâche d'apprentissage est illustré dans la figure 1, C.

Figure 1 - Illustrations des labyrinthes des tâches d'entraînement discriminatoire (A) et de la séquence motrice (B), et de la tâche d'apprentissage (C).



Le traitement du premier jour consistait dans l'entraînement, les deuxième et troisième jours de l'expérimentation en l'administration de 30 essais de la tâche d'apprentissage, répartis en cinq sessions de pratique. Deux sessions de sept essais, séparées d'un repos de 15 minutes, furent administrées les deuxième et troisième jours, cependant le troisième jour comprenait une session additionnelle de deux essais, précédée d'un repos de 15 minutes. Les deux premiers essais de chacune des sessions (i.e. les essais 1, 2; 8, 9; 15, 16; 22, 23; et 29, 30; ont été sélectionnés pour servir de variables dépendantes, et ce, pour les deux critères d'apprentissage: temps d'erreur et temps total.

RÉSULTATS

Les résultats furent analysés dans le cadre d'un schéma expérimental 4 × 10, avec mesures répétées au dernier facteur. Les groupes et les essais formaient les deux facteurs. Le modèle de l'analyse multivariée de la variance fut employé pour vérifier les hypothèses spécifiques pertinentes au problème étudié. Les vecteurs analysés étaient composés de deux ou quatre essais. Les analyses statistiques furent basées sur les deux critères d'apprentissage: temps d'erreur et temps total. Le nombre total d'hypothèses spécifiques vérifiées dans l'étude était de 48, à chacune étant assignée un alpha de .001. Les statistiques t de Bonferroni ont servi à faire, simultanément, les inférences statistiques. L'alpha choisi pour l'étude était inférieur ou égal à .05.

Temps d'erreur

Les moyennes et les écarts types des mesures prises au temps d'erreur sont présentés au tableau I. Une interaction significative entre les groupes et les sessions d'apprentissage fut obtenue lorsque le changement en performance du groupe ECD fut comparé à celui du groupe témoin, $F(4,45) = 6.63$, $p < .001$. Les deux groupes ont démontré un gain en performance, favorisant le groupe témoin, de la première à la dernière session. Ce dernier groupe n'ayant pas reçu d'entraînement démontra un niveau de performance inférieur à celui du groupe ECD, aux premiers essais de la période d'apprentissage (figure 2). Une autre interaction significative entre les groupes et les sessions apparaît lorsque le changement en performance des groupes ECD et ECM fut comparé à la période d'apprentissage, $F(4,45) = 12.25$, $p < .001$. Ce résultat favorisait le groupe ECM, groupe qui avait initié la période d'apprentissage à un niveau de performance plus bas que le groupe ECD (figure 2). Différemment, les comparaisons du gain en performance des groupes témoin et ECM, et des groupes témoin et ECI, étaient non-significatives.

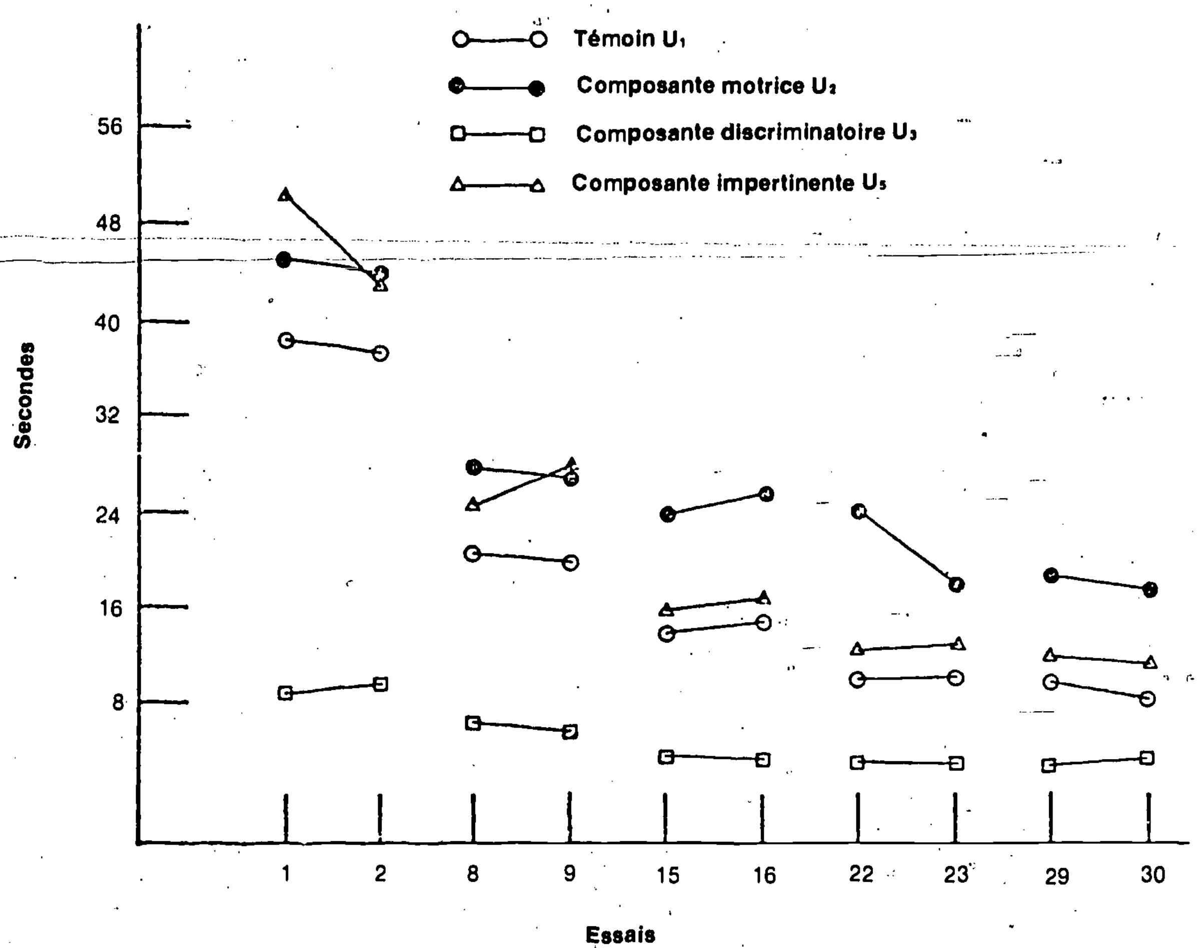
Au niveau des trois premières et de la dernière session d'apprentissage, les comparaisons faites entre les groupes témoin et ECM ne se sont pas avérées significatives. Une différence significative fut cependant mise en évidence, en faveur du groupe témoin, à la quatrième session d'apprentis-

Tableau I - Temps d'erreur des groupes en secondes.

Groupes*		Essais d'apprentissage 1	2	8	9	15	16	22	23	29	30
U_1	$\bar{X}$	37.92	37.07	20.23	19.47	13.65	14.37	9.77	10.14	9.56	8.07
	s	21.11	22.07	19.08	10.96	9.07	8.66	6.60	7.85	7.45	6.56
U_2	$\bar{X}$	44.45	43.63	27.60	26.78	23.84	25.19	23.48	17.81	18.58	17.55
	s	19.41	15.77	12.53	11.94	14.72	14.07	13.97	9.82	9.36	11.50
U_3	$\bar{X}$	8.40	9.21	6.11	5.63	3.44	3.15	2.72	2.90	2.48	3.13
	s	6.08	7.79	7.77	6.24	4.98	3.21	3.29	3.50	2.32	3.17
U_4	$\bar{X}$	50.12	42.62	24.38	27.54	15.56	16.71	11.96	12.91	11.95	11.01
	s	27.64	23.81	15.76	16.85	10.99	12.11	10.39	10.27	8.37	9.58

* U_1 = groupe témoin ; U_2 = groupe de la composante motrice ; U_3 = groupe de la composante discriminatoire ; U_4 = groupe de la composante impertinente.

Figure 2 - Interaction entre les composantes « entraînées » et les sessions pour le temps d'erreur.



sage, F (2,47) = 10.14, p < .001 (figure 2). Lorsque les groupes témoin et ECD furent comparés aux cinq sessions d'apprentissage, une seule valeur F, significative, fut obtenue en faveur du groupe ECD, et ce, pour la première session d'apprentissage F (2,47) = 10.44 p < .001 (figure 2). D'autres comparaisons entre les groupes ECM et ECD révélèrent des différences significatives, en faveur du groupe ECD, aux cinq périodes d'apprentissage, dans l'ordre, F (2,47) = 12.87, p < .001 ; F (2,47) = 11.39, p < .001 ; F (2,47) = 17.52, p < .001 ; F (2,47) = 19.58, p < .001 ; F (2,47) = 18.25, p < .001 (figure 2). Cependant, aucune des comparaisons faites entre les groupes témoins et ECI ne fut significative.

Temps total

Les moyennes et écarts types dans les mesures prises au temps total sont illustrés au tableau II. Une interaction significative entre les groupes et les sessions fut obtenue lorsque le groupe témoin fut comparé au groupe ECM, F (4,45) = 6.03, p < .001. Le degré d'amélioration en performance pendant la période d'apprentissage fut plus prononcé chez le groupe témoin que chez le groupe ECM (figure 3). Les autres résultats des analyses d'interaction entre les groupes et les sessions n'étaient pas significatifs.

Trois effets principaux significatifs apparurent lorsque les groupes témoin et ECM furent comparés aux trois premières sessions d'apprentissage, dans l'ordre, F (2,47) = 9.20, p < .001 ; F (2,47) = 8.91, p < .001 ; F (2,47) = 8.42, p <.001.

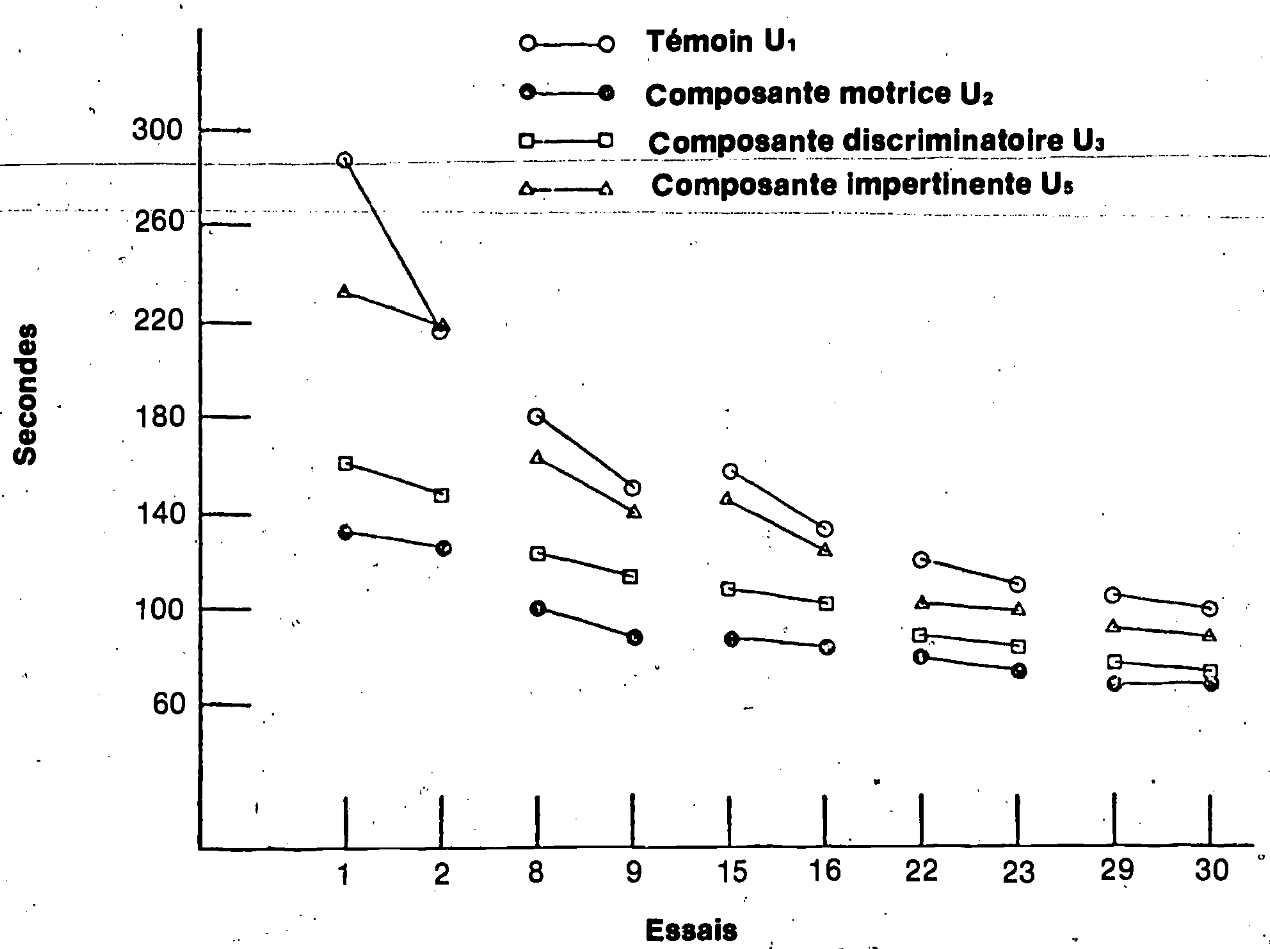
Tableau II - Temps total des groupes en secondes.

		Essais d'apprentissage									
Groupes *		1	2	8	9	15	16	22	23	29	30
U_1	$\bar{X}$	288.13	217.55	181.97	150.46	158.05	133.11	120.09	109.19	105.11	99.90
	s	134.92	66.92	59.40	36.48	42.96	34.73	28.75	27.86	28.54	29.50
U_2	$\bar{X}$	133.51	126.14	101.51	88.08	88.26	84.31	79.44	74.76	68.48	69.51
	s	44.65	35.23	28.30	25.80	26.02	22.97	20.33	17.92	15.96	16.34
U_3	$\bar{X}$	161.42	147.67	124.10	113.71	108.64	102.11	88.22	83.83	76.40	73.40
	s	30.36	29.39	24.46	18.41	30.92	28.65	26.24	25.25	22.27	21.27
U_4	$\bar{X}$	232.89	216.47	163.01	140.65	146.03	124.09	101.43	97.96	91.21	88.90
	s	97.98	93.92	86.04	58.80	80.16	66.17	35.08	30.22	37.07	35.88

* U_1 = groupe témoin ; U_2 = groupe de la composante motrice ; U_3 = groupe de la composante discriminatoire ; U_4 = groupe de la composante non-pertinente.

Cependant, cette comparaison aux quatrième et cinquième sessions approchait le seuil de signification choisi ($p < .001$), $F(2,47) = 6.17$, $p < .005$; $F(2,47) = 7.13$, $p < .005$. Les différences observées favorisaient le groupe ECM (figure 3). Un autre effet principal significatif fut trouvé, en faveur du groupe ECD, lorsque les groupes témoin et ECD furent comparés à la première session d'apprentissage, $F(2,47) = 8.38$, $p < .001$ (figure 3). Aucune différence significative ne fut obtenue lorsque cette dernière comparaison fut réalisée à chacune des quatre dernières sessions d'apprentissage, et lorsque les groupes témoin et ECI ainsi que les groupes ECM et ECD furent comparés aux cinq sessions d'apprentissage.

Figure 3 - Interaction entre les composantes «entraînées» et les sessions pour le temps total.



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DISCUSSION

Les résultats de cette étude supportent un modèle de transfert de l'apprentissage moteur qui intègre les études antérieures sur les aptitudes humaines et les phases d'apprentissage moteur, ainsi que celles sur le transfert de l'apprentissage moteur. Les résultats ont mis en évidence que:

a) ECD et ECM ont interagi avec les phases d'apprentissage de la tâche employée pour produire des effets de transfert;

b) seulement ECD a démontré des effets positifs de transfert à la phase initiale d'apprentissage, tandis que seulement ECM a produit des effets de transfert (interférence) à une phase plus avancée ou finale d'apprentissage lorsque le temps d'erreur fut analysé; et

c) ECD et ECM ont résulté en des effets positifs de transfert, d'importance relative similaire, à la phase initiale d'apprentissage, tandis que seulement ECM a démontré des effets positifs de transfert pendant la phase finale d'apprentissage lorsque le temps total fut pris en considération.

L'importance de l'emploi des deux critères d'apprentissage utilisés pour refléter les effets de transfert de ECD et ECM fut également appuyée par les résultats.

L'hypothèse formulée par FERGUSON (1954, 1956) dans le domaine de la psychologie différentielle et des stades de pratique supporte les résultats de la présente étude. En effet, il suggérait que différentes sortes d'apprentissage antérieur (aptitudes) peuvent produire des effets de transfert différents à une ou plusieurs phases d'apprentissage, et que les composantes (aptitudes) qui transfèrent et produisent des effets à une phase d'apprentissage peuvent être différentes de celles qui transfèrent et produisent des effets à une autre phase. Dans le même domaine, BUSS (1973) proposait récemment que deux changements possibles peuvent expliquer les effets de transfert:

a) les changements en exigences ou en structures d'une tâche pendant le processus d'apprentissage, et

b) les changements chez l'individu au plan des processus comportementaux ou de la structure cognitive.

Par conséquent, les résultats de l'étude peuvent probablement s'expliquer, à la fois, par les exigences de la tâche utilisée dans l'étude aux phases initiale et finale d'apprentissage, par la nature des composantes soumises à l'entraînement.

Les résultats de plusieurs études en psychologie différentielle qui ont utilisé l'approche expérimentale, l'analyse de la corrélation, ou l'analyse factorielle, sont en accord avec les résultats de cette étude. En plus de l'étude de FLEISHMAN et RICH (1963), nombre d'études ont démontré que les aptitudes humaines, particulièrement importantes à la phase initiale d'apprentissage de certaines habiletés motrices, possèdent des composantes perceptuelles et/ou cognitives, et que les aptitudes qui contribuent à la performance au stade final de pratique correspondent en grande partie à des composantes motrices (BLIXT, 1970; FLEISHMAN, 1957; FLEISHMAN, 1960; FLEISHMAN & HEMPEL, 1955; HINRICHS, 1970; INOMATA, 1971; PARKER & FLEISHMAN, 1961; REYNOLDS, 1952; etc.).

Les conclusions de cette recherche sont aussi en accord avec les concepts ou modèles descriptifs ou explicatifs des phases d'apprentissage des habiletés motrices. En général, ces concepts ou modèles comprennent, d'une part, une phase initiale d'apprentissage, associée en particulier avec des caractéristiques ou des processus perceptuels, verbaux, et/ou cognitifs, d'autre part, une phase finale qui est décrite en termes de phase motrice ou automatique (ADAMS, 1967; FITTS, 1964; GENTILE, 1972; KEELE, 1968; LA FAVE, 1972; MILLER, GALANTER & PRIBRAM, 1960; REYNOLDS, 1952; ROBB, 1974; RUDIK, 1963).

À cet effet, FITTS et POSNER (1967) ont proposé que la phase initiale d'apprentissage se caractérisait par le transfert de *sets*, modes d'attaque et de stratégies généraux, associés aux habiletés apprises antérieurement, et en relation avec la tâche nouvelle. Au contraire, l'absence de différence significative dans cette étude, entre les groupes témoins et ECI, suggère que les stratégies apprises pendant l'entraînement, qui transfèrent à la tâche d'apprentissage, sont plus de nature spécifique que de nature générale.

Des effets de transfert différents ont résulté de ECD et de ECM à la phase finale d'apprentissage pour le temps total et aux phases initiale et finale d'apprentissage lorsque le temps d'erreur fut analysé. Ces résultats supportent les études qui ont montré que l'entraînement de composantes différentes produisait des effets de transfert différents (BAKER, WYLIE & GAGNÉ, 1950; ELLIS & MULLER, 1964; GAGNÉ & FOSTER, 1949a, b; LERSTEN, 1968; McALLISTER, 1953; VACHON, 1973a; VANDERPLAS, SANDERSON & VANDERPLAS, 1964).

Lorsque les groupes témoins et ECD furent comparés en temps total ou en temps d'erreur, à la phase initiale d'apprentissage, des effets de transfert positifs furent évidents, alors qu'aucun effet de transfert ne fut observé à la phase finale d'apprentissage. En contradiction avec ces résultats, FITTS et POSNER ont proposé que les effets positifs du transfert persistaient jusqu'à la phase terminale d'apprentissage d'une habileté. Cette dernière affirmation est supportée par quelques études (GAGNÉ & BAKER, 1950; GAGNÉ, BAKER & FOSTER, 1950; VACHON, 1973a). Elle est aussi supportée par un résultat de la présente étude: les effets de transfert de ECM sont apparus aux phases initiale et finale d'apprentissage, lorsque la mesure du temps total fut considérée.

D'autre part, les études qui ont révélé que les effets de transfert se produisaient à la phase initiale d'apprentissage et tendaient à disparaître pendant la progression de l'apprentissage, supportent les données de l'étude concernant le groupe ECD (ADAMS, 1954; BAKER & WYLIE, 1950; GAGNÉ & FOSTER, 1949a, b; GAGNÉ, BAKER & FOSTER, 1950; McALLISTER, 1953).

Ces derniers résultats semblent s'expliquer par l'importance de la nature des phases d'apprentissage pour le transfert de ECD. En effet, il existait probablement une relation entre ECD

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et la phase initiale d'apprentissage qui était particulièrement associée avec des processus non-moteurs. D'autre part, la phase finale fut considérée comme étant associée à des processus moteurs. Ces processus semblaient peu impliqués dans ECD et aucun effet de transfert ne fut évident dans cette situation. L'oubli de la composante discriminatoire, ou le plafonnement de la performance au temps d'erreur pendant l'apprentissage, ne peuvent expliquer les résultats obtenus (VACHON, 1975).

L'observation de l'interférence chez le groupe ECM, au temps d'erreur, à la phase finale de pratique, entre en conflit avec les résultats des quelques études réalisées sur l'interférence proactive. En effet, ces études indiquaient,

a) que l'interférence, lorsqu'elle se manifeste, apparaît pendant une brève période de temps qui suit la fin de l'entraînement, ou seulement aux premiers essais de pratique d'une tâche d'apprentissage, et

b) que des effets de transfert positifs tendent à se manifester entre les deux mêmes tâches, soit à la suite d'une longue période de temps après la fin de l'entraînement, ou aux derniers essais de pratique de la tâche d'apprentissage (ADAMS, 1954; BUNCH, 1939; CRATTY, 1962; LERSTEN, 1968; McCORMACK, 1958, VACHON, 1973b).

L'explication possible de ce dernier résultat peut se faire en considérant, à la fois, la nature de ECM, les stratégies ou processus reflétés par le temps d'erreur, et les exigences de la tâche d'apprentissage à ses phases initiale et finale d'apprentissage. D'une part, ECM impliquait l'acquisition d'une séquence motrice et de la vitesse, sans emphase sur l'apprentissage discriminatoire et la précision. D'autre part, le temps d'erreur (le critère d'apprentissage discriminatoire) fut considéré comme reflétant l'apprentissage discriminatoire et la précision pendant la pratique de la tâche d'apprentissage. Ainsi, si apprendre à agir rapidement pendant ECM, et performer avec précision pendant l'apprentissage s'opposaient, de façon non-linéaire, le dernier résultat pourrait alors s'expliquer. De plus, si cette hypothèse est véridique, l'interférence devrait être apparente à la phase initiale tout comme à la phase finale d'apprentissage. Cependant, les résultats démontrent que les effets d'interférence ont augmenté en importance pendant l'apprentissage.

La nature des phases d'apprentissage a pu aussi influencer ce résultat. En effet, à la phase initiale d'apprentissage, le sujet peut avoir adopté les stratégies apprises pendant ECM sans négliger la précision, compte tenu qu'elle était associée aux exigences de la tâche à cette phase de pratique. Ainsi, en temps d'erreur, les performances des groupes ECM et témoin étaient similaires tandis qu'en temps total, la performance du groupe ECM était supérieure à celle du groupe témoin. D'autre part, à la phase finale d'apprentissage, le sujet peut avoir opté pour la vitesse, laquelle coïncide alors avec les exigences de la tâche et l'entraînement. En conséquence, des effets de transfert positifs de la part de ECM sont apparus à cette phase finale d'apprentissage lorsque le temps total fut employé, et des effets d'interférence sont apparus au temps d'erreur qui lui était associé avec la précision. Il semble donc possible de formuler l'hypothèse suivante: l'interférence observée n'est pas une variable de performance mais une variable d'apprentissage. Les deux stratégies peuvent ainsi avoir été choisies par le sujet selon la nature de l'entraînement et les phases d'apprentissage.

ELLIS (1969) formulait l'hypothèse que l'interférence est optimale lorsque deux systèmes d'habitude possèdent une force égale. Cette hypothèse semble en accord avec les résultats de l'étude de SIIPOLA et ISRAEL (1933) et s'avère une autre explication plausible du dernier résultat.

Contrairement aux résultats discutés jusqu'à présent qui mettent en évidence des effets différents de transfert à une phase particulière d'apprentissage à la suite d'entraînements différents, plusieurs études en apprentissage moteur rapportent des effets de transfert positifs et équivalents à la suite d'entraînements différents (HOLTON & GOSS, 1956; etc.).

Des résultats similaires ont été obtenus dans cette étude lorsque ECM fut comparée à ECD à la phase initiale d'apprentissage en temps total. Ces résultats pourraient s'expliquer en termes de similarité des réponses pour le groupe ECM et en termes de similarité des stimuli pour le groupe ECD. Cependant, tous les autres résultats de l'étude ne peuvent s'expliquer adéquatement en référant à ces seuls concepts puisque les entraînements ont produit des effets de transfert différents, selon la phase d'apprentissage et le critère d'apprentissage concernés. Il faut donc trouver d'autres explications.

Le fait que le groupe ECD démontra un transfert positif à la phase initiale d'apprentissage en temps total peut s'expliquer de bien des façons (GAGNÉ, BAKER & FOSTER, 1950; LORDAHL & ARCHER, 1958; VANDERPLAS, SANDERSON & VANDERPLAS, 1964). L'explication qui semble la plus convenable mérite d'être décrite. En continuité avec les discussions précédentes, il est possible de développer une explication théorique. D'une part, ECM et le temps total étaient en relation, et pour cette raison le dernier critère était particulièrement sensible aux effets de transfert de ECM. En outre, il est fortement probable que des processus moteurs étaient associés à la performance de la phase initiale de pratique jusqu'à un certain point, mais à un degré moins grand que les processus non-moteurs. Il est alors possible d'avancer que les effets de transfert de ECM étaient susceptibles d'apparaître, en temps total, à cette phase initiale d'apprentissage. Cependant, ces effets de transfert étaient probablement limités en importance à la phase initiale d'apprentissage tandis que ceux de ECD étaient favorisés vu la nature non-motrice de cette même phase d'apprentissage. Aussi, pour cette dernière raison, le critère d'apprentissage temps total était probablement d'importance secondaire à la phase initiale d'apprentissage lorsque comparé au critère temps d'erreur.

L'explication la plus satisfaisante des résultats semble correspondre aux relations qui existent entre la nature des composantes, la nature des phases d'apprentissage des habiletés motrices, et la nature des critères d'apprentissage employés. Il semble qu'une telle conception du transfert de l'apprentissage moteur peut convenir aux domaines de la psychologie expérimentale, de la psychologie différentielle, et susciter de nouvelles recherches sur le transfert de l'apprentissage moteur. Il faut cependant considérer que l'étude du problème central de cette recherche, que le cadre théorique suggéré comme explication des résultats sont, tous deux, à leurs phases initiales de développement.

CONCLUSIONS

Les résultats de cette étude ont entraîné les conclusions suivantes:

1. ECD (l'entraînement d'une composante discriminatoire) et ECM (l'entraînement d'une composante motrice) interagissent avec les phases d'apprentissage des habiletés motrices pour la production d'effets de transfert. Ainsi, l'interaction, entre la nature des composantes «entraînées» et celle des phases d'apprentissage d'une habileté motrice, est un facteur déterminant du transfert des apprentissages antérieurs.
2. ECD produit des effets de transfert positifs qui apparaissent à la phase initiale d'apprentissage et qui tendent à disparaître lorsque l'apprentissage moteur progresse. Ce résultat semblait supporter le point de vue que les stratégies acquises lors de ECD sont appliquées à la phase initiale ou perceptivo-cognitive d'apprentissage, mais que leurs applications sont non-pertinentes pendant la phase finale ou motrice de l'apprentissage moteur.
3. ECM démontre des effets de transfert positifs sur le critère d'apprentissage de la séquence motrice (temps total) et interfère avec la performance sur le critère d'apprentissage discriminatoire (temps d'erreur) à la phase avancée ou motrice d'apprentissage moteur. Il fut aussi observé que ECM: produit des effets de transfert positifs en temps total, et n'entraîne aucun effet de transfert en temps d'erreur à la phase initiale d'apprentissage. En plus de la pertinence de ECM pour l'apprentissage de stratégies qui sont appliquées subséquemment, principalement pendant la phase finale ou motrice d'acquisition de l'habileté motrice, l'importance des relations entre les composantes «entraînées» et les critères d'apprentissage, fut également supportée pour l'analyse des effets de transfert.
4. Les phases initiale et finale d'acquisition de la tâche d'apprentissage employée sont respectivement associées avec une composante discriminatoire et une composante motrice. L'exécution de la tâche exigerait successivement des stratégies discriminatoires et motrices au cours de son acquisition.

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SCIENCES DU SPORT : DISCIPLINE ACADÉMIQUE

PHYSICAL EDUCATION, THE SPORTS SCIENCES AND WHITEHEAD'S DILEMMA

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INTRODUCTION

I am grateful to John Salmela for having given me the opportunity to collect and attempt to organize the ideas represented in this paper. My own interests as a teacher and coach over almost thirty years have centered around learning, both cognitive and psychomotor, as well as the psychology of sport. For that reason I saw this assignment as an opportunity to clear up, or at least bring into sharper focus, many uncertainties that have been building in my mind for some time. These uncertainties relate to the debate or dialogue (it takes both forms), about our identity as a field. The discussion is well documented in our journals, textbooks, and less formal publications and is alive and well in the proverbial smoke-filled rooms, coffee lounges, and wherever workers in our field meet. The questions take various forms: What is physical education? It is a field of knowledge? A discipline? Are any of our more restricted sub-areas such as psychomotor learning or sport psychology disciplines or sub-disciplines? What is or should be the relationship between these sub-areas and physical education? Are they part of physical education, should they, or can they, stand apart? Do they relate better to other established disciplines outside this field? Are we a profession? What is a professional? A specialist? What problems are researched? Who selects them? On what basis?

Looking at this list it occurs to me that when I was asked to speak to this meeting I accepted eagerly because it was the first question related to physical education that I had been asked in a long time to which I could give a definite answer!

But difficult as it may be we must come to some agreements so that we can better direct and coordinate our efforts, assign tasks, and earn increased respect in the general community.

To that end this paper is an attempt to examine the current meanings, relationships, and possible relationships of several concepts of central concern to the field of physical education.

It begins with a discussion of the ideas of some critics of specialization and proceeds to examine current views of the concept of an academic discipline. Then, since psychology has been widely recognized as a discipline for some decades, and because it has an obvious relationship to the field of interest represented at this meeting, I will sample a substantial body of literature that assesses the state of that art and the fruits of a great deal of research effort.

In the final two sections, the possibility of physical education as an applied profession and some implications for research in such a profession are discussed.

SPECIALIZATION

In primitive societies, it can be said with some truth that the whole culture resides in each individual, whereas in modern industrial societies the inevitable effect on the growth of technology is the development of more skills, techniques, processes, and related information than any one person can gain control over. This situation then forces people, either through intent or by accident, to acquire mastery over some selected areas of the increasingly unmanageable total bank of accumulated knowledge. Such specialization has reached its highest level of institutionalized development in computer, space, and other electronic technology, and in another often very different sense, in the professions. The intensive education and/or training involved in advanced technology or the professions leads to a degree of expertise that is the basis of job security or mobility, as desired, relatively high income, and high status. That is of course, provided the job for which the training prepares one does not become redundant as a result of new developments. It is axiomatic that a technological society depends on highly specialized professionals and skilled technicians for its maintenance and continued development. This has tended to create a general feeling that specialization is of itself and in itself a good thing. But there has also been a persistent undercurrent of suspicion and uneasiness concerning the ends to which such uncommon knowledge might be put. This anxiety is expressed in the recurring theme of the "mad scientist" who spends his time developing potions of incredible power; constructing monsters out of corpses, electronic components or a mix of the two; or, with the help of a cadre of others like himself, assembles an army of automatons equipped with a variety of death dealing ray guns and super vehicles for the purpose of world domination. The mystique that has always surrounded knowledge inaccessible to the average man, is the source of this myth as it appears to be the source of a good deal of the impetus towards current interest in, if not obsession with, various manifestations of mysticism. It was also the traditional source of the witch doctor's power in primitive cultures.

But on a higher intellectual plane, a number of this century's scholarly thinkers have been more explicit in their views of what they consider to be serious dangers inherent in our collective dependency on knowledge available through, and generated by highly specialized professionals.

Notable among such men was Alfred North Whitehead. He pointed out that while progress would be made in this way it would be progress in a narrow and restrictive groove that prevents important cross-referencing with, and awareness of, developments in other fields. He elaborated:

> The danger arising from this aspect of professionalism are great, particularly in our democratic societies. The directive force of reason is weakened. The leading intellects lack balance. They see this set of circumstances, or that set; but not both sets together. The task of coordination is left to those who lack either the force or the character to succeed in some definite career. In short, the specialized functions of the community are performed better and more progressively, but the generalised direction lacks vision. The progressiveness in detail only adds to the danger produced by the feebleness of coordination. (1962/1925, p. 176).

It is interesting that Buckminster Fuller (1962), the American inventor, philosopher, poet, mathematician, architect, etc., offers the explanation that this state of affairs was well known to powerful men in the past and had been put to work in their selfish interests. Fuller's contention is that J. P. Morgan, whose endowment funded the establishment of one of America's first graduate schools at Harvard, did so in order to have a place to put bright young men who might otherwise become troublesome to Morgan and others like him. These world masters, as Fuller called them, controlled the international economic destiny up to the end of World War I by means of a "great unseen syndicate of world commerce mastery" (1962, p. 56). This mastery was a direct consequence of their ability to integrate and plan in a large-scale, comprehensive, and practical way. Such planning (scheming?) required not only an accurate perspective of current affairs and extensive integrative abilities but specialized technical knowledge. Thus, the graduate school as Fuller sees it, served to neutralize potentially dangerous rivals while providing the required source of information. It did more. The idea of an "all-star" team of specialist graduates was attractive enough that other private and state universities soon followed suit, as indeed did universities in other countries. So the "seed money" to establish the first graduate schools in the U.S. paid off handsomely when many similar schools opened up, most of them at public expense.

The subsequent sorting process resulted in the brightest of the educated being rendered ineffective in integrating, in putting things together, because of their highly specialized and therefore narrowing education. This left the second-rate, "not-so-bright," individuals to run business and governments, and unavoidably, to be the planners and controllers. This bind is what Fuller labelled, "Whitehead's dilemma": specialists are necessary to generate required knowledge but their training renders them incapable of comprehensive planning which is then, by default, left to less-able people.

The proportions this dilemma had for Fuller are seen vividly in his description of the ultimate relationship between the specialist and his "keeper".

> Then as corporation executives these not-quite-so-brights take on the pure scientist experts and cultivate them like special hybrid egg-laying hens in special houses. The corporations take on the task of putting appropriate specializations together to exploit the synergetic advantages thus accruing. The business man becomes the integrator of the bright one's capabilities (1962, p. 53).

The analogy may be stretched too far for some. However, it was precisely and understandably the strategy used by the U.S. War Department in the early 1940's to maintain necessary secrecy within the massive team of scientists and techniciens who were converting Einstein's famous formula, $E = mc^2$, into the awful reality of the first atomic bomb.

> It is unlikely that Einstein knew much of the technological details involved in the Manhattan Project. For one thing, General Groves' policy of compartmentalization made it difficult for any one man to know more than the necessary minimum — or to impart it, even if he wished to do so (CLARK, 1972, p. 697).

It is fair to point out that while the influential Spanish thinker ORTEGA (1932) referred to the narrowing and insular effects of specialisation in much the same vein as Fuller, he drew an entirely different, but equally uncomplimentary view of the scientist as specialist:

> For it is necessary to insist upon this extraordinary but undeniable fact: experimental science has progressed thanks in great part to the work of men astoundingly mediocre, and even less than mediocre. That is to say, modern science, the root and symbol of our actual civilization, finds a place for the intellectually commonplace man and allows him to work therein with success. The reason [is that a]... fair amount of the things that have to be done... [are] mechanical work of the mind which can be done by anyone, or almost anyone (pp. 110-111).

Not content with this description, Ortega went on to characterize the specialist as one who: 1) takes pride in avoiding study of anything outside his field and dismisses such curiosity in others as "dilettantism", and 2) having confused his partial, albeit in-depth, knowledge with being learned is then subject to some sort of generalizing effect which both creates a desire to be dominant outside his specialty and, more surprising, makes it difficult for him to accept the authority of "specialists" in other fields. Ortega thus sees these men as becoming "hermetically" insulated, self-satisfied and as entering a state of "'not-listening', of not submitting to higher courts of appeal..." (p. 113).

C. P. Snow is yet another outspoken critic of the fragmenting effects of traditional methods of preparing specialists. He makes the case that added to the isolation of scientific specialities from each other there is a deep cleavage characterized by a total lack a meaningful communication between intellectuals in the sciences and humanities. "Between the two", SNOW (1964/1959, p. 4) wrote, there exists "a gulf of mutual incomprehension — sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding." He continues, "The non-scientists have a rooted impression that the scientists are shallowly optimistic, unaware of man's condition... the scientists believe that the literary intellectuals are totally lacking in foresight, peculiarly unconcerned with their brother men, in a deep sense anti-intellectual, anxious to restrict both art and thought to the existential moment" (p. 5).

Snow summarizes the implications of this division in this way:

> In our society (that is, advanced western society) we have lost even the pretense of a common culture. Persons educated with the greatest intensity we know can no longer communicate with each other on the place of their major intellectual concern. This is serious for our creative, intellectual and, above all, our normal life. It is leading us to interpret the past wrongly, to misjudge the present, and to deny out hopes of the future. It is making it difficult or impossible for us to take good action (p. 60).

One might add that there is, in addition to the scientific and humanities, a third world of the ordinary person, the semi-skilled and relatively un-skilled. If there is little communication within and between the intellectual worlds, or cultures, as

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Snow referred to them, there is little or no communication between the intellectuals and ordinary people.

Let me assure the reader that these descriptions are not offered in any sadistic or masochistic way nor are they presented as quaint anochronisms. They were serious statements by respected scholars about possibilities of some importance. The question is, what relevance do they have for us at this point in the development of the field of physical education?

No matter what direction we take, we cannot avoid developing many specialists. Considerable thought should be given to content and processes in both undergraduate and graduate programs to improve the perspective of current world conditions. We need to assess communication within the field and with groups outside the field that could profit from our input.

The specialization we require could be developed in the context of an academic discipline or an applied profession, or through some combination of the two. To move toward a better understanding of the differences let us examine the concept of an academic discipline.

THE FUNCTION AND CHARACTER OF CURRENT ACADEMIC DISCIPLINES

If you accept Kiger's (1971a) definition of an academic discipline "as a recognized branch or segment of knowledge within the domain of rational learning" (p. 99) then literally any area or sub-area of learning may qualify for the label. Our concern is the process through which those interested in a "branch of knowledge," succeed in having it "recognized" as a discipline by the scientific establishment. The branches of knowledge that are so recognized appear and disappear on the tides of changing times. "What is a discipline for one age may become the nonsense or superstition of the next" (KIGER, 1971a, p. 99). Current disciplines fall into or cut across the three broad domains of knowledge: the humanities, the social sciences, and the natural sciences.

Recognition on this continent of a new branch of knowledge as a discipline does not follow any precise pattern but there are *three* conditions that appear necessary and sufficient. *First*, there must be a group a researchers concentrating on the particular branch of knowledge. The larger this group and the larger the portion of the broad scientific research community that respect their work, the better. *Second*, the researchers and other scholars in the field must create and organization or society devoted to "the advancement and diffusion of knowledge" in the field of concern. *Third*, this society must pass successfully through a screening process following application for membership in one of the three national (American) councils of learned, or scientific, societies: The American Council of Learned Societies, The Social Science Research Council, or the National Academy of Sciences — National Academy of Engineering — National Research Council. KIGER (1971a) reports that in 1970 about 60 learned societies, were recognized by one of these three prestigious groups.

There are Canadian equivalents to these councils but membership requirements are much less exacting, as a glance at the list of organizations represented at the 1975 Annual Meeting of the Royal Society of Canada and Conference of Learned Societies, held at the University of Alberta, indicates. Almost none of the traditional disciplines, such as mathematics and physics were represented as such. Their only presence was within such umbrella organizations as the Royal Society of Canada. Societies concerned with more esoteric subspecialties, e.g. The Society for the History of Philosophy of Mathematics, and the Canadian Society For the History and Philosophy of Science, were present. So were such bodies as The Canadian Association of Slavists, and The Canadian Society For Biblical Studies, and many others which could hardly be considered representative of academic disciplines. For those who consider it important to have physical education, or any sub-area within this field, "recognized" as a discipline, it appears that the frequently encountered reliance on U.S. institutions cannot be avoided.

It will therefore be useful to get an accurate description of the function of American learned societies. Having been "created primarily for the purpose of advancing and disseminating knowledge within the academic disciplines," BLOLAND and BLOLAND (1974) explain,

> American learned societies have played a critical rôle in developing, standardizing, and formalizing the disciplines as theoretical and methodological structures, in promoting the establishment of emerging subfields of knowledge as independent spheres of study, and in supporting these subfields in the intrauniversity competition for status and institutional resources. At the same time, learned societies contributed to the "professionalization" of the disciplines, drawing scholarly identification and loyalty away from institutions of academic employment toward the national disciplinary peer group and promoting the growth of national reward or career systems within each of the disciplines. They also served as convenient loci for the operation of a national academic labor market (p. 5).

This statement makes the case that American learned societies representing academic disciplines have been extremely important in developing current national university "reward or career systems". Perhaps the most obvious feature of which is the "publish or perish" doctrine which I had always been given to understand was enunciated by university administrations. While the learned societies have effectively drawn "scholarly identification and loyalty" *away* from universities toward closely knit peer groups within each discipline, it has been precisely these same peer groups which have set the important conditions for recognition and advancement of all university faculty members, whether involved with these societies or not. If such a self-serving situation existed in business or government it would be hard to avoid charges of conflict of interest. The "national disciplinary peer group" exerts its authority primarily through control of articles published in its official journal(s), papers it accepts for presentation at the annual meeting of the society, and through identifying these occurrences as the most important evidence of scholarly merit. It bears repeating that this evidence of merit both determines status among national and international peers in the discipline, and strongly influences academic promotion and assignments to be granted the individual professor within his university.

There is yet another way in which recognized academic disciplines have experienced a powerful influence from their learned societies. These societies have insisted on a "gradual withdrawal from practical pursuits and a striking deemphasis on the intellectual responsibility of the scholar towards the uses of his product in the practical sphere or toward service to specific clientele groups in the soceity" (BLOLAND and BLOLAND, 1974, p. 6). In short, they have required a commitment to theory and to each other, as opposed to practice and service to others as clients.

This section has set out to clarify what is currently meant by the term "academic discipline" and to identify the rôle of the learned society that gives body to it. In summary the salient factors appear to be these:

1. The viability of the learned society depends on a significant group of workers producing research and associated scholarly writing to a standard acceptable to themselves. To a lesser degree this scholarly output must be acceptable to established scholars in related disciplines who might encounter it or refer to it in their own work since recognition of a new discipline depends primarily on the approval of the established scientific community.
2. The hallmark of research in academic disciplines is "a narrow commitment to scholarship — to the advancement of knowledge for its own sake" (BLOLAND and BLOLAND, 1974, p. 6). This strategy appear to be based in the faith that generating new knowledge will advance civilization and furhter, that "an inherent power for order in the world would absorb [the scholar's] product into its beneficent economy without his assuming responsibility for the process" (SCHORSKE, 1968, p. 980: in Bloland and Bloland, 1974, p. 6).
3. Examination of the two preceding points leads to the inescapable conclusion that members of academic disciplines are exclusively university researchers who rely on their own peer group for validation and who intentionally communicate only within the peer group. Further: the institutionalized structure of the discipline has no need whatsoever for professionals in the field other than university researchers.

I intend to develop the arguments further but it will be useful to indicate at this point that for physical education as a broad field, or for any of its presently recognized subfields, I consider that efforts to gain recognition as an academic discipline would be both inappropriate and dysfunctional. While I am concerned with our specific case, KIGER (1971b) reports a growing general concern:

> More and more thinkers now believe that the specialist disciplinary system which made for a century of progress has reached the stage in which a reconstitution, a new synthesis is needed. They argue that men are needed who can span existing specialized disciplines in order to evaluate and ascertain not just how something can be accomplished but what its probable consequences will be and perhaps more importantly, whether it should be done at all (pp. 104-105).

This suggestion rests well with an interest in overcoming some of the more serious shortcomings of narrow specialization.

I believe it is essential to emphasize that this does not mean simply a shift from fragmented specialties to so-called "interdisciplinary" studies. That is part of it, but equally important, we must create and apply the means by which highly educated people (specialists) develop an accurate perspective of the modern world along with the integrative abilities required to relate sophisticated technical knowledge to its real world context. This would inevitably and dramatically slow down the present rate of generating new knowledge, willy-nilly, and allow us to begin to relate and apply available knowledge, assess our present state, and select more intelligently where we are to go and the means of getting there.

The present helter skelter generation of data in the academic disciplines reminds me of an enthusiastic ditch digger committed to digging as deep and as fast as he can. It works alright at first but soon his shovel handle is too short and to make matters worse, most of what he throws out, falls back. All he can see is the mud walls and floor (there may be a flood coming), and unless he changes his approach his immediate problems will be rendered irrelevant by the cave-in that buries him.

But perhaps the foregoing assessment of the viability of moving towards the status of an academic discipline is too harsh and unrealistic. Lacking a working time machine with a feed forward attachment, we cannot accurately determine what our real fate would be if we were to forge ahead as a discipline. Such a course of action would generate some fairly predictable thorny problems of a highly practical nature and some of these will be touched on in a later section. At the moment though, let us try to weigh the possibilities of progress we could reasonably expect from a research effort of a proposed discipline of psychomotor learning or sports psychology, or if it serves one better, a discipline embracing both of these areas. Conveniently enough these areas relate closely to the established discipline of psychology. Psychology has enjoyed this status for most of this century. The next section reviews the opinions of a cross-section of psychologists who are less than satisfied with the result.

A BRIEF OVERVIEW OF CRITICISM OF AN ESTABLISHED, RELATED, DISCIPLINE

While psychology is recognized as a discipline it also has obvious involvement as an applied profession in counselling, personnel assessment, psychotherapy and other forms of clinical work. But the purpose in this sect[illegible] is to direct attention to evidence of progress as a dis[illegible]ne. Research done in the name of psychology as an academic discipline would be aimed at building a theoretical framework to unify or relate the important abstractions in the field. The large body of research available on clinical problems relates to the work of professional psychologists as separate and distinct from the development of psychology as a discipline.

What is the present status of a theoretical framework in psychology? Perhaps the single best person to attempt to answer this question is Sigmund Koch who in 1952 accepted an assignment from the American Psychological Association to direct a study to assess the total state of the field. The seven-volume study published in 1959 entitled, *Psychology: A Study of a Science*, is considered a landmark in the field. As recently as 1969 Koch reiterated the conclusions the arrived at as a result of his unique vantage point as editor of this impressive series. "Whether as a 'science' or any kind of coherent discipline devoted to the empirical study of man, psychology has been misconceived," KOCH (1969) wrote. He continued,

> This is no light matter, for me to confess after a 30-year career given to exploration of the prospects and conditions for psychology becoming a significant enterprise.
>
> But the massive 100-year effort to erect a discipline given to the positive study of man can hardly be counted a triumph. Here and there the effort has turned up a germane fact, or thrown off a spark of insight, but these victories have had an accidental relation to the programs believed to inspire them, and their sum total over time is heavily overbalanced by the pseudo-knowledge that has proliferated.
>
> The idolatry of science in our age has insured that this phony knowledge be taken seriously by people everywhere — even by sensitive, creative or sophisticated people. Such 'knowledge' when assimilated, is no neutral addition to a person's furniture of confusions. It has an awesome capacity to biais the deepest attitudes of man toward Man, to polarize sensibility (p. 14).

A very similar conclusion had been arrived at earlier by ZANGWILL (1956): "Experimental psychology has produced many facts, a few generalisations, and even an occasional 'law'. But it has so far failed to produce anything resembling a coherent and generally accepted body of scientific theory" (p. 168). The most depressing aspect of this is that no authoritative voice suggests that things are about to improve. The usual exhortations to keep at it and we'll do it, are missing.

This has created serious public credibility problems for psychology. Since most people learn to function socially with at least minimal effectiveness, we can take this as evidence that they are doing so on the basis of their having recognized some low level behavioral laws even though these laws may be neither fully nor precisely formulated in their minds. People use these simple laws as a basis for both predicting behavior (e.g., What will he say if I ask for his help?) and interpreting past behaviors (e.g., Why did he accept so eagerly? Why do I do things like this?). "These predictions and explanations are not based on anything which is referred to as psychological theory," SCRIVEN (1956) pointed out,

> but merely on our observations and 'common sense' inference. One might wish to say that there is an implicit theory in our classifications and inference in these cases. If so, then my point can be rephrased to state that *in the cases in which we feel most certain most often of our behavioral predictions and explanations, they are based on the theory implicit in common sense* and *not* on theories developed by professional psychologists (p. 331). (Emphasis mine.)

Since psychology has rarely been successful in providing higher order theories of use in explaining behavior, the psychologist is left with resources for such explanation which are little better than the average man's. Claims for psychology as a science then must contend with Mazur's statement that "The scientist must have better theories than the layman or he's really not a scientist at all. It physics is a science because it is empirical and theoretical, it is also a science because physicists' theories about the physical world work better than the non-physicists' theories" (1968, p. 195).

To judge by the problems selected for investigation and the research designs utilized in a very large percentage of past and current studies, there are many psychologists who continue to accept on faith the hypothesis that the missing, higher order, theoretical formulations can be developed. Unfortunately, few, if any, psychologists who have given the matter serious thought agree. "The test of the Milliam hypothesis [that a satisfactory theoretical structure can be developed by emulating the methods of natural science], has not been a sleazy one," KOCH (1969) concluded, but

> In my estimation, the hypothesis has been fulsomely disconfirmed. I think it by this time utterly and finally clear that *psychology cannot be a coherent science*, or indeed a coherent field of scholarship, in any specifiable sense of coherence that can bear on a field on inquiry. It can certainly not expect to become *theoretically* coherent; in fact, it is now clear that no large subdivision of inquiry, including physics, can be (p. 66). (Emphasis in original.)

This strong and unambiguous view is shared by SCRIVEN (1956, p. 332) and PEREBOOM (1971, p. 439) among others. Acceptance of it does not require abandoning research efforts. It does require a reconsideration of the bases for identifying problems and adopting research methods. Promising suggestions for such revisions will be mentioned later. At the moment it will be more to the point to outline the perceived reasons for failure to construct a coherent science of psychology.

Psychology of the methods of hard science. KOCH (1969) offered the interesting observation that the natural sciences, particularly physics and biology, were formalized into disciplines only after lengthy development by a procession of scholars. During this foundation phase, a large body of knowledge and methods for extending and refining that knowledge, was collected. The creation of these disciplines, as defined areas of study, then came as an evolutionary extention to previous development and consolidation. The early successes in these fields, exemplified by the valuable contributions of Newton and Darwin, created "an apparently wholesome Victorin vision: that of a totally orderly universe, totally open to the methods of science, and a totally orderly science, totally open to the strategems — and wants — of man. It was against this background," KOCH (1969) wrote,

> that psychology was *stipulated* into life. At the time of its inception, psychology was unique in the extent to which its institutionalization preceded its content and its methods preceded its problem. Never had thinkers been given so sharply specified an invitation to create, or been so harried by social wish, cultural optimism, and extrinsic prescription into the advance scheduling of ways of means (p. 64).

Psychology, like Topsy, "just growed", it didn't have any real historical development. One day it wasn't there, the next it was a reality, "stipulated into life", simply declared to exist. While the founders, those who had stipulated its creation, could not locate an existing body of appropriate knowledge, they could borrow the *methods* of the highly successful fields of physics, and to a lesser extent biology. This is exactly what they did (HILGARD and BOWER, 1966, p. 424; KOCH, 1959, p. 64; PEREBOOM, 1971, p. 436; SCRIVEN, 1956, p. 336). Which is not to say that these methods were entirely inappropriate then or since. Many aspects of the scientific method are indispensable to the legitimate study of any domain of knowledge. But the purchase was a package deal and some of the obligations assumed with the package proved less than helpful.

Notable among these was the "atomic belief... that science is built by piling one fact upon another" (HUDSON, 1972, p. 41), and that understanding complex, molar, phenomena is achieved by assembling the component atoms suitably linked by a theoretical framework. The insight that provides conceptual links between such apparently unrelated phenomena is recognized as the essence of creative thinking (BRONOWSKI, 1965/1956, p. 13). It is fascinating to follow, in simplified form, the general train of thought by which Einstein pieced together a series of apparently isolated but crucial, simple phenomena (BARNETT, 1957). These were the atomistic components (where atomistic is used as a metaphor, rather than in the Bohr sense of the atom). When he had provided the explanation of how these critical simple, phenomena linked together, and translated those relationships into a set of mathematical formulations, he arrived at the theory of relativity. The atomistic approach obviously worked in physics and it was a process of this same sort, without the mathematical representation, that Darwin had used in arriving at his theory of evolution. Why didn't this approach work in psychology? The answer to this question could be elaborated at great length but I will restrict this discussion to three areas of difficulty.

First, is the fact that in the natural sciences the objects of study are inert and homogeneous. Rays of light, or the percentage composition of water, can be counter on both to behave and to yield to analysis in extremely predictable ways. In the case of Darwin's work he was interested in anatomical and physiological features of animals from a classification or taxonomic point of view. Observations of these features will understandably result in highly consistent data also. Had Darwin been interested in animal *behavior* he would have had to contend with infinitely more variance and unpredictability. And in the case of human, far from being inert, they respond and learn in *many* unpredictable ways and unknown or intentionally covert motives as well as highly individual value systems direct their behavior. It is therefore impossible to defend the assumption that repeated observations of the same individual, human or animal, are in fact observations of the "same subject" in the way that repeated observations of inert objects can be assumed to have a one-to-one correspondence.

The second important diffference between observing the effects of manipulations, treatments, of inert objects and humans, or animals, is that *science measures end states*. The electrolysis of water yields predictable volumes of hydrogen and oxygen at predictable production rates provided simple information related to electrodes, temperatures, concentrations and current are known. The actual processes or mechanisms by which the end state is reached need not be known, are often not know, or erroneously explained. But in behavioral studies, the same end state, or observed behavior, may have been arrived at by not only unknown mechanisms but, more important, *by a wide variety of quite different mechanisms*. PEREBOOM (1971, p. 447) offers an interesting example of how such a situation may complicate the explanation of even a relatively simple study in response duration. Since identical observations in a controlled experiment may be explained in a variety of recognized, and unrecognized, ways the difficulties in drawing durable retestable inferences are apparent. The experimenter first cannot be sure of the sources of differences in his date, and even if he can be, he seldom if ever has ways to identify the means of mechanisms that caused the effects. Unable then to draw reliable inferences from particular experiments, it is no wonder that higher order theories fail to materialize out of the results.

The situation is unproductive enough in perception and information processing studies in which the stimulus is fairly simple and observations are usually made on one subject at a time. But if psychology is to contribute to our understanding of human behavior in any substantial way, and an atomistic approach won't work, it will eventually be necessary to study behavior in more complex situations. This means a richer physical environment, complex unpredictable stimuli and uncontrollable interactions among numbers of people.

This leads us to the third difficulty in using the borrowed methods of the hard sciences. It is "the relatively greater complexity of the *simplest phenomena we are concerned to account for* in a behavioral theory... [and for this reason] practical problems of prediction, or explanation *at any level* (i.e., including theory-building), are more likely to be insoluble in the study of behavior" (SCRIVEN, 1956, p. 332).

This point was emphasized by MISCHEL (1974, p. 256) in pointing out that in the relatively simple problem of attempting to predict voluntary delay of gratification in a subject, and using only seven of the many variables that could influence this behavior, there would be 120 interactions to consider. Commenting on this particular example, CRONBACH (1975) wrote that:

> If reactions are so complexly conditioned, it is not even faintly surprising that we get contradictory conclusions from experiments taking only two or three factors into account.
>
> The problem is as pressing for cognitive psychology as for personality. Newell (1972) lamented the current fragmentation in the study of information processing. He tallied 59 colonies of investigators, each collecting data on its own narrow task. Because the fine structure of the task and the person's characteristics influence outcomes, results obtained under such disparate conditions cannot be linked up. Newell doubted that the usual experimental strategy of narrowing conditions, refining results, and looking for generalizations of limited range can generate adequate cognitive theory (pp. 120-121).

But whether the "theories" generated to this point are adequate or not they "rarely die in psychology, they just accumulate" (PEREBOOM, 1971, pp. 445-446). This appears to result from the fact that the "critical experiment" relied on in physics to dispose of possibilities and identify "true" from "untrue" explanations is seldom if ever applicable in psychology. There are simply too many variables with too many interactions involved to pinpoint sources of effects. For this reason literally any proposition put forward for consideration at any time maintains a degree of viability not because it has even been shown to be fruitful but because it is not possible, within the borrowed restrictions of the natural sciences, to disprove it. PEREBOOM (1971) explained this situation in the following way.

> Thus as we proceed from the simpler, the more pervasive and, at the same time, the theoretically more manageable behaviors towards those more complex and variable, the probability may increase that alternative and actually incompatible or partially incompatible principles will be needed in order to interpret differences Ss, species, settings, or occasions. Hence we have an even more fundamental basis for the failure of critical experiment than the operational problems discussed earlier (p. 448).

The problems Pereboom refers to are those of adequate control and generality which he considered extreme not only as related to the experimental design but when one is faced with drawing plausible inferences.

This brings us full circle in our search. The obvious answer, from the point of view of natural science, is to design experiments that simplify conditions to a point where adequate control is possible. We are forced back to collecting bits of information from closely controlled experiments. In a word the ill-starred atomistic approach. The other alternative is to heed Pereboom's (1971) advice that "more effort be directed toward fitting our empirical approach to the subject matter rather than attempting to do the latter" (p. 439).

CONCLUSIONS

If it is the purpose of a discipline to build a science by developing a coherent theoretical framework then one must counter KOCH's (1969) argument that "Psychology's larger generalizations are not specified and refined over time and effort" (p. 66), or accept his harsh assessment of failure. The century-long effort in psychology has "here and there...

turned up a germane fact, or thrown off a spark of insight," but more frequently it has developed "pseudoknowledge" and "ameaningful thinking" (p. 66). Here Koch indicated that the "a" in ameaningful has the same force as the "a" in words like amoral. "Ameaningful thought or inquiry regards knowledge as the result of 'processing' rather than discovery. It presumes that knowledge is an almost automatic result of a gimmickry, an assembly line, a methodology" (p. 14).

Advocates of a "hard science" approach who consider control, replication, and generality are not only desirable but feasible in a multidimensional field should take note of the trend in the natural sciences. It was clearly identified at least a generation ago and continues to gather strength.

> Even if it is thought possible to produce a precise general theory of basic behavior, it would be wrong to conclude that exact predictions and faultless explanations will be possible in the field of practical problems; for they are now very rarely achieved in this area by any sciences. The practical problems of physics *today* are engineering problems, meteorological problems, aerodynamical problems: and to these there are not often exact solutions, but only compromises and approximations (SCRIVEN, 1956, p. 334).

Academic Discipline Status?

If I read the current interest in the question of an identity for physical education, and associated sub-fields of interest, correctly it revolves around implications inherent in the concepts of a "discipline" and a "profession".

An academic discipline was identified earlier as being embodied in a society of research scholars and so this concept *cannot* have general applicability to the whole field which now includes teachers and many others who are certainly not research scholars. Further, it is impossible for me to see how one can defend pursuit of academic discipline status for any of our sub-fields such as psychomotor learning, sports psychology, or physiology of exercise, to name only three. The reasons for this conclusion are as follows.

1. A discipline, by definition, requires a commitment to narrow scholarship which is to say the construction of theory. The failure of psychology to build a coherent theoretical framework, despite much greater resources than we could ever aspire to, leaves us with little hope in this direction. CRONBACH (1975, p. 123) has made an excellent case for the *value of abstractions and limited theorizing* and one would be well advised to continue efforts to generate these. He has also made the relevant point that investigators concerned with questions of a physiological nature can expect more success in building durable theory in an accumulative way than can those working on problems with more obvious social dimensions.

2. An academic discipline requires that loyalties be to the national, or international, peer group of university researchers. This relegates co-workers within the university not involved in the prescribed area and any person not involved in research, even though involved in significant full-time work in the field of physical education, to a secondary position. It encourages the establishment of a "pecking-order" which has only its snob appeal for justification. Communication is between researchers only and an elaborate rapidly changing jargon makes attempts to deal with outsiders difficult.

3. Since an academic discipline by definition, seeks to deemphasize both practical implications of research and responsibility to apply research findings, any sub-area wanting recognition as a discipline would have a contractual problem. What schools or faculties of physical education in Canada would agree to support a self-declared discipline on these grounds? If they would not, are there any psychology departments that would accept them into the fold?

4. The academic discipline is a closed, unresponsive system of a type not suited to evolve and adapt. This is inevitable since it is responsible to itself and restricts communication to its own members. As HUDSON (1972) describes it, "Both department and examiner, in other words, can ensure that a radical challenge to their conception of the subject is unlikely to occur from within it. The persuasive, and if necessary the coercive, resources of such university teachers are formidable" (p. 102).

The danger is that research areas within departments, especially those offering the Ph D., can become preoccupied with producing graduates who are near duplicates of their mentors. The research output of mentor and student reverberates through the department dissertation bibliographies and co-authored articles in several academic journals while the rest of the world goes blissfully on, unaware and unaffected by the entire process.

5. There has been a dramatic change in the public view of academic activity since the 1960's. Boland and Boland (1974) explained the change in this way:

> the shift in national priorities away from the support of higher education — and particularly of academic research — reflects a growing national concern for pressing social and environment problems for which basic research is no longer thought to hold the key. And as the prestige of academic research diminishes in the public eye, there is increasing pressure from important external constituencies of the university... to reduce expensive graduate and research programs in favor of the development of programs with a more immediate service function: undergraduate education, continuing education, vocational training and community service (p. 113).

They went on to point out that this would likely result in graduate and research programs losing some of their former importance, and in less emphasis in the academic reward system on scholarly and scientific achievement.

The rate of change of total world conditions demands direction which requires input from educated people. That is, provided one takes the optimistic view that conditions are still controllable and reversible. But the academic discipline is concerned with theoretical issues which render it unable as well as unconcerned with producing information and concepts for this purpose.

In summary I see these reasons as providing ample argument for abandoning consideration of moving toward discipline status. The only viable alternative in our present context appears to me to be development as an applied profession.

Physical Education as an Applied Profession

One of the most effective ploys available for evading issues is to deliberately avoid assigning precise meanings to crucial terms or to point out that such terms can be used in many ways. Assigning explicit definitions is one of the features of the scientific method that is essential in all domains of knowledge. The foregoing examination of the current concept of an academic discipline attempted to do so since this word is used in many ways. The same is true of the word "professional". It has so many different connotations and shades of meaning within various usages that it is hopeless to use it without agreeing on a definition.

MORFORD (1972) has recently reminded us that a profession is a dynamic entity in that there is a loop connecting current knowledge and practice with the underlying and demonstrably relevant theory. Refinements or advancements in one are accounted for by appropriate adjustments in the other. It works both ways: practice feeds back to theory, and theory feeds forward to practice. In our field this implies that most, if not all, researchers would work closely with those delivering the service of the profession. Indeed they would themselves often be involved in delivering professional service in which they had a research interest.

What is a profession?

There is fairly wide general agreement on this matter and it will help to briefly outline the consensus characteristics:

1) an essential social function is performed,
2) the professional has a degree of expertness resulting from extended training and practice and based on theory and practical knowledge,
3) the interests of the client are placed before those of the professional,
4) the government recognizes it, and often limits practice to those with specified qualifications,
5) the special nature of services renders the client unable to adequately assess service (This is changing.) and,
6) a professional organization exerts a variety of controls on admission and practice (CONRAD, 1971, pp. 432-433).

No existing profession, including medicine, engineering, and law, could in truth meet all of these conditions. No matter how one viewed it, physical education or any of its sub-fields could not either. The fit for some professions is better than others. But I am quite satisfied to speak of an *emerging* profession of physical education, however imperfectly it might fit the ideal requirements at this time. It is much closer today than it was ten years ago, and in another decade, we can only blame ourselves if it isn't closer. The real problems, should we move toward a clearer identity as an applied profession, will be in getting government agreement to limit practice to designated professionals, and in developing an adequate professional organization.

It is not the intention of this paper to go further into this question. What would be more to the point would be to attempt to identify some of the components of the present field of physical education within the framework of an applied profession. The definitions are mine and will not be acceptable to others in many instances but at least it provides a point of departure. In the final analysis of course, all definitions are arbitrary.

The field of physical education is the *service* provided the clients of professionals in the field (the *clients* of teachers, coaches, workers in: physical recreation, sport, dance, and fitness activities, and administrators of these programs); the written literature, including relevant material from other professions and from academic disciplines; the functions of preparing professionals to deliver services; and the necessary research and development activity. These latter functions relate to improving preparation of professionals, refining and developing new theoretical and applied concepts, and improving available service and the appropriate delivery system.

A physical education professional is a "specialist" in the sense in which this term was used in the first section of this paper. Hopefully we will work to minimize the restricting, limiting effects of too narrow a program of preparation. A professional or specialist is one who holds a degree in physical education and/or recreation, or an education degree with a physical education major, or equivalent. This preparation is combined with a minimum of two years successful work experience or some adequate form of internship. Equivalent to the physical education degree might well be any approved degree with an appropriate one year program in physical education. This would meet much objection from some but I offer it for several reasons — it is only one of a variety of ways of qualifying, it might help in avoiding some of the ill effects of specialization described earlier. Whether it was generally acceptable or not is not crucial since whatever agreements we begin with would be modified in the light of experience. Evolution will occur so we should not be frozen into inaction because of difficulties in reaching agreement on initial conditions.

A research and/or development worker is a professional in the above sense who has a relevant graduate degree or equivalent experience. He devotes a minimum of one quarter time to research and/or formal development and, except in rare cases, is also engaged in delivering service to undergraduates. Where graduate programs exist he will most likely spend some of his work time with graduate students. We have discussed communication problems between fields of knowledge. These are difficult enough to deal with. When researchers are allowed to restrict themselves to direct contact with graduate students only, we create unnecessary problems *within* the field. It not only severely limits communications within a field where all professionals have a *serious obligation* to communicate, but it stifles new developments which can only come in an open responsive system in which even the researchers' ideas can be honestly questioned.

Alternatives must be examined to bring researchers into significant contact with others in different specializations so that the worst dangers of narrow specialization in a complex multivariant field can be avoided.

Some suggestions for research

The available examples of medicine, engineering and agriculture should reassure us that integrity and suitable development can be attained in an applied profession. There would be no difficulty other than time and effort in building the necessary and frequently referred to, field of knowledge. A good deal of it already exists in the better texts, standard references, journals, and other publications. Recent revisions in several university undergraduate programs in Canada, including Alberta, have reflected the move to a more coherent organization of knowledge, even if, as in psychology, we may never be able to arrive at a satisfactory theoretical framework.

The applied fields of medicine, engineering, and agriculture, again stand as excellent examples of the fact that a vigorous and fruitful research program can be developed without direct reliance on the existence of a corresponding academic discipline. It should also be apparent that these fields generate substantial financial support from government and public sectors *because* their research and development work are seen to produce results. As in the cases of thalidomide and DDT this work sometimes has bad effects but these are examples of the precise type referred to by Buckminster Fuller. Dangers of this kind from the results of applied research can be avoided by a more liberal education for specialists combined with a greater sense of public responsibility and unavoidable government controls. In any case when a cancer researcher speaks, internists, radiologist, and general practitioners listen and learn. When a researcher in animal nutrition speaks, agriculturists and farmers listen and learn. All too often when a physical education researcher speaks, only his research colleagues listen. If a teacher of coach hears, he is likely to say either: So what? ... or, What did he say?

Or course it is true that more and more research being done in our field is exactly the type that is needed in an applied profession. If more agreement can be reached that our future is as an applied profession it would soon release a good many talented people to begin to focus on the improvement of important aspects of the services we deliver.

I certainly do not have a lot of ready answers. The concern of this paper has been with how we identify ourselves as a field and the directions implied in our identity. A re-directed research effort should get some useful guidelines from hard won experience in psychology. What appears to be the most promising ways of improving things? The responsible critics of scientific psychology such as Koch, Pereboom, Scriven, Cronbach, Hilgard and Bower, Hudson, and Glass, to name but a few of the most articulate, are surprisingly close to agreement.

1. Studies of traditional design in which every effort is made to control key variables and sampling is done to maximize generalization should be continued in areas where the *results can be seen to have some real meaning*. Much more care should be given to matching research methods to the demands of problems. KOCH (1969) would rule out large areas of psychology from traditional controlled experiment approaches.

> The term 'science' cannot properly be applied to perception, cognition, motivation, learning, social psychology, psychopathology, personology, esthetics, the study of creativity or the empirical domains of the extant humanities. To persist in applying this highly charged metaphor is to shackle these fields with *highly unrealistic expectations*, the inevitable heuristic effect is the *enaction of imitation science* (p. 67). (Emphasis mine.)

2. There is a strong movement toward more attention to "descriptive generality". PEREBOOM (1971) for example believes that even work in psychology as an academic discipline, or "as a basic science, our preferred option now is to give descriptive generality our first priority" (p. 449). CRONBACH (1975) echoes the plea:

> Let the author file descriptive information, at least in an archive, instead of reporting only those selected differences and correlations that are nominally 'greater than chance'. Descriptions encourage us to think constructively about results from quasi-replications, whereas the dichotomy significant/nonsignificant implies a hopeless inconsistency... Instead of making generalizations the ruling consideration in our research, I suggest we reverse our priorities. An observer collecting data in one particular situation is in a position to appraise a practice or proposition in that setting, observing effects in context (p. 124).

This approach features descriptions which pay attention to controlled variables but equal attention to those which are not controlled, as well as observations of personal characteristics, reactions, and unexpected events that occur during treatment and data collection. This leads to an understanding of local peculiarities and Cronbach suggests that as the experimenter "goes from situation to situation, his first task is to describe and interpret the effect anew in each locale, perhaps taking into account factors unique to that locale of series of events... generalization comes late, and the exception is taken as seriously as the rule" (p. 125). This appears to be an unavoidable strategy given the context-bound nature of the majority of the phenomena in which we are interested.

In some cases, statistical treatment of data will be missing entirely and only frequencies, percentages, and other simple arithmetic information reported. "The implication is," PEREBOOM (1971) believes,

> That non-rigorous research need not really be second-class science after all, that, if one wishes generality as well as naturalistic relevance, one's efforts might be better directed toward optimizing observations and recording, and minimizing control and manipulation (see Webb, *et. al.*, 1966). Perhaps we are, or should be, closer to the naturalist the 'astute observer of human behavior', and even to the humanities, than many of us would care to admit (p. 452).

CONCLUSION

One of many grounds on which the reader might disagree with the preceding discussion relates to the lack of concern for scientific objectivity and value-free research which have been held to be important in any scientific study. If to-day's problems in physics are indeed engineering problems one comes face to face with value questions in a hurry. Should research continue on super jets known to have serious, and as far as we know, irreversible effects on essential layers of the stratosphere? Nettler (1970) points out that:

> Knowing man scientifically is not only difficult, but it may not provide the answers men need when they ask for explanation. Today's significant questions are moral questions, not the technical ones that science might satisfy. The needs are of *that* moral nature, that some empirical truth is immoral (p. 171).

But attempting to answer value questions is not an easy task. Especially since values and facts are often hostile to each other. When an individual or a group are committed to a cause, or an idiology, then facts become unnecessary and if discovered or available facts run *counter* to the particular value, hostility is almost sure to follow (NETTLER, 1972). This problem is not easily solved. But retreating to passive objectivity will not help in putting matters straight. HARDIN (1968;1974) has attempted to analyze world population problems in terms of the causal web of real-life contingencies. His analysis provides a chilling view of the conflict between current "liberal" values and the facts of overpopulation and what disastrous effects policies based on these values are likely to have.

If educated people are to have any influence on the headlong rush of world change then the centrality of value-free research and scientific objectivity must be challenged. While our concerns are not as weighty as those of over-population or destruction of the Van Allen belt, there are many significant problems awaiting our attention. CRONBACH's (1975) advice applies as well to researchers and other working professionals as it does to psychologists.

> I suspect that if the psychologist were to read more widely in history, ethnology, and the centuries of humanistic writings on man and society, he would be better prepared for... his work. (p. 125).

We have the good fortune to be associated with a field that has important responsibility for the growth and development of all our people but besides, is involved with a wide panorama of human expression through sport, dance, and other leisure activity of a physical nature. Piaget has given us insight into how inexorably the activities of our concern are involved in the development of intellectual and emotional competence. Many facets of games, sport, and dance have a deep, widespread, and enduring appeal for large numbers of people. We need to give serious thought to how well our present patterns of organization and professional values enable us to serve the society that supports us.

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ATTITUDES ET SPORT

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ATTRIBUTION OF ATTITUDES TOWARD PHYSICAL ACTIVITY AS A FUNCTION OF SUCCESS

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The concept of attitude and attitude change has received considerable attention in the psychological literature during the past century. Despite its relatively long history, consensus regarding an attitude definition and the causes of attitude change has been subject to a slow evolutionary process. In a recent book, TRIANDIS (1971) addressed himself to these concerns. While discussing the topic of attitude change, Triandis proposed that one's attitude toward an object can be dependent on the pleasantness or unpleasantness associated with the previous experience with that object. He also postulated that positive effect (emotion) is attached to those categories which assist one in reaching goals and negative effect is attached to those which thwart success.

A similar view of attitude change is held by FREISCHLAG (1973). In a study designed to determine some of the causes of changing attitudes toward physical education, he observed that the "law of effect" can be seen to interact with attitudes about physical activity. Freischlag stated that "people tend to repeat those experiences that are perceived as pleasant and in which they found success" (p. 21).

Results from studies conducted by CARR (1945), VINCENT (1967), and REEVES (1972) seem to support the views held by Triandis and Freischlag on the subject of attitude change. These studies sought to determine the relationship between the expressed attitude toward physical education and success in physical education activities. In each of these studies, an attitude toward physical education inventory was administered prior to participation in the physical education class and the final mark in the course was utilized as the success factor. In each case there was a significant relationship between expressed attitudes and success. However, one is unable to determine from these findings whether prior positive attitudes toward physical education resulted in success or whether prior success in physical education resulted in the formulation of positive attitudes.

HOLBROOK (1971) and PETERICH (1970) pointed their concerns about attitude change in the direction of specific sports (gymnastics and football). They reported that as performance success increased so did attitudes toward the sport.

Apparently a continuum of attitude toward physical education and sport exists relative to the degree of success reached in the specific endeavor. Increased positive attitudes seem to be a function of increased success. As an aside, it is interesting and intriguing what comprises success. This need not always be winning for all individuals. In light of the small number of athletes who possess the ability to be a winner or a superior performer, there is a good possibility that for the majority of athletes, success has a very different meaning. In fact, some athletes may view success in sport simply as their ability to make the team.

However, this does not deny that success has some ties to winning in the eyes of some participants. Since success is sometimes a fleeting characteristic, what might be the expected outcomes of failure? Triandis indicated that attitude may be a function of the degree of pleasantness associated with the task. One might infer from this that if success was removed, the result should be the formulation of negative attitudes or at least less positive attitudes.

The present study was undertaken to determine if the attribution of attitudes toward physical activity was a function of prior success. It was predicted that athletes would have a more positive attitude toward physical activity than non-athletes since athletes have had many opportunities to experience success (or rationalize defeat). Athletes should be expected to possess more favorable attitudes toward physical activity than one-time athletes, the latter being defined as those individuals who were dismissed from teams for disciplinary reasons or for lack of skill. Participation has been denied to these individuals and with this has also gone the possibility of success. Non-athletes should express more favorable attitudes toward physical activity than one-time athletes since neither success nor failure in physical activity is a part of their recent experiences.

METHOD

Subjects

Subjects for this investigation consisted of 60 male high school students between the ages of 15 and 17 years. Twenty were selected from varsity teams and were classified as varsity athletes. The remaining 40 subjects were selected according to their ability to meet specified criteria. Twenty subjects were selected and classified as one-time varsity athletes on the basis of at least one year of varsity experience and subsequent dismissal from the team either because of a perceived lack of ability or for disciplinary reasons. None of the one-time athletes left the team on their own accord. The remaining 20 subjects were selected and classified as non-athletes since they had never participated on an organized athletic team and were not presently involved in any recreational or sport pursuit.

In order to elicit controls on the sampling procedures, equal numbers of subjects in each classification were drawn from each school. For example, if two one-time varsity athletes were dismissed from the football team at School X, then two varsity athletes were selected from that school's football team. In such a case, two non-athletes were also selected from School X.

Testing Instrument

The *Attitude Toward Physical Activity Inventory* (semantic differential format) devised by KENYON (1968) was administered to all subjects. Seven independent dimensions of physical activity are represented:

(1) physical activity as a social experience,

(2) physical activity for health and fitness,

(3) physical activity as the pursuit of vertigo,

(4) physical activity as an aesthetic experience,

(5) physical activity as a catharsis,

(6) physical activity as an ascetic experience, and

(7) physical activity as a game of chance.

Procedure

Physical education teachers and coaches at various high schools throughout central New York State agreed to assist the investigators in securing subjects. The subjects who met the criteria were contacted and agreed to take part in the study. Data were collected during one testing session at each high school from which the subjects had been selected. Subjects were asked to express their personal attitude toward the seven dimensions of physical activity. The investigators assured the subjects that the administration of the inventory was not a test and that there were no right or wrong answers. Subjects were not required to put their names on the inventory.

RESULTS

In Table I are the mean ATPA scores for all subjects.

Table I – Means for Athletes, Non-Athletes, One-Time Athletes, and Totals of ATPA Scales.

Subjects \ Scales	Social	Health & Fitness	Pursuit of Vertigo	Aesthetic	Catharsis	Ascetic	Chance
Athletes	46.75	46.20	43.29	45.70	45.59	39.04	34.39
Non-athletes	41.20	41.39	34.59	38.39	40.59	27.84	37.54
One-time athletes	42.39	38.89	36.75	37.54	40.09	28.84	34.29
Totals	43.45	42.16	38.21	40.54	42.09	31.71	35.08

The summary of the 3 × 7 ANOVA is presented in Table II.

Table II – Analysis of Variance of Means of ATPA Scales for Athletes, Non-Athletes and One-Time Athletes.

Source	df	MS	F
Groups (G)	2	1 614.79	15.29 *
Error $_b$	57	105.61	
Scales (S)	6	1 082.88	16.12 *
G x S	12	117.33	1.74
Error $_w$	342	67.15	

* $p < .01$

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Significant attitude differences toward physical activity existed among athletes, non-athletes, and one-time athletes, $F(2,57) = 15.29$, $p < .01$. Post hoc comparisons of the group differences failed to locate where the difference or differences existed.

Significant scale differences discriminated the expressed attitudes toward physical activity of the athletes, non-athletes, and one-time athletes, $F(6,342) = 16.12$, $p < .01$. Post hoc comparisons revealed significant differences between groups on the following dimensions: health and fitness, pursuit of vertigo, aesthetic, and ascetic.

As predicted, the athletes reported more favorable attitudes toward physical activity than the non-athletes since three dimensions (vertigo, aesthetic, ascetic) yielded significant results. In no case did the athlete group reveal lower mean scores. Comparison between athletes and one-time athletes yielded differences on the previously mentioned dimensions plus health and fitness. The athlete group reported a more favorable attitude toward physical activity on all four dimensions. In no cases did the mean scores of any dimension of physical activity differ significantly between non-athletes and one-time athletes.

DISCUSSION

Attribution of attitudes toward physical activity was a function of prior success in physical activity since athletes' attitudes differed significantly from one-time athletes' and non-athletes'. Caution must be exercised. however, since the attitudes of one-time athletes was not known prior to their dismissal. However, since they had similar varsity athletic experience as the athletes, there was little reason to believe that as a group they would possess dissimilar attitudes unless the dismissal was related to an attitude change. It is not too difficult to expect that removal from a desired status would cause some disappointment and negative feelings about the entire situation — persons and objects alike. One way to accept such a situation is rationalization and to disclaim any value in that endeavor.

Findings reinforce the concept that attitudes are a function of the degree of pleasantness or unpleasantness associated with previous experiences in the endeavor (TRIANDIS, 1971). More favorable attitudes are attached to pleasant situations and less favorable attitudes are attributed to unpleasant situations.

Athletes report more favorable attitudes toward physical activity for the pursuit of vertigo, aesthetic, and ascetic values than do one-time athletes and non-athletes. This is reasonable since athletes are participating in endeavors that are characterized as such. A well-executed movement in sport is often appreciated more by those individuals who know what the movement entails. On the other hand, individuals who are not cognizant of the difficulty involved in such a movement may perceive the activity in a completely different light. For example, an artist may perceive his painting as a masterpiece of originality simply because he is aware of the time, effort, and difficulty involved in the work. However, an individual who is not cognizant of the difficulty involved in such work may view the same painting as a series of colored spots placed at random on a piece of canvas.

Participation in most sporting endeavors — weekend tennis to varsity football — requires periods of long and hard training if even a modicum of success is envisaged. Since non-athletes never participated in those organized sports which require a great deal of hard training, they are likely unable to perceive the intrinsic values of such activity. Conversely, they might even visualize the effort as foolish and misplaced. One-time athletes could hardly be expected to attribute much importance to the ascetic dimension since several of them were dismissed for violating training rules.

Although physical educators and others advocate the positive benefits of sport participation, there is a distinct possibility that unsuccessful experiences may promote less favorable attitudes toward physical activity generally. A case in point is the health and fitness dimension. Since athletes and one-time athletes differed significantly in their attitudes toward this dimension, what impact does dismissal from sport have? It may well be that removal of an athlete from a desired sport endeavor triggers a less favorable attitude toward sport participation and its purported values. One of such values is health and fitness. Unlike other speculated benefits such as social and emotional, fitness values only acrue through participation in some type of physical activity. Any reduction in the positive attitudes toward physical activity may well result in reduced participation and with it, reduced values.

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SELF CONCEPT AND ATTITUDINAL DIFFERENCES IN ELEMENTARY AGE SCHOOL CHILDREN AFTER PARTICIPATION IN A PHYSICAL ACTIVITY * PROGRAM

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Many positive social and psychological values have been attributed to participation in physical activity. "It is often claimed by physical educationalists...that...physical activity...[is] of psychological benefit to the individual. As yet this assumption does not rest on any well-established scientific findings" (KANE, 1972, p. 103). Two such constructs which have been researched are self concept and attitude; however, these studies have generally dealt with young adolescents through the age of adulthood. Very few have been done which investigated these constructs in the elementary school age child, particularly with reference to physical activity. WYLIE (1974) and SIMON and SMOLL (1974) suggest that lack of or inadequate instruments could be the reason for this dearth of research with young children.

Researchers have long recognized that a positive self concept tends to produce positive behavior and a negative self concept, maladaptive behavior (WOOLNER, 1966; ROGERS, 1951; WYLIE, 1968). Once a child is born his self concept starts to develop. For the most part, the initial development of the self takes place through sensory stimulation and physical manipulation of the environment (WYLIE, 1968). As a person learns about the surrounding environment he also starts to identify himself in terms of others.

COOLEY (1922) focused on this point with his "looking-glass self" theory. He stated that a person's self concept is affected by what one thinks others think of him. MEAD (1934) expanded on this and noted that people have a tendency to observe and imitate the behavior of "significant others." The implication is that social interaction is a necessity for development of the self concept. HARRIS (1973), after reviewing self concept theories, stated that a common denominator in these theories was that self concept development occurred as a result of social interaction.

A child assumes many social rôles in the process of "growing up." He maintains the rôles for which he receives positive reinforcement. Physical activity can play an important part in positive self concept development because there are many chances for a person to achieve success through physical activity. Self testing activities provide a basis for a person to assess his strengths and weaknesses. HELLISON (1973) believes "that physical education has a unique, although limited, potential for providing significant others who can influence self-esteem of the participants in certain physical education programs" (p. 12).

LEWIS (1972), CARY (1963), and JOHNSON, FRETZ, and JOHNSON (1968), when dealing with exceptional children, found significant positive changes in the self concept of children who participated in programs of physical activity. Other studies dealing with adolescents and adults have found equivocal results. NELSON (1968) and SAKERS (1968) found no improvement, in self concept after participation in a physical education program; whereas MARSHALL (1969) and GOURLEY (1969) found positive changes.

The development of positive attitudes (affect) is considered a desirable outcome of the physical education experience. Good feelings toward physical activity ultimately result in behaviors which are synonymous with a positive attitude. Although this relationship of congruence between affect and behavior is in doubt (LaPIERE, 1937; LINN, 1965; TRIANDIS, 1971; ZAICHKOWSKY, L. B., 1973) it has been demonstrated that, for the most part, positive attitudes toward physical activity do exist (ALBINSON, 1975).

Attitude studies of elementary age children have been virtually non-existent in relationship to physical activity. The lack of proper instruments to measure this construct concerning the movement dimension has been a main reason. Recent attitude scales toward physical activity developed for children (MANCINI, 1974; SIMON and SMOLL, 1974) should enable investigation into this important area.

Research, such as that of LEVINE and MURPHY (1943) indicates that a person's attitude may affect what a person learns and retains. Therefore, the development of positive attitudes toward physical activity should be an objective of physical educators.

The purpose of this study was to explore the differences in the self concept and attitude scores of children involved in a physical education program with those who were not.

METHOD

Subjects

One hundred and eighty-four (184) Boston elementary school children, grades one through five, from the same school district and with similar socio-economic status were the subjects used in the experimental groups.[1] Eighty-six children from another Boston school district were used as the control group. Their socio-economic status was similar to the experimental group. Random sampling of the school populations was used to select the 270 participants in the study. An analysis of variance on pre-test scores indicated that groups were not significantly different on self concept or attitude scores.

Instruments

Self concept was measured by The Piers-Harris Children's Self-Concept Scale (PIERS, 1969). This scale (PH) consists of 80 statements to be answered yes or no depending upon how

* The initial intent of this study was to compare two different teaching styles, therefore, two experimental groups were established. During the course of this study, administrative difficulties prevented the investigators from carrying out this portion of the project. However, both experimental groups were retained even though they represent only one treatment condition.

the respondent generally feels about himself. The highest score attainable is 80. The validity of this scale is represented by a correlation of .68 with the Lipsitt Children's Self-Concept Scale. The reliability using the Spearman-Brown odd-even formula for grades 6 and 10 was .90 and .87, respectively (PIERS, 1969).

Attitudes toward physical activity were measured by the Cheffers and Mancini Human Movement Attitude scale (MANCINI, 1974; MANCINI, CHEFFERS, and ZAICHKOWSKY, L. D., in press). This scale (CAMHM) uses a non-verbal medium of artists' pictures depicting different aspects of the physical activity program. Face validity was obtained from oral responses of elementary age students describing each picture. Subjects respond to each picture on a three point scale of like to dislike. Possible responses were indicated by a face with a smile (like), an expressionless face (neutral), or a face with a frown (dislike). The highest attainable score was 81. Test-retest and split-half reliability measures were .97 and .87, respectively.

Procedure

Subjects in the experimental groups received instruction at the physical education center at Boston University once a week for a period of 45 minutes per week. The length of the program was 23 weeks — from October, 1974 through April, 1975. The curriculum was centered around movement exploration experiences as well as gymnastic activities. The control group received no formal physical education instruction in their school.

Subjects were tested (PH and CAMHM) at the beginning and end of the program. The subjects were tested 20 at a time by the investigators. Because the PH scale is worded at the third grade reading level the 80 items were read aloud to all subjects. This was done to assure that the children in grades one and two understood the statements. The CAMHM scale was completed in the same time period by the subjects after the instructions were given to the group.

RESULTS

A two by three by five factorial analysis of covariance (using the pre-test as the covariate) was utilized to test for treatment, sex, and grade differences on the dependent variables of self concept and attitude. A significant F ratio was obtained for the main effect of treatment on the self concept scale, $F(2,239) = 4.82$, $p < .01$. The Scheffe technique for multiple comparisons revealed that the experimental groups had significantly higher self concept scores than the control group. The adjusted means for the two experimental groups were 61.98 and 61.43. The adjusted mean for the control group was 57.66.

Statistical significance was also reached on the main effect of sex for the attitude instrument. $F(1,239) = 8.41$, $p < .01$. The girls expressed more favorable attitudes than did the boys. The adjusted mean scores were 69.18 and 66.75, respectively.

DISCUSSION

The results indicate that those persons who participated in a physical education program have more positive self concepts than those who did not. These results agree with those of CARY (1963), GOURLEY (1969), JOHNSON *et al.* (1968), LEWIS (1972), and MARSHALL (1969), who reported positive self concepts after participation in a physical education program. It is possible that the opportunity for social interaction in the physical education setting and the high ratio of teachers to students may have allowed the subjects chances to view themselves in a more positive fashion as suggested by HELLISON (1973).

The finding of no sex difference is concurrent with the information reported by PIERS (1969). It seems that boys and girls develop their self concepts in a similar manner. The adjusted mean scores for grades one through five were 60.74, 60.54, 59.62, 60.22, and 61.04, in that order. This downward trend in self concept scores, although not statistically significant, is similar to that noted by STANWYCK (1972) and FELKER (1974). That is, the scores tend to decrease until the fifth grade when an upturn is noted. The results of this study show the beginning of that upturn at grade four. According to FELKER (1974), this decrease and resultant increase may be attributed to the pressure of the early school years on the child.

The statistically significant difference between the sexes on the attitude scale is similar to findings reported by ALDERMAN (1970), KENYON (1968), and ZAICHKOWSKY, L. B. (in press) utilizing older subjects. MANCINI *et al.* (in press) reported no significant sex differences on attitude scores for elementary age children after participation in a physical education program.

Mancini *et al.* also reported a significant downward trend on attitude scores in grades one and two, three and four, and five and six. They suggest that this evidence supports the popular contention that schooling so channels attitudes that a gradual decline in interest results. Although statistically significant results were not found among grades, in this study, the downward trend is still visible. The means for grades one through five on the attitude scale were 69.31, 67.98, 68.93, 67.68, and 65.63, respectively. The upward trend at grade three may be explained by the inclusion of a greater number of girls in this group and a greater number of boys in grade two. This could raise the mean in the third grade and lower it in the second because girls were shown to have more positive attitudes than boys. When grades are grouped in the same fashion as Mancini *et al.* (in press) the downward trend is consistently present, though small.

The results of this study can not establish cause and effect relationships and should be interpreted with that point in mind. The fact that statistically significant differences do exist can not be overlooked. It is possible that participation in a program designed to achieve positive social and psychological change can be achieved. Based on the results of this study it seems that a physical education program which promotes social interaction does prove to be beneficial in positive self concept development. Further investigation of this idea is currently underway by Martinek.

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COOPÉRATION, COMPÉTITION ET SPORT

THE DEVELOPMENT OF THE SKIMETRIC DIFFERENTIAL INVENTORY: A CHILDRENISTIC APPROACH[1]

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BACKDROP

Our initial two years of research in the north was carried out in the MacKenzie Delta area of the western Canadian arctic in the fall of 1971 and Spring of 1972. The board of directors for the Inuvik based Territorial Experimental Ski Training Program (TEST) invited our research team to evaluate the psycho-social effects of the TEST program. We had some serious reservations about the original goals of TEST which were essentially to shape in the competitive ethic in order to give Indian and Eskimo youth a chance to compete in the rapidly approaching "modern" world. One specific objective was to motivate northern youth to greater general achievement in life through an achievement oriented ski program. However, regardless of our personal biases we did feel that it was important to attempt to assess the effects of the program for a variety of reasons one of which was to enable native groups to be in a better position to determine what kinds of programs they wanted for their people.

We were attracted by the call of the north and looked forward with anticipation to experiencing it on each excursion. We experienced the northern dilemma, we witnessed a confrontation between cultures and we became immersed in the problem of fusing past and future. Through our initial experiences we gained a great deal of respect for the northern people and also learned a great deal about approaching our research problem. The more we got into the study and into the culture, the more complex the value question became. It was not as clear cut as we had once thought. What happens to a relatively cooperative and trusting culture when it is invaded by a competitive, insensitive and exploitive group of people from another age?

Although some interesting trends did emerge from the first phase of our study, some methodological problems were experienced in our initial work. Firstly, the TEST program had been in full operation in Inuvik for 5 years before our research team began any assessment. Consequently it was impossible to obtain any baseline measures on either TEST participants or nonparticipants. Secondly we experienced a serious problem with respect to research instrumentation, as standardized psycho-social inventories and indices from the south have given absolutely no consideration to the northern perspective. Three simple examples of the inappropriateness of a southern bias in northern research are presented below.

1. *Socio-economic index* — When assessing the socio-economic level of Canadian subjects a commonly used standard index is the Blishen Canadian Occupational Scale (BLISHEN, 1967). This scale, which correlates highly with scales from other industrialized countries, utilizes education, income as well as a "social standing" or "prestige" measure as a basis for ranking occupations and establishing socio-economic ratings. Three hundred and twenty occupations are listed with accompanying socio-economic index scores, and are placed in rank order from highest to lowest. The 320th occupation listed is "Trappers and Hunters". In some settlements this is almost the entire population.

2. *Academic Records* — Even something as simple as attaining and making comparisons with respect to academic achievement is often an insurmountable task in northern settlements. Normally several grade levels are combined due to the fact that a few teachers handle grades 1 through 6 or 8. There are also extreme ranges of age within one grade level, which more often than not has nothing to do with intelligence. Some children are out trapping with their families and start "school" late by our standards. Others may go out in the bush for months at a time, and others may stay in the settlement for the entire school year. The discrepancy between time in school, the courses being taken, the level at which a child is working, etc. make grades a very questionnable area of comparison. In addition, grades, as we know them, are often not assigned to students in settlement schools.

3. *Personality Inventories* — Many standardized personality inventories refer to terminology, concepts or experiences which are foreign to or inappropriate for the sample population. Three questions taken directly from the Children's Personality Questionnaire (PORTER and CATTELL, 1963) serve to illustrate this point. Visualize an Indian or Eskimo settlement — population 98; largest building — one story pre-fab home next door; mode of ground transport — walking, dog sledge, and skidoo only.

CPQ - Question 1. Which story would you like better: One about killing Indians or about how Indians made clothing?

CPQ - Question 2. If people push you in a bus, do you just smile or do you get mad?

CPQ - Question 3. When visiting a new building do you like to have someone show you around or do you like to find your own way?

ROGERS (1972) has cautioned against the wholesale use of personality instruments that have been developed in another cultural milieu, without an adequate research program designed to ascertain the applicability of its constructs. When this cautionary note is transferred into positive action with respect to northern research, it essentially means that northern instruments must be designed within the northern culture.

1. The research being presented in this session was supported through services and/or financial assistance by the University of Ottawa Northern Science Research Group of Indian Affairs and Northern Development, Boreal Institute for Arctic Studies, Faculty of Physical Education — University of Alberta, Department of Kinanthropology — University of Ottawa, Department of Psychology — Carleton University, The Department of National Defense, the Territorial Experimental Ski Training Program, and the people of the North.

With reference to our initial research tools we experienced best results with open ended interviews and open ended questionnaires which had been pre tested in the north for comprehension. One way in which this was done was to go over each question individually with a child (or adult). If there was a word or concept which was unfamiliar, it was explained to the child until he indicated that he understood. The child was then asked to explain the word or concept in his words. His words were subsequently used to formulate the question, thereby ensuring comprehension. (e.g. outboard motor = kicker).

The problems we encountered with the first phase of our study coupled with the obvious need for instruments which were relevant and applicable to the north, led to new directions for the second phase of our study (1973–1975). We decided to attempt to get meaningful baseline measures in settlements before skiing was introduced. Our main source of data for phase two was to be obtained through:

a) the use of individual interviews designed for specific purposes,

b) the recording of standard patterns of behavior, and

c) the design of a northern based psychometric inventory.

The remainder of this paper is focused upon the development and assessment of this latter item known as the Skimetric Differential Inventory (or the skimetric scale).

DEVELOPMENT OF SKIMETRIC DIFFERENTIAL INVENTORY

Our objective was to develop and assess a psychometric inventory designed specifically for use with indigenous children in the Canadian Arctic. Through the creation of this instrument an attempt was made to fulfill several important criteria. The inventory had to be:

1. Clearly comprehensible to a group of people two cultures apart (i.e., not only indigenous people from the north but also children from within this culture).
2. Motivating for the children to respond to and capable of maintaining this motivation over a series of administrations (i.e., we wanted it to be fun to fill out and motivationally durable for use in a longitudinal study).
3. Capable of measuring a series of important and relevant self attributes within a short period of time (i.e., approximately 15 minutes).
4. Capable of eliciting acceptable levels of reliability and validity.

In short our goal was to design and validate a children's psycho-social inventory for use in the Canadian Arctic, which was motivationally attractive to the child and also reinforcing for the researcher to administer. This posed an exciting and creative challenge for the researchers to contend with. The inventory format was influenced by CANTRIL's work (1965). GARDNER's stereotype differential (1968), Osgood's Semantic Differential (1957), as well as northern childrens great love for comic books. CANTRIL (1965) devised a non verbal "man on the mountain scale" for use in Africa which proved to be useful in predicting discontentment and revolution. The scale consistes of a simple drawing of a mountain upon which the subject was asked to place himself (i.e., where he was now and where he wanted to be). Cantril's man on the mountain-format was adapted in part for use in our skimetric scale.

The inclusion of bi-polar dimensions was influenced by Gardner's stereotype differential which has its roots in the semantic differential. The modified semantic differential format seemed appropriate to assess selected self attributes and value orientations of native northern children since the scales required judgments of the extent to which one end or the other of a particular scale was applicable or relevant to the concept being rated. In addition the semantic differential bi-polar format has a research history which has shown it to be highly reliable in measuring a wide variety of concepts and has been used in different cultures. (OSGOOD *et al.*, 1957; GARDNER *et al.*, 1968).

The final format adopted for the skimetric differential was a series of bi-polar personality/value dimensions, each anchored by cartoon like stick figures with accompanying verbal statements. The cartoon like stick figures accompanying each pole on each variable were introduced partially as a motivational device and partially to strengthen the simple verbalization presented.

The original skimetric scale was comprised of 22 carefully selected items which, as a result of two years of prior research in the north, were deemed to be important self attributes for northerners and/or important life variables which should be assessed with respect to possible influences from the outside world. (e.g., TEST). An attempt was made to tap some of the same variables which were explored in our initial northern research through the use of standardized instruments originating from the south (GLASSFORD *et al.*, 1973). Although these instruments were inadequate in many respects for use with young northern children, some of the self dimensions which they were designed to measure were felt to be relevant and important. Through our newly designed instrument we attempted to assess salient variables from Rosenberg's Self Esteem Test, Piers-Harris Children's Self Concept Scale, Rosen's Ahievement Motivation Inventory, major dimensions of meaning reported by Osgood (i.e., evaluation, potency and activity), as well as items which were of specific relevance to the traditional northern way of like. Six of the skimetric scale items were directly related to the cooperative/competition domain. These items attempted to tap the importance of sharing, helping others, man vs. nature, teamwork, winning and being humble in victory.

Through a series of individual interviews with Eskimo and Indian children each skimetric scene was scrutinized to ensure that it was easily comprehensible in terms of content and format. An initial reliability check (test — immediate retest) was also conducted with a small sample of 15 native northern elementary school children residing in the Ykon Territories. From this limited sample it was found that 19 of the 22 individual skimetric scale items had reliability coefficients which were significant beyond the .01 level.

The instrument was then administered to 380 northern children residing in a variety of settlements in the western arctic (i.e., Yukon and Northwest Territories). This data was subjected to both item and factor analysis, and additional data was collected and analyzed in an attempt to further assess the validity of the inventory.

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SKIMETRIC SCORING

On each of the 22 cartoon like items, subjects are requested to place themselves anywhere along a continuum which extends from one extreme to another, as is the case with the semantic differential. The maximum score range on a particular item is from 0 to 8 depending upon where on places him/herself on the 8 cm line.

The skimetric scale is scored by merely measuring the distance from the beginning of the line to the mark which has been placed on the 8 cm line by the subject. This is normally done with a clear plastic centimenter ruler. Interjudge scoring reliabilities were conducted on 3 randomly selected skimetric inventory items in attempt to assess scoring reliability. With a sample of 22, the interjudge scoring reliability for items 4, 12 and 18 was .99 in each case. These significant correlation coefficients demonstrate that two people can measure the position of the mark on the continuum in the same way.

SKIMETRIC ADMINISTRATION

1. Describe the inventory as a game involving pictures 'like in comics'. Refer to the first item. Point out the guy on the left who is full of energy (act it out) and the guy on the right who is very tired (act it out). Then ask how they feel right now and get them to show you where they are on the wiggly line. Tell them they can use any part of the wiggly line because everyone probably feels different. Using examples of various hypothetical responses might help at this point. (e.g., If you are very tired you would mark here (right end of line); If you are feeling full of energy you would mark this end of the line (left end); If you are sort of in between you would mark somewhere near the middle of the line.

2. Ask the children to try the remaining items. "Show how you feel by marking the wiggly line for each cartoon picture". For lower grados (i.g., 1, 2, or 3) or for poor readers, it may help to work as a group, reading each time aloud to assure that the items are understood. If the items are read, care should be taken to avoid emphasizing one end of the scale as opposed to the other (e.g., through voice intonation or raised eyebrows).

3. Note that items 19,21 and 22 provide a choice between two alternatives. Ask the children to make an X on the alternative of their choice.

CHILD'S EYE VIEW

From a child's perspective the skimetric scale was 'great' because it was "lots of fun." Whoever heard of a test or psycho-social assessment inventory that was fun to fill out? Behavior observations of children's reactions to the skimetric scale indicated that they not only understood it but also really enjoyed the process of filling it out. Upon completion of the inventory they often asked if they could do more and expressed disappointment when they were told there was no more. Many children also wanted to keep their copy of the inventory. In addition, this positive motivational orientation toward the test was durable over time (i.e., three or four administrations). The children were certainly not bored with this inventory as had been the case with previously used standardized inventories (e.g., CPQ). They were attentive to each skimetric scene and did not appear to have any problem relating to the concepts presented. They appeared to respond very carefully to each item taking great care to place themselves precisely where they thought they should be. If a researcher were to ask a child "are you sure you should be there," the child made it clear that he or she knew where they should be on the bi-polar scale.

POLARITY ANALYSIS

Polarity analyses were undertaken to confirm the above impressions that the skimetric variables were meaningful and useful for the self evaluation of young native northern respondents. Such analyses are widely used in the development of instruments for use in the study of ethnic stereotypes. (GARDNER, WONNACOTT and TAYLOR, 1968). Extremity of judgments on each concept on the skimetric scale was assessed by mean of the t-distribution. Assuming an underlying normal distribution, the statistic $(\bar{X}\text{-}U)\ \sqrt{N}/s_d$ is distributed as t with N-1 degrees of freedom. Consensus in individual self perceptions may be inferred when the mean deviates significantly from an assumed population mean of 4.0 on the 8 cm line and 1.5 for the composite variable 20, and when the variability in the distribution of scores is low. High levels of agreement are not considered evident unless the mean deviates by at least one unit from the neutral position. Table I presents the means, standard deviations and t's for each skimetric scale variable. The variables have been ranked in terms of the magnitude of the t statistic. It should be noted that 19 of 20 t values are significant beyond the 1 percent level with the remaining one being significant at the .02 level.

Table I - Means, standard deviations, and tests of polarity of the 20 skimetric scale variables listed in rank order (N = 380).

Rank		Variable description — Low score — High score [1]	Mean	Standard Deviation	T
1	3	Sad — Happy	6.27	1.78	24.79**
2	17	Don't like Sharing — Like Sharing	6.28	1.88	23.62**
3	01	Energetic — Tired	1.90	1.96	– 20.91**
4	02	Loner — Likes being with others	6.17	2.13	19.82**
5	18	Helping others — Beating others	2.00	2.00	– 19.57**
6	19	Likes teamwork — Prefers working alone	1.98	2.03	– 19.46**
7	12	Lively — Lazy	2.20	1.99	– 17.58**
8	09	Many friends — Left out	2.19	2.02	– 17.48**
9	05	Smart — Dumb	2.40	1.93	– 16.16**
10	11	Accept things — Can change things	5.76	2.17	15.80**
11	07	Good — Bad	2.76	2.12	– 11.37**
12	15	Spend now — Save for later	5.40	2.39	11.37**
13	04	Strong — Weak	2.78	2.19	– 10.88**
14	13	Show off — Not show off	5.25	2.31	10.55**
15	16	Work hard — Have fun	2.87	2.57	– 8.59**
16	10	Not good at sports — Good at sports	4.91	2.32	7.66**
17	20	New (man vs. man ; brag ; win) — Traditional (man vs. nature ; humble ; help)	1.78 [2]	0.88	6.20**
18	06	Kids follow me — Kids do not follow me	4.67	2.42	5.39**
19	08	Thinker — Doer	3.63	2.51	– 2.85**
20	14	Shy — Outgoing	3.69	2.54	– 2.41*

** $p \leq .01$.
* $p \leq .02$.
1. Variables 1-19 have a maximum score range from 0 to 8. Variable 19 corresponds to item 20 on the skimetric scale.
2. Variable 20 is a combination of 3 dicotomous choice items (i.e., skimetric scale items 19, 21, 22) which when combined have a maximum score range from 0 to 3, with a mean of 1.5.

And examination of the distribution of skimetric scale variables evidencing the most extreme consensus, revealed that native northern children see themselves as happy, energetic people who like sharing their things with other kids, who like to be with others, who like to be part of a team all working together and who feel that trying to help others (rather than beat others) is most important. The obtained scores reflected in the polarity analysis lend some credibility to the skimetric inventory and to the meaningfulness of the variables since the direction expressed by the subjects in certain of these variables was as expected from reports on the northern personality (VALLEE, 1961). In addition, the finding that children from northern settlements express a positive orientation toward cooperative values, which were reportedly so evident at one point in time, was also reflected behaviorally in one settlement by the children's acceptance of a cooperative game (McNALLY and ORLICK, 1975).

FACTOR ANALYSIS

Pearson product-moment correlation coefficients were computed among the different skimetric scale variables. The resulting matrix was factor analyzed using the Principal Axis solution and the factor matrix was rotated by means of the Normalized Varimax solution (NIE, HULL, JENKINS, STENBRENNER and BENT, 1975). Portions of the rotated matrix showing variables with appreciable loadings (i.e., greater than .30) are presented in Table II.

The meaning of a factor was inferred from commonalities among its defining variables. Variables were considered to contribute to the definition of a particular factor if they loaded higher on that factor than on any other factor and if their loadings exceeded .30. These criteria usually resulted in a cluster of 2 or 3 variables defining each factor.

Factor I which accounted for 47% of the common variance was found to have 5 defining variables (Variables 5, 7, 11, 16 and 18). This cluster of defining variables (i.e., smart, good, can effect change, feel that studying or working hard and helping others is important) suggests that Factor I is a *General Self Evaluation Factor*. This factor also loaded appreciably (i.e., above .30) on variables 3 and 12 (happy and lively) but these variables did not have their highest loadings on Factor I. With respect to Factor I it appears that northern children who see themselves in a positive manner (i.e., intelligent, good, and capable of effecting change) also feel that working hard and helping others is important.

Factor II which accounts for 16% of the common variance was defined as a *Traditionalism Factor*. The defining variables for this factor are variables 10, 13 and 20 (sports ability-negative loading, non exhibitionist and traditional values). Factor II also loads appreciably on variable 18 (helping others). It appears that for northern youth, saying you are good at sports is not associated with traditional values (e.g., being humble and cooperative).

Variables 1, 3 and 12 (energetic, happy and lively) contributed to the definition of Factor III, which accounted for 12% of the common variance. Factor III was labelled as an *Active/Well Adjusted Factor* due to the fact that the defining variables denote energy, life satisfaction and activity. This factor also loaded appreciably on Variable 4 (strong).

Table II - Rotated factor matrix depicting appreciable loadings of skimetric scale variables (N = 380).

	Variables	Factors						
		I	II	III	IV	V	VI	VII
1	Energetic — Tired			.672*				
2	Loner — Likes Being with Others					− 512*		
3	Sad — Happy	−.321		−.381*				
4	Strong — Weak			.313			.467*	
5	Smart — Dumb	.590*						
6	Kids follow me — Kids do not follow							
7	Good — Bad	.510*						
8	Thinker — Doer							
9	Many Friends — Left out						.604*	
10	Not good at sports — Good at sports		.514*				−.324	
11	Accept things — Can change things	−.351*						
12	Lively — Lazy	.316		.332*				
13	Show off — Not show off		−.302*					
14	Shy — Outgoing							
15	Spend now — Save for later				.728*			
16	Work hard — Have fun	.441*						
17	Don't like sharing — Like sharing					−.318		.509*
18	Helping others — Beating others	.335*	.306					
19	Likes teamwork — Prefers working alone					.724*		
20	New — Traditional		−.303*					

* Met criteria of defining variable (i.e., loading on this factor was higher than on any other and factor loading was above .30.

1. Copies of the complete correlation matrix and principle axis matrix are available from T. D. Orlick and J. T. Partington.

Factor IV which received a high loading from only Variable 15 (spend now) accounted for 8% of the common variance. This factor was defined as a *Temporal Orientation Factor.*

Factor V was defined as a *Collective Orientation Factor* and accounted for 6% of the common variance. Variables which contributed to the definition of this factor were Variable 19 (likes teamwork) and Variable 2 (likes being with others). This factor also loaded appreciably on Variable 17 (likes sharing).

Factor VI was defined as a *Perceived Potency/Sociability Factor* and also accounted for 6% of the variance. Variable 9 (Many friends) and Variable 4 (strong) both contributed to the definition of this factor. Factor VI also received an appreciable loading from Variable 10 (sports ability). For native northern children, perceived popularity and perceived physical strength appear to be positively related.

Variable 17 (sharing — negative loading) was the sole contributing variable towards the definition of Factor VII. This final factor was defined as a *Sharing Orientation Factor* and accounted for the remaining 5% of the common variance.

An analysis of the way in which the individual variables covary in the factor analysis lends support to the validity of the instrument. For example, on Factor V, Variable 2 (likes to be with other kids) and Variable 19 (likes to be part of a team, all working together) have a strong positive relationship. One would expect these variables to be closely related if the instrument was accurately tapping each of these variables.

CRITERION GROUP VALIDITY

An initial attempt at determining criterion validity for the skimetric differential was undertaken by the "known groups" procedure. It was decided to use the criteria of achievement-non achievement as the basis for the initial criterion group composition even though the skimetric differential was designed to assess a broader range of self attributes. This decision was determined by the fact that part of the original mandate in assessing the TEST ski program was directly related to achievement (i.e., objective 1, "to investigate in Indian and Eskimo youth in the Yukon and Northwest Territories can be motivated to higher general achievement as students and citizens through participation in competitive athletics" (GLASSFORD, *et al.*, 1973: 3). It was important to know whether the skimetric scale was capable of distinguishing between these groups and to determine how selected self attributes related to achievement and non achievement in the north.

The population from which the criterion group samples were drawn consisted of families residing in Inuvik, Northwest Territories. Inuvik, which in the Eskimo language means "place of man" is situated in the Canadian western arctic approximately 140 miles north of the arctic circle. It is an educational and governmental center as well as a base for petroleum exploration. With a population of approximately 3 000 people, Inuvik in a highly populated center, by northern standards. This becomes evident when one considers the fact that the total NWT population (about 38 000) is scattered throughout 1.3 million square miles and that 60% of the settlements are inhabited by less than 300 people.

"Achieving" and "non achieving" Inuvik families were identified by 3 expert witnesses, each of whom were white northerners who had spent a significant portion of their life in the north working in the educational system and who were familiar with families residing in the area. To assist the expert witnesses in identifying appropriate families, the following construct definitions of achievement as outlined by JACKSON (1967) and McCLELLAND, (1953) were utilized at the outset.

Definition of Achievement (JACKSON, 1967).

Achievement orientation: Aspires to accomplish difficult tasks; maintains high standards and is willing to work toward distant goals; responds positively toward competition; willing to put forth effort to attain excellence.

Defining adjectives: striving, purposeful, industrious, enterprising, productive, ambitious, resourceful, competitive.

Defining behaviours: will keep working on a problem after others have given up; doesn't mind working while others are having fun; prefers to be paid for how much work done rather than how many hours worked.

Prime test for teh achievement motive (McCLELLAND, 1953)

Determine whether the individual(s) in the family have an achievement goal — does he want to perform better or does he care about performing better?

Performing better is indicated by an individual doing one or more of the following four things:

a) outperforming someone else (e.g., getting a bigger share of the market, running faster, getting a higher grade, etc.) "Joe decided he would get first price in the spelling contest";
b) meeting or surpassing some self-imposed standard of excellence (e.g., doing something faster, cheaper, more efficiently, etc.). "Ed was practicing in order to lower his golf score by three strokes";
c) doing something unique (e.g., inventing something). "Carol wanted to be the first woman to sky dive successfully from 1 000 feet";
d) being involved over a long term in doing something well-where there is an indication of great involvement over time in the achievement goal (e.g., being a success in life, becoming a welder, dentist, professor, businessman, etc.) "Linda had spend eight years practicing ballet in preparation for her performance tonight".

Once the expert witnesses had been oriented toward an understanding of motivation (as outlined above), they were asked to try to think of one or two of the most achievement oriented native northern families they knew and to explicitly state their criteria for selecting this particular family. The first few families identified enabled the researchers to transcribe the achievement guidelines originating in the south to specific examples of achievement oriented behavior in the north, which served as a basis for identifying other northern familes. Some characteristic noted for Inuvik based achieving families included: moved out of bush so children could go to school, among the first natives to build a co-op home, always a steady wage earner, active on town council, has a good job (e.g., with oil company, school, own business), hard working, enterprising, has initiative.

When asked to identify some of the most non achieving families (i.e., representative of polar opposite with respect to achievement orientation in the north), some of the following behavioral components were associated with these families. Frequently out of work, short period of work-long layoff, heavy drinking, live in rental housing which is poorly maintained, children have poor attendance at school, children are probably in lower grade level than average child their age, children often smell of fish or fuel oil and look unclean and scruffy, children wander around late at night. In the final analysis two of the most common differences which distinguished between Inuvik families defined as "achieving" and "non achieving" related to the consistency with thich one works and drinks.

Once families had been identified as achieving or non achieving and attempt was made to test any children from these families who were of elementary school age. All testing was done in the elementary school consequently necessitated that the children attend school. The final sample consisted of 30 children from achievement oriented families and 19 children from non achievement oriented families, most of whom were in grade 3, 4 and 5. The skimetric differential was administered to the children in small groups, each of which was comprised of subjects from both achieving and non achieving families.

Differences between the skimetic differential factor score profiles for achieving and non achieving groups were assessed by discriminant analysis using the stepwise selection method (NIE *et al.*, 1975). With a cut off value of 1.0, the first step in the analysis excluded factor I and II from the inclusion matrix. Subsequent steps computed multivariate partial F ratios to test the statistical significance of the amount of centroid separation added by each variable over and above the separation produced by the previously entered variables. This stepwise procedure identified factor V (Collective Orientation Factor) as the most discriminating variable ($F = 3.03$, df 1,47, $p < .05$). The non achievement group was found to be more collectively oriented than the achievement group. The only other variable which added significantly to this separation between groups was Factor VII, Sharing Orientation Factor, ($F = 4.56$, df 1,46, $p < .01$). Regardless of the substantive meaning of these findings, it suffices for our present purposes to conclude that the skimetric differential has the potential for discriminating changes in respondents who differ in terms of achievement motivation. Some of the other concepts assessed by this inventory which were not found to be directly related to achievement in the north will need further work to assess criterion validity.

Some pilot work has already commenced which is aimed at making comparisons of northern and southern children based on skimetric differential responses. A small group of Ottawa children (N = 23) recently completed the skimetric inventory. A brief look at this data revealed that on 5 variables their mean scores differed by at least one full point from the northern sample. Northern children appeared to be more cooperative (i.e., helping others is more important than beating others), less exhibitionistic and to have more friends than these southern children. Due to time limitations with respect to the present paper, this data, along with that of a more representative southern sample will have to await a later date for proper presentation.

CONCLUSIONS

In conclusion it can be said that northern children residing in the western arctic clearly understand each time on the Skimetric Differential, found the items to be meaningful, could easily respond to the format utilized, responded very carefully and precisely and enjoyed filling in the inventory. Some degree of criterion group validity was evident with achievement and non achievement groups, factor loadings lent support to the validity of the inventory, test-retest reliability was acceptable, it was motivationally durable and took 10 to 15 minutes to complete. When one compares the skimetric differential inventory to other psychometric research tools which are available for use with indigenous northern children, one has to look upon if favorably. When it is stringently compared to what a psycho-social inventory has the potential of being, it is merely a humble beginning with a great deal of room for improvement and refinement.

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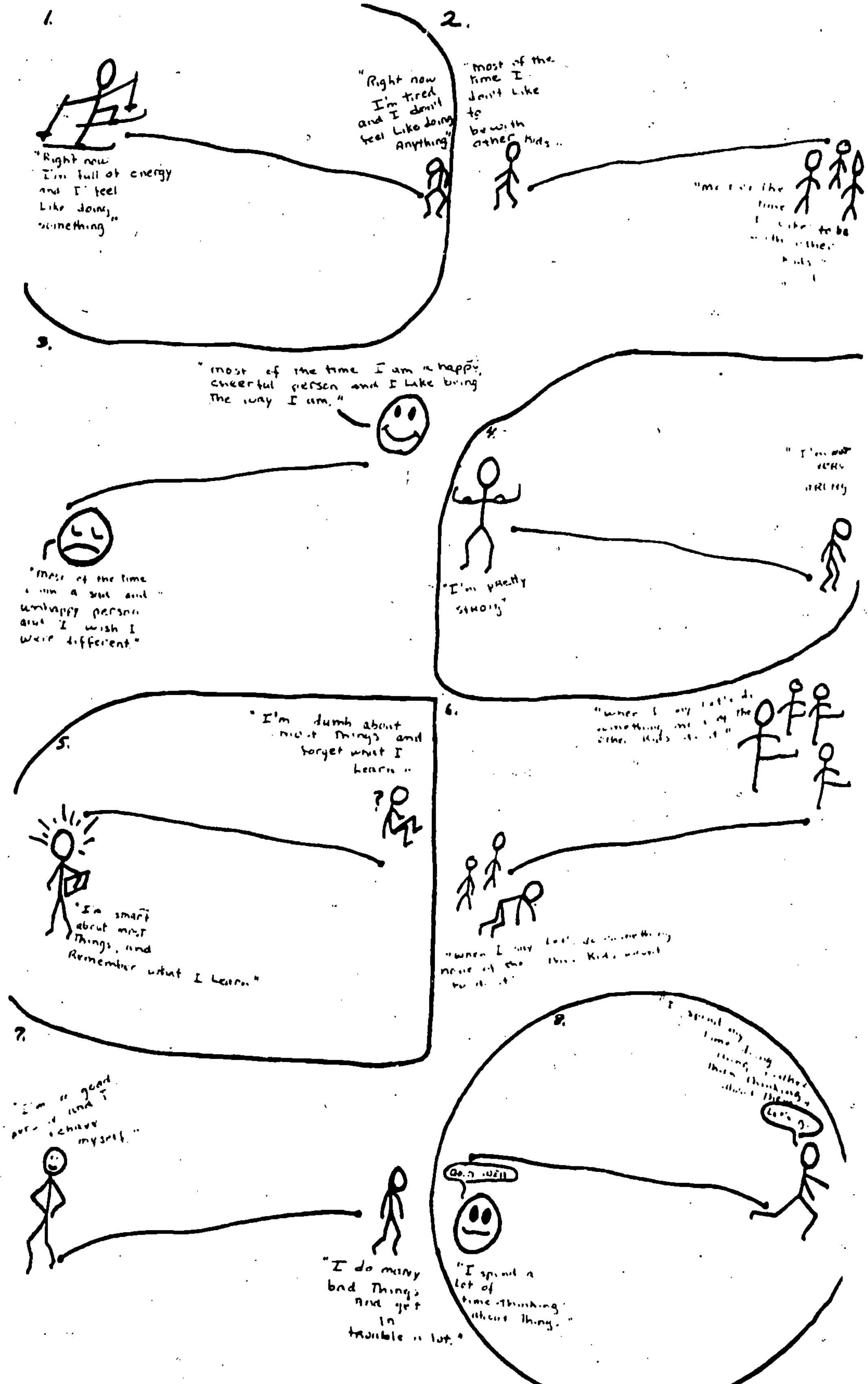
1.
"Right now I'm full of energy and I feel Like doing something"
"Right now I'm tired and I don't feel Like doing Anything"
2.
"most of the time I don't Like to be with other Kids.."
3.
"most of the time I am a happy, cheerful person and I Like being the way I am."
unhappy person and I wish I were different."
"I'm pretty strong"
"I'm dumb about most things and forget what I Learn."
5.
"I'm smart about most things, and Remember what I Learn."
6.
7.
"I do many bad things and get in trouble a lot."
8.
"I spend a lot of time thinking about things."

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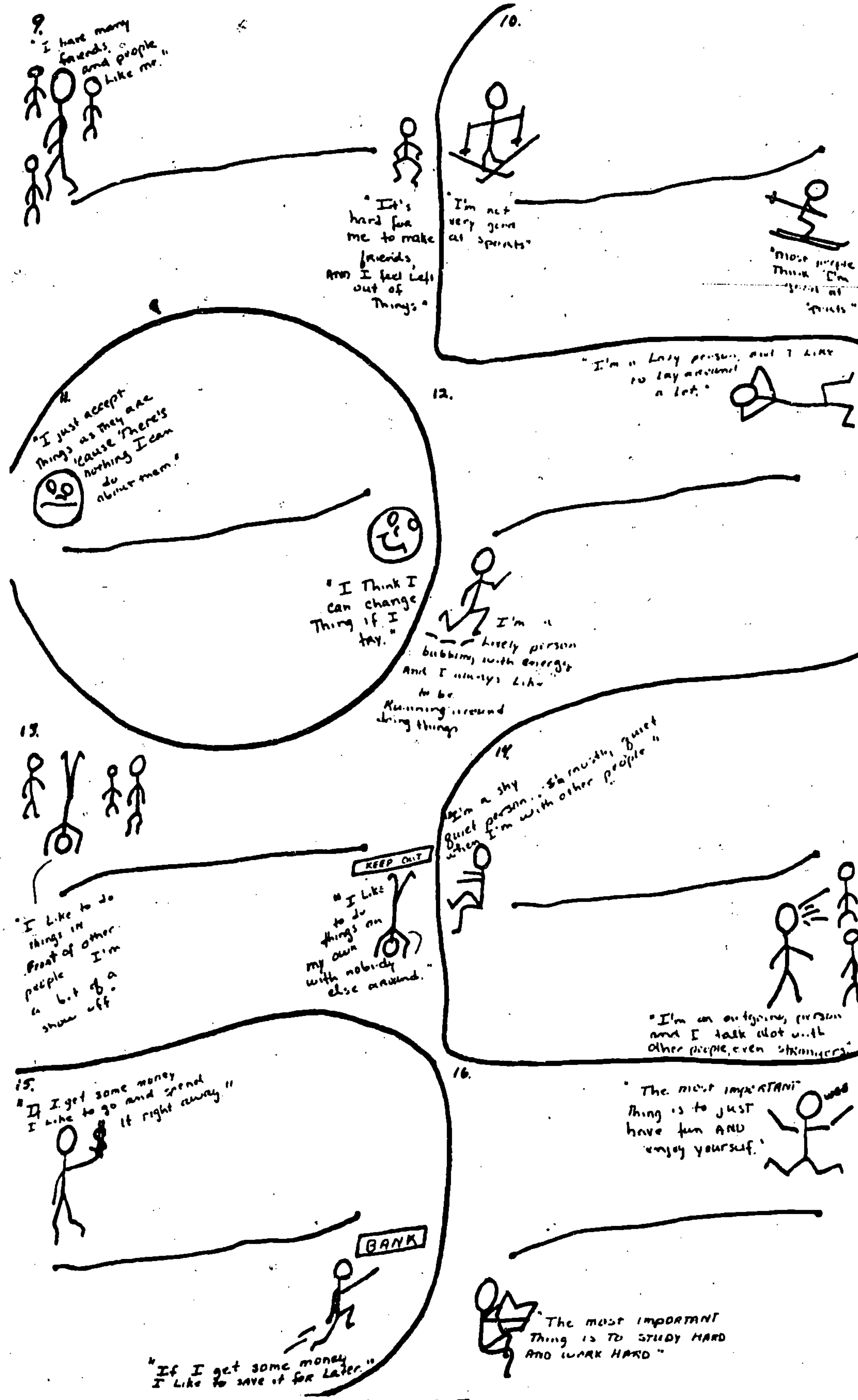
9.
"I have many friends, and people like me."
10.
"It's hard for me to make friends, And I feel left out of Things."
"I'm not very good at sports"
"most people Think I'm good at sports"
"I'm a Lazy person, and I like to lay around a lot."
11.
"I just accept things as they are 'cause there's nothing I can do about them."
"I Think I can change Thing if I try."
12.
"I'm a Lively person bubbling with energy, And I always Like to be Running around doing things"
13.
"I Like to do things in front of other people I'm a bit of a show off."
KEEP OUT
"I Like to do things on my own with nobody else around."
14.
"I'm a shy quiet person... when I'm with other people"
"I'm an outgoing person and I talk alot with other people, even strangers."
15.
"If I get some money I Like to go and spend it right away."
BANK
"If I get some money I Like to save it for Later."
16.
"The most IMPORTANT Thing is to JUST have fun AND enjoy yourself."
"The most IMPORTANT Thing is TO STUDY HARD AND WORK HARD"

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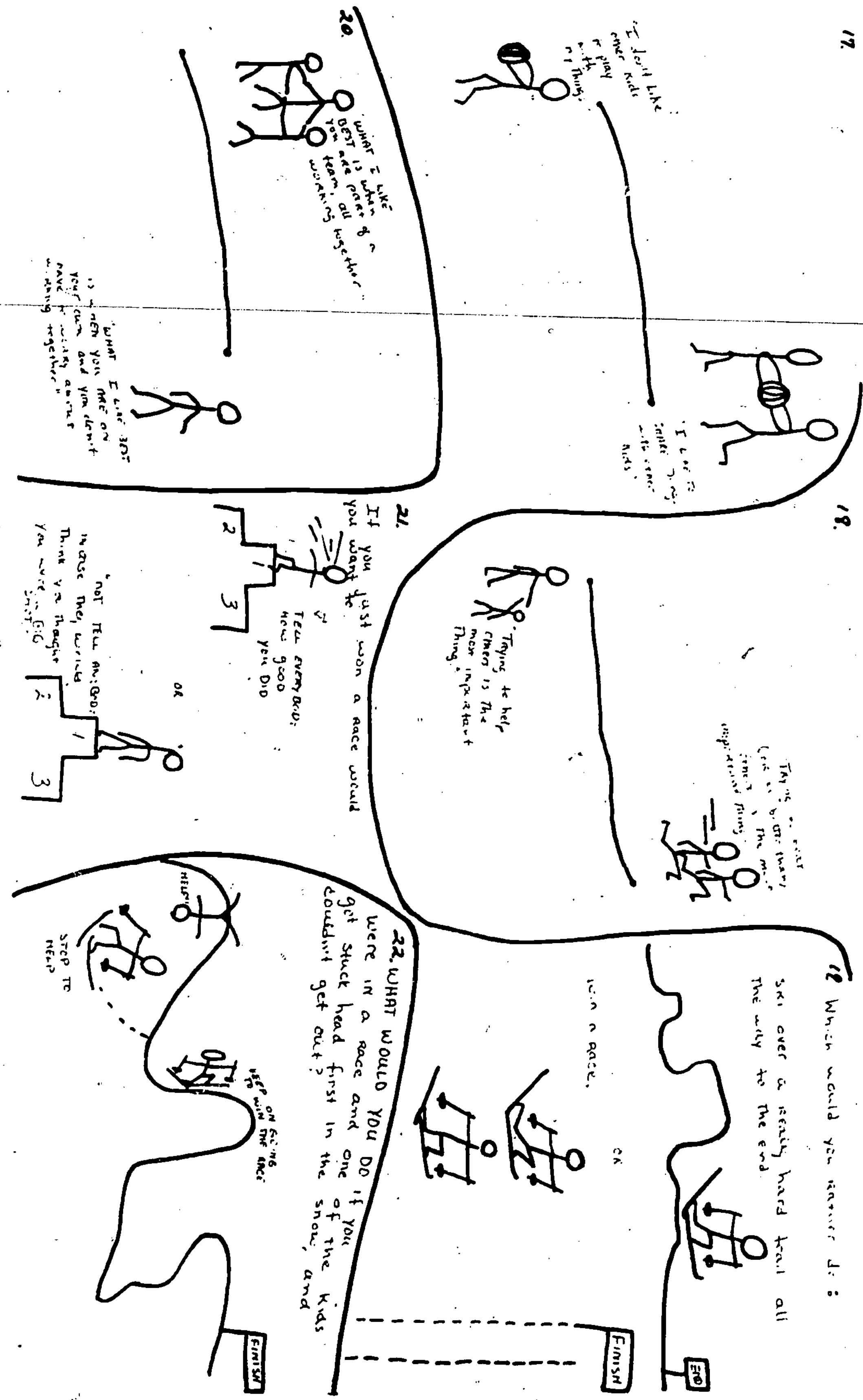
17.
"I don't like other kids to play with my things."
"I like to share things with other kids."
18.
"Trying to help others is the most important thing."
19. Which would you rather do:
ski over a really hard trail all the way to the end.
END
or
win a race.
FINISH
20.
"WHAT I LIKE BEST is when you are part of a team, all working together."
21.
If you just won a race would you want to
TELL EVERYBODY HOW GOOD YOU DID
OR
"NOT TELL ANYBODY IN CASE THEY WOULD THINK YOU THOUGHT YOU WERE A BIG SHOT."
22. WHAT WOULD YOU DO if you were in a race and one of the kids get stuck head first in the snow, and couldn't get out?
HELP
KEEP ON GOING TO WIN THE RACE
STOP TO HELP
FINISH

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EFFECTS OF THE TERRITORIAL EXPERIMENTAL SKI TRAINING PROGRAM IN TULITA, N.W.T.

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This report comprises an evaluation of effects of the *Territorial Experimental Ski Training Program* (T.E.S.T.) on northern native youth in Tulita (Fort Norman), N.W.T. TEST was conceived in 1963 by Father Mouchet in collaboration with the Northwest Territories Recreation Department to satisfy the need for an outdoor education program economical in terms of facilities and equipment and yet physically and mentally stimulating. The program was launched in Inuvik in 1964 and has since spread into the settlements.

The study is important for several reasons. First, the initial evaluation of TEST (GLASSFORD, SCOTT, ORLICK, BENNINGTON, & ADAMS, 1973) would seem to be of little value for understanding TEST effects on native youth in their natural setting. This is because evaluation was retrospective and focussed primarily on participants in Inuvik which is an urban center with a high proportion of non-native residents. Second, and perhaps closer to the current concerns of sports psychologists, it will be seen that the TEST committee knowingly and purposely involved northern native youth in the kind of "zero-sum" competition familiar to us in Southern Canada and the Western World but which may be quite unlike that practiced in the north (VALLEE, 1967). This point is particularly noteworthy since sports trends associated with our kind of competition are currently being critically examined (e.g., McMURTRY, 1974; ORLICK & BOTTERILL, 1975). Finally, in this era characterized by economic strain and galloping bureaucracy there is a growing need for careful and continuous surveillance of all costly large scale programs in both the public and private sectors (CAMPBELL, 1969).

Tulita lies at the junction of the MacKenzie and Great Bear rivers in the North West Territories. It was selected as the target of this study since TEST had not yet been introduced there and because it had been identified by a native consultant on the TEST advisory committee as a relatively traditional settlement. The majority of the 289 residents are Athapascan Indians of the Slave tribe, many of whom still support themselves largely by hunting and trapping. The town has only 16 white residents, is serviced by neither highway nor dependable air flights, and does not yet receive television transmission.

A broad data base was obtained not only from the 23 boys and 33 girls available for TEST in grades 1 to 6, but also from adult native and non-native residents. The study was conducted by a team of five investigators together with volunteer assistance from teachers and members of the adult education class in Tulita. To date, four separate visits have been made in Tulita by various members of the research team.

We gratefully acknowledge the four teachers of Colin Campbell School for their cooperation and assistance. Special thanks are extended to Brian Menton, school principal/teacher and head ski coach, and to Dorothy Menton, teacher and great cook.

The *Evaluation by Objectives* model will be used as a framework for organizing our "hard" data in the first section of this paper. "Soft" data will be considered in the latter half of the paper. The *Evaluation by Objectives* model was selected from the several models available for evaluative research at the program level (LARKIN, 1974) in view of its similarity to classical experimental design familiar to most social scientists. This model requires that a program's objective be defined by a clear statement which summarizes the ultimate achievement expected and the activities related to obtaining the objective.

The main long range objectives of the TEST committee were as follows:

1. To give Indian and Eskimo youth a chance to compete in the *MODERN* world in a field where they have sufficient environment, culture and understanding to excel to greatness.
2. To explore if northern youth participating in an activity where they have the ability to succeed, can be motivated by their success for greater general achievements and determination in life itself (PETTERSON, 1968, p. 2).

For the interested coach a personalized account of the competitive crosscountry ski training activities developed to obtain these objectives has been provided by the recently retired head TEST coach, Malcolm Hunter (TAYLOR, 1975). For purposes of this discussion it is sufficient to know that the objective of TEST was to make northern native youth more generally achieving through their involvement in a competitive cross-crountry ski program.

Our evaluation will be organized according to the four levels of measurement proposed by JAMES (1962) as appropriate for the *Evaluation by Objectives* model. These levels include evaluation of effort put into the program by those responsibles, evaluation of performance and performance adequacy of participants, and efficiency of the program in achieving the stated goals.

EVALUATION OF EFFORT

This criterion involves the counting of activities that are reported to be attempts at achieving the program goals. The following activities undertaken by the ski coaches (teachers) in Tulita clearly attest to their high level of effort. First, an "alcoholism" grant was obtained to purchase fifteen ski equipment packages. Regular training sessions were organized for after school and weekends. These were initiated in August by regular runs to the town dump in which the coaches themselves participated. Later they took the form of 18 to 30 kilometer ski "runs" through the bush. Also each season ski clinics have been conducted by the central TEST coaching staff. Moreover, frequent charter flights have been arranged to neighbouring settlements for regional competitions which culminate each year in the spring *Top of the*

World races in Inuvik. Finally, this past year a two day overnight ski marathon was organized by the Tulita TEST coaches for which participation was high from both skiers and townspeople who assisted by transporting food in their skidoos.

EVALUATION OF PERFORMANCE

This criterion for program evaluation involves such indices as the number of participants involved. By this minimal standard the TEST program in Tulita has been a great success — after two years of operation all but four native youths are skiing regularly. This result is noteworthy considering the prevailing stereotype that natives are changeable and unpredictable and also contrasts sharply with the rather poor school attendance records obtained in most northern schools. Perhaps curriculum planners would do well to consider seriously offering a higher proportion of outdoor education. The obtained high involvement in TEST also is surprising when considered in light of some base line data obtained in 1973 before the introduction of TEST. Specifically, we had involved the kids in what we call our "Ski-matic Apperception Test." Those familiar with projective devices will have guessed that this test resembles the T.A.T. used in both clinical settings and the thematic materials developed by McClelland and his coworkers for their study of social motives (ATKINSON, 1958). Five scenes were shown by means of a slide projector representing young native skiers in typical situations before, during, and after events. Kids were asked to make up an imaginative story for each scene describing among other things the feelings being experienced by the skiers portrayed. The rationale behind this kind of assessment is that respondents may "project" some of their own anticipated reactions onto the actors shown. Content coding identified the following profile of projected reactions: "cold" (28%), "feeling fun, excited, happy, good" (18%), "scared, might fall" (14%), "miserable, lousy, bad, sad, not well" (14%), "nervous, anxious, silly" (10%), "hot, warm" (6%), "full of energy" (5%), and "tired" (5%). Clearly two thirds of their anticipated reactions to skiing were negative. We also had asked the kids to provide a preference ranking for six types of winter sports. The order obtained from "most" to "least preferred" was as follows: volleyball, soccer, skiing, hunting and trapping, basketball, skating and hockey. Thus, both sets of base line indices suggested that kids reactions to skiing might not be too positive. That is why we feel that the high participation obtained for TEST in Tulita is quite significant. It is worth adding here that our recent questionnaire survey of recreation needs in Tulita showed that skiing was mentioned most frequently by kids in response to the question, "What kind of games or sports would you like to play after school if you could do anything you wanted?", and 83% felt that "there should be more opportunities to ski." However, to avoid bias it should also be noted that the same survey showed that the kids feel there should be more opportunities for indoor sports and that they would like to be able to watch T.V. (There were no gym or T.V. facilities at that time.)

In sum, although current involvement in TEST is surprisingly high considering initially reserved attitudes, it is important to recognize that this interest may be partly understood with reference to the relative paucity of winter recreational options available.

ADEQUACY OF PERFORMANCE

This criterion concerns the extent to which a program has been useful in reaching its objective. The problem addressed by the TEST committee was the apparent underachievement of northern native youth and the objective was to correct this problem by motivating youth to greater general achievement through competitive skiing. Unfortunately, the TEST committee did not specify clearly what they meant by "general achievement." We therefore turned to the psychological literature on achievement motivation to assist us in identifying criteria for our evaluation. We found that achievement motivation as defined by the leading expert, David McClelland, denotes such things as caring about and wanting to perform better in terms of out-performing someone else, meeting or surpassing some self imposed standard of excellence, doing something unique, or being involved over a long period in doing something well (McCLELLAND, ATKINSON, CLARK, & LOWELL, 1953). Translated into the experience of native school children we felt that this could mean such TEST specific behaviours as training regularly over time and winning in regional competitions. At a more general level we also felt that it could mean earning higher grades in school and generally talking and thinking about daily life more in achievement terms.

Considering the specific ski data first it should be noted all participants who trained regularly in 1973-4 also did so in 1974-5 — there were no quitters. Skiers train hard even through the coldest, darkest part of the winter. After two years of such dedicated training Tulita skiers won more medals per capita than any other team at the 1975 *Top of the World* races. Parenthetically, the Tulita coach informed me at the end of that meet that he intented to buy a small supply of medallions to present to those in his team who had not won a single event in order that they would not feel too disappointed. Clearly, Tulita TEST participants work hard and want to excel in skiing.

But does this "sports achievement" motive generalize to other aspects of their performance and experience? We examined this question first in terms of the association between changes in school achievement (above and below the median grade level difference from norm estimated by teachers) and experience in TEST (never skied, skiing regularly, member of team for *Top of the World*). The non-significant Chi-square (X^2 = .55, df = 2) suggests that as yet TEST effects do not seem to have generalized to school achievement.

Our second approach to examine generalization of TEST effects utilized McCLELLAND's (1953) methods of studying underlying motivation by content analyses of people's thinking reflected in material like books, art, and music. For our study the monthly *Tulita News* was analyzed because the greatest proportion of contributions are made by school children. The paper is edited by the 12 native adult education students with some limited coordination by the teachers. Samples were taken from five editions before and five after the introduction of TEST to form an interrupted time series. Each of these sets of five editions spanned almost the entire school year. Six stories were taken from each edition, two each from "Sport news", "Town news", and "Bush news." These selections were made "blind" by student assistants unfamiliar with the research design. Samples ranged from 6 to 10 lines of text and amount of text representing each edition was approximately equal. The sixty selections were identified with a special numeric code and printed in a booklet in random order. Content analyses were in terms of the motivational thema *Affiliation, Achievement*, and *Power* assessed by the usual coding method (ATKINSON, 1958). In addition, temporal orientation (past, present, future) of each story was assessed as well as frequency counts of possibly salient words such as "work", "play", "win", "lose", and personal names and references. Coding for each variable was accomplished by a different team of two judges. Coders were undergraduate volunteer assistants unfamiliar with the purposes of the research. Each coder and each team worked independently. Interjudge agreement was computed for those variables whose assessment involved some inference. Scoring was reliable as indicated by the following indices: Affiliation, r = .86; Achievement, r = .83, Power, r = .96; Temporal Orientation, 95%. Each of the resulting interrupted time series was analyzed comparing the pre-TEST distribution with the after-TEST distribution. Significant findings were obtained from only two of these analyses: The words "play" and "win" occurred less frequently following the introduction of TEST (Play, $t = 2.69$, $df = 8$, $p < .05$; Win, $t = 3.8$, $df = 8$, $p < .01$). Considering our personal bias toward play over organized competitive sports it is tempting to discuss the meaning of the lowered frequency of "Play" following TEST. However, the lowered incidence of "Win" is harder to interpret. Hence, neither result will be discussed before further replication. In any event the impact of these two out of nine significant findings pales against the clarity of the overall traditional image reflected from these content analyses. For example, both before and after TEST the social motivation profile was highest on *Affiliation* and lowest on *Achievement* and most of the text reflected a "present" orientation.

To summarize this lengthy section on the adequacy of TEST for increasing achievement among youth in Tulita it appears that TEST increases "sports achievement" motivation but has had no measurable impact to date on more general achievement in terms of school performance and underlying social motivation.

EVALUATION OF EFFICIENCY

This criterion requires a comparison of the chosen program against different methods of accomplishing the same goal. For our study it would presuppose that the TEST organizing committee had made an exhaustive search of the literature on how to change achievement motivation and had included two or three of the most promising methods in their design in order to determine their relative effectiveness. Unfor...nately, but understandable considering their limited budget, the TEST committee elected to evaluate the skiing program exclusively. Accordingly, we are left to speculate on how much more or less effective other programs might have been relative to TEST and on how various programs might have suited different individuals. Certainly there is no paucity of alternatives for shaping achievement motivation (e.g., McCLELLAND, 1965), and for improving school achievement through changing self attitudes (e.g., De CHARMS, 1972; ARONSON, 1975).

This would be an appropriate point to terminate our analysis since all "hard" data appropriate to the *Evaluation by Objectives* model have been reported. Our conclusion at this point would be that both coaches in Tulita together with those in Inuvik have been working diligently, and the youth in Tulita, where few recreational alternatives exist, have participated actively and successfully in TEST, but there is as yet no evidence of improvement in general achievement among participants.

It would be unwarranted and unrepresentative, however, to finish on this pessimistic note — unwarranted considering limits of the *Evaluation by Objectives* model, and unrepresentative considering additional data obtained which do not satisfy the constraints of that model. Just as there are reasons to feel that there may be serious limitations involved in exclusively applying only experimental design to the study of man (GIORGI, 1970), its analogue for evaluating programs shares in these limitations. Foremost is the narrow conceptual framework imposed: change is viewed in terms of discrete cause-effect laws; measurement of change must be in terms of tightly operationalized manifest variables; and above all the investigator must remain "objective." Even the most enlightened in the physical sciences shifted from this dogma years ago persuaded by findings and insights provided by the authors of quantum physics (MATSON, 1966). The preferred position is fast becoming that of the "involved" scientist who appreciates the interdependence and cybernetic currents of influence among variables heretofore inappropriately labelled as "dependent" and "independent." Because we subscribe to this position, often referred to as "third force" or "humanistic", we have been concerned with obtaining a complete evaluation of TEST effects even though this has meant sacrificing our "objectivity" by living for short periods in Tulita, skiing, playing and praying with the kids, talking with the townfolk, and participating in TEST advisory committee meetings. From these involvements we have recorded a considerable amount of "soft" data in the form of measurements and impressions of personal and interpersonal changes among TEST participants, as well as indices of the broad context of attitudes within which TEST operates in TULITA. The remainder of this report will summarize this "soft" data.

CHANGES IN PERSONAL ADJUSTMENT AND IDENTITY

To obtain measures of TEST effects on personal adjustment and identity all kids in grades 3 to 6 were given the Skimetric Differential (ORLICK, PARTINGTON, SCOTT, & GLASSFORD, 1975) just before TEST was introduced to Tulita in 1973. This self report measure comprises 22 bipolar scales sampling a broad range of personality needs and attitudes. We had intended to provide an experimental design by retesting two years later and dividing the sample into experimental and control groups on the basis of their participation or non-participation in TEST. However, the previously cited fact that just about everyone in Tulita is now skiing rules out the expected control group — an interesting paradox for our evaluation. Nevertheless, we completed the before-after comparison of 30 skiers in the knowledge that even such "pre-experimental" designs may sometimes be interpretable provided that extraneous sources of variance can be ruled out through logical analysis (CAMPBELL & STANLEY, 1963). Raw test score profiles were converted to factor score profiles (based on the factor matrix obtained by ORLICK *et al.* 1975) and the pre-post sets were compared by stepwise discriminant analysis (NIE, HULL, JENKINS, STEINBRENNER & BENT, 1975). They were found to differ significantly on six of the seven factors. After participating in TEST kids report feeling stronger and more socially accepted ($F = 8.75$, $p < .01$), more energetic, happy, and lively ($F = 6.35$, $p < .01$), less inclined to be oriented toward the future ($F = 4.61$, $p < .01$), more traditional toward competition ($F = 4.32$, $p < .01$), judge themselves more positively ($F = 3.56$, $p < .05$), and seem more inclined to want to do things as an individual rather than collectively ($F = 2.34$, $p < .05$).

Without a control group we have to ask ourselves whether such apparent changes might have come about not because of TEST but through such means as alternative learning experiences, or simple growth and maturation, or even result from statistical artifacts like regression toward the mean. We don't have the space to deal at length with these or other possible influences, however, a few logical counters may serve to raise confidence in the validity of these apparent changes. First, the meaningfulness to respondents of the Skimetric Differential together with our use of factor scores suggest that the data may have been sufficiently reliable to exclude the operation of regression effects. Second, the usual pattern of development in native identity seems to proceed toward lower not higher self esteem. Also, our research assistants living in Tulita have not reported any new significant alternative learning opportunities for the kids. Finally, the r[illegible]nificant differences obtained were in terms of the [illegible] which included feeling stronger and having more friends, results which are certainly consistent with common-sense expectations for effects of TEST.

It must be apparent to you that we feel personal changes are taking place associated with TEST involvement. Our belief rests not only on this slim psychometric data base. It is strengthened by our subjective impressions of how much more self assured Tulita kids seemed when relating to us not on the ski trails than when we met them in school or in the teachers' homes. Our hunch is also supported by our vivid recollection of the kids' enthusiastic cheers when we showed them movies of international ski meets in which their new northern ski heroes like the Firths, Kelly, and others were competing against the best white skiers in the world. In our view these cheers suggest that the seed of pride in their northern identity may have been planted and nurtured by TEST.

CHANGES IN INTERPERSONAL RELATIONS

Possible changes in interpersonal relations associated with involvement in TEST were assessed through annual sociometric testing from 1973 to the present. Each year kids are asked to rank order the three kids from among any in their school who they would most prefer as friends. Two analyses of this data were conducted. The first found no association between kids shifting sociometric status from 1973 to 1974 and their involvement in TEST ($X^2 = 1.36$, $df = 1$, n.s.). The second found no association between kids shifting sociometric status from 1974 to 1975 and whether or not they were selected to attend the *Top of the World* ski competitions ($X^2 = 0.04$, $df = 1$, n.s.).

Althout[illegible] we are satisfied with the validity of these findings as they apply to the majority of TEST participants, we have reason to feel that TEST "superstars" may experience some interpersonal difficulties while they remain in their own settlement. This is based on our careful examination of what appeared to happen to the real "up-and-comer" in Tulita. In 1973 before TEST he was low in popularity (7% expressed an interest in having him among their top three friends). in 1974 as he began to be a good skier he became very popular (18%), but in 1975 when he really began to excell his popularity dropped (7%). This case was discussed with one of our native TEST advisors and we learned that it is a common practice to "correct" by ridicule and social isolation those who try to go beyond normative prescriptions for performance. This suggests that the upper level of achievement developed in native youth by TEST may be bounded by group norms. It may also be the case that such norms operate against more general achievement as in school performance. If this analysis is valid and if achievement is the main objective, it follows logically that TEST officials and school authorities should consider two alternatives — either move kids away from their settlement when they begin to show strong evidence of achievement, or work toward changing the counter-productive normative constraints.

CHANGES IN SOCIAL ECOLOGY AND PREVAILING ATTITUDES

Effects of TEST on the social ecology in Tulita were assessed in terms of Barker's *Behaviour Setting* construct (BARKER & WRIGHT, 1955). A behaviour setting is a combination of action and place. It is identified in terms of repeatable patterns of social behaviour occurring in a particular place and within a particular predictable time frame. Consider an example from a hypothetical community. The school gym from 9 to 5 Monday to Friday is one setting in this community while the same gym from 8 to 11 every Saturday evening is another setting. The first may be called "gym class" and is led by the teacher. The second is called the "bingo" and is led by the president of the P.T.A. Barker and his coworkers have shown that adolescent development is directly influenced by the complexity of behaviour settings available. Accordingly, we wanted to examine whether TEST effects might be reflected in, or mediated through, changes in the number and kind of behaviour settings in Tulita. Data were gathered by a team of volunteer assistants including the four elementary school teachers, the 12 native adults in the Adult Education class, the nurse, and the clerk from the Hudson's Bay store. Behaviour settings were identified from personal experiences of this team and by studying announcements of events on bulletin boards and in the newspaper. Thirty-one settings were found to characterize the social ecology of Tulita in 1973. When these were reviewed in 1974 it was found that one rather insignificant setting was missing but three new settings had developed. One of these, the school drop-in center really excited us since we felt that it might reflect increasing initiative associated with TEST participation. However, because of our close contact with the community we soon learned that the center had been proposed and was administered by two of the teachers. Nevertheless, the remaining two new settings were clearly linked to TEST. They were the ski shed behind the school for storing and waxing skis, and the coach's house for informal visits by the skiers. This setting could be important for generalizing TEST effects since it provides an acceptable social bridge to white values in general.

Our final analysis of TEST effects focussed on adults' attitudes toward skiing. The rationale for this grew from our recognition of the importance of reference group support for maintaining attitudes and for adolescent adjustment in general (SHERIF & SHERIF, 1964). Observations of enthusiastic spectator support as well as generous financial contributions toward participants' transportation to regional meets suggest that a generally positive attitude to regional prevails among adults in Tulita. This is confirmed by results from our recent adult recreation survey which showed that 50% felt that compared to other activities cross-country skiing best fits the north and the northern way of life. In addition, 60% reported that they had tried to ski themselves, and of these 100% said that they had liked it.

On the other hand, impressions obtained from a single interview with the mother of one of Tulita's best skiers stand in sharp contrast to the accepting attitudes expressed by most other adults. Her sad comment was, "He doesn't visit home much anymore." We got the impression that although she felt that recreational skiing was acceptable, she also felt that by involving her son in serious competitions across the land, TEST had stolen him away from home and from his future role in the community. At this point we do not know how representative this reaction might be of attitudes held by parents of top skiers in other settlements. However, considered together with the isolated bit of evidence of social censure by peers toward a developing skier previously discussed in the section on interpersonal effects of TEST, this mother's reaction raises the possibility that an upper limit on achievement may be present in the north which may become manifest only when a native youth begins to excel. Expressed another way, the relatively low incidence of really top achievement among native youth may be more a function of reference group norms than of individual motivational deficits.

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COOPERATIVE SPORT STRUCTURES: A PRELIMINARY ANALYSIS[1]

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INTRODUCTION

This study was designed to investigate one possible avenue for increased participation in physical recreation by providing an alternative game structure which reduces the amount of competition usually associated with organized sports. Although this may eventually prove to be applicable to many segments of Canadian society the initial pilot study was conducted with a unique group of native northern children from the Western Canadian Arctic. Most of these children were Athapascan Indians residing in Fort Norman, NWT.

The rationale for focusing on the control of competition as a possible source of increased participant satisfaction in sport was twofold. The first motive was stimulated by recent findings in sport research regarding athletic drop outs. This was an area of concern because of the magnitude of the numbers dropping out of sport and because of the health problems facing a majority of Canadians associated with insufficient physical activity.

The extent of the drop-out problem was illustrated by the Canadian Amateur Hockey Association statistics. The number of registered players dropped off as a function of increased age with only 11% of the total number of players being over the age of 15 (ORLICK, 1974).

As a result of interviewing 60 athletic drop-outs, aged 7 to 19, ORLICK found that 50% alluded to the competitive emphasis of the program as the main reason for dropping out. This included such thing as... "seriousness of the program, lack of enjoyment and emphasis on winning and on being the best". The coach was also a primary cause of dropping out for another 17%. "The coach was said to leave people out, criticize too much and push too hard.". Together these two areas accounted for 67% of the drop outs and could generally be categorized as competitive emphasis (ORLICK, 1974). At the elementary school level the breakdown was slightly different. Forty percent mentioned lack of playing time and 60% mentioned lack of successful or rewarding experiences as the primary reason for quitting.

Although it might be said that the above observations apply only to a small segment of the population who "haven't got what it takes to make it in sports", there is evidence to suggest that these feelings are much more wide spread. The results of a questionnaire answered by a random sample of over 700 high school students clearly showed that variables related to competitive emphasis played a major role in inhibiting sports participation (McNALLY, 1974). If these kinds of problems are beginning to surface with respect to competitive sport in the south, it might be wise to think twice before replicating it in the north.

The above studies suggested that more opportunities to play sports for fun need to be made available where everyone has an equal opportunity to participate, where the outcome of the game is not of paramount importance and where there are plenty of opportunities to experience success. It was felt that rule changes within the framework of existing sports might provide these contingencies.

A second motive for this study evolved from a concern for the sports programs which have been promoted in the north by "outsiders". Major factors influencing the development of many sports in the Arctic, (e.g. hockey, soccer and skiing) can be traced to the presence and influence of non-natives in the North.

The Territorial Experimental Ski Training Program, (TEST) which was introduced to give native youth an opportunity to excel at an activity where they could compete on an equal basis with non-natives, relied heavily on non-native personnel for coaching and administration. Although competing against one's peers, as opposed to competing with nature, was reportedly not traditional behavior, the skiers appeared to soon adapt to it. The TEST program has been quite successful in meeting its performance objectives and now the nucleus of the Canadian national cross country ski team is made up of native northerners.

Although the TEST program has had many positive spin-offs in terms of motivating children to participate and giving them something to be proud of, it has also had some negative effects. Adults are usually pleased that children are participating but some parents fear that if the child gets too good it will be one more force tearing him away from the family, both psychologically and physically. Training and travelling takes up much of the child's time and this exposure to other life styles, may serve to alter his attitude towards his family and home. Drop out problems were also evident with respect to the competition phase of the program (GLASSFORD *et al.*, 1973).

As a result of recent political developments and increased education, a movement is developing among native northerners to assert themselves. Part of this movement involves the vivification and preservation of some traditional ways of life. There has been a revewed interest in traditional sports and games.

In conjunction with the revival of these traditional games it was felt that something could be done to adapt some of the southern sports which have become an integral part of the northern children's lives to be somewhat more reflective of the traditional culture. Two elements, of the traditional approach to games seemed to fit in well with the elements previously mentioned as being desirable for sports in the south, namely equal participation by all who wish to participate and cooperation among those participating, with the main objective being fun and a diversion from work and everyday life.

1. Appreciation is extended to Glynne Turner, the University of Ottawa Northern Research Group of Indian Affairs and Northern Development and the participating children and teachers for their assistance in this study.

As a result of the above two motives it was felt that two pilot projects should be carried out, one in the N.W.T. and one in a southern community. The first pilot study was conducted in Fort Norman, NWT, and a second was carried out at a later date in Ottawa, Ontario. This paper is essentially a report on these pilot studies along with their implications.

NORTHERN STUDY

Northern Subjects and Setting

The subjects were grade 7 and 8 students in a relatively isolated community of 289 on the MacKenzie River approximately 100 miles south of the Arctic Circle. There are no roads leading into the community and the next closest settlement is 70 miles down the river. The subjects were primarily Slavey Indians, Mountain Indians and some Meti.

The type of sport activities possible in this settlement in the winter is limited by climatic conditions, lack of indoor recreation facilities and lack of sports equipment. The temperature in December averages 15° below zero but with wind chill usually averages out at about 45° below zero. At this time of year it is generally just light enough to play sports outside by 10:30 a.m. and the light remains until about 3:00 p.m. There are no indoor sports facilities except for the classrooms. Outdoor facilities include a large flat surface with rink boards suitable for ball hockey and standards for a volleyball net. Sports equipment available to the children was limited to hockey sticks, broomball brooms and cross country ski equipment for about 10 children.

The Game

It was decided that Broomball would be the sport used in this study, due to limitations in facilities and equipment for other sports.

Broomball is a game which is similar to ice hockey but is played with a ball (instead of a puck) and with brooms (instead of hockey sticks). It is normally played on ice but skates are not used. It can be played on any firm surface.

The new rules for Broomball were introduced by the children's regular teacher because it was felt that they would be more receptive to new ideas if they came from someone they knew well.

The Rules

The children normally play non-positional broomball with penalty shots for high sticking or very rough play. They were asked to play as they normally do but with the following new rules.

- The first new rule as explained to the children was: "each goal your team scores is a gift to the other team. If you get the goal, they get the point."
- The second rule was that "the person who scores the goal gets to be on the team with the most points. If you score and your team has the most points you stay on the same team but if the other team has the most points then you change teams".
- The third rule was that "there is no goalie".

Northern Observations

The children cooperated right from the start. Although they did'nt understand the implications of the rule changes they were quite willing to play and find out what would happen.

It was obvious from the start that the teams were uneven in ability. However, after the strongest team had scored three goals, three players had moved to the weaker team which then began to score. Once the score was even again there was a tendency for it to stay near a tie.

After several goals had been scored the players began to realize what was happening but they didn't have much time to figure out what their strategy should be. At this point some of the more aggressive players held back from the play for awhile but gradually got back into it when they realized that the individual who scored would always become a member of the team with the most points, although if he did change teams it was always to the weaker team. Thus there were pros and cons to scoring. Once they realized this they all began to try to score. This was particularly evident on penalty shots because there was no goalie. At one time, in the middle of the game, the penalty shooters were obviously not trying to score but the strategy changed after awhile as they began trying again.

Scoring itself and the final score became less important to the indivivual players because of the way the rigid team structure was broken down. Possibly as a result of this, the players used less body checking and "hacky" play. They played the ball more.

As a result of not having a goalie there tended to be more scoring than in their normal broomball games, thus providing more opportunities for success experiences. At the end of the game the teacher announced that the winners were supposed to take the brooms back into the school. Nearly everyone took in a broom.

The children's evaluation of the rule changes (through the use of a questionnaire) showed several general trends. First, there appeared to be very good acceptance of the new rules by the girls whereas the boys showed moderate acceptance. The degree of acceptance by the girls was illustrated by their response to questions 1, 2, 5, and 6 (see Table I). Fifty percent of the girls could think of nothing wrong with the new rules and 69% of the girls would not revise the new rules as they said they liked them as they were.

Both boys and girls generally liked not having goalies (question 3). The teacher explained that in a normal broomball game only one or two goals were scored. However, without goalies, (plus the other new rules), about 20 goals were scored per game. It is felt that increased opportunities for success experiences made the game more fun for the players.

It is significant that in terms of improving the rules to make them more fun only 4 out of 24 suggested not giving the point away or not switching sides. It is also significant that none of the players said they would not want to play broomball again using the new rules.

The fact that the children played the game and cooperated to the extent that they tried to score even when the point was going to the other team but the scorer was not going to the other team, since his own team had more points, is quite significant.

The previously mentioned observation that at the end of the game nearly everyone carried a broom back to the school indicated that regardless of the final score most of the children felt like winners. Perhaps there was a positive feeling associated with both receiving and giving away a point.

Northern Acceptance

Cooperative rules, as applied to the game of reverse score broomball were quite well accepted by the sample of Indian children from the Western Canadian Arctic. In particular the females enjoyed the new rules and were quite positive in their comments. It was felt by the teacher that, because of the degree of acceptance by both the boys and girls he would have the children play using these rules again. The adult education teacher in the community was also quite interested in having the adults play broomball with the children using these rules. Unfortunately this was not done before the researchers left the settlement. However, this does point to an interesting feature of the rules. They tend to make the integration of unequal players quite smooth. The rules certainly have potential for co-ed groups and when different age groups are participating together.

The success of this pilot project in the N.W.T. suggests that rule modifications in sports in the North should be examined more thoroughly. The rules may be particularly useful in community sports where participants of all ages can play together. This in fact used to be an integral part of the native culture. The acceptance of the rules also suggests that similar rule modifications should be experimented with in southern Canada. These results indicate that initially the rules should be tried with either an all girls group or with a co-ed group.

SOUTHERN REPLICATION

An attempt was made to replicate this cooperative game with grade 7 and 8 students (boys and girls) who were attending the University of Ottawa summer day camp. Reverse score broomball was played indoors in the University arena. The initial reaction of the Ottawa children to this game was markedly different from that of the northern children.

Immediately after the new rules were introduced to the children, remarks such as "that won't work", "what is the point of the game", and "how do you win", were voiced openly by several of the boys. In spite of their reservations concerning the value of such a game, they agreed to try it. The game began with an equal number of players on each side and since neither team had a goalie, there was a lot of early scoring. After 5 minutes of play, the yellow team was ahead by 3 points and consequently had 3 extra players. Within minutes the yellow team scored twice to even out the score somewhat. As the game progressed the yellow team again went ahead by 3 points, having had been scored upon 3 times. At this time (i.e. having a several point advantage and additional players), many players on the yellow team began to stand around rather than play the ball. Two boys on this team decided to try to score on their own goal so that they would get additional points. The children seemed to perceive the team with the most points as the "winning" team, even though points were given to the team when it was scored upon and it was actually the weaker team.

Some of the better players scored three or four times and were alternating teams regularly. One of them said that he did not know which team he was really on. Another child remarked that each person would only play for himself since only he could benefit from scoring a goal (apparently because he could go to the winning team). It should be noted that very few of the girls complained about the game and some of them seemed to enjoy it. However, many of these children, particularly the more assertive boys, seemed to feel that any game which did not offer one team (or individual) a chance to win in a more traditionally southern manner was "a waste of time".

When we compare these observations to those of the northern children, the extent to which competitive game socialization has taken hold in southern Canada by 13 years of age becomes apparent. The northern children's receptivity to this cooperative game seems to demonstrate a greater willingness to cooperate and share. Perhaps it also indicates an acceptance of playing for fun rather than an overconcern with outcome.

A brief look at the questionnaire data presented in Table 1 shows that when children were asked what they thought of the new rules, positive responses were obtained from 85% of the northern girls, 57% of the southern girls, 45% of the northern boys and 9% of the southern boys. An obvious difference is evident between boys and girls and northerners and southerners. Fifty percent of the northern boys and 50% of the northern girls felt that these rules were more fun than the regular ones, whereas only 18% of the southern boys and 43% of the southern girls felt this way. In addition twenty one percent of the northern children felt that the *best thing about the new rules* was the point going to the other side. No southern children expressed this feeling. When asked if they would like to play this game again, 38% of the southern children said no. No northern children responded in this manner.

It should be pointed out that when reverse score broomball was played with a younger group of Ottawa children (i.e. 10 year olds), they were much more receptive than their older peers. For example 71% of the girls and 63% of the boys responded positively to the new rules and 57% of the girls and 45% of the boys felt these rules were more fun than the regular ones. When asked if they would like to play this game again, only 11% indicated that they would not like to.

Table I – Childrens evaluation of the new rules:
A comparison of northern and southern grade 7 and 8 student responses

1. **What did you think of those rules?**

	Northern Children	*Southern Children*
Positive response	84.6% girls 45.4% boys	57.1% girls 9.0% boys
Negative response	15.4% girls 54.6% boys	28.5% girls 72.7% boys
Neutral response	0.0% 0.0%	14.2% girls 18.1% boys

2. **How much fun was it to play using these new rules compared to regular rules?**

	Northern Children	*Southern Children*
More fun	50% girls 50% boys	42.8% girls 18.1% boys
Less fun	21% girls 21% boys	28.5% girls 72.7% boys
Same amount	29% girls 29% boys	28.5% girls 0.0%

3. **What is the best thing about the new rules?**

	Northern Children	*Southern Children*
No goalie	50% boys & girls	33% boys & girls
Changing sides	12% boys & girls	16% boys & girls
Point to other side	21% boys & girls	0%
No body checking	5% boys & girls	0%
Like nothing	0%	33% boys & girls

4. **Do you think you would ever want to play using these rules once everyone was used to them?**

	Northern Children	*Southern Children*
Yes	33.3% boys & girls	5% boys & girls
Maybe	67.6% boys & girls	55% boys & girls
No	0% boys & girls	38% boys & girls

5. **What was the worst thing about the new game?**

Northern Children

	Giving Point Away	*Switching Teams*	*No Goalie*	*Nothing*
Males	63%	9%	18%	9%
Females	33%	0%	17%	50%

Southern Children

	Everything	*No Goalie*	*No Reply*	*Nothing*
Males	54%	9%	27%	9%
Females	42%	0%	0%	42%

14% of females didn't understand the rules.

6. **What changes could we make in the new rules to make it more fun?**

	Northern Children	*Southern Children*
Nothing Nothing	69% girls (8) 18% boys (2)	57% girls (4) 0% boys
Have goalies	36% boys (4)	0%
Team that scores gets a player from other team	7% boys (1) 18% boys (2)	0% 0%
Don't give point away	15% girls (2) 0% boys	14% girls (1) 0%
Don't switch sides	18% boys (2) 0%	0% 0%
Don't change point & side on penalty shot	9% boys (1) 0%	0% 0%
No face off	9% boys (1) 0%	0% 0%
No body checking	7% girls (1) 0%	0% 0%
No lifting the ball	7% girls (1) 0%	0% 0%
Change rules back	0% 0%	45% boys (5) 0%
Don't know	0% 0%	45% boys (5) 28% girls (2)

CLOSING REMARKS

During the summer of 1975, a series of cooperative games were tested with elementary school age children in the Ottawa area, which expanded upon some previous work in this area (ORLICK, 1975). With respect to the cooperative games tested thus far three points are evident:

1) the younger the group, the more willing they are to accept cooperative games,
2) females are more receptive to cooperative games than males, and,
3) cooperative games become more acceptable with repeated exposures.

In addition, the present study indicates that native northern children are more receptive to cooperative games than southern children in the same grade level. The acceptance or rejection of cooperative games appears to reflect the degree of conditioning to the competitive ethic.

Cooperative games, such as the one presented in this paper, would appear to have great potential value for assessing past conditioning with respect to competitive or cooperative behavior. Upon introduction of a game, through behavior observations, one can immediately see and hear a child's rejection or willingness to accept the cooperative conditions of the game. Cooperative games, which are less dramatic than reversing scores, also have the capacity to elicit cooperative behaviors (ORLICK, 1975). In addition, cooperative or semi-cooperative games have the potential to meet the needs of those segments of our population whose needs are not being met through competitive games. This is certainly an area worthy of further investigation.

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ANXIÉTÉ, NIVEAU ÉMOTIONNEL ET SPORT

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HIGH PRESSURE COMPETITION AND ITS EFFECTS

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The age of Aquarius is the age of organized athletics and high mass consumption (ROSTOW, 1971). What was sport is now athletics, recognized to be a marketable commodity providing occupation for thousands, entertainment for millions, and millions for those entrepreneurs providing such entertainment. It is reported, for example, that 100 shares of Maple Leaf Gardens stock, worth $100 in 1936, would today sell for almost $19 000 while the City of Toronto supports a minor hockey organization (Metropolitan Toronto Hockey League) which, in the 1975-1976 season enrolled over 8 000 youngsters: youngsters who clearly feel themselves to be engaged in a work-like activity. Two twelve year olds recently sued the MTHL on the grounds that Metropolitan League action had "prejudiced their professional prospects". One result has been that all over Canada, parents are seriously concerned with the loss of playfulness and increase in hostility found in many minor sports such as hockey and Little League baseball. In this climate of opinion, the Windsor Minor Hockey and Little League organizations in 1972 contacted the Sports Institute for Research of the Faculty of Human Kinetics at the University of Windsor for assistance. From this initial approach stems the many studies carried out by SIR/CAR under the direction of Drs. DUTHIE and MORIARTY and in particular the Citizenship, Sportsmanship and Manhood study (1974) supported by a grant from Canada Council (grant #572-1768). In this study, many of the facets of Little League as played in the Windsor area were investigated, the goals and objectives of sub-organizations were carefully analyzed while parents, coaches, fans and participants were contacted, interviewed and responded to questionaires of various sorts. The information gathered was fed-back to officials, executive and parents in a series of face-to-face interactions at all levels so that incongruities between objectives and intents and what ensued could be clearly recognized. In a practical field situation the complexity of human interactions, both intentional and unintentional were analyzed and discussed.

Discrepancies were seen between regular House League situations and the championship or All Star playoff situations. During League play, in House League situations, the observed behaviour was one of cooperation and good-will between competing teams and between spectators of the competing teams. Generally, the main behaviour emitted by spectators could be classified as encouragement and there was little or no observable hostile reaction at any of the interaction points observed. During playoff time, this mood, under the influence of the high pressure competition, changed. The shift towards a semi-professional or athletic orientation was associated with a diminution of playful behaviour and an increase in winning as an institutionalized expectation. The facial expression of players altered, along with the expressions of participating members of the team sitting on the bench. The professionalization of sport begins with the transformation, in STONE's terms, of play into work (1972). Harassment of officials was recorded as increasing along with disparagement of opposing participants. Clearly two divergent socio-psychological models were perceived. On the one hand, we had play, a baseball situation involving House League participation and on the other, playoff — All Star baseball, clearly perceived as a different situation in which different behaviours were role modelled. For this reason, a study was designed to test the differences between House League and All Star identification classes in a stimulus-ambiguity situation. Binocular rivalry, as described by ENGEL (1961), is a form of stimulus-ambiguity in which the rivalry is induced by means of a steroscope which allows for the simultaneous presentation of two different images to the monocular field of the observer. In this study, the unstructured stimulus situation consisted of 1 hostile and 1 non-hostile athletic picture being tachistoscopically presented to Little League participant subjects. In stimulus-ambiguity situations, as in binocular rivalry, perceptual response relies upon the functional value of the stimulus to the perceiver.

From KILPATRICK's (1951) transactional theory of perception, the dominant image emerging from the rivalry field will be that stimulus which has the greatest value or meaning for the observer. Lacking relevant meaning, the non-dominant image will be suppressed either completely or partially (ENGEL, 1956). Due to different demands made in the Little League situation on participants, it is posited that All Star players will become more ego involved with or familar with hostility than House League players. The selective process of visual perception then relies upon the All Star subject being more receptive to hostile stimuli than league subjects. Response differences in the binocular rivalry situation are thus seen as a function of the individual subject's identification class.

Identification class differences arise, if and only if, individuals have some symbol by which they represent this identification class to themselves (LaFAVE, HADDAD and MARSHALL, 1970). Sub-cultural factors associated with hostility in athletics may become the symbol by which House League and All Star identification classes are able to recognize themselves. In this study, the main research hypothesis was that a subject's identification class (All Star or House League) would provide the basis for resolution and, hence, the perception of certain hostile athletic stimuli in a binocular rivalry situation. Given such perceptual selectivity, when hostile and non-hostile athletic slides serve as stimuli, it was posited that regularities of perception in regard to hostile slides would demonstrate membership of a different identification class. Method: each League and All Star identification class was represented by 13 volunteer subjects divided into control and experimental groups. Both groups were tested before and after the treatment condition: All Star Play.

Paired with six hostile athletic stimuli, showing scenes from baseball, surfing, rodeo, football, hockey and tennis were six non-hostile athletic stimuli representing matched activities previously so categorized by a panel of judges. Subjects viewed each stimulus pair through a modified steroscope capable of inducing a binocular rivalry situation. In the process, eye dominance was tested and any possible eye dominance effect obviated by repeated presentation to the right and left monocular fields.

Verbal response by subjects to each stimulus pair were recorded as an indication of binocular resolution and hence stimulus dominance.

Transactional functionalism interprets perception according to the factors of familiarity, significance and meaning of cues (KILPATRICK, 1961). The more significant stimuli are those most readily perceived in ambiguity situations. Both ENGEL (1956) and BAGBY (1957) demonstrated that meaningful cues are those which determine the dominance of stimuli during monocular rivalry situations. PETTIGREW, ALLPORT and BARNETT (1958) showed that responses linked with heightened concern and involvement in relevant issues based upon cultural membership, particular expectancies, and attitudes, played an important part in binocular resolution. In 1959, HASTORF and MYRO concluded that when both monocular stimuli have definite meaningful content, what was perceived was no longer a function, merely of formal stimulus properties but that individuals resolve monocular rivalry in terms of meaningful content.

Thus, all studies cited support the proposition that. in this study, hostile athletic content served as meaningful, familiar cues for members of the All Star identification class who selected hostile athletic slides (H) as dominant over non-hostile (NH) athletic slides. House League subjects failed to discriminate between the two types (H, NH) of slides in this way. Many studies have indicated that sports involvement is an important agency for sub-group socialization (HELANKO. 1957; LÜSCHEN, 1967; DUNLOP, 1971); Societal-functionalism models which posit that an occurence does not become an event until certain significance is given to it, clearly are an exemplification of this process (NEISSER, 1966 and GREGORY, 1970). In this study, social learning at House League and All Star levels were shown to be different in their social learning effects. Boys who played at an All Star level clearly became more ego-involved with their situation; losing a game was no longer an acceptable social norm, winning had been institutionalized in that loss of a game disqualifies an All Star team in the playoffs from further participation. SHERIF and SHERIF (1969) concluded "for individuals highly involved in an issue the threshold of acceptance for relevant stimuli is heightened while the threshold of rejection is lowered".

The threshold of acceptance for the hostile athletic (H) stimuli was influenced by the relevant cues provided in the All Star situation. Familiarity with intrinsic and extrinsic reward system associated with success and the negative reinforcement and negative sanctions associated with failure add to this perceptual framework. Hostile athletic stimuli transmit relevant meaning to All Star identification class.

At the House League level, which excludes the playoff situation, winning is less emphasized and has less social importance. Participation is required by League rules and is controlled by these (Little League Handbook and Manual, 1972). In the House League situation, there is less structure, less emphasis on winning, more intrinsic satisfaction, less spectator interest, with the result that relevant cues and role models for hostility are less likely to be available.

The House League identification class consequently perceived no significant difference between hostile athletic stimuli (H) and non-hostile (NH) athletic stimuli.

Past experience and participation in high pressure competition at the All Star level was confirmed (P .01) by this group's perception of hostile athletic stimuli (H) in the non-reactive binocular rivalry situation. The advantages of this in eliminating task demand characteristics (ORNE, 1962) techniques mean that these results are much more likely to be indicative of the psychological patterning which controls behaviour (SHERIF and SHERIF, 1969). The hypothesis that All Star players, as an identification class, resolve a binocular rivalry situation in favour of hostile athletic stimuli was upheld while House League players perceived no difference between hostile athletic stimuli and non-hostile athletic stimuli. In the identical stimulus situation created by this laboratory experience, boys exposed to House League play for the same period of time as others who were exposed to a higher, more intense form of competition, represented by All Star play, perceived no differences. House League players have clearly not been sensitized or habituated to hostility in sports situations. The transactional functionalism model of perceptual response explains these differences in terms of sports activity and the identification classes this engenders. From this study we see that not only does high pressure competition as found at the All Star levels of Little League bring about an organizational shift but it is also responsible for changes in the psychological patterns of participants. In another study, COLBORNE (1975) using a Prisoners Dilemma approach, found that athletes in a situation which could be perceived as either competitive or cooperative were better able to adapt, making competitive responses when it was to their best advantage to compete and cooperative responses when it was to their best advantage to cooperate. This would seem to indicate that children exposed to competitive situation became sensitized to cues indicative of such situation and are able to make adjustments having perceived such cues.

In our study it was found that All Star competitors also learn to make adjustments to their environment. Through high pressure All Star competition the identification class was altered. The real life situation in which hostility is sanctioned often contrasts with a contrived laboratory situation, however stimulus-ambiguity provides a relatively undistorted and disguised technique of transfering similar psychological conditions from the field to the laboratory. Future studies in social-psychological research should strive towards this multi-dimensional process which will yield the best results possible.

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EMOTIONAL AROUSAL IN ATHLETICS: NEW CONSIDERATIONS

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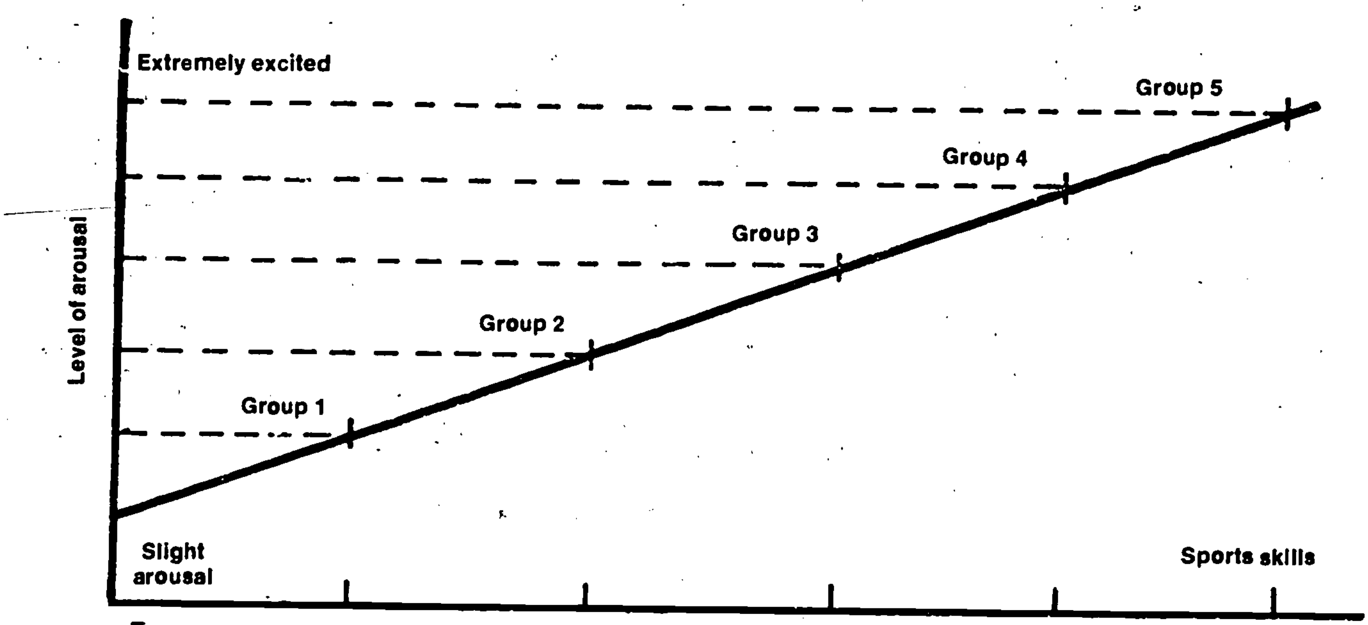
INTRODUCTION

It has been generally accepted among sport psychologists that well learned athletic performance, in essence, is action requiring varying degrees of emotional arousal for optimal performance depending upon the nature of the task confronting the participants. On the basis of research and other evidence, OXENDINE (1970) contends that a high level of arousal is essential for optimal performance in gross motor activities involving strength, endurance and speed, but it interferes with performances involving complex skills requiring fine muscle movements, coordination, steadiness, and general concentration (Figure 1).

Figure 1 – Optimum arousal level for some typical skills.



For football	Field goal kicking;	Quarterback;			Blocking; Tackling;
For other sports	Figure skating Golf putting; Basketball free throw; Bowling; Archery;	Fencing; Tennis; Fancy dives; Baseball pitching;	Boxing; Soccer skills; Gymnastics; Basketball skills; High jumping;	Running long; Swimming; Wrestling; Judo; Running long jump;	Weightlifting; Sit ups, Push ups;

It has not only been assumed that the emotional arousal level for optimal performance varies depending on the particular sport, but that the optimal execution of different skills involved in playing a particular sport may also require different arousal in performers (OXENDINE, 1970; SINGER, 1972). The game of football is given as an example. According to OXENDINE (1970: 28), this game "... is so varied and complex that optimum emotional arousal for the different skills may vary from near the norm line to extreme high levels".

In this context, then, ideally different levels of arousal would be needed for players assigned to different positions if they were to perform optimally, i.e., as expected or outstanding. It is believed, for example, that if guards and tackles are to exhibit speed and power most effectively in blocking the individual straight across the line, they would have to be aroused to the highest possible degree. Therefore, these athletes should be found at the high end of the arousal scale (Figure 1). At the lower end of the scale, OXENDINE depicts the field goal kicker who would probably perform best if he was calm and relaxed and would focus his attention on the task at hand and thus have the accurate and rather delicate response necessary for success. Since other football skills require a combination of these several factors, they fall somewhere between the two extremes as speculated by OXENDINE (Figure 1).

Optimal performance of different motor tasks, however, may not be the only variable requiring different levels of arousal. According to OXENDINE (1970: 24), "... high anxiety versus low anxiety..." may also influence the athlete's level of pre-competition arousal. Although Oxendine does not define this construct, it presumably refers to anxiety proneness or trait anxiety, a generally acquired behavioral disposition. This relatively stable condition of an individual is following the Spielberger Trait State Anxiety Theory (SPIELBERGER, 1972), in distinct contrast to state anxiety which refers to situationally aroused transitory states. Pre-competition emotional arousal of participants in athletics is one such situationally determined transitory state. It occurs in response to a very specific set of anxiety arousing stimuli, i.e., athletic competition. These transitory states can be, according to SPIELBERGER (1972), meaningfully determined in terms of individual self-reports about the performer's feelings, providing motivation of the subjects to report accurately and honestly and cooperation are assured and appropriate instrumentation is available. SPIELBERGER (1970) has recently developed such an inventory, STAI (State-Trait Anxiety Inventory), with two separate scales which measure state anxiety and dispositional or trait anxiety. The inventory has been considered to possess most impressive theoretical and methodological credentials (LEVITT, 1967; MARTENS, 1971). The test was therefore chosen to be used in the present investigation of the validity of the above stated popular propositions regarding pre-competition emotional arousal level of athletes as generally accepted by sport psychologists.

THE PROBLEM

Although the notion that optimal performance of specific tasks in athletics is associated with different optimal pre-game emotional arousal levels of performers has been widely accepted, it has never been tested out systematically. The present study was undertaken with the main purpose of examining the validity of the two above stated propositions stated by OXENDINE regarding the emotional arousal level for the typical participant in athletics. More specifically, this investigation was focused on examining 1. the possible differences in pre-competition emotional arousal level of football players assigned to different playing positions and whose subsequent game performance was rated optimal; 2. the effect of trait anxiety on pre-competition emotional arousal level of football and basketball players.

A second purpose of this investigation was to study the effect of different athletic environments on emotional arousal of participants.

METHODS AND PROCEDURE

Subjects

Over 300 high school football and basketball players who participated in the 1973/74 Edmonton Senior and Junior High Schools' Football League and the 1973/74 Edmonton Senior High Schools' Boys Basketball League, were the subjects (Ss) of this study. In football, ten teams, seven senior and three junior teams, participated in the study. At the senior football level, two city regional divisions, North and South, were played. Since the investigator wanted to include only those teams from the two divisions that had a fair chance to make the playoffs the selection of three North side teams and four South side teams was based on the pre-season predictions of the strength of the teams by the coaches and sports writers in the Edmonton daily newspaper, the Edmonton Journal. The three junior football teams were included only because the respective head coaches expressed interest in this research and wanted to be included. In total, 15 senior and 15 junior teams participated in the two leagues. In basketball, almost all Edmonton teams were involved since out of 16 competing teams, 14 participated in the research.

Experimental instruments

The pre-competition emotional arousal of all Ss was measured by the SPIELBERGER STAI State Anxiety Inventory (1970). This scale consists of 20 statements (e.g., "I feel self-confident", "I feel nervous", "I feel jittery") that ask the S to indicate how he feels *at a particular moment* in time (e.g., immediately prior to the game); the S checks one of the following: "not at all", "somewhat", "moderately so", "very much so". The trait anxiety of all Ss was measured by the Spielberger STAI Trait Anxiety Inventory. The scale also consists of 20 statements (e.g., "I take disappointments so keenly that I can't put them out of my mind") that ask the S to report how he *generally* feels; the S rates himself on the following four-point scale: "almost never", "sometimes", "often", "almost always".

The performance of each athlete was evaluated subjectively by the respective coaches on the Coach's Performance Evaluation Questionnaire of the Athlete (CPEQ). The scale, developed by the investigator on the basis of extensive consultation with many Edmonton coaches, includes three ratings of individual performance: "poor or below his ability performance"; "average or close to his ability performance"; and "outstanding performance".

Experimental design

In football, the design of the study called for repeated administration of STAI state anxiety scale throughout the playing season to all Ss in three different experimental athletic environments which were either stressful or non-stressful in nature: practice environment, regular season competitive environment, and playoff competitive environment. There were eight regular season games played. In contrast, the basketball data was collected starting at the mid-point of the regular season with eight games remaining.

The criterion for a stressful condition was that the state anxiety scale was administered to the Ss approximately one half hour or less before the game in the locker room where the Ss were changing. The test was administered for the most part within minutes of actual competition. The criterion for a non-stressful condition was that the testing was done during a practice session at least one week before any competitive game situation. Generally, only two attempts were made to secure practice state anxiety scores. Since some of the Ss skipped practice on the day of the test administration, only one practice state anxiety score was available on these Ss for statistical treatment. STAI Trait anxiety scale was, however, typically administered at regular team meetings in the classroom or locker room environment before commencement of the regular season. The retest on trait anxiety scale was administered to most of the Ss during the playing season or immediately after the season.

After every game, the individual playing performance of all Ss was rated by the respective coaches on the CPEQ.

Although it was hoped to secure the information on state anxiety of all Ss from all the games they played, this was not possible to achieve. The most common reasons for missing some data were: 1. S forgot to fill out the questionnaire; 2. S quit the team during the season; and 3. there was not enough time to fill out the questionnaire. The following criteria were used in selection of Ss for statistical analysis: Ss who failed to obtain four or more state anxiety scores during regular season and Ss who failed to qualify for the playoffs were excluded from further research. Due to the single game elimination competition in the playoffs, one or more state anxiety scores for each S were necessary if the S was to be included in further analysis. The only exception to this were Ss involved in junior football. None of the three teams included in this research qualified for playoff competition; therefore, only the effects of two experimental conditions on state anxiety of these Ss were investigated.

On the basis of skill involved for different positions in football for the purpose of this study, seven groups were identified on the basis of a study by WILLIAMS et al (1972): Group I: offensive, defensive tackle; Group II: defensive end, offensive center, guard and tight end; Group III: defensive line and corner back; Group IV: quarterback; Group V: defensive half back, offensive half and full back, flanker, split end; Group VI: wing back, safety, wide receiver; Group VII: kicker.

Statistical analysis

When examining the possible differences in pre-competition emotional arousal level of Ss assigned to different playing positions in football, only the pre-competition emotional arousal scores associated with optimal performance for each S were treated statistically. These values were obtained by averaging only those pre-competition state anxiety scores which were associated with optimal performances, i.e., "average or close to his ability" or "outstanding" performance scores. State anxiety scores associated with a "poor or below his ability" performance were not considered in the analysis. One-way analysis of variance was used for comparisons in optimal pre-competition emotional arousal levels between seven categories of football players as defined in this study.

For the purposes of this study, two trait anxiety groups of Ss were defined: high trait anxiety Ss (HT Ss) and low trait anxiety Ss (LT Ss). These two groups were differentiated on the basis of the mean trait anxiety computed for the respective groups of Ss examined in this study. Since some of the Ss were retested on trait anxiety, the mean values were used in statistical analysis.

When examining the effect of trait anxiety and experimental conditions on emotional arousal of all Ss, the Ss' mean state anxiety values for each experimental condition were computed. These mean state anxiety values were then treated statistically with a series of two factor ANOVA with repeated measures on one factor. Changes in mean state anxiety values as a function of trait anxiety and experimental conditions were also presented schematically.

All conclusions of the study were based on the .01 probability level of significance.

RESULTS

The results presented in Table I show no significant difference in optimal pre-competition state anxiety elevations between different positions played in the two levels of football competition.

Table I - Summary of the analyses of variance of the effects of playing positions in football on optimal pre-competition arousal level at two levels of competition.

Level	Source of variance	df.	MS	F
Junior High	Between positions	6	167.45	1.94
	Within positions	61	86.20	
Senior High	Between positions	6	49.86	0.83
	Within positions	176	60.09	

Table II - Summary of the analyses of variance of the effects of the experimental conditions on pre-competition state anxiety for high trait anxiety Ss and low trait anxiety Ss.

Level and sport	Source of variance	df	MS	F
Junior high football	A-Trait (A)	1	2,278.4	3[illegible]3 *
	Error (b)	90	60.6	
	Conditions (C)	1	8,348.4	153[illegible] *
	A x C	1	64.6	1.19
	Error (w)	90	54.5	
Senior High football	A-Trait (A)	1	1,472.8	15.04 *
	Error (b)	64	97.9	
	Conditions (C)	2	5,003.2	126.31 *
	A x C	2	9.5	0.24
	Error (w)	128	39.6	
Senior high basketball	A-Trait (A)	1	4,199.0	35.14 *
	Error (b)	94	119.5	
	Conditions (C)	2	2,915.9	95.31 *
	A x C	2	0.6	0.02
	Error (w)	188	30.6	

* Significant at .01 level.

The effects of trait anxiety and experimental conditions on state anxiety were evaluated in Table II. In Figure 2, changes in state anxiety for HT Ss and LT Ss were plotted as a function of the experimental conditions at two levels of competition in football and one level of competition in basketball. All graphs demonstrate differences between the two groups of Ss with the HT graphs running higher than LT graphs in all experimental conditions. These differences were all significant as indicated by significant F values for trait anxiety in Table I.

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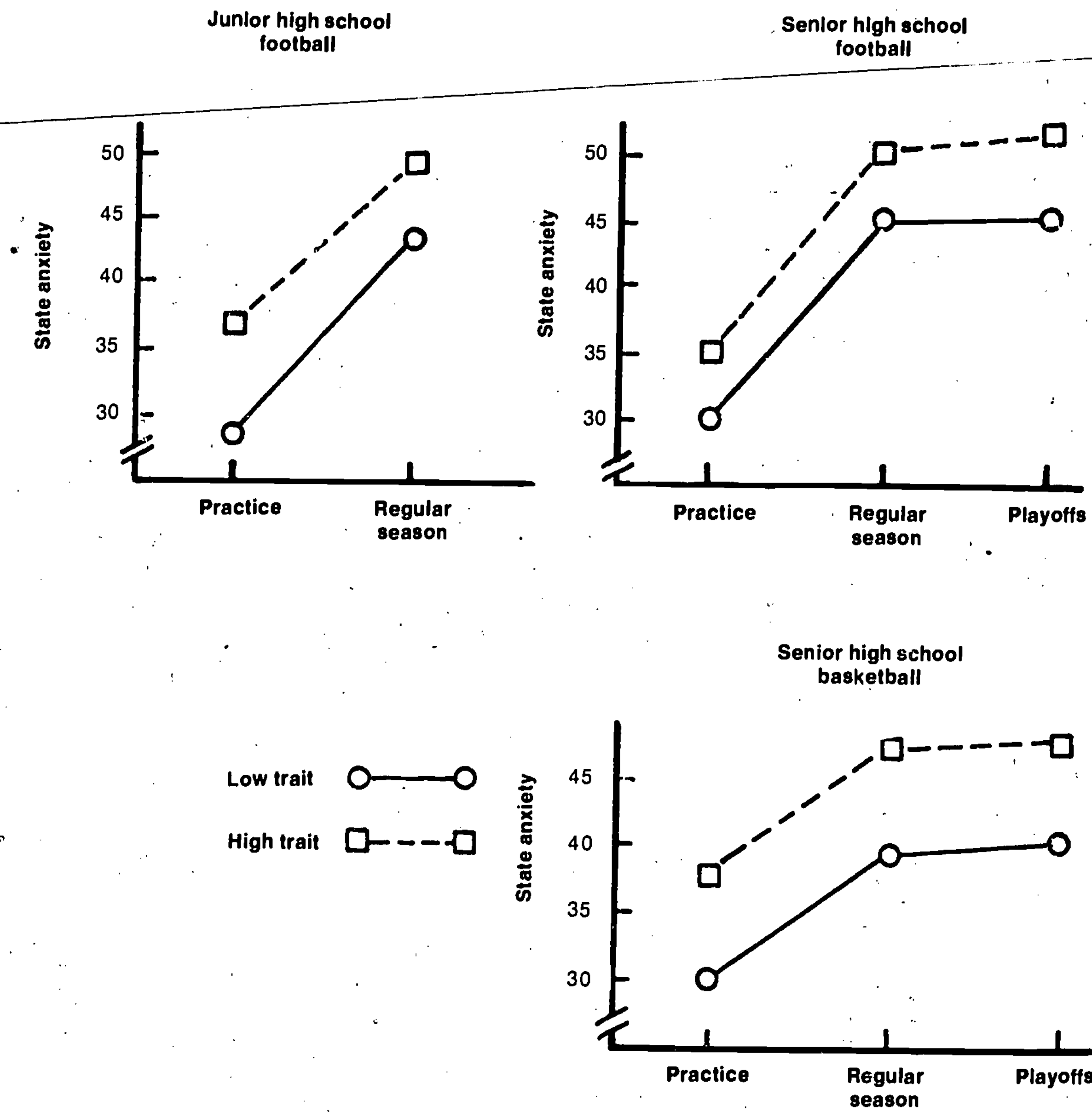
Figure 2 – Pre-competition state anxiety scores for high trait anxiety Ss and low trait anxiety Ss as a function of the experimental conditions.



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All HT and LT graphs do show a sharp increase in state anxiety from their low in practice and level off at regular season and playoffs (as indicated earlier, there were no playoff scores available for junior football). These changes in state anxiety were all significant (Table II: all F values for experimental conditions were highly significant) with the significance lying between practice and regular season. This was also indicated by Scheffe's post hoc multiple comparison analyses.

DISCUSSION

The results in Table I indicate no significant differences in optimal pre-competition emotional arousal level in football players who were playing different positions, suggesting that playing positions in football do not differentially affect emotional arousal in the individuals playing these positions. Thus, quite contrary to the popular belief, a quarterback, who is usually somewhere in the middle of an emotional arousal scale, could show similar elevations in pre-competition emotional arousal prior to a game as a tackle or a field goal kicker on the same football team who represent the two extremes on such an emotional arousal scale. If differences did exist in experiencing pre-competition emotional arousal between positions, then the causes for these differences would have to be found elsewhere.

When the effects of trait anxiety on emotional arousal levels of athletes were studied, high F values were obtained (Table II) indicating significant differences between HT Ss and LT Ss. HT Ss involved in two levels of football and one level of basketball experienced significantly higher elevations in pre-competition emotional arousal than the LT Ss on similar levels of competition in the two sports.

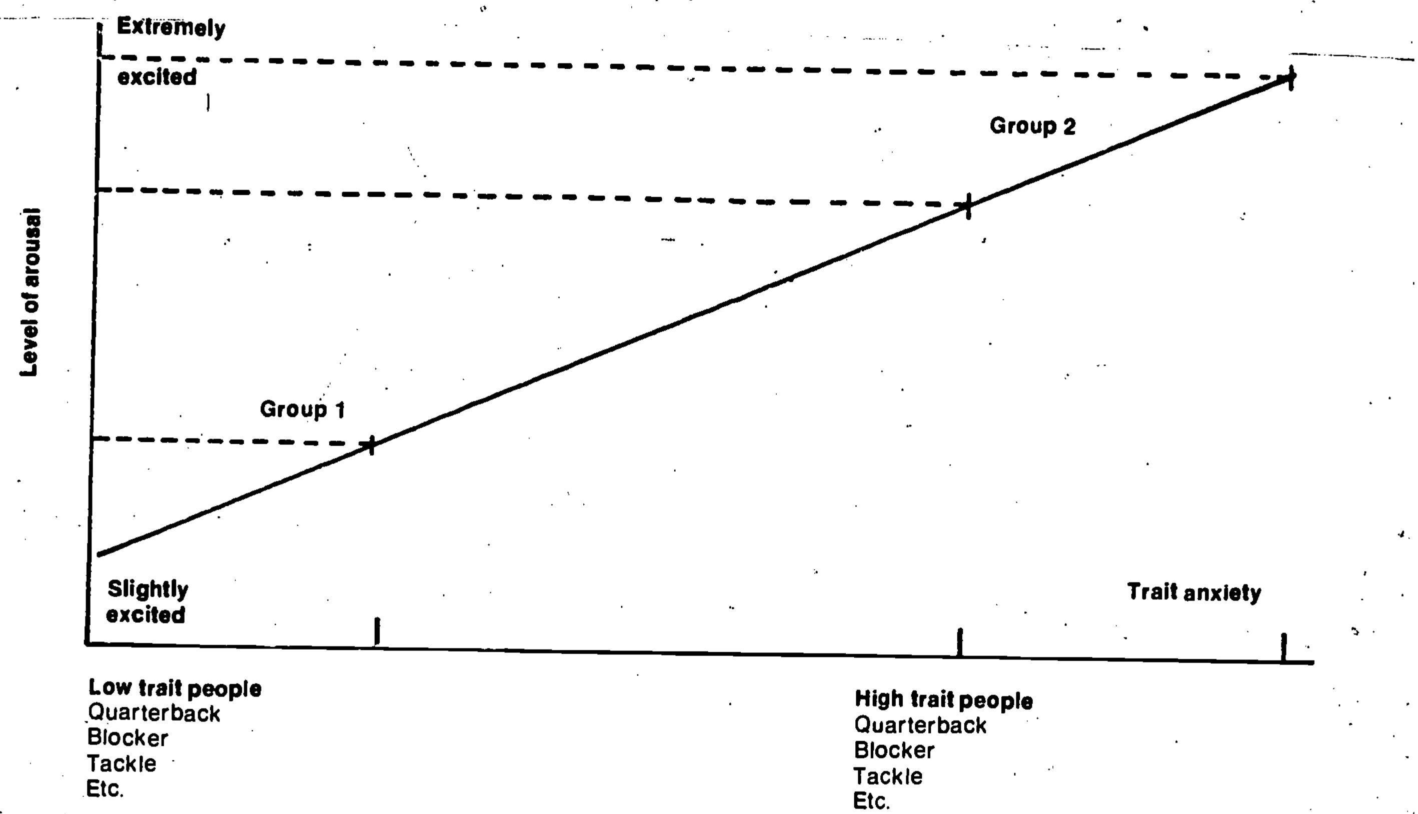
Similar differences in emotional arousal between the two groups of Ss were also observed in a non-stressful athletic environment, the practice. These differences were highly significant and are shown in Figure 2. These results supported OXENDINE's proposition and confirmed the general notion of other leading sport psychologists (CRATTY 1973, SINGER 1972) that HT Ss are liable to show higher elevations in pre-competition emotional arousal than LT Ss. Furthermore, these results were also in agreement with Spielberger's Trait-State Anxiety Theory which predicts differences in state anxiety in individuals who differ in trait anxiety (SPIELBERGER, 1972: 44).

The fact that HT Ss are generally more prone to experiencing higher degrees of emotional arousal than LT Ss suggests that a LT anxiety quarterback will show only moderate or low optimal pre-competition emotional arousal, whereas a HT anxiety quarterback will in contrast experience high elevations of optimal pre-competition emotional arousal. In view of the results of this study, the performances of both LT anxiety and HT anxiety quarterbacks can be satisfactory, despite the fact that they show differential levels of optimal pre-competition emotional arousal as measured by an introspective self-report on the Spielberger STAI State Anxiety Inventory.

This finding is important and has significant implications regarding the optimal pre-competition emotional arousal-motor behavior relationship in physical activity and athletics. It indicates that a *wide range* of individuals, in terms of their emotional arousal level, may perform well in tasks that require rather delicate responses of fine muscle groups. Traditionally, it has been assumed that only individuals who exhibit low levels of emotional arousal would perform well in such tasks.

Similarly, a wide range of individuals, in terms of their emotional arousal level, may exhibit adequate performance in tasks that require only brute strength and speed in blocking or tackling. Traditionally, it has been believed that in these tasks only highly emotionally aroused individuals would perform their tasks effectively. Thus, a low-strung guard, for example, whose elevation in optimal pre-competition emotional arousal is relatively low, may perform just as outstandingly in blocking as a high-strung individual performing the same job, but whose optimal pre-competition emotional arousal was significantly higher.

Figure 3 - Reconsidered optimum pre-competition emotional arousal level for football skills.



Intuitively, these findings make sense since many experienced coaches can point to great differences in pre-competition emotional arousal as indicated by pre-game overt behavior of various individuals playing the same positions on the team and whose performances have been outstanding or satisfactory. Thus, it seems, it is not the requirement of different positions (or skills) in football that may differentially affect the pre-competition emotional arousal of football players, but other variables such as trait anxiety. This is shown in Figure 3. Extroversion, introversion, and experience may be, according to OXENDINE (1970), additional factors that have such an effect.

In view of the results of this study, the part of Figure 1 related to football skills would have to be reconsidered as shown in Figure 3. It is possible, however, that football skills are not sufficiently varied in their complexity as they have been expected to be, therefore showing no differences in pre-competition emotional arousal between Ss playing these positions. Other sports skills, on the other hand, may sufficiently vary in nature and complexity and may very well require varying degrees of emotional arousal of participants in these skills. Further similar research in this area with athletic teams playing different sports is needed to further reveal the validity of OXENDINE's speculations.

Furthermore, the results of this study indicated that athletic competition is a stressful environment for the participants. It evoked significant elevations in state anxiety immediately prior to the contest. It was consistently observed that significant rises occurred between practice and regular season, but stabilized over the two stressful competitive conditions, regular season and playoffs. This observation is in agreement with previous research (GINN, 1959; JOHNSON, 1949, 1951; KNAPP, 1966; LAMPMAN, 1967; MILLER, 1960) which demonstrated changes in anxiety, emotional stresses, and reactions in athletes in competition which were measured with several different psychological instruments.

TUTKO has speculated, on the basis of clinical research, but contrary to the results of this study, that "... the more crucial the contest, the higher the degree of anxiety" (TUTKO, 1971: 917). Intuitively, playoff competition may be regarded as a more crucial contest than regular season competition because it decides the eventual winner. Every contest is important and by losing, further competition is terminated. Additionally, only the best teams remain and winning becomes progressively more difficult. Therefore, the longer a team (or a player) stays in playoff competition the greater, it would appear, is the psychological threat of such competition to the individual members of the team. The same reasoning would apply to championship contests and tournaments. The results of the present study, however, contradict TUTKO's speculation, since state anxiety in senior high school football and basketball where playoffs occurred did not demonstrate any changes from regular season competition to playoff competition.

To reconcile the obvious disagreement between the results of this study and TUTKO's speculation, another variable, playing performance of the athlete in such psychologically intensified conditions, has to be introduced. The most popular concept to explain the relationship between anxiety and motor performance in athletics has been the inverted U concept (CRATTY, 1973; OXENDINE, 1970; SINGER, 1972) which has in turn been explained in terms of Duffy's arousal theory. These theories suggest that there is an optimal activation or emotional arousal point (or possibly a range) at which an individual performs well. When one experiences a higher or lower activation level which obviously differs from the optimal level, then the performance of this individual is impaired. Theoretically, then, although elevation in state anxiety in playoffs and other championship competitions over and above the optimal level required by the inverted U hypothesis is quite possible, it is elevated at the expense of a decrease in performance. The results of this study suggest that the relationship between pre-competition state anxiety and performance of athletes is a stable one. Once it is established during the regular season, it is maintained throughout playoffs. This finding is thus in disagreement with TUTKO's speculation and agrees with SINGER who states that "... the highly proficient athlete is one who demonstrates not only superb skills, but also emotional control under all sorts of circumstances" (SINGER, 1972: 125).

It is interesting to note that the vertical differences in state anxiety between the LT Ss and HT Ss in Figure 2 remained very stable. In a competitive situation both groups' state anxiety increased by the same amount on the state anxiety scale. It could be argued that since the HT Ss did, throughout the competitive season, remain on the respective teams, they must have performed most of their assignments satisfactorily. This indicated that an increase in state anxiety from its practice level was preferable for both groups, LT Ss and HT Ss, in a competitive situation. This agreed with Singer's statement that "... a certain amount of anxiety acts to prepare the athlete for competition" (SINGER, 1972: 127). The practical implications of this observation are important, because it is generally believed that HT athletes are easily aroused and in competition tend to be over-aroused, whereas the opposite is true for LT Ss. Therefore, HT Ss have to be calmed down and LT Ss have to be activated for the purpose of bringing both groups to an optimal level for an optimal performance (SINGER, 1972: 127). The fact that HT Ss did stay on the team suggests that their performance was not impaired by elevations in state anxiety prior to competition. On the contrary, they performed just as well as did LT Ss. This suggests that LT and HT Ss do not follow the same inverted U curve as has been traditionally assumed, but that there are at least two such curves, one for the HT Ss and one for the LT Ss. The two curves are placed at different levels on a state anxiety scale continuum. Thus, different pep talks, one for the LT Ss and one for the HT Ss, as often suggested in athletics, would seem to be redundant. However, this does not imply that an over-excited athlete performing very poorly is not a possibility. This athlete would, of course, have to be approached on an individual basis.

Two methodological aspects of the study, definition of the emotional arousal and subjective performance evaluation of football players, need clarification at this point. The fact that Oxendine's emotional arousal refers to changed physiological conditions of performers, whereas in this study, emotional arousal has been defined phenomenologically in terms of the Spielberger Trait-State Anxiety Theory, may seemingly cause a methodological problem and thus reduce the validity of the findings. However, this problem is overcome by the fact that both OXENDINE and SPIELBERGER assume very close association between physiological (changes in heart beat, respiration, galvanic skin response) and phenomenological (feelings of tension, apprehension, anxiety, excitement) aspects of emotional arousal changes of the performers. Since both aspects form the two sides of the same phenomena, it does not matter which one is measured, as long as accurate, valid and reliable test instruments are being used. According to SPIELBERGER, transitory states (pre-competition emotional arousal is a transitory state phenomena) can be meaningfully determined in terms of individual self-reports about the performer's feelings, providing motivation of the Ss to report accurately and honestly and cooperation are assured and appropriate instrumentation is available. The Ss in this study were highly motivated to participate in the research because of several factors: 1. Most other rival teams were also participating in the study; 2. The responses were not exposed to their coaches; 3. Their coaches were also participating by evaluating their performance after the game; 4. The results were made available to them after the season.

From the aforegoing, it is clear that the STAI state anxiety scale successfully measured the presence and strength of state anxiety levels of Ss in non-stressful and stressful competitive athletic situations. When maintaining the conceptual distinction between state and trait anxiety, STAI seems to be the only appropriate tool for research purposes, particularly in investigations similar to the present one, where measures of state anxiety were obtained repeatedly over longer periods of time with the same Ss. According to Levitt, "STAI is the most carefully developed instrument, from both theoretical and methodological standpoints" (LEVITT, 1967: 71). MARTENS (1971) has expressed similar satisfaction and has recommended the instrument in this type of research. Furthermore, the test construction procedures described by the originators (SPIELBERGER et al, 1970) are highly sophisticated and rigorous. The validating data on the STAI presented by SPIELBERGER et al (1970) are clearly in accord with SPIELBERGER's conception of Trait-State Anxiety Theory. The STAI state anxiety scale was designed to measure specific situational anxieties and as such it has proved to be very useful in studying the presence and strength of pre-competition emotional arousal in athletes. The STAI state anxiety scale is brief, easy to administer and is recommended for repeated testings. This makes the instrument particularly attractive for similar research in real life situations where an in-depth study of specific anxiety-arousing situations in competitive sports and their influence on motor behavior is investigated.

As to the completely subjective measure of performance evaluation of football players by their coaches, it could be argued that it has many advantages because of the many factors involved in each competitive situation which cannot be evaluated objectively. Intangibles such as the state of conditioning (at the time the evaluation is made), strength of the opposing team, strategy employed, general health status, injuries, field conditions, and other similar factors influence every athlete's performance and cannot be included in any objective measure devised so far. The coaches were well qualified to make such an evaluation since they knew the sport, the Ss, and the conditions under which the evaluations were made. Most evaluations were made after a videotape analysis of the games played. It was felt that this was the only possible and convenient way of repeated performance evaluation of such a great number of Ss that would ensure the coaches' cooperation.

CONCLUSION

OXENDINE's propositions regarding differential effects of playing positions on optimal emotional arousal of football players, whose playing assignments differed, does not hold for the Ss in this study. More similar research in real life situations would have to be completed before any valid conclusions could be drawn along this line for performing athletes.

Other major findings and conclusions of the study were:

1. High Trait Ss exhibited significantly higher state anxiety levels than Low Trait Ss over all experimental conditions.
2. In response to the psychological stress associated with athletic competition, state anxiety significantly increased in all Ss. These significant increases in state anxiety occurred between practice and regular season athletic environments. Over the two competitive experimental conditions, regular season and playoff environments, state anxiety showed stability at the senior level of competition.
3. STAI was successfully used in measuring the presence and strength of state anxiety levels of Ss in non-stressful athletic environments.

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COMPETITIVE ANXIETY: THEORY AND RESEARCH

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Over the past several years we have been investigating sport competition as a social psychological phenomenon and the anxiety frequently manifested when preparing to compete. From our research we have the following developments to report:

1. A model for the study of the competitive process.
2. A theory of competitive stress.
3. The delineation of the construct competitive trait anxiety and the development of an inventory (SCAT) to assess this construct.
4. Empirical research that validates SCAT and investigates state anxiety during the competition process.

In the following sections of this abbreviated report we will summarize each of these four developments.

A MODEL FOR THE STUDY OF THE COMPETITIVE PROCESS

Elsewhere MARTENS (1975) has outlined in detail a four-stage model for the study of competition as a process. The stages of the model are the objective competitive situation, the subjective competitive situation, the responses and the consequences of engaging in the competitive process. The objective competitive situation refers to the actual physical and social environment that exists in reality and which must contain the stimulus properties essential for competition to be initiated. Our working definition of the conditions essential for an objective competitive situation to exist is: a situation in which the comparison of an individual's performance is made with some standard in the presence of at least one other person who is aware of the criterion for comparison and can evaluate the comparison process.

How the person perceives, accepts, and appraises the objective competitive situation is termed the subjective competitive situation. The subjective competitive situation is determined then by an interaction between the objective competitive situation and attributes of the person — i.e., those attributes affecting perception. Competitive trait anxiety is one personality disposition that we have investigated to determine its influence on the subjective competitive situation.

The third stage of the model is how the person responds which is largely determined by the subjective competitive situation. The major response of interest in our research here has been state anxiety, and in some cases motor performance and satisfaction. The final stage of the competitive process is the consequences arising from the comparison process.

The value of this model of competition lies in its delineation of the components involved in the process and how different variables affect the interrelationships among these components. The distinction between the objective and subjective competitive environment is most important and has been ignored in most previous competition research.

A THEORY OF COMPETITIVE STRESS

The objective of the theory of competitive stress is to predict the levels of state anxiety (A-state) among different people in varying competitive situations. The theory is based on the competitive process model (MARTENS, 1975), SPIELBERGER's (1972) trait-state theory of anxiety, and McGRATH's (1970) conceptual model of stress.

Threat is an important construct in the theory and is defined as the *perception* of psychological or physical danger. In competition the degree of threat is theorized to be a function of the uncertainty (U) of the outcome and the importance (I) of the outcome. U is determined by an estimate of the probability of success (P_s). U is maximum when $P_s = .50$ and decreases as P_s increases in its deviation in either direction from .50 P_s is determined by the participant on the basis of the content and availability of information about the discrepancy between (a) the standard in the comparison process and self's ability, (b) the self's ability and actual performance, and (c) actual performance and performance outcome.

I is determined by both the intrinsic value of the outcome, or incentive value of success (I_s) and the extrinsic value of success (E_s). Thus $I = I_s + E_s$. As the P_s increases I_s decreases, or:

$$I_s = 1.0 - P_s$$

Disregarding E_s, threat (T) is a multiplicative function of P_s and I_s.

$$T = f(P_s \times I_s)$$

That is, as the product of the $P_s \times I_s$ interaction increases it causes increases in the probability that the situation is threatening. When E_s is constant in the competitive process, threat is highest when $P_s = .50$ (maximum uncertainty).

E_s combines with I_s to determine the total value of I. Thus threat in a competitive situation is theorized to be:

$$T = f[U \times (I_s \times E_s)]$$

or,

$$T = f(U \times I)$$

As the value of (U × I) increases, it increases in the probability that the situation is threatening. As threat increases, it causes increases in A-state. Thus the theory of competitive stress may be expressed as:

$$\text{A-State} = f(T) = f(U \times I)$$

COMPETITIVE TRAIT ANXIETY AND SCAT

Competitive trait anxiety is a construct that describes individual differences in the tendency to perceive competitive situations as threatening and to respond to these situations with A-state reactions of varying intensity. The theory of competitive stress predicts that persons higher in competitive A-trait perceive more competitive situations as threatening and/or more threatened in a competitive situation than persons with lower levels of competitive A-trait.

The Sport Competition Anxiety Test (SCAT) was developed for the purpose of providing a reliable and valid instrument for measuring competitive A-trait. Both a child and adult form of SCAT were developed and involved testing over 2500 persons. Item discrimination, reliability, and internal consistency of SCAT exceed substantially normal test construction standards. The content validity of SCAT was judged high by six experts rating the items. Concurrent validity was determined by correlating other personality tests with SCAT. Moderately positive correlation coefficients were obtained when SCAT was correlated with other non-specific trait anxiety scales. This provided evidence that SCAT was measuring an anxiety component but not the same construct as the general trait anxiety scales. Other personality scales correlated with SCAT as predicted from knowledge about the relationship of these constructs with anxiety.

Reliability, internal consistency, content and concurrent validity are necessary qualities of a personality inventory, but in addition an inventory must have predictive and construct validity. In the remainder of this report some of the research which has examined the predictive and construct validity of SCAT is presented.

PREDICTIVE AND CONSTRUCT VALIDITY OF SCAT

Experimental Studies of Competitive Trait Anxiety as a Predictor of State Anxiety Prior to, During, and After Competition

Two experimental studies assessed the effects of competitive trait anxiety (A-trait) and competition outcome (success-failure) on state anxiety (A-state) prior to, during, and after competition. Both experiments served two purposes. The first purpose was construct validation of SCAT by assessing whether differential levels of A-state were manifested by high- and low-SCAT persons when in a stressful competitive situation. Previous findings in the general anxiety literature have evidenced consistently that high trait anxiety individuals exhibit higher A-state levels than low trait anxiety individuals when confronted with psychologically stressful situations. Therefore, it is hypothesized that high SCAT persons evidence higher A-state than low SCAT persons when in a stressful competitive situation.

The second purpose was to examine the influence of competition outcome as well as the interactive effect of SCAT and competition outcome on A-state. Based on previous research it was hypothesized that state anxiety decreases with success and increases with failure. In addition, the interaction hypothesis stated that high trait anxiety individuals evidence higher levels of state anxiety than low trait anxiety individuals after failure and lower levels of state anxiety after success.

The design for Experiment I was a SCAT × Success-Failure (2 × 3) factorial. SCAT was administered several weeks prior to the experimental phase to 306 ten- to twelve-year old males. Forty-one subjects from the upper quartile (high SCAT) and 42 from the lower quartile (low SCAT) on SCAT were selected and randomly assigned to one of the following three success-failure groups: (a) win 80% of the contests (W_{80}); (b) win 50% of the contest W_{50}); (c) win 20% (W_{20}). A-state was assessed by the Spielberger state anxiety inventory for children (SAI-C) and by palmar sweating. The initial A-state assessment was made after an eight-minute rest period and prior to entering the testing area. A-state assessments were also made immediately prior to competition (pre-competition), after competition (post-competition), and after the final debriefing (post-debriefing).

Experiment II involved the addition of a sex group factor and a fourth no competition control (NC) success-failure condition. The design was a Sex × SCAT × Success-Failure (2 × 2 × 4) factorial. Following similar procedures and using the same age group as Experiment I, SCAT was administered to 490 males and females with 45 male and 45 female high SCAT subjects and 45 male and 45 female low SCAT subjects being selected for further testing. An equal number of subjects of each sex were randomly assigned to the four success-failure groups. State anxiety was assessed by the SAI-C and by a linear slide device. A scale, labeled from − 50 (calm) to + 50 (nervous) was located behind a metal slide and the subjects moved to a pointer attached to the slide handle to the number on the scale depicting how they felt. The initial A-state SAI-C measure was administered at the same time as SCAT and the initial A-state slide measure was assessed prior to entering the testing area. Both a-state measures were taken during pre-competition, after ten contests (mid-competition), and during post-competition.

The remaining procedures for the two experiments were almost identical. The experimental testing was conducted in a mobile van parked on the school site. Subjects competed on a complex motor maze task for 20 contests via a purported computer hookup with a bogus opponent at another school in a similar van. Success-failure was manipulated by the experimenter and evaluation potential was maximized through instructions, knowledge of results, and emphasis on the subject's ability as the primary determinant of the outcome. Subjects were carefully debriefed at the termination of both experiments.

Similar analysis techniques including univariate analysis of variance, multivariate analysis of covariance, and multiple regression were performed on the data from both experiments. The SAI-C results were generally consistent for both experiments and the SAI-C and linear slide results were consistent for Experiment II. The palmar sweat results were disappointing and not very informative.

The findings supported the first two hypotheses. High SCAT persons evidenced higher A-state than low SCAT persons when in a stressful competitive situation by generally no differences were found in non-competitive situations. Success-failure was found to be a strong situational factor affecting state anxiety with failure experiences significantly increasing A-state and success experiences significantly reducing A-state. Finally, the predicted SCAT × Success-Failure interaction did not materialize. The results indicated that the immediate situational success-failure factor was stronger than the dispositional SCAT variable. In sum, the results add construct validity to SCAT and further evidence that its primary purpose is to identify persons who manifest differential anxiety levels when confronted with a stressful competitive situation.

Field Studies of Pre-Competition State Anxiety

The validity of SCAT as a predictor of pre-competitive A-state was assessed in a field setting with three separate samples of athletes. Individuals identified by SCAT as high in competitive A-trait were hypothesized to perceive competitive situations as more threatening and to respond with higher levels of A-state than individuals identified as low in competitive A-trait. High and low competitive A-trait persons were not expected to differ in A-state in non-competitive situations. The

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relationship between competitive A-trait, as measured by SCAT and A-state, as measured by SPIELBERGER *et al.*'s (1970) state anxiety inventory was investigated with five women's intercollegiate volleyball teams (n = 52), United States Military Academy instructional boxing classes (n = 115), and nine girls' interscholastic basketball teams (n = 137).

The volleyball teams, from five Illinois universities, were competing at the state volleyball tournament. The initial A-state scale (A-state 1) and SCAT were administered to four of the five teams the evening before the tournament and the fifth team completed the same two scales on the morning of the competition. One pre-competition A-state measure (A-state 2) was obtained at courtside immediately prior to a game on the first day of the tournament when teams were engaged in round-robin pool play. A second pre-competition measure (A-state 3) was obtained during the second day of the tournament immediately prior the either a quarter-final or semi-final match.

The instructor of the boxing classes administered SCAT and the non-competitive A-state measure (A-state 1) at the beginning of a regular class in which a film was shown. Pre-competitive A-state (A-state 2) was assessed immediately before a competitive bout near the completion of the course.

The basketball teams completed the non-competitive A-state measure (A-state 1) and SCAT in an after school session at least three days prior to their next game. A-state 2 was obtained at courtside immediately prior to a regular season game.

Data from the volleyball and boxing samples, which were gathered before the basketball data, yielded only moderate relationships between SCAT and pre-competitive A-states. The correlation of SCAT with A-state in the volleyball sample increased from A-state 1 ($r = .18$) to A-state 2 ($r = .23$), and was statistically significant at A-state 3 ($r = .37$, $p < .01$). Surprinsingly A-state did not increase substantially from A-state 1 (41.06) to either A-state 2 (41.46) or A-state 3 (42.79). Comparison with norms reported by SPIELBERGER *et al.* (1970) for college females indicated that even the A-state 1 mean of 41 was in the 75th percentile. Apparently, the volleyball players' A-state levels were already elevated a day prior to the tournament competition. In contrast A-states observed in the boxing sample increased substantially from A-state 1 (37.48) to A-state 2 (52.70). The correlation between SCAT and A-state, however, increased only slightly from A-state 1 ($r = .35$, $p < .001$) to A-state 2 ($r = .40$ $p < .001$).

Because certain items on Spielberger's A-state scale did not appear to be directly relevant to competitive sport situations, the A-state measure was modified following its use with the volleyball and boxing samples. The modified A-state measure, consisting of five activation items and five deactivation items, was developed from factor analyses of the volleyball and boxing A-state scores and from subjective inspection of the A-state scale. The modified scale was used as the A-state measure with the basketball sample. Results indicated that the basketball players increased in A-state from A-state 1 (18.44) to A-state 2 (27.96). Furthermore, the correlation of SCAT with A-state showed a marked increase from A-state 1 ($r = .25$) to A-state 2 ($r = .64$). These results were in accord with the hypothesis. SCAT was only moderately related to A-state in the non-competitive situation but in pre-competition (A-state 2) for which SCAT was designed, SCAT accounted for 41% of the A-state variance.

The overall results from the three samples were mixed about the ability of SCAT to predict pre-competitive A-state. Evidence from the basketball sample, using the modified A-state scale and better non-competitive measures, yielded the strongest support for SCAT as a valid predictor of pre-competitive A-state.

Predicting Pre-Competitive A-state in Female Athletes

In order to determine the validity of SCAT an independent measure of competitive A-trait was sought which could then be compared with SCAT. In sport the assessment of competitive A-trait is commonly done subjectively by the coach. Coaches are generally quite confident in their ability to evaluate player attributes, particularly such an important factor as A-trait. Thus the correlation between SCAT and coaches' ratings of player competitive A-trait was examined. A moderately high correlation coefficient was expected which would provide further concurrent validity for SCAT.

Sixteen intercollegiate women's volleyball teams participating in the Illinois state tournament served as subjects. Subjects completed the SCAT the first day of play during ten-minute testing sessions. That same day each coach was given a rating form for every girl and was asked to indicate how anxious the athlete generally becomes when competing. The correlation coefficients between SCAT and the coaches' ratings revealed great discrepancies among teams, with correlations ranging from $-.57$ to $+.62$. The correlation for all tems combined was .14.

As a result of the inconsistent findings from the volleyball sample further consideration was given to the process by which the coaches were asked to rate their players as well as the manner in which SCAT was completed by team members. Two methodological concerns were examined. First, several coaches indicated that the question relating to the athletes' anxiety was somewhat ambiguous; a more precise operational definition was needed. Another factor was the tournament atmosphere and its effect on both the coaches and players. Because of tournament scheduling both SCAT and the coaches' ratings were filled out at various times during the tournament, with some teams completing the forms prior to matches, some during lengthy breaks, and some immediately after matches.

Based on the information from the first sample tested, adjustments were made in testing procedures as well as the coaches' rating form. In the second sample SCAT was compared with Spielberger's Trait Anxiety Inventory and with the coaches' ratings for nine high school girls' basketball teams.

Subjects completed the two trait anxiety measures in after-school sessions while coaches completed the coaches' rating forms at the conclusion of the season. As a result of feedback from the volleyball coaches, a revision was made on the coaches' rating form utilized in the basketball study which attempted to delineate more explicitly the possible emotional states experienced by athletes. As a result of factor analytic work on Spielberger's state anxiety questionnaire, five terms defining high levels of state anxiety and five terms defining low levels of state anxiety were used as the polarities on a nine-point continuum. Coaches were asked to respond by indicating their perception over the course of the season of the athletes' emotional state immediately prior to competing.

Similar to the results from the volleyball data, low correlations were obtained between the coaches' ratings and SCAT (r = .14 for all teams combined). Spielberger's trait anxiety inventory also was not significantly related to the coaches' ratings ($r = -.13$ for all teams combined). The relationship between SCAT and Spielberger's A-trait was r = .44 which corroborated other SCAT concurrent validity studies.

Two explanations may account for the low correlations between the coaches' ratings and SCAT. SCAT may be a poor predictor of actual competitive A-state. Alternatively the coaches may be inaccurate in their perceptions of the players' A-state as reported by the players. To determine which explanation was correct each measure of competitive A-trait was correlated with the players' A-state just prior to competition. Using the concept of incremental validity, it was hypothesized that SCAT would have the highest correlation coefficient with the players' A-state, the Spielberger's Trait Anxiety Inventory would have a somewhat smaller correlations coefficient, and that the coaches' ratings would have even a smaller correlation coefficient with the players' A-state scores. This hypothesis was supported. SCAT was substantially correlated with the players' A-state (r = .64). Spielberger's Inventory correlated substantially less (r = .30), and the correlation coefficient for the coaches' ratings was very low (r = .12).

These results clearly show that SCAT is a better predictor of player's A-state than a general trait anxiety inventory and coaches' ratings of competitive trait anxiety.

Summary

Our research on competitive anxiety has emanated from a model of competition and a theory of competitive stress. Almost all of our research to date has been to establish a foundation (a theory) and the tools (SCAT) for future investigation of competitive anxiety. The evidence accumulated so far indicates that SCAT is a reliable and valid instrument for assessing competitive trait anxiety. The theory of competitive stress has not been rigorously tested as yet. (We have some limited data to support the theory, although this evidence was not included in this report.)

Our future research plans should be obvious. The theory of competitive stress will be investigated. In addition our attention will be directed toward understanding how persons who differ in competitive trait anxiety differ in their behaviors in competitive situations as the uncertainty and importance of the situation vary. In order to improve our research capabilities we will need to continue to improve our methods for assessing A-state. This means we will need a better understanding of the arousal mechanisms in the body and how they affect covert as well as overt responses

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THE EFFECT OF AROUSAL INDUCED BY COMPETITION ON LEARNING AND PERFORMANCE OF A MOTOR SKILL

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Competition frequently occurs during the learning and performance of physical skills, however the effect of this variable is empirically unclear. WANKEL (1972) summarized the experimental evidence on the effects of competition, and reported seven studies showing positive effects on performance, three studies showing negative effects, and six studies showing differential or nonsignificant effects. The results are further confused by the addition of variables such as achievement motivation (RYAN and LAKIE, 1965) and sex of opponent (FREISCHLAG, 1973).

There are three major theoretical positions which could help explain the effects of competition on performance and learning if competition is seen as producing arousal. According to the "inverted-U" hypothesis, the effect of competition will vary with the level of arousal induced by competition. If competition leads to optimal arousal for the individual, performance will be enhanced. If arousal is above or below optimal, performance will be impaired. This hypothesis only makes predictions for performance (observable behavior of short duration) not for learning (a rather permanent change observable in performance following practice).

ZAJONC's (1965) drive theory suggests that arousal, in this case produced by competition, will elicit the emission of dominant responses. In an easy, or well-learned task, the dominant response will be correct, so arousal should improve performance. In a difficult, or unlearned task, the dominant response will be incorrect, so arousal should impair performance.

Consolidation theory of learning has not been related to the effects of competition, although it has been studied using arousal induced by shock (MARTENIUK and WENGER, 1970; SAGE and BENNET, 1973). This theory makes clear distinctions between short-term effects (performance) and long-term effects (learning). According to this theory, enhanced arousal will facilitate learning because the neural memory trace established by practice will be more "robust" under high arousal, and will produce improved long-term memory (SAGE and BENNET, 1973). Both previous studies that used arousal induced by shock reported no significant differences between control and arousal groups on initial *performance* trials, but found significantly greater *learning* for the arousal group.

The present study was designed to determine the effects of arousal induced by competition on the performance and learning of motor skills. Three specific questions were asked.

1. Does competition create arousal? To determine this, the State-Trait Anxiety Inventory was administered to measure arousal levels.
2. Does competition influence the performance of learning of a motor task? To determine this, all subjects were brought back 24 hours later and tested under the no-competition condition.
3. Does the effect of competition vary with the difficulty of the task? To determine this, two levels of difficulty of the Fitts tapping task were used in the experiment.

METHOD

Subjects

Ss were 28 undergraduate Physical Education students who were randomly assigned either to the control condition (performance alone) or to the competition condition.

Apparatus

The tapping apparatus consisted of two metal plates mounted on a wooden base, and a plastic-coated, metal stylus. The plates were divided into target areas (brass colored), and error areas (silver colored). Both sets of targets had a center-to-center distance of 10 in., with one set of targets being once inch wide, and the other, 0.25 inches wide. Both the plates and the stylus were electrically connected to an electronic counter that recorded both the number of times the stylus was in contact with the target and the number of times the stylus contacted the non-target area.

The State-Trait Anxiety Inventory developed by SPIELBERGER, GORSUCH and LUSHENE (1970) was used to determine whether competition actually created arousal for the Ss.

Procedure

The general procedure for the Fitts tapping task was to tap alternately between two targets as quickly as possible. A difficulty score for this task was calculated with the Fitts Index of Difficulty (ID). This formula $ID = \log_2 (2A/W)$ takes into account the distance between the target centers (A) and the target width (W) and produces an estimate of the amount of information (in bits) processed in hitting one target.

To perform the tapping task, S grasped the stylus in the right hand and tapped alternately as quickly as possible between the targets on the metal plates. Two sets of targets were used. Both targets had a center-to-center distance (A) of 10 in. The "easy" tapping task had a target width of one inch, producing an ID of 4.3. The "difficult" tapping task had a target width of 0.25 inches, giving an ID of 6.4. Each S was given 15 trials on Day 1 and 10 trials on Day 2. All Ss performed the first five trials alone. Ss in the Control group continued to perform alone throughout the remaining trials. Ss in the Competition group performed trials 6–15 alternately with another S with whom they competed, and returned to performing alone on Day 2. The order of presentation of the easy and difficult tasks was balanced among Ss. The A-State Anxiety Inventory was administered to all Ss following Trial 15 on Day 1. The A-Trait Anxiety Test was administered prior to testing on Day 2.

The datum recorded was the number of taps on target in 15 seconds. The datum analyzed was the amount of information processed in 15 seconds, which was computed by multiplying the number of taps by the Index of Difficulty. The data were analyzed by a 3-way analysis of variance, the first factor being Performance Condition (alone vs competition), the second being Task Difficulty (easy vs difficult) and the third, being Trials (15 on Day 1 and 10 on Day 2).

RESULTS

Anxiety Scores

To determine if there were any differences between the groups in "normal" anxiety levels, the scores of the A-Trait Anxiety Test were compared. As may be seen in Table I, the group means were very similar and were not significantly different, t = 0.61, p .05. To determine the effect of competition on arousal, the scores of the A-State Anxiety Test were compared. Contrary to expectation, the means were not significantly different, t = 0.87, p .05.

Table I - Means and Standard Deviations of A-trait and A-state Anxiety Scores.

Group	Mean A-trait	SD	Mean A-state	SD
Control (n = 15)	38.1	8.96	44.4	13.02
Competition (n = 14)	39.4	7.75	40.9	7.04
t score	.42		.91	

Level of Difficulty

The performance level (number of taps per second) was much lower in the difficult tapping condition (1.95) than in the easy condition (3.73). In terms of information processed, more information was processed in the easy condition (16.03 bits/sec.) than the difficult condition (12.46 bits/sec.), F = 113.97, p 7.05.

Performance Condition

Since there was a significant performance condition × trials interaction (F = 2.36, p .05) these results are most easily seen in Figure 1. The two groups (Competition and Control) were not significantly different on the first five trials. From trial 10 through 15, the groups were significantly different. On Day 2, there were no significant differences between the Competition and Control groups over the 10 trials. The means for these trial blocks are shown in Table II.

Figure 1 - Mean number of taps in 15 sec. for Competition and Control groups on Day 1 and Day 2.

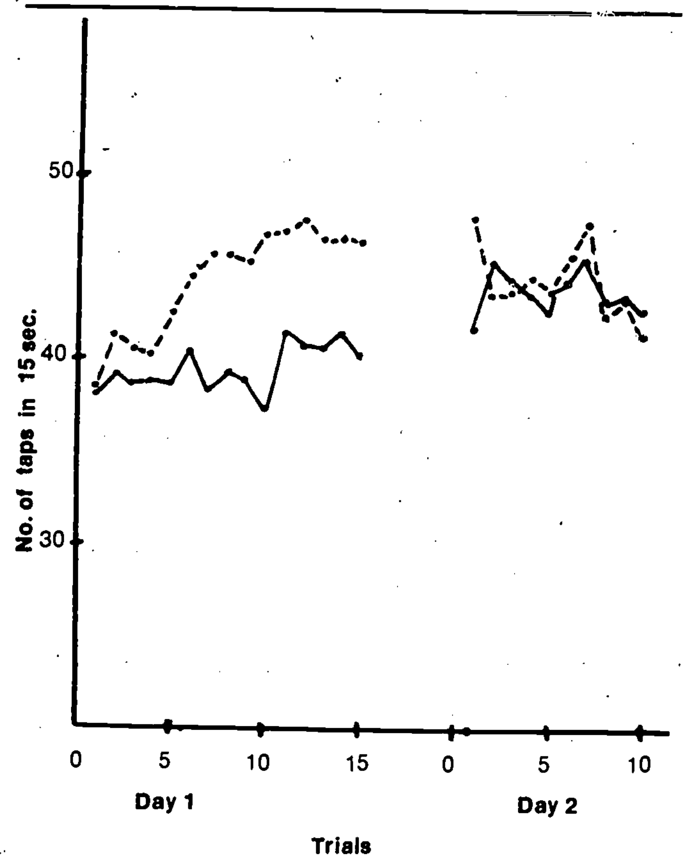

Table II - Mean Number of Taps for Blocks for Control and Competition Groups.

	Trials		
	1-5	11-15	16-25
Control	38.4	40.9	43.6
Competition	40.5	46.7	44.9

DISCUSSION

Several interesting results were produced, but the answers to the questions which led to the study are still not clear.

In terms of the first question, competition did not induce the type of arousal measured by the State-Trait Inventory, since there was no difference between the Competition and the Control group on these test scores. Unfortunately, no other measures of arousal were collected, so it was not obvious how competition affected the Ss, although it was clear from the results that it had some effect.

In answer to the second question, competition clearly influenced only performance and not learning. This was shown by the finding that competition only affected the tapping behavior while the Ss were competing (Trials 6-15 on Day 1). If competition had enabled the Ss somehow to learn to tap better, this improved learning should have been evidenced by higher tapping scores for the competition Ss on Day 2. This was not the case, since there were no significant differences between the groups on Day 2. These results were contrary to prior findings (MARTENIUK and WENGER, 1970; SAGE and BENNETT, 1973) which indicated that arousal influenced learning and not performance. The major differences between these studies and the present study were the methods used to induce arousal (shock as opposed to competition) and the methods used to analyze the data. It seems possible that shock induced a "negative" type of arousal which depressed performance while it was present. Performance came up to its "true" level on Day 2 when no shock was present. Since SAGE and BENNETT (1973) did not analyze the actual performances on Day 2, it is possible that their Arousal and Control groups did not perform significantly differently on Day 2.

In answer to the third question, competition affected the performance on the easy and the difficult task in the same way. This was supported by the lack of a significant interaction between performance condition and level of difficulty. These findings were contrary to ZAJONC's (1965) drive theory predictions that arousal would improve performance on the easy task, but impair performance on the difficult task, since competition improved performance on both tasks. There are two possible reasons for this finding. One is the level and type of arousal induced by competition, and the other is the nature of the task used in the present experiment. It is possible that competition did not create the "correct" type of arousal, or did not create a sufficiently high level of arousal, to impair performance on the difficult task.

The alternative explanation is that the effect of competition or arousal is specific to the type of task being performed. The Fitts tapping task used in the present study is a highly motor task, i.e., there is little to no cognitive involvement in performing the task. The difficulty of the task is increased by increasing the requirements on the motor system for accuracy. It may be that increased arousal will positively influence the performance of the motor component of skills, but negatively influence the cognitive component.

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CLASSICAL THEORIES OF EMOTION: HISTORICAL MILESTONES *

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The study of emotion is an interesting and fascinating area of past and contemporary psychology. Unlike areas of scientific inquiry it is beset with multi-dimensional problems of definition, control, and interpretation of behavioral, physiological, and situational variables. The fact that emotional behavior has not been studied as scientifically or with the same breadth and depth as other aspects of psychology attests to the complexities of the problem. For these and other reasons, some authorities have suggested that emotion serves no useful purpose in psychology and therefore should not be studied systematically. The fact that emotion continues to appear in the psychological literature discredits to some extent this belief.

The study of emotion is as old as psychology itself. It seems that man has always been interested in his many and diverse behaviors and has spent an inordinate amount of time trying to untangle the ways in which he interacts with others and with his environment. Charles DARWIN (1872), for example, talked about the innate determinants of emotional behavior. He speculated that man's habit of curling the lips when smiling is an evolutionary vestige from the carnivore's habit of baring its teeth in rage (FANTINO, 1973). Darwin concluded that much of man's repertoire of emotion behavior is inherited.

Even at the start of scientific psychology with the development of the first recognized laboratory by Wilhelm Wundt at the University of Leipzip in 1879, psychologists were still preoccupied with the study of emotion through introspection. In fact, WUNDT (1902), as cited by FANTINO (1973, p. 284), formulated what he called a tridimensional view of emotion. In his system, he speculated that there were three ways in which emotions vary:

(1) excitement-depression;

(2) strain-relaxation; and

(3) pleasantness-unpleasantness.

Since Wundt and his pupil, E. B. Titchener, were associationists and believed strongly in the use of introspection, there was little 'hard' data to support their beliefs.

Other scholars of Wundt's era also studied emotion but with the advent of behaviorism and the idea that psychology should become more objective, the study of emotion declined. However, a review of ancient and modern literature will uncover the fact that it is permeated with descriptions of emotional states (WOODWORTH and SCHLOSBERG, 1965). And, the fact that emotion, despite the problem of studying it objectively, has such wide application to a number of psychological processes, e.g., learning, aggression, motivation, and personality, makes it an important area of investigation today.

The purpose of this paper is to trace the historical milestones in the study of emotion and show how various theoretical positions have contributed to our understanding of emotional behavior. The coverage is not inclusive but selective of the many and diverse ways which have been used to study emotional responses in man.

EMOTION — A DEFINITIONAL APPROACH

One of the major reasons why psychologists have not uncovered more convincing evidence about emotion is that it is so difficult, if not impossible, to define. The late Elizabeth DUFFY (1934), raised the cogent question: Does the concept of emotion serve a useful purpose in scientific psychology? The fact that Duffy spent most of her life studying various aspects of emotion, for example, arousal of what she called activation, indicates that she should have answered "yes" to her own question.

There are many approaches to the study of emotion. And, the definitions of the proponents of each approach reflect their individual and collective biases. The behaviorists, such as SKINNER (1953, 1974), avoid the definitional problem by studying emotional behavior rather than emotion in and of itself. In other words, the behaviorists ignore mentalisitc concepts such as emotion and focus directly on overt behavioral responses to various stimuli.

Activation theorists, such as DUFFY (1941), R. B. MALMO (1959), and D. B. LINDSLEY (1951), define emotion as: "an adjustment made to a stimulating condition of such a kind that the adjustment involves a marked change in energy level" (DUFFY, 1941, pp. 292-293). More contemporary definitions such as those by C. N. COFER (1972) and D. O. HEBB (1966) emphasize the motivational properties of emotion. Hebb, for example, believes that emotions are special states of motivation. John I. LACEY (1965, 1967), a critic of activation theory, concluded that emotion is as difficult a concept as can be found in the psycho-physiological literature. Cofer agrees with Lacey and suggests that there is no satisfactory definition of emotion.

Psychoanalytically oriented psychologists, such as the late Abraham MASLOW (1970) and Erich FROMM (1973), are certainly not willing to accept Cofer's position. Since everyone experiences emotion in one form or another, they contend that most psychologists are not willing to sweep the definitional problem under the rug. Therefore, dynamic theories, such as those of FREUD (1925, as cited by FANTINO, 1973) and more recently by P. T. YOUNG (1961), focus on the hedonistic or self-gratification concept of emotion. YOUNG (1961, p. 352) defined emotion as: "a variety of affective processes distinguished from others as an acute (brief and intense) affective disturbance."

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In a far more recent review, Karl PRIBRAM and Diane McGUINNESS (1975) attempt to clarify the terms arousal, activation, and effort. Relating these terms to recent developments in neuropsychology and psychophysiology, these authorities state that there are three separate, but interacting, neural systems. One system, they claim, controls arousal, which is defined as: "phasic physiological responses to input" (PRIBRAM, *et al.*, 1975, p. 116). The second system controls activation, which they define in "terms of tonic physiological readiness to respond" (PRIBRAM, *et. al.*, 1975, p. 116). The third system coordinates arousal and activation and is defined in terms of demanding effort.

In the opinion of this author there are still some problems with the above definitions. That is, they are lacking in clarity. For example, is it proper, scientifically speaking, to define such concepts in terms of what they demand rather than what they are? Pribram's, *et. al.*, third system which coordinates arousal and activation, is defined as demanding effort. The fuzziness of operational definitions lead to unclear research findings.

The solution to the problem perhaps lies in the application of operationalism. That is, a "statement which reduces an unobservable concept into a publicly verifiable set of operations" (CORSO, 1967, p. 39). As indicated above, J. F. Corso, would suggest that terms such as emotion be operationally defined in terms of overt changes in physiological or behavioral responses. In a word, operational definitions give concepts objective meaning.

This approach is certainly a viable one but there are still some problems connected with it. First, in attempting to define operationally the terms emotion or arousal it should be pointed out that every stimulus does not arouse the same feelings with comparable intensity in every person. Second, there are wide individual differences in the experiential effects of specific stimuli. For example, GROSSMAN (1967) suggests, what he calls the pervasive influence of learning. And, third, to complicate the problem even further, the so called physiological correlates of emotion tell us very little about the physiological processes responsible for the emotional reactions (GROSSMAN, 1967). Obviously, as you can see, the application of operationalism also has its draw backs. Nevertheless, it is perhaps the only way researchers can attack the underlying substrates of emotion. At least operational definitions avoid the problem of trying to study the physiological basis of hypothetical constructs.

EARLY THEORIES

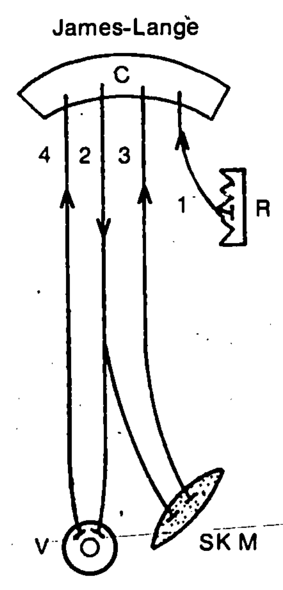
As psychology emerged as a discipline, separate from philosophy and physiology in latter half of the nineteenth century, it was defined as the descriptive science of consciousness (BORING, 1950). Thus, the goal of psychology at that time was to study conscious experiences largely through a process called introspection. Wundt in Germany and E. B. Titchener in the United States utilized introspection by presenting stimuli so that observers could describe their experiences. The basic idea at that time was to discover the elements underlying various phenomena and formulate them into laws. These laws were referred to as laws of association (COFER, 1972). Thus, even as early as 1879, the study of conscious processes or what was later on called emotion was a dominant force in psychology. Perhaps the reason for this development was that emotions are often linked to motivation. And, much of psychology since its inception has been preoccupied with the study of what makes man behave as he does.

The James-Lange Theory

The first major breakthrough in uncovering the complexities of emotional behavior came about in 1884 when William James presented his theory of emotion. James, the father of functionalism, suggested that physiological changes were the basis for emotional experiences. The perception of these bodily changes, James contended, was emotion.

A contemporary of James, Carl Lange, drew similar conclusions about the causes of emotional states and together they formulated the classical James-Lange theory of emotion. Figure 1 shows that receptors (R), such as the skin, pick up stimuli and relay them to the cerebral cortex (C). The cortex processes these stimuli and sends impulses to the viscus (V) and skeletal muscles (SKM) via nerve pathways. As indicated in Figure 1, impulses may also originate in the viscus and skeletal muscles and be sent to the cortex via nerve pathways.

Figure 1 - The James-Lange Theory of Emotion. R refers to receptor, C to the cerebral cortex, V to viscus, SKM to skeletal nerve pathways, with the arrows indicating direction of impulses. (From: C. N. Cofer. *Motivation and Emotion.* Glenview, Illinois: Scott, Foresman, 1972, p. 59).



Basically, Lange's contribution was to point out to James the importance of vascular changes such as blood pressure, heart rate, and vasodilation.

The Cannon-Bard Theory

Despite the wide acceptance of the James-Lange theory, it was not without its critics. One of the foremost critics was W. B. CANNON (1927). Cannon proposed an alternate theory in which he described the role of the thalamus in the regulation of emotion. As a result of this emphasis, Cannon's theory is referred to as a 'thalamic theory' or 'emergency theory' of emotion. The theory was revised in 1934 by Bard and is now called the Cannon-Bard Theory.

Like the James-Lange theory, Figure 2 shows that impulses travel along sensory nerves to the cortex (C). If the stimuli are of an emotion-producing variety, they can stimulate the cortex to release the thalamus from the inhibition which the cortex normally holds over it. Discharges by the thalamus go to the cortex to produce emotional experiences. If the stimulation of the thalamus is intense, inhibition can be overcome directly and the thalamus can discharge to the cortex and to the viscera. Cannon and Bard speculated that the sympathetic branch of the autonomic nervous system could cause the discharge of sugar, augment respiration and shift the blood distribution from the viscera to the heart, brain, and skeletal musculature when some threat occurred to the organism. The parasympathetic division of the autonomic nervous system, Cannon said, inhibited bodily functions under conditions of threat.

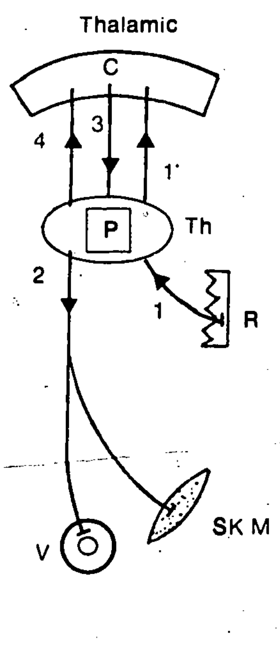


Figure 2 - The Cannon-Bard Theory of emotion. R refers to receptor, C to the cerebral cortex, V to viscus, SKM to skeletal muscle, Th to the thalamus, and P to pattern. The lines represent nerve pathways, with arrows indicating direction of impulses. (From: C. N. Cofer. *Motivation and Emotion.* Glenview, Illinois: Scott, Foresman, 1972, p. 59).

The theories of James-Lange and Cannon-Bard are referred to as peripheral-origin theories of emotion because they suggest that the regulation of emotion is in the periphery of the organism, i.e., the viscera, the skin, the blood vessels. Central approaches, rather than peripheral views, postulate that the seat of emotion lies in the central nervous system: the brain, and spinal cord. The first central theorist was J. W. Papez.

Papez's Theory

Prior to Papez's contribution to the understanding of the neurophysiological basis of emotion, the invention of the electroencephalograph led to the important discovery by MORUZZI and MAGOUN (1949) that stimulation of the reticular formation of the brainstem elicited the cortical arousal response. Furthermore, additional support for the regulatory role of the reticular formation came about from research which showed that lesions in the brainstem reticular activating system abolished the activation pattern in the cortex. The lesions produced lethargy, apathy, and somnolence (GROSSMAN, 1967).

Papez was the first researcher to hypothesize a relationship between specific cortical mechanisms, e.g., cingulate gyrus, and emotion. Papez, an outstanding neuroanatomist, was convinced that the expression of emotion depended on the integrative action of the hypothalamus. Figure 3 shows that Papez speculated that there were primative sensory centers in what he called the subthalamus. Stimuli from the receptors

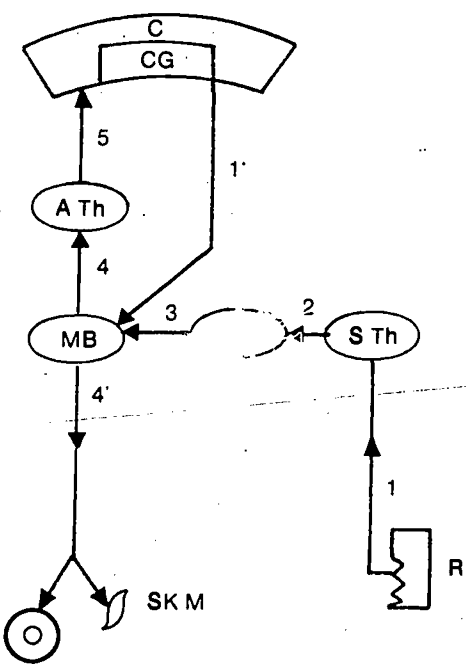


Figure 3 - Papez's Theory of Emotion. R, sensory receptor; S th, subthalamic sensory receiving centers; AH, anterior and medial hypothalamus; MB, mammillary bodies; A Th, anterior nucldi of thalamus; CG, cingulate gyrus; C, cortex; V, viscera; SKM, skeletal muscles. (From: S. P. Grossman, *A Textbook of physiological Psychology* New York: Wiley, 1967, p. 530).

(skin, ears, eyes, etc.) reach the subthalamus where they are relayed via diffuse fibers to the anterior and medial portions of the hypothalamus. Path #3, Figure 3, is routed to the mammillary bodies which also receive input from the cortex Path #1[1]). This input comes from the medial forebrain bundle, the fornix and the mammillary peduncle (GROSSMAN, 1967). From the mammillary bodies stimuli may follow one of two paths (#3 or #4[1]). First, it may proceed via the mammillothalamic tract to the anterior nuclei of the thalamus or it may proceed via Path #4 to the viscera and skeletal musculature. Path #5 shows the transfer of input via the thalamocortical tract to the cortex of the cingulate gyrus. According to Papez, the cingulate gyrus produces the appropriate emotional reaction.

Despite the intuitive nature of Papez's theory, it did not receive a great deal of support in psychology because his findings were not supported by behavioral data. However, Papez's basic premise that the hypothalamus played a significant role as an effector mechanism of emotional expression led MacLEAN (1949) to develop his theory of emotion. Incidentally, MacLean agreed with Papez's statement that "only the cerebral cortex is capable of appreciating all the various affective qualities of experience and combining them into such states of feeling as fear, anger, love, and hate" (as cited by GROSSMAN, 1967, p. 531).

MacLean's Theory

Basically, MacLean's (1949) views differed from Papez's in that he de-emphasized the role of the cingulate gyrus. He emphasized in his theory that the hypocampus and the amygdaloid complex were largely responsible for the subjective experience of emotion. The cingulate gyrus, according to MacLean, was a visceromotor center which integrated various autonomic and somatic motor responses.

Unlike Papez, however, McLean failed to spell out the specific course of events from the reception of an emotion-producing stimulus to the expression of emotion. Furthermore, although Papez's explanation was particularly appropriate at the time it was made, both MacLean's and Papez's theories proved to be untenable by modern day standards. Research has shown that the physiological and neurological mechanisms involved in the regulation of emotion are far more complex than either Papez or MacLean suggested.

Activation-Arousal Theory

The concept of activation or arousal was presented by Elizabeth DUFFY in 1950. After more than twenty years of work, Duffy derived her theory from the research evidence she had gathered from numerous investigations. Basically, she views man as an energy system. That is, the organism obtains, processes, stores, and releases energy to meet internal and external environmental demands placed upon it. Thus, a kind of energy balance or homeostasis is achieved whereby food intake, stored energy, work production and heat regulation interact with one another. DUFFY (1962, p. 17) summarized this concept well when she said: "...every response of the organism is fundamentally concerned with energy transformation and release...." Responses may be overt or covert but they both require the release of energy.

Throughout her many papers Duffy talks about "the 'level of activation' of the organism as the extent of release of potential energy, stored in the tissues of the organism, as this is shown in activity or response" (DUFFY, 1962, p. 17). She also points out that the degree of overt activity of the organism is not necessarily synonymous with the degree of activation. That is, covert activity, particularly under high stress, may require high energy expenditures, as does overt activity. In sum, the level of activation is the extent of release through metabolic activity in the tissues of the organism.

In other words, we are dealing with an unidimensional concept of arousal or activation in which the degree of activation may be thought of as occurring on a continuum with high arousal at one end; a low arousal, as in sleep, at the other.

Activation theorists such as DUFFY (1957), MALMO (1959), and LINDSLEY (1951), believe that all variations in behavior may be said to occur in either direction or intensity. However, it is the intensity aspect of behavior to which activation or arousal applied (CATALANO, 1967).

One of the most widely known and most frequently utilized human performance applications of activation theory is the inverted-U hypothesis. This theory postulates that various tasks require different levels of arousal or what HULL (1943) called drive. For example, high activation may be all right for gross tasks, such as line play in the sport of football, but low arousal is more suitable for fine motor skills, such as releasing an arrow in the sport of archery. In a word, there is, Duffy suggests, an optimum level of activation for each task. Of course, YERKES and DODSSON (1908) reached this same decision much earlier than Duffy.

Criticism of Activation Theory

Like most theoretical positions, arousal or activation theory is not without its critics. In a penetrating analysis of the basic tenets of this theory John I. LACEY (1967), cogently points out the lack of supportive data for this position. He contends that recent developments in psychophysiology and neurophysiology suggest that activation or arousal theory needs rather drastic revisions. LACEY (1956, 1967) goes on to say that many experimental results contradict activation theory. And, it appears that these findings can *not* be attributed to sampling error, poor experimental control or to the unreliability of measurement.

Lacey's position challenges Duffy's, Malmo's, and Lindsley's unidimensional concept of arousal. He is of the opinion that arousal is multidimensional in scope. That is to say, there are different forms of arousal, e.g., electrocortical, autonomic, and behavioral. Furthermore, Lacey postulates that one form of arousal can not be used as a valid index of another. In a word, he is suggesting a dissociation of somatic and behavioral arousal mechanisms.

For activation theory to be tenable, Lacey contends, high intercorrelations among physiological indexes of arousal are needed. The results of many investigations, e.g., DARROW (1929), and LACEY, BATEMAN and VAN LEHN (1953), do not support this position. In fact, the inter-correlations are low, in some instances approaching zero. Therefore, Lacey is of the opinion that the widely held belief that autonomic, electroencephalographic and skeletal-motor activation occur simultaneously and in equal measure is lacking in scientific validity (LACEY, 1967). Lacey concluded that there is little or no support for a general or generalized concept of arousal such as the one expressed by Duffy, Malmo, and Lindsley.

In contrast to Duffy, *et. at.*, Lacey makes a plea for a direction of change rather than an amount of change measurement of arousal. He and his associates (LACEY, BATEMAN, and VAN LEHN, 1953) base their 'directional' position on the results of their investigations which show that:

> The autonomic nervous system does indeed respond to experimentally imposed stress 'as a whole' in the sense that all autonomically innervated structures seem to be activated usually in the direction of apparent sympathetic predominance. But, it does not respond 'as a whole' in the sense that all autonomically innervated structures exhibit equal increments or decrements of function (LACEY, BATEMAN, and VAN LEHN, 1953, p. 8).

Because of the above statement, Lacey indicated that one cannot predict with any degree of confidence the activation level of one physiological measure from another. Furthermore, research results support his conclusion that... "there is no such thing as the correlation among somatic variables" (LACEY, 1967, p. 23). In fact, others, e.g., Catalano, agree with Lacey that r's vary as a function of many variables, e.g., time of day and age.

Some researchers, such as LAZARUS (1963), have attributed low correlations among physiological indexes of arousal to the use of different subjects. Lazarus, et. al., suggest that r's should be produced from intraindividual rather than interindividual measures of activation. To support his position Lazarus generated an r of .707 between palmar conductance and heart rate responses. Although .707 is a moderately high r, it only accounts for approximately 50 percent of the shared variance among the two variables.

These and other findings led LACEY (1967, p. 24) to conclude that: "The uncritical use of an activation concept of emotion fails to do justice to the differential activities of the nervous system."

Duffy's Retort

Just before her death in 1971, Duffy attempted to answer the critics of her activation theory. Much of the criticism of her work, as mentioned previously, was centered around the low inter-correlations among the physiological correlates of arousal. According to J. I. Lacey, if activation theory is tenable, then high intraindividual inter-correlations among physiological indexes must be found. These statistics have not been forthcoming and have led researchers such as Lacey to conclude that activation theory needs substantial revisions.

Duffy acknowledges the correlational problem but points out that the low r's are due to the differences in latency times among physiological systems. When intraindividual, rather than interindividual measures are used, higher correlations are forthcoming. DUFFY (1972, p. 608) concluded that: ... "individuals apparently differ in their characteristic degree of activation, as well as, fluctuations in activation and in the length of time they require, after stimulation, to recover or return to prestimulus level of activation." She also acknowledged the fact that different situations arouse different individuals to a different degree. But, within individuals, Duffy suggests, activation in different situations remains relatively stable. Much of the confusion, Duffy points out, is caused by researchers who fail to differentiate between directional and intensity aspects of behavior. Basically, individual differences in arousal are caused by differences in the degree of excitability of the nervous system.

Summary

Uncovering some of the historical milestones in the development of theories of emotion has revealed a lack of agreement about the underlying basis of one of man's most basic behaviors. Much of the problem of understanding the complexities of emotion may be traced to the failure of researchers to agree on a clear-cut definition of the term. As a result, some scholars, such as the late Elizabeth Duffy, have raised the basic question: Does the term serve a useful purpose in scientific psychology? The fact that Duffy and others have spent a life-time studying the underlying substrates of emotion leads one to conclude that it is an important concept in contemporary psychology and deserves detailed, systematic investigation.

Despite the fact that everyone experiences emotion in one form or another, emotional behavior has not received the attention which it rightfully deserves. Its wide application to numerous areas of psychology, e.g., learning, motivation, aggression, and personality, makes emotion a viable area for further study. Despite the obvious need for further investigation, there appears to be a paucity of ongoing research. When research is done, current approaches deal with emotion at either the behavioral or physiological level. Conspicuous by their absence in the psychological literature, are studies which deal with man's emotional behavior rather than the responses of animals.

Although theorizing about emotion has not been advanced appreciably since the development of activation theory by Duffy, Malmo, and Lindsley, brain lesion research may in the future allow investigations to pose more tenable hypotheses. Recent developments in neurophysiology and psychophysiology may clear the way for new theories of emotion.

Since most of all the great psychologists have at one time or another focused attention on the emotional properties of animals and/or man, it is most difficult to single out the great leaders. There is little doubt, however, that Darwin, Wundt, James, Duffy, Lacey, Malmo, Lindsley, Papez, Cannon, Bard, Moruzzi, and Magoun have made significant contributions. Their work and the work of others attest to the complexities of human and animal behavior and the difficult task of trying to untangle innate, behavioral and situational variables which affect emotion.

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COMPETITION AND ANXIETY IN THE LEARNING OF TENNIS

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In *Education and Ecstasy*, LEONARD (1965) expressed his concern about the value of competition in the learning process when he stated:

> Competition... with grades, honors, and tests of all kinds gathering about them a power and glory all out of proportion to their quite limited function as learning aids... (82-83).

Sport by definition (ASMUSSEN, 1965) has as a fundamental characteristic the element of competition inherent within it. Of what value is competition when one is learning a new sport skill?

Research findings generally concur that competition enhances performance for individuals taking motor or physical fitness tests (BASSIN, 1966; RYAN, 1965; STRONG, 1963). However, the literature on the effects of competition when learning a new sport skill shows inconsistent results about the value of competition.

Competition was found not to be the best method for the learning of archery skills (CLAWSON, 1965) but for boys who practiced basketball in a competitive situation, their scores on six of seven skill tests showed significant improvement when compared to boys who practiced basketball in a non-competitive situation (WILKES, 1966). STITT (1964) studied the consequences of different types of competition upon the basketball dribbling performance of girls. She concluded from inconsistent results that there was a general lack of effect from the selected competitive incentives. McGOWAN (1968) also found mixed effects from competitive emphasis in basketball performance. He concluded that performance under the stress of competition will improve or deteriorate depending upon the situation and the anxiety level of the subjects. The inconsistencies of research on competition as a motivator may be due to not being able to determine and maintain the optimum range of motivation which is necessary for enhancing performance (EYSENCK, 1963).

Anxiety and its relationship to learning and competition has long been an important area of study... In the learning of sport skills, researchers (DAUGERT, 1966; KARBE, 1968; PECK, 1966) have noted that no relationship or a negative relationship occured between anxiety and sport skill performance. MARTEN's (1971) excellent review of anxiety and motor behavior noted a lack of consistent trends in research on the relationship between anxiety and motor behavior. He ascribed this inconsistency to inadequate anxiety measurements, the nature of the tasks studied, and the methodological weaknesses in the design and analysis of experiments.

The major purpose of this study was to determine whether or not the results of a competitive emphasis method of instruction differed from a non-competitive emphasis on females terminal skill, knowledge, and satisfaction in learning to play tennis. A secondary purpose was to investigate what effect different grading policies and students, levels of trait anxiety had upon the beginning player's skill, knowledge and satisfaction.

METHOD

Four beginning university women's tennis classes were selected to participate in this study under the following paradigm.

		Methods of Instruction	
		Competitive	Non-Competitive
Grading Policies	Letter Grades	N = 27	N = 25
	Pass/No Pass	N = 21	N = 19

The classes were randomly selected as to which treatment they would receive and each girl was informed at the time of registration of the restriction in grading policy and was allowed to withdraw if she did not wish to participate. The participants, however, were not aware that two different methods of instruction were to be used by the investigator who taught all four classes. All girls indicated that they had no previous tennis experience. Classes met twice a week for 11 weeks. In the competitive method of instruction, the investigator imposed as many interpersonal comparisons and types of competition as could be incorporated into the lesson plans. In the non-competitive method, the investigator avoided any inter-personal comparisons and competitive references and emphasized only personal improvement.

HEWITT's (1965) backboard test was given to each girl on the fifth day of class after she had had an introduction to the grip, footwork and groundstrokes of tennis and the test was readministered on the last class day of the session. HEWITT's (1964) knowledge test Form A was given on the first class meeting while parallel Form B was administered on the next to the last class period of the session. A course satisfaction questionnaire constructed by the author was administered on the last day of classes and asked the subjects for their rating of pre- and post-satisfaction with the course, satisfaction with the method of instruction used in the class, and satisfaction with their own skill improvement in the course.

The IPAT Anxiety Questionnaire (CATTELL, 1963) was administered in class to each subject during the second week of the session according to standardized procedures in an attempt to ascertain the trait anxiety of each subject.

RESULTS

The pre- and post-test scores for skill, knowledge, and course satisfaction were analyzed by a two-way analysis of covariance for students who participated under differing methods of instruction and grading policies. A two-way analysis of variance was applied to the post-test scores of the student's satisfaction with the method of instruction score and satisfaction with their own skill progress score. The .05 level of confidence was accepted for all comparisons with the Scheffé post-hoc comparison used where appropriate. A zero-order correlation matrix was produced using all dependent variables.

Table I shows the means, variance and F-ratios for skill, knowledge and course satisfaction under differing methods of instruction and grading policies.

Table I – Two-Way Analysis of Covariance for Skill, Knowledge, and Course Satisfaction Under Differing Methods of Instruction and Grading Policies.

Source		Mean Pre	Mean Post	SS	df	MS	F
Skill							
A (Grading Policies)	Letter	10.30	11.97	1.13	1	1.13	0.38
	Pass/No Pass	10.31	11.75				
B (Methods of Instr.)	Competitive	10.97	12.24	0.06	1	0.06	0.02
	Non-Comp.	9.64	11.48				
AB				23.03	1	23.03	7.70**
Error				260.29	87	2.99	
Knowledge							
A (Grading Policies)	Letter	49.95	73.93	28.03	1	28.03	0.46
	Pass/No Pass	49.62	72.75				
B (Methods of Instr.)	Competitive	50.76	71.52	377.97	1	377.97	6.18*
	Non-Comp.	48.81	75.16				
AB				5.43	1	5.43	0.09
Error				5317.89	87	61.13	
Course Satisfaction							
A (Grading Policies)	Letter	7.87	8.88	0.24	1	0.24	0.91
	Pass/No Pass	8.02	8.88				
B (Methods of Instr.)	Competitive	7.99	8.63	6.12	1	6.12	23.33**
	Non-Comp.	7.86	9.13				
AB				0.22	1	0.22	0.83
Error				19.41	74	0.26	

* $p < .05$ F_{05}; 1,87 = 3.95 F_{05}: 1,74 = 3.98

** $p < .01$ F_{01}; 1,87 = 6.92 F_{01}: 1,74 = 7.01

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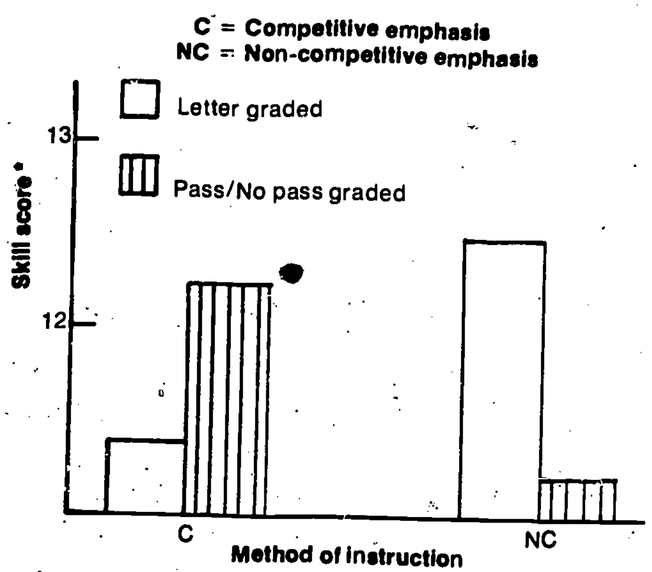
The interaction between the method of instruction and grading policies for the dependent variable skill was significant beyond the .01 level. The interaction is illustrated in figure 1 which shows that subjects in the non-competitive method with letter grades and subjects in the competitive method with pass/no pass grades had higher skill performance scores than the other two groups.

Figure 1 - Class means for the skill test under differing methods of instruction and grading policies.



* Adjusted class mean for Hewitt's Revision of the Dyer Backboard Tests.

The subjects in the non-competitive method of instruction had significantly higher knowledge and course satisfaction scores than those subjects in the competitive method. Grading policies had no significant influence upon knowledge or course satisfaction scores.

The subjects satisfaction with the method of instruction used in their class and satisfaction with their own skill progress is noted in table II.

Subjects were significantly more satisfied with the pass/no pass grading policy and the non-competitive method of instruction. There were no significant differences in satisfaction with their own skill progress regardless of grading policy or method of instruction.

There were no significant differences among high, average, or low trait anxiety groups[1] for skill, knowledge, or satisfaction measures while participating under either the differing methods of instruction or grading policies. In addition, no significant correlation was found between the anxiety score and skill, knowledge or satisfaction scores as is noted in table III.

The pre- and post-skill test showed a high positive correlation while the pre- and post-knowledge test was low. There was a low negative correlation between skill and knowledge tests.

1. The recommended sten range for high, average and low trait anxiety could not be adhered to because there were too few scores falling into each category to allow adequate statistical treatment. Consequently, the range for high anxiety was moved down one sten and the range for low anxiety moved up one sten. In effect, one-fourth of the subjects were then classified as high anxiety, one-fourth low anxiety and one-half as average anxiety.

Table II - Two-Way Analysis of Variance for Satisfaction with Method of Instruction and Satisfaction with Self Progress Under Differing Methods of Instruction and Grading Policies.

Source		Mean	SS	df	MS	F
Satisfaction: Method of Instruction						
A (Grading Policies)	Letter	7.62	8.86	1	8.86	8.03**
	Pass/No Pass	8.23				
B (Methods of Instr.)	Competitive	7.69	4.56	1	4.56	4.13*
	Non-Comp.	8.09				
AB			2.38	1	2.38	2.16
Error			97.10	88	1.10	
Satisfaction: Self Progress						
A (Grading Policies)	Letter	6.42	0.07	1	0.07	0.04
	Pass/No Pass	6.35				
B (Methods of Instr.)	Competitive	6.19	5.06	1	5.06	2.70
	Non-Comp.	6.61				
AB			2.98	1	2.98	1.60
Error			164.65	88	1.87	

* $p < .05$
** $p < .01$

$F_{.05}$; 1,88 = 3.95
$F_{.01}$; 1,88 = 6.92

Table III – Zero Order Correlations.

Variable	1	2	3	4	5	6	7	8	9
1		.723	–.078	–.339	–.059	.008	.612	.618	
2			–.029	–.079	–.128	.097	.362	.354	.037
3				.331	.265	.246	.385	.390	–.055
4					.069	.092	–.397	–.601	.018
5						.349	.032	.024	–.069
6							.091	.087	.089
7								.984	.126
8									

1. Skill: Pre-Test.
2. Skill: Post-Test.
3. Knowledge: Pre-Test.
4. Knowledge: Post-Test.
5. Satisfaction: Method of Instruction.
6. Satisfaction: Self Progress.
7. Course Satisfaction: Pre-Test.
8. Course Satisfaction: Post-Test.
9. Anxiety Levels.

DISCUSSION

The major finding of this study was an interaction between grading policies and method of instruction which supports the inverted-U hypothesis of motivation for learning tennis skills. Students who were under some stress but not too much (i.e., competition & no grades or no competition & grades) responded with better skill performance. Under the non-competitive emphasis the students performed better on the knowledge tests and were more satisfied with the course and the method of instruction than those under the competitive method. This suggests that for beginning students, non-competitive approach toward the teaching of sport skills should be emphasized; at least for females. This is probably contrary to how most physical education classes are taught.

The failure to find any relationship between the anxiety measure and tennis performance is understandable in this study. First, having to dilute the groups towards the mean lessened the probability of finding significant differences. Second, the use of only trait anxiety, as opposed to the newer models and tests for state-trait anxiety (ENDLER, 1962; ENDLER, 1975), does not allow for a thorough inspection of anxiety under differing situations. However, it is interesting to note that while no significant differences existed, students high in anxiety were consistently less satisfied with the course the method of instruction, and especially their own self progress when they participated in the competitive classes; yet they had higher skill scores than the average or low anxiety groups. No such consistency was found for the non-competitive classes regardless of anxiety level.

The paradox of seeming differences among anxiety levels needs further indepth study with new instruments under controlled competitive situations to determine the optimum range of motivation for skill performance.

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COMBATING STRESS: WHAT ABOUT RELAXATION TRAINING AND BIOFEEDBACK?

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Stress is a well known aspect of man, primarily because it has an unavoidable negative effect on his psychological well-being (e.g. anxiety), physiological responses (e.g. high blood pressure), and ultimately his mental and physical performance.

Athletic performers are no different from the rest of the members of society in having to deal with innumerable stressors in today's rapidly changing world. Although many performers are aware of the fact that stress is psychologically and physiologically harmful, few are aware of techniques to prevent or alleviate stress.

The purpose of this paper will be to explore the concept of stress as it relates to human performance, then to look at ways in which stress can be counteracted. More specifically, psychophysiological relaxation techniques will be discussed as well as the relatively new technique of biofeedback.

STRESS AND THE ASSOCIATED CONCEPT OF ANXIETY

The terms anxiety and stress are common place in the English language and have served as a topic of research for both psychologists and physiologists. However, stress and anxiety are historically difficult to define and as a result are often times used interchangeably. A clarification of these terms is necessary. After reviewing the literature concerning these two concepts, CRATTY (1973) believes that stress is a short-range phenomena, governed by the situation. Stress appears as an intervening variable between the situation and performance and is evidenced by reactions of the body to meet a threat. Anxiety, on the other hand, is a more general continuing state of the organism, a personality trait. SPIELBERGER (1970) however believes that anxiety has a situational or state dimension to it.

A certain amount of anxiety is necessary for an individual to perform optimally, since anxiety, in a broad sense, refers to a general state of alertness. However when a great amount of anxiety is produced human performance generally decreases. This performance decrement is also dependent upon the nature of the task and the skill level of the performer. This finding has been documented in a number of studies which have utilized both motor and verbal tasks (MATARAZZO & MATARAZZO, 1956; TAYLOR & SPENCE, 1952; FARBER & SPENCE, 1953). It has also been demonstrated that whenever stressful events are introduced to performers classified as high anxious they perform more poorly than low anxious individuals (LUCAS, 1952).

STRESS AND THE FIGHT-OR-FLIGHT RESPONSE

W. B. Cannon first coined the term "fight-or-flight" in describing an animal's physiological response to a stressful situation. The reflexive responses are characterized by increases in metabolism (oxygen consumption), blood pressure, heart rate, rate of breathing, and amount of blood pumped to the skeletal muscles. Later the Swiss Nobel Laureate, Dr. W. R. Hess, demonstrated that the controlling center for the fight-or-flight response in the cat is located within the hypothalamus (HESS, 1957). When electrically stimulated, the hypothalamus and other portions of the nervous system secrete epinephrine and nor-epinephrine which leads to physiological changes noted in the fight-or-flight response. Man exhibits similar fight-or-flight responses to stressful situations.

Although the fight-or-flight response is necessary for man's survival, the stresses of today's society have led to its excessive elicitation. This has led to a condition of persistent hypertension (high blood pressure) in many individuals. Hypertension is more significant than serving as an index for measuring stress. It is one of the most important factors predisposing man to heart attack and stroke (BENSON, 1974).

WHAT HAPPENS TO HUMAN PERFORMANCE WHEN STRESS IS INTRODUCED?

Sport performers are individuals under a certain amount of stress, so it seems reasonable that highly anxious competitors may have trouble adjusting to the competitive situation. Stressful or anxiety producing situations may include:

1. fear of failure,
2. fear of success,
3. fear of crowds,
4. fear of physical harm to their bodies,
5. situations requiring mental vigilance,
6. situations of uncertainty.

The research literature shows that for both verbal and motor tasks it is generally found that when stress (such as failure) is introduced in the laboratory, performance of a simple task is facilitated whereas performance of a complex task is inhibited (BEAM, 1955; HOWELL, 1953). Since, for all practical purposes, most skilled motor performance is complex in nature, it is reasonable to assume that stress inhibits skilled performance.

Given then that a variety of stressors act on a performer by generally increasing anxiety, increasing muscular tension and decreasing performance through sympathetic action; it behooves the scientific community to try and reduce anxiety producing tension. Exercise proponents have suggested over the years that physical activity helps reduce anxiety which is brought on by the stresses of life. Yet there are numerous instances of highly trained individuals succumbing to coronaries. Obviously exercise is not the sole remedy. It is my belief that relaxation training in conjunction with exercise provides us with the best stress combatant.

TECHNIQUES OF RELAXATION TRAINING

JACOBSON (1938) is perhaps the pioneer worker in the field of contemporary relaxation training. However, he was by no means the first, since the Hindus have practiced relaxation techniques for centuries. Jacobson has consistently conceptualized anxiety and relaxation as incompatible physiological states characterized by degrees of muscle tension. To try and induce muscle relaxation Jacobson developed a technique called *Progressive Relaxation* (PR). The technique involves teaching subjects to relax by sensitizing them to proprioceptive feedback from major muscle groups.

At this time there is no research evidence which suggests that PR has any effect on physiological processes other than reduced muscle tension (JACOBSON, 1938), and lowered arousal (PA[illegible] 1969) (See Table I). Similarly few studies have demonstrated the efficacy of Jacobsonian techniques for enhancing motor performance. BENSON (1958) showed that the Jacobson method had some merit under certain conditions of learning to swim. RABEN and ROSENTSWEIGH (1971) showed that subjects who "learned to relax" were facilitated in learning a novel paddleball skill.

Drawing from the work of JACOBSON, WOLPE (1958) developed the technique of *Systematic Desensitization* (SD). Although the practice utilizes progressive relaxation, the technique is different in that the individual is presented with a hierarchy of anxiety-evoking stimuli (least anxiety-producing to most anxiety-producing). Jacobson's method, in contrast, pays little attention to the anxiety producing stimuli. In densensitization the individual attempts to maintain a relaxed state while imagining the anxiety scene. After mastering a given anxiety situation he or she attempts a more difficult one until the anxiety provoking stimulus is desensitized.

SHULTZ and LUTHE (1959) later developed another relaxation technique called *Autogenic Training* (AT). The subject induces relaxation by repeating suggestions of warmth and heaviness to himself over and over until he is able to voluntarily shift to a state of low-arousal. In all, six exercises dealing with the limbs, abdomen, forehead, cardiac regulation, and breathing are practiced in a horizontal position with closed eyes (LUTHE, 1969). As with PR and SD, AT has little research support for performance improvement other than that reported by Luthe.

Hypnosis has also been used as a technique to induce relaxation. The procedure has the subject receive suggestion of relaxation in a semisupine position. BARBER (1971) has probably conducted the most extensive research dealing with the physiology of hypnosis. Barber maintains that physiological states vary the same way during hypnosis as they do during waking behavior. Suggested states of arousal and relaxation are accompanied by either increased or decreased metabolic rate, heart rate, blood pressure, skin conductance, and respiratory rate; corresponding to the change seen when these states are induced by nonhypnotic means.

Studies have demonstrated that man is capable or producing more strength on a hand dynamometer (WELLS, 1947) and greater work capacity under hypnosis (JOHNSON, MASSEY, & KRAMER, 1960) however there seems to be a scarcity of studies dealing with hypnosis and complex motor performance.

CLYNES (1970) has developed another psychophysiological relaxation technique called *Sentic Cycles*. The sentic cycle which is composed of eight sentic states is a self-induced emotional experience. The sequence of states employed include: no emotion, anger, hate, grief, love, sex, joy, reverence. The only reported research is that by Clynes himself.

Yoga has been employed as a relaxation technique by the Hindus for thousands of years. The technique utilizes meditation practices and physical manipulations in a quiet environment. BAGCHI and WENGER (1957) reported that Yoga could produce a 70% increase in skin resistance, decreased heart rate, and EEG alpha wave activity. This led them to suggest that Yoga provided deep relaxation without drowsiness or sleep.

Zen is similar to Yoga, from which it developed, and is associated with the Buddhist religion. The subject meditates in a quiet atmosphere with eyes closed and in a cross-legged posture. The subject, while breathing irregularly, concentrates on the Koan (an alogical problem) or on prayer and chanting. No published research exists which demonstrates the efficacy of Zen or Yoga for improving motor performance.

Transcendental Meditation (TM) is a popular Hindu relaxation technique which has also been practiced for many years. To meditate the individual sits in a comfortable position, arms supported, feet slightly raised, and eyes closed. He or she then repeats a montra or meaningless one syllable word. This is done for about twenty minutes in the morning and evening. The physiological changes associated with TM show decreased sympathetic nervous system activity and are thus opposite to the fight-or-flight response; that is, decreased oxygen consumption, decreased respiratory and heart rate, diminished blood lactate levels, and increased peripheral blood flow (WALLACE & BENSON, 1972). To date there have been no controlled studies on the effects of TM on motor performance.

BENSON (1974) reports successfully using the elements common to TM relaxation in his laboratory. He merely places the individual in a quiet environment, gives him or her a mental device (single syllable sound such as "one"), asks the individual to have a passive attitude, and assume a comfortable position. Benson claims that this simple relaxation technique produces similar physiological changes to those brought about by meditation.

BIOFEEDBACK AS A TECHNIQUE FOR INDUCING RELAXATION

Although the previously mentioned techniques do bring about relaxation, the individual practicing the technique never knows for sure whether relaxation is really occurring. Without the benefit of feedback, learning to relax may take a long time. The recent accelerated growth in electronic instrumentation has made it possible for an individual to obtain information about his or her physic[illegible] states which formerly were difficult to measure. This [illegible]nique, known as *biofeedback*, simply detects a physiological event and converts the electronic signal into either auditory or visual feedback. The individual practicing muscle relaxation thus receives immediate and continuous feedback about the state of muscle relaxation and can more readily learn to relax.

The basic technique used in EMG biofeedback relaxation training involves the placement of electrodes on the subject's frontalis muscle (BUDZYNSKI & STOYVA, 1969). Although other muscle groups such as the forearm have been experimented with, Budzynski and Stoyva have demonstrated that the frontalis, which is frequently involved in anxiety, is superior for the purposes of relaxation training.

Table 1 - Physiological Parameters Affected by Different Methods of Relaxation Training*
(General references citing support).

Technique	Physiological Response						
	Muscle Tension	Oxygen Cnsmpt.	Resp. Rate	Heart Rate	Alpha Waves	Blood Pressure	Skin Resistance
Progressive Relaxation Jacobson (1938)	↓	—	—	—	—	—	—
Systematic Desensitization Wolpe (1958)	↓	—	—	—	—	—	—
Autogenic Training Luthe (1968)	↓	—	↓	↓	↑	?	↑
Hypnosis Barber (1971)	—	↓	↓	↓	—	?	↑
Sentic Cycles Clynes (1970)	—	↓	↓	↓	—	—	—
Yoga & Zen Hoenig (1968)	—	↓	↓	↓	↑	?	↑
Transcendental Meditation Wallace & Benson (1972)	—	↓	↓	↓	↑	?	↑
Biofeedback Blanchard & Young (1974)	↓	—	↓	↓	↑	↓	—

* Adapted from Benson et al. (1975).
— = not measured.

The technique of biofeedback also has enabled individuals to control heart rate, blood pressure, skin temperature, muscle tension brain waves, retrain muscles, and reduce headaches. It is significant however that many studies which have demonstrated biofeedback effects lack adequate control and experimental design. Numerous anecdotal case reports, systematic case studies, and single group studies appear in the literature.

At the present time no published studies are available which have employed biofeedback as a relaxation aid for competing athletes. It seems to this writer that biofeedback techniques can be utilized effectively in teaching relaxation to anxiety-prone athletes. Although this area has tremendous research potential it is important that we conduct sound experimental research and not continue to employ anecdotal reports and uncontrolled designs. It is also true that the other methods of relaxation training; i.e. PR, TM, etc. deserve more scientific verification and perhaps application to the improvement of human motor performance.

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ATTRIBUTION DES CAUSES DE SUCCÈS OU D'ÉCHEC ET SPORT

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WIN-LOSS CAUSAL ATTRIBUTIONS OF LITTLE LEAGUE PLAYERS

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Achievement behavior from an attributional analysis standpoint assumes that achievement behavior is cognitively mediated by attributions of causality for success and failure to one or more of four factors: Ability; effort; luck; and task difficulty (WEINER *et al.*, 1971; WEINER, 1974). Each factor is jointly classified as either internal (ability, effort) or external (luck, task difficulty) and stable (ability, task difficulty) or unstable (effort, luck).

Empirical investigations of causal attributions following success and failure at a task have generally found that success is attributed internally and failure externally (FITCH, 1970; STREUFERT & STREUFERT, 1969; WORTMAN *et al.*, 1973; SIMON & FEATHER, 1973; ISO-AHOLA, in press). These findings have been interpreted as supporting self-enhancing, approval-seeking, ego-defensive, or self-serving strategies in causal ascriptions. The self-serving hypothesis assumes an individual as being strongly motivated to view himself positively and thus attribute success and failure to those factors which promote the greater positive view of self. Success is attributed to internal factors, failure to environmental or situational factors. Despite being so generally accepted, the theoretical and empirical underpinnings of such self-serving biases has been called into question (BEM, 1972; KELLEY, 1971). To be truly self-serving in their attributions, individuals who succeed must indulge in self-enhancing attributions under success and in self-protective attributions under failure (MILLER & ROSS, 1975). MILLER and ROSS, in a recent review of the literature, conclude that the extant literature provides some support for self-enhancement attributions following success, but little support for self-protective attributions following failure. One criticism MILLER and ROSS have of previous experimentation investigating causal ascriptions is that the tasks used have not been ego-involving. Low ego-involving tasks such as anagram construction may not evoke self-serving attributions merely because the tasks are low ego-involving. Recent evidence supports this contention in that students engaged in university examinations (FEATHER & SIMON, 1973) and individuals involved in therapy service (ARKIN, in press) gave self-serving attributions following success and failure. Thus, any task that seeks to investigate self-serving attributions should utilize ego-involving tasks.

An alternative position to the self-serving attribution analysis assumes that individuals use available information in an essentially logical fashion to infer the causes of outcomes (MILLER & ROSS, 1975; NICHOLS, 1975). This logical analytic position compares success and failure feedback in terms of the information they provide the individual concerning the influence of a given causal factor. The logical analysis approach is assumed to operate in situations where the individual is inferring the causes of his own behavior, not outcomes of other's behavior, and that the task is important to the subject so that the subject will apply effort to the task. Knowledge of the difficulty of the task is known to the subject and the difficulty level is assumed to be perceived as being at least moderately difficult. This is the case in many real life achievement situations. In such cases, task difficulty remains similar for both succeeding and failing individuals and is unlikely to be evoked to explain success or failure. Thus, in developing a logical analysis of causal attributions, the major task is to predict ability, effort and task ascriptions (NICHOLS, 1975).

In most experiments dealing with causal attributions the subject is confronted with a novel task in which criteria for success and failure are unknown to the subject and outcomes are only known when the experimenter gives (usually erroneous) feedback. Thus, if the task is novel, then internal attributions following success and external attributions following failure are to be expected. However, if the individual has experience, practice, and thus an expectancy associated with the task, then attributions following outcomes may differ. Most activities engaged in by individuals in life are activities in which they have previous experience. Thus, it appears that prior experience at the task is an important consideration when investigating causal attributions. Evidence exists (FEATHER & SIMON, 1973) that unexpected outcomes (success or failure) are attributed to the external factor of luck while expected outcomes are attributed to the internal factor of ability.

When the task is one in which the individual has prior experience, then the self-serving position differs from the logical position in terms of causal ascriptions to ability (NICHOLS, 1975). The logical position assumes that feedback is more attributable to ability if the feedback is consistent with previous success-failure experiences. Success following success experiences should be attributed to ability more than success following failure experiences. Also, failure following failure experiences should be attributed to poor ability more than failure following success experiences. The self-serving position maintains that subjects will attribute ability in accord with outcome regardless of previous experience.

According to NICHOLS (1975), both the logical and self-serving positions predict higher attributions to effort for success than failure. Direction of outcome rather than the consistency of the outcome to previous experience should determine effort attributions.

Luck is an unstable dimension and as such may be more readily involved to explain outcomes inconsistent with previous experience rather than outcomes consistent with previous experience (FEATHER & SIMON, 1973). Thus, the logical analysis position maintains that failure after success experiences and success after failure experiences should be attributed to luck more than success following success experiences and failure following failure experiences. The self-serving position predicts that outcome alone determines causal ascriptions. Failure is attributed to luck more than is success regardless of previous success-failure experiences.

Mouvement. Actes du 7e symposium en apprentissage psycho-moteur et psychologie du sport. Octobre 1975.

Most of the attributional literature has concerned itself with individual ascriptions of outcome following success-failure experiences. However, in real life a great deal of human activity is conducted in groups or teams. What are the causal attributions of individuals when engaged in team activities? Do individuals differ in attributions to team and to self when confronted with either success or failure? Evidence suggests not. ISO-AHOLA (in press) found that children engaged in Little League use the standard of team performance as the criteria of their own performance. Thus, as the present study also used Little League children, no differences between self and team attributions was expected.

METHOD

Subjects

Two hundred and two Little League baseball players (all boys!) participating in the Champaign-Urbana Little League leagues were the subjects in the study. Subjects came from 18 teams and data were gathered at nine different ball games. The teams participated in five leagues and all teams participating in those leagues were used with the exception of one team whose coach refused to participate. This meant the loss of two teams. The other 4 leagues in the 9-league association were used by a colleague for a separate study. The 5 leagues used in the present study were chosen at random from the 9 leagues. As all members of each team participated for a few innings of the game at least, all members of the teams who were suited up were used.

The attribution questionnaire consisted of 7 questions pertinent to team and self, causal attributions. The questions were all asked on a five-point Likert scale (1-5). The questions took the general form, for example:

Did you win today because your *team* tried:

1	2	3	4	5
Very Hard	Hard	Pretty Hard	A little	Did not Try at All

Procedure

Prior to testing, each Little League president was contacted and permission was sought to contact each coach and manager for each team within that particular league. Prior to the game, each coach and manager was asked if they would participate. When permission was obtained (one coach refused), the experimenter requested the coach to inform his team that following the game, the team must return to its dugout and complete a short questionnaire.

Upon conclusion of the game and the traditional handshake, the players returned to the dugout and the experimenter gave the questionnaire to the players with the appropriate instructions for completing the questionnaire. Every attempt was made to gently prevent any adult from assisting or instructing a player (one father insisted upon helping his son fill in the questionnaire; that player was not included in the analysis). The player then filled in the questionnaire and returned same to the experimenter.

Independent Variables

Outcome was obviously determined by whether the team won or lost. A further analysis utilizing degree of defeat or victory was used as suggested by Iso-Ahola (in press). If teams lost by 5 or more runs, they were categorized as clearly defeated teams; if teams lost by less than five runs, they were categorized as closely defeated teams; if teams won by five or more runs, they were categorized as clearly victorious teams; if teams won by four or less runs, they were categorized as closely victorious teams.

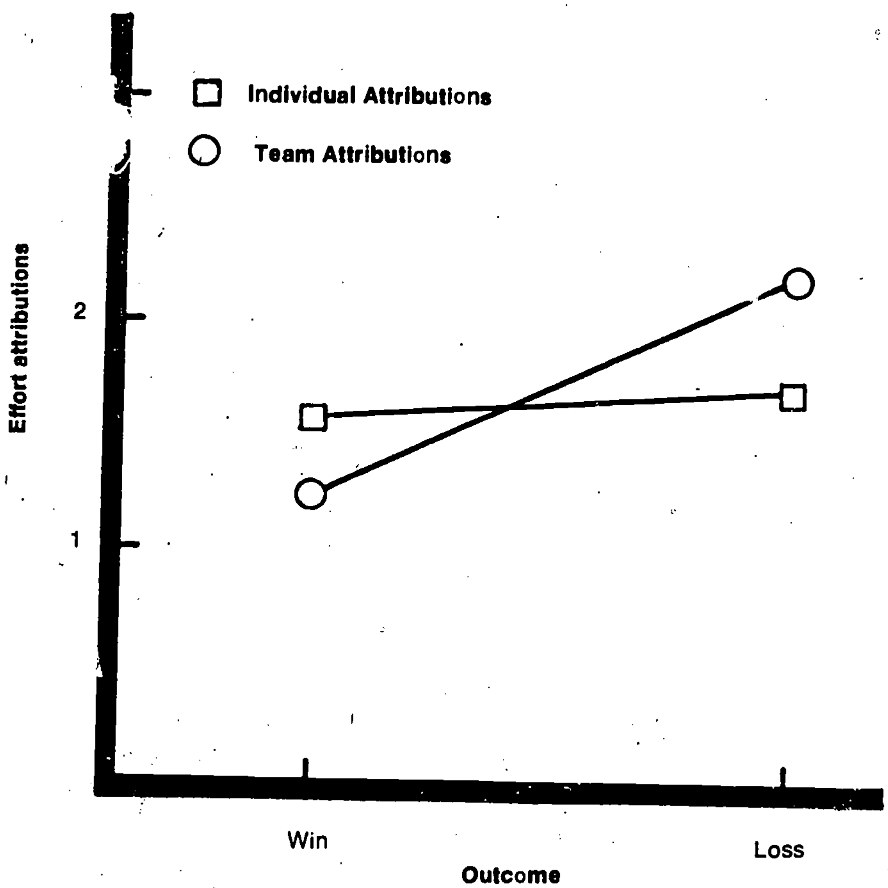
Success-failure experiences of the teams were determined by the win-loss records of the teams prior to the game in which the data was collected. The win-loss record of the teams for the previous four games was taken as the criterion. The experimenter wished to consider only those games when the teams had practiced and thus were playing at close to their potential. Thus, the last four games were utilized as opposed to considering the games of the season to date. To be considered a team that had a history of past success experiences, teams had to have won the last four games. Obversly, to be considered a team with a history of past failure experiences, a team must have lost the last four games. This produced a population of eight teams. Ten teams had to be omitted from the analyses utilizing past success-failure experiences because they did not meet the criteria.

RESULTS

Team versus Individual Attributions

The causal attribution data for team and individual ascriptions were subjected to 2 × 2 × 2 ANOVAs (Outcome × Previous Experience × Team versus Individual) for effort, luck, and ability choices with repeated measures on the last factor. Congruent to hypothesis, no reliable main effects for team versus individual causal attribution choices emerged ($F < 1$). No interactions involving the team versus individual factor emerged except in the effort ascriptions. A statistically significant interaction ($F [1,343] = 4.63$, $p < .05$) was found for team versus individual choices by outcome. This interaction is demonstrated in Figure 1. NEWMAN-KEULS *post hoc* paired comparisons were conducted on the data and revealed that the attributions to team effort when losing were reliably less ($p < .05$) than the attributions to individual effort and team effort when winning. In other words, players considered that when the team lost the team tried less hard than both team and individual efforts when winning. Thus, effort was considered to be an important part of winning games. Significantly, individuals considered that they tried just as hard independent of outcome. Since effort ascriptions were different depending on whether the players were attributing effort to the team or to themselves, both team and individual attributions will be presented in the rest of the paper.

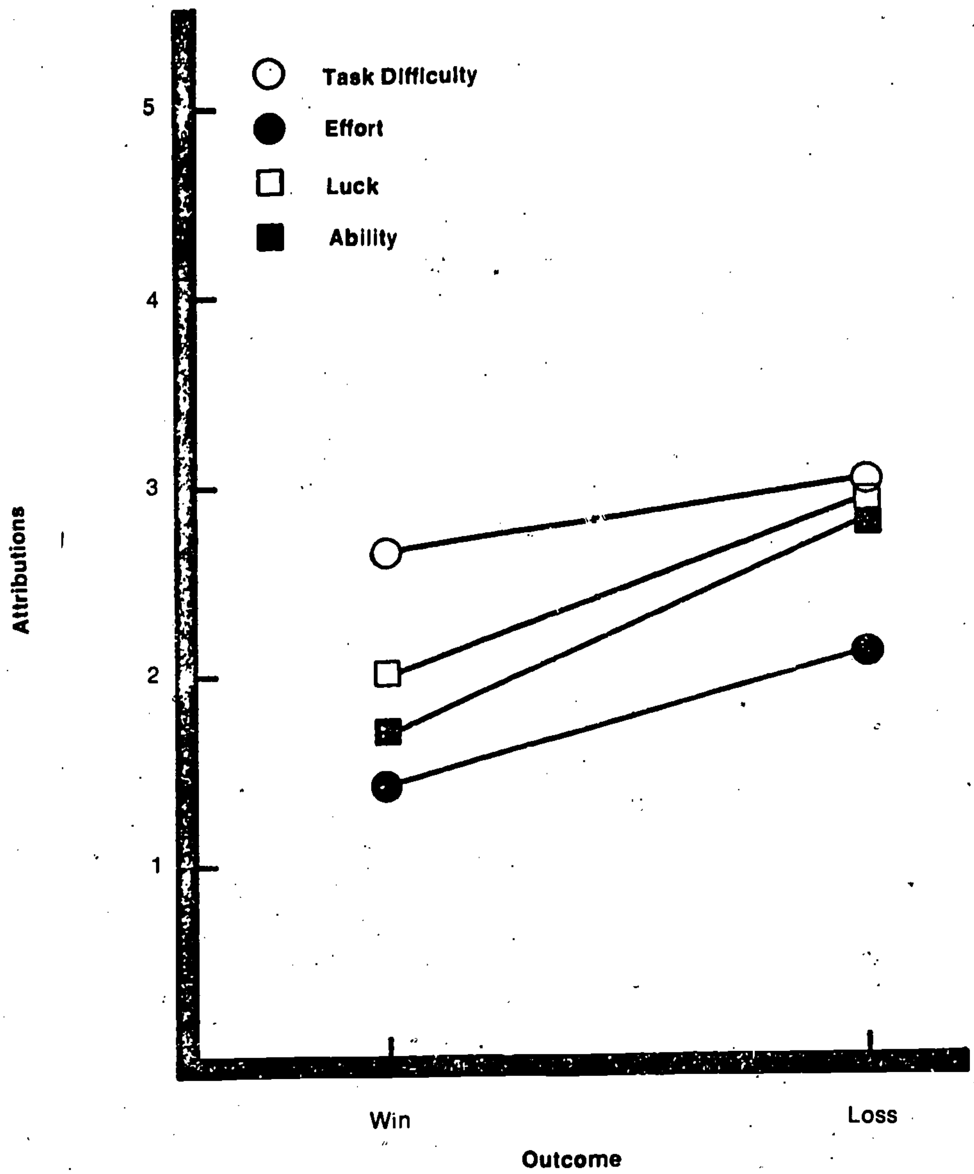
Figure 1 – Team and individual attributions.



Outcome

Figure 2 graphically demonstrates the mean attributions for team effort, task difficulty, team ability and team luck. When the data pertinent to each causal attribute was individually subjected to ANOVA, task difficulty was not reliably different (F [1,181] = 2.92, p < .05). This supports the contentions of NICHOLS (1975) in that individuals who are engaged in an ego-involving task that is perceived as being relatively difficult will not invoke task difficulty as a causal attribute of winning or losing.

Figure 2 - Team attributions over outcome.



Effort causal ascrip... e reliably different for outcome (F [1,183] = 29.63, p < .001). Winning teams determined that they exerted more effort than losing teams. Similarly, winning teams determined that luck was less a factor in winning than losing teams (F [1,186] = 14.61, p < .001). Thus, losing teams considered luck to be a factor in losing. Successful teams were also reliably different from unsuccessful teams in terms of ability ascriptions (F [1,183] = 130.88, p < .001). Successful teams considered themselves to have more ability than did losing teams.

Interestingly, individual players on teams did not attribute differential effort ascriptions to themselves as a function of outcome (F [1,188] = 1.72, p < .05). Regardless of whether they won or lost, the players considered themselves to have tried just as hard. However, winning or losing did have a profound effect upon ability ascriptions (F [1,185] = 48.39, p < .001). Individuals on teams which lost considered themselves to have only average ability ($\bar{X}$ = 2.6, on a 1-5 low ability to high ability scale), while individuals on teams which won considered themselves to have high ability ($\bar{X}$ = 3.7). Again, in terms of luck, individuals on winning teams considered luck to be less a causal factor than individuals on losing teams (F [1,186] = 15.11, p < .001).

Outcome × History of Success-Failure

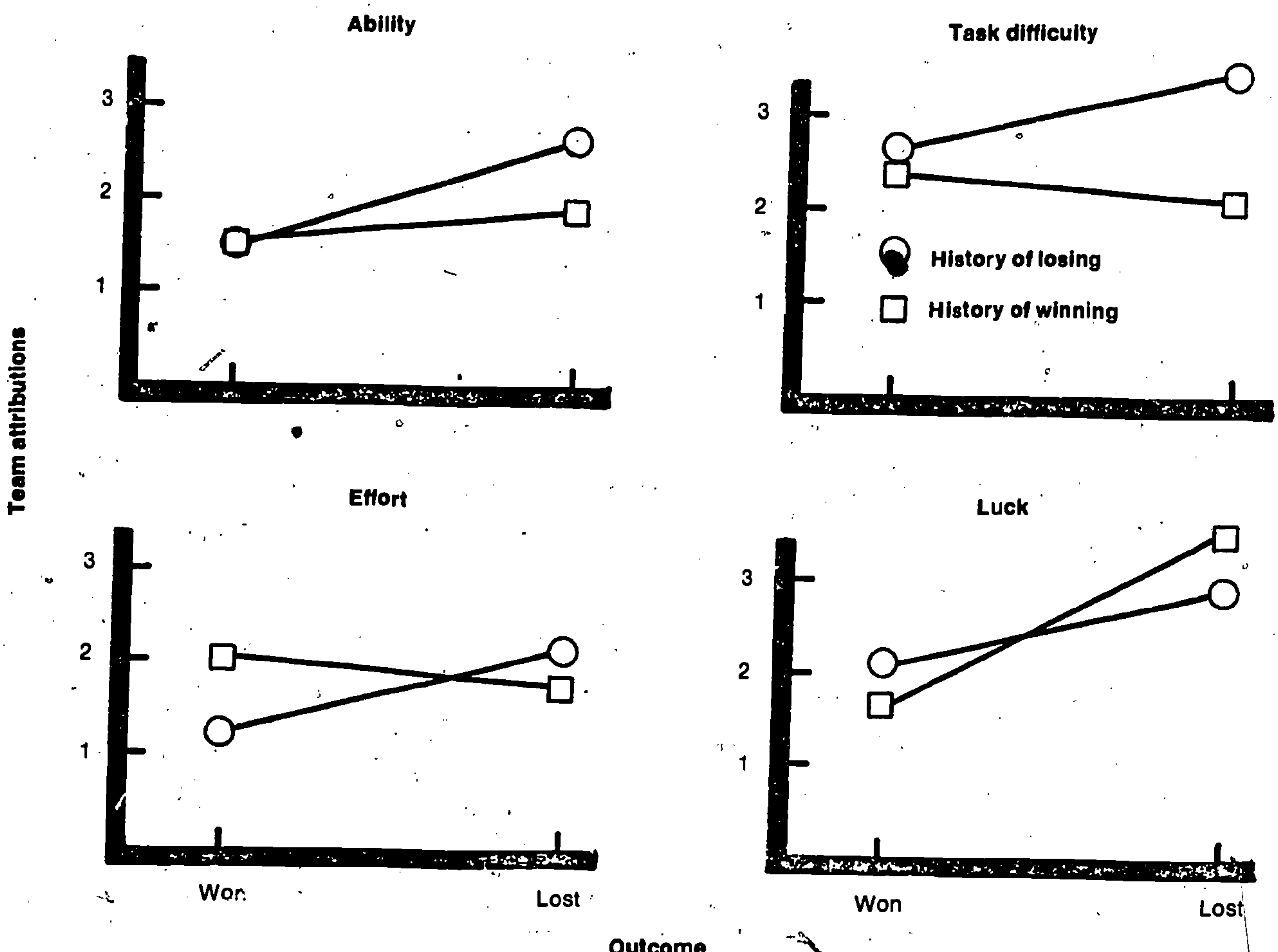
The following analyses were only conducted upon those teams which met fairly rigorous criteria. Teams had either to have won or lost all of their previous four games in order to be included in the analyses. Teams were thus categorized as being either successful or unsuccessful teams. These criteria produced the following teams which supplied the data that were used in 2 × 2 (Outcome × Success-Failure History) ANOVAs: Two previously successful teams that also won their game (22 subjects); two previously unsuccessful teams which won their game (27 subjects); three previously unsuccessful teams which lost their game (31 subjects); and one previously successful team that lost its game (12 subjects).

Team Attributions

Task difficulty

Figure 3 diagrams the causal team attributions of task difficulty, effort, luck and ability for teams with a history of winning and for teams with a history of losing. As is apparent from Figure 3, the only main effect that was significant was for the factors of past experience (F [1,82] = 10.57, p < .001). Those teams which had a history of failure invoked the attribution of difficulty to a greater extent than those teams which had a history of succeeding. The interaction of outcome and past history was marginally significant (F [1,82] = 3.89, p < .052). NEWMAN-KEULS *post hoc* analyses were conducted on the data but no reliable effects emerged. The unequal on NEWMAN-KEULS procedure utilizing the harmonic mean to estimate cell frequencies is a conservative procedure (WINER, 1971, p. 217), but no other *post hoc* analyses were completed. It is interesting to note that subjects with a history of success were apparently reluctant to invoke task difficulty as a reason for their failing at this particular game.

Figure 3 - Team attributions.



Effort

The ANOVA analyzing the effort attributions revealed that neither the main effect for outcome ($F[1,85] = 1.69, p < .05$) nor past history ($F[1,85] = 1.09, p < .05$) was reliably different. However, the interaction of outcome and past history was reliably different ($F[1,85] = 5.41, p < .05$) and *post hoc* NEWMAN-KEULS analyses were conducted. The paired comparisons revealed that winning successful teams and losing unsuccessful teams differed from winning unsuccessful teams ($p < .05$) in that winning unsuccessful teams maintained that they had exerted reliably more effort than either winning successful teams or losing unsuccessful teams.

Luck

When asked how much luck had been a factor in winning and losing, outcome was the only significant main effect ($F[1,88] = 11.57, p < .001$). The history of past success and failure did not interact with luck attributions. Thus, losing teams ascribed luck as being a causal attribute for losing to a reliably greater extent than winning teams.

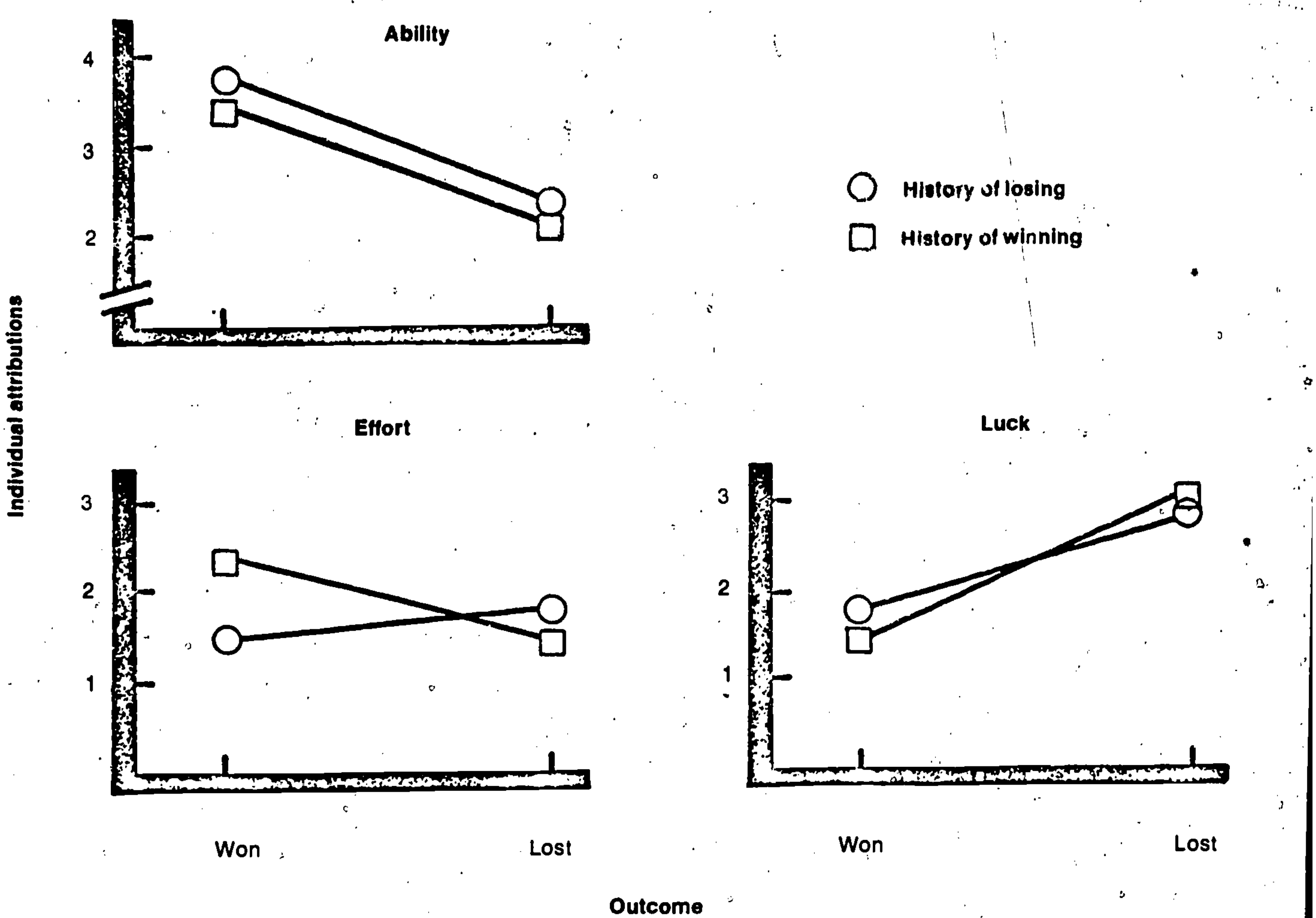
Ability

Both main effects of outcome ($F[1,85] = 26.53, p < .001$) and past history ($F[1,85] = 8.32, p < .01$) were statistically significant. However, a statistically significant interaction also materialized which warranted the analysis of the simple main effects. NEWMAN-KEULS *post hoc* paired comparisons revealed that unsuccessful teams which lost were reliably different in ability attributions than all other winning successful teams, losing successful teams, and winning unsuccessful teams. Unsuccessful teams which lost ascribed reliably poorer ability to themselves to explain their loss than did any of the other teams.

Individual Attributions

Figure 4 illustrates the individual causal attributions of winning and losing of players who were on operatively defined successful or unsuccessful teams. The questions asked the players whether their own ability, effort, or luck contributed to the team success or failure.

Figure 4 - Individual attributions.



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Effort

No significant main effects for outcome ($F [1,88] = 2.18$, $p < .05$) or previous experience ($F [1,88] = 1.109$, $p < .05$) materialized when the individual attribution data for effort was subjected to ANOVA. A significant interaction did materialize ($F [1,88] = 5.16$, $p < .05$) and NEWMAN-KEULS *post hoc* paired comparisons revealed that players on successful teams which lost ascribed greater effort to themselves than players on successful teams which won. In other words, despite having lost, the team players on previously successful teams which lost ascribed reliably greater personal effort to themselves than did players on previously successful teams which won.

Ability

The ANOVA on ability causal attributions revealed that only the main effect for outcome was statistically significant ($F [21,85] = 23.14$, $p < .001$). No significant outcome by history interaction occured. In terms of ability, those players on teams which won ascribed greater ability to themselves than did players on teams which lost.

Luck

Similarly, only the main effect of outcome was statistically significant for luck attributions ($F [1,86] = 9.97$, $p < .01$). Again, players on teams which lost invoked luck as a causal attribution to a reliably greater extent than players on teams which won.

DISCUSSION

It was assumed in this study, with some justification, that individuals engaging in Little League competition were ego-involved in the task. When engaged in such an ego-involving task in which individuals do have experience and thus have formulated expectancies relative to the difficulty of the task, it was predicted that task difficulty would not be invoked as a causal attribute of winning or losing. This was supported in the present study, task difficulty was not invoked by players to attribute their outcome. Further support that players adopt logical, information-processing strategies is given by the statistically significant main effect for past won-loss experiences. As would be expected, teams which consistently won considered the task relatively easier than teams which consistently lost. An interesting interaction almost occurred ($p = .052$) and it is interesting to speculate on this marginally significant finding. As Figure 3 illustrates, previously successful teams which lost did not invoke task difficulty as a causal attribute of losing, while previously unsuccessful teams which lost did invoke task difficulty. Members on previously successful teams evidently felt that the difficulty of the task had not changed and that other factors probably explained their current outcome. This also supports the logical position.

The logical position assumes that causal attributions to ability should be greater for previously successful teams which won than for previously unsuccessful teams which won. Likewise, to be consistent, failure after failure experiences should be attributed more to poor ability than failure after success experiences. The self-serving position assumes that individuals attribute ability in accord with outcome regardless of previous experience. The failure-ability causal ascription data of the present study supports the logical standpoint. Individuals on losing unsuccessful teams considered the team to be poorer in ability than losing successful teams. Teams which lost and had a history of losing recognized and were prepared to admit that they were poor in ability. Teams which lost but had previously been successful considered themselves to have just as much ability as successful teams which won. These players probably assumed that losing was a temporary state of affairs for them and did not consider themselves diminished in ability.

The luck causal ascription data, on the other hand, support the self-serving position. To support the self-serving position, luck ascriptions should be outcome-related only. The logical position states that outcome and past history should interact in that luck is invoked to attribute inconsistent success or failure (FEATHER & SIMON, 1973). The analyses revealed that luck was invoked as a function of outcome only — losing was attributed to luck more than winning. However, inspection of the data (Figure 3) reveals that the order of the group means is in accord with the predictions emanating from the logical viewpoint. It must be emphasized that the interaction in this analysis was not statistically significant ($p > .05$), but it is interesting to note the order of the group means.

NICHOLS (1975) stated that both self-serving and logical positions predict that outcome alone will determine effort causal attributions. However, in the present study an interaction occurred, teams which were previously unsuccessful ascribed greater effort to themselves to causally attribute winning than previously successful teams which won. This is evidence for self-serving attributions. Also, unsuccessful teams which won exerted more effort than unsuccessful teams which lost — losing teams with a history of losing claimed that they exerted the least effort. This is more support for the self-serving position.

The individual attributions also revealed some interesting findings. Despite having lost, players on previously successful teams which lost ascribed greater effort to themselves than players on successful teams which won. When this is coupled to the ability data which revealed that losing teams ascribed less ability to themselves than winning teams, then the attributions support the logical analysis viewpoint. Players on previously successful teams which lost considered themselves low in ability but did try hard. This is evidence for a self-derogatory bias, players reasoned that they did try hard, but just did not play well that day.

An important finding of the present study is that previous experience with the task does interact in a meaningful way with outcome when Little League players were constrained to causally attribute their winning and losing. The contentions of NICHOLS (1975) relative to logical information processing of individuals in achievement tasks received some support, but players also frequently invoked self-serving strategies. In terms of achievement behavior, consistent failure does affect causal ascriptions of effort and ability in that individuals playing on losing teams regarded themselves as being low in ability and effort. Further, when players on losing teams won, they ascribed winning to effort, an internal but unstable attribute. Thus, winning in the future may not be consistent.

Unsuccessful teams which won also considered themselves more lucky to win than successful teams which won. Again, an unstable attribute is invoked. In short, teams which consistently lost were more likely to attribute success to unstable factors than successful teams, thus losing teams did not expect that success would be insured in the future. Previously successful teams, on the other hand, attributed failure to unstable factors, thus expecting to win in the future. Significantly, winning teams which lost did not differ in their ability ascriptions from previously winning teams which won.

It is interesting to speculate that these ascriptions for success and failure may *produce* behaviors characteristic of high and low achievement-oriented behavior. Sports are the most important source of social comparison for boys of this age (VEROFF, 1969) and it may be that consistent success-failure experiences may socialize the child to achievement behaviors. Failure experiences lead to low achievement behavior in that players feel they have little ability and on subsequent failure want to give up or "drop out" of the activity — behaviors characteristic of low achievement behavior. Consistent failure leads players to invoke external and unstable attributes to explain future success. Success experiences, on the other hand, lead to high achievement behavior in that players feel that they have ability and do try hard. When teams which have previous success experiences actually lose, they attribute this to external, unstable factors and thus imply that success is more likely to occur in the future. Thus, individuals with success experiences persist longer and try harder to subsequently succeed — behaviors characteristic of high achievement behavior.

Whether success-failure experiences within sport actually generalize to other achievement tasks is highly speculative, but it is noteworthy that physical activities are a very important area in which children are socialized to many behaviors considered appropriate by the culture in which the individual finds himself.

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A TEST OF THE ATTRIBUTION THEORY OF SUCCESS AND FAILURE WITH LITTLE LEAGUE BASEBALL PLAYERS[1]

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One of the most straightforward questions social psychology has presented involves how people interpret their success and failure in various situations. Because of its simplicity and marked social relevance, this kind of question-asking is referred to as "naive" psychology (HEIDER, 1958). In light of its direct nature, it is surprising that this question has not been studied more in natural settings. Is not real life, especially "the achieving society," full of competitive situations that are quite easily available for field experimentation on the attribution processes? To the extent that the attributions have been studied only in the laboratories, "naive" psychology has not exploited its inherited social relevance. Therefore, the initiation of this study was primarily motivated by the need to apply the attribution theory of success and failure (WEINER et al., 1971; WEINER, 1973) in a field setting. The field study reported here was carried out with Little League baseball players.

Using individual tasks, WEINER and his associates (1971) have investigated individuals' attributions for success and failure. They have shown that success is generally attributed to internal factors (ability and effort), while failure is attributed to external factors (especially to task difficulty). An obvious question arises: does the same pattern occur even in the case when success and failure vary in their absolute sense, i.e., when the margin is large or small? FEATHER (1969) found that when subjects just barely succeeded or barely failed, they tended more often to attribute the outcome to external (luck) rather than to internal (ability) factors. In the case of clear-win or clear-loss, subjects showed a tendency to make internal ascriptions. Based upon these results and HEIDER's (1958) notions, FEATHER then argued that since the extreme performance is an unusual event, clear success or failure provides more information about a person's distinctive ability (or lack of it). Therefore, a definite outcome enables attribution of success or failure to stable properties of self. In order to shed further light onto the problem of attributing immediate outcome to internal or external factors, this study included four classes of the immediate outcome: clear-win, bare-win, bare-loss, and clear-loss.

A second determinant of attributions may be the similarity of the immediate outcome (success or failure) to those experienced in the past. FRIEZE and WEINER (1971) found that when subjects had either repeatedly succeeded or had repeatedly failed in the past, they attributed present outcomes (both successes and failures) to ability and task (stable factors). This finding confirms KELLEY'S (1967, 1973) notions of consistency over time as an important determinant of causal judgments. Correspondingly, the unstable variables (luck and effort) were the most common attributions when individuals succeeded after having had no prior successful experiences, and when individuals failed after succeeding repeatedly in the past. In accord with these results, FEATHER (1969) has documented that unexpected successes and failures are more frequently attributed to luck than are expected outcomes. For these reasons, past success/failure was included as another independent variable in this study.

As pointed out earlier, our current knowledge of attributional processes comes mostly from experimental laboratory situations in which subjects experience success or failure *individually*. Different considerations may arise when an individual experiences success or failure together with others (for example, teammates). However, the nature of these differences is unclear. It is not known to what factors individual group members attribute their group's output or how group and self-attributions of success and failure differ from one another. In other words, is a group seen as being responsible for success and failure, or does the individual take the responsibility for the group performance? It has been established (SHAW & BREED, 1970) that when members are accused by others for group failure, they tend to counter-attack, for example, by underevaluating group abilities. However, it is less clear how group members react to success and failure when no one blames them publicly for the group outcome.

The above questions lead to another question: what motives or strategies are underlying persons' causal attributions for certain outcomes? In other words, do people show a tendency toward ego-centered attributions?: Failure is attributed in such a way that the attribution does not do any further harm for a loser, but instead tends to protect one's self (ego-defensive behavior); success is attributed in such a way that the attribution does not take anything out of a person's win, but instead tends to promote success and thus one's self (ego-offensive behavior). When considering these questions one has to keep in mind the general and quite unequivocal findings of attributions for success and failure thus far. Holding other variables constant, it appears that people attribute causality to themselves when succeeding while attributions for failure are assigned to situational determinants (e.g., WEINER et al., 1971; WORTMAN, COSTANZO, & WITT, 1973; STREUFERT & STREUFERT, 1969). Also, *actors* tend to attribute the causes of their behavior to factors in the *environment*, while *observers* tend to assign causes of behavior to internal *dispositions* of the actor (JONES & NISBETT, 1971; NISBETT et al., 1973). The findings suggest that individuals are, in general, ego-defensive or self-enhancing (see KELLEY, 1967; JOHNSON, FEIGENBAUM, & WEIBY, 1964) in their causal judgments. WORTMAN, COSTANZO, and WITT (1973) propose that subjects begin to construct strategies that enhance self-esteem even before undertaking the task. If this ego-centered standpoint is true, then it follows that group members will take less individual responsibility for losing than for winning. If the motivation of an individual to view himself positively is a guiding factor in causal judgments, then members should attribute failure of a

1. I am greatly indebted to Carol Dweck, Rainer Martens, and Robert S. Wyer, Jr. for their encouraging criticism during the study. Their continuous insights for the previous drafts of this paper were vital while shaping the article.

team performance to a lesser degree to their team (especially to a lesser degree to internal factors of their team). This notion rests on the assumption that "team value may affect member ego level" (DUSTIN, 1966, p. 237). Supporting this hypothesis, DUSTIN indeed found that team members would react to their team's poor performances in such a manner as to prevent declines in their own ego levels. ZANDER (1971, p. 134) suggested that ego-defensive behavior is more common among relatively incompetent group members than among the more competent ones; i.e., a group's most capable member is more concerned about the outcome of group performance than his own fare, while the reverse is proposed to be true for less competent members. Thus, it could be expected that these differences hold for individuals who perform poorly or well in a group task ("individual performance").

This very same self-enhancing motive may well have produced the results reported by BLAKE and MOUTON (1962) and FERGUSON and KELLEY (1964). In these studies, group members tended to overevaluate their own group's products. This hypothesis is supported by the fact that competition increases overevaluation of the group product (FERGUSON & KELLEY, 1964). Thus, with an increase in importance of the situation (i.e., increase in competitiveness), overevaluation of group products tends to increase. It is obvious that possibilities for self-enhancement improve, and use of ego-centered strategies becomes more important when the situation increases in significance.

In sum, the purpose of this field experiment was to examine how team members account for their team's success or failure in terms of four attributional variables: effort, ability, luck, and task difficulty. Team- and self-attributions for group outcomes were examined separately. The major independent variables were immediate outcome, past success of the team performance, and individual performance (objective and subjective) within the group performance.

The following hypotheses were tested. The first two are alternative hypotheses suggested by the literature.

1. Clear-win and clear-loss are internally (ability and effort) attributed, whereas bare-win and bare-loss are externally (task and luck) attributed. This same pattern of attributions will occur for team as well as self attributions (FEATHER, 1969).

2. Subjects are ego-centered in their causal judgments, i.e., team success is internally attributed while team failure is externally attributed. The same attributional patterns will occur for team and self-attributions (e.g., WEINER et al., 1971; WORTMAN, COSTANZO, & WITT, 1973).

3. Those who perform poorly within their group are more ego-centered in their causal judgments than those who perform very well within their group in the task (ZANDER, 1971).

4. Subjects belonging to team with consistent and repeated past success attribute their team success to stable factors (ability and task), while subjects with low and inconsistent past success also attribute their failure to stable factors in the order of task and ability (WEINER et al., 1971).

METHOD

Subjects

One hundred fifty Little League baseball players in Urbana-Champaign participated in the study. Their average age was 11.3 years. Subjects represented 13 different teams and data were collected during 11 different ball games. (In two of the ball games, both the winning and the losing teams were used. In all other cases, only one team — either the winners or the losers — was included in the sample.) The 13 teams within the four leagues were randomly chosen from four of nine leagues in the region (a total of 42 teams). Data were collected in different fields on consecutive days over a two-week period. The scores of these games resulted in three clear-win, three bare-win, four clear-loss and three bare-loss teams (criteria for this classification will be explained later). All the players participating in the game filled out questionnaires. Thus, the substitutes were also a part of the sample, leaving out only those players who did not get any chance to play during the entire game. Each team was used only once in the study. Originally, there were 156 subjects in the sample, but six of them were excluded from the analysis because of inadequate understanding of the task requirements. One team could not be included in the study because the coach of the losing team would not grant permission, even though he had agreed to do so before the game.

Procedure

At the conclusion of the ball game, subjects were immediately taken to an appropriate place on the field, mostly in the middle of the field, to fill out the questionnaires. No one was allowed to communicate with the players once the game was over until the questionnaires were filled out. Subjects were told before the game that they would be asked "a couple of questions right after the game." No direct reference was made to the purpose of the study. Prior to filling out the questionnaires, subjects were given brief instructions. They were then separated to ensure that each subject worked alone on the questions. This procedure lasted about 10 minutes. After finishing the task, subjects returned to their coach.

Dependent variables

On the questionnaire, the subjects were asked nine questions pertaining to self-, team-, and coach-attributions, answers to which were repeated along a 5-point scale from very much (5) to not much at all (0). Attributions to team efforts were inferred from answers to the question, "How much do you think that your team won (lost) today because the whole team was (not) trying hard?"; attributions to team luck from answers to "How much do you think that your team won (lost) today because the whole team was (not) lucky?"; attributions to team ability from answers to "How much... because your teammates are (not) good players?"; and attributions to task difficulty from answers to "How much... because the opposite players were (not) good players?"

Questions related to self-attributions to ability, effort, and luck were identical except that the phrase *"the whole team"* or *"your teammetes"* was replaced by *"you,"* and underlined in each case. (This difference was also emphasized when subjects were told about the questionnaire task.) The question measuring task difficulty for self-attributions was, of course, posed differently from the team question: "How much do you think that your team won (lost) today because the opposing players did not (did) make it hard for *you* in the field and in batting?" Subjects were also asked a question pertaining to the importance of their coach in affecting the outcome: "How good was your coach in helping your team performance (playing) today?" (A 5-point scale from "very good" to "very bad" was utilized.) It appeared that subjects understood their task well, since no questions were raised as to these measures.

Independent variables

Immediate outcome was determined as follows: the clear-win condition consisted of teams winning the game by a margin of five runs or more (on an average, they won by 9.0 runs); the bare-win by the score difference from one to four runs (on an average, they won by 3.6 runs). Correspondingly, clear-loss was said to occur when the team was beaten by five runs or more (they lost, on an average, by 8.2 runs); the bare-loss situation occurred when the team lost by one to four runs (on an average, by 2.6 runs). These criteria were based upon the pilot observations and discussions with the coaches which indicated that the players had a "giving-up" attitude when there was a difference of five or more runs. However, the deviations from the cut-off score difference of "five" to the above values of "bare" and "clear" conditions (see the above averages) were very obvious, thus indicating that the bare and clear conditions of success and failure, represented extreme cases on the immediate outcome continuum. Therefore, the division of the immediate outcome variable into these four subclasses appeared well justified. For purposes of multiple regression analysis (to be described later), this variable was also defined as a continuous variable according to the actual score differences (the range of scores was from -9 to $+14$).

Past success was measured by the percentage of wins a team had achieved thus far during the season, based upon 12 previous games on the average. The values ranged from 7% to 82%. This variable was also classified as a two-category (high-low) factor for purposes of ANOVA. Past success was considered high if the team had succeeded 75 to 82% of the time. "Low" ranged from 7% to 27%. The five teams with past success varying from 33% to 73% were not included in ANOVA (but were included in the multiple regression). Because of the large range of the winning percentage, these five teams could not be considered to purely be representative of a "moderate" class of past success.

Individual performance data were obtained by two measures. First, the team coach in question was asked to name the two best and the two worst players on his team "on the basis of today's game." Secondly, each player's performance scores were checked after the "today's" game from the official scorebook. Based on the scorebook information, an index of individual game performance for each player was formulated by adding the total number of runs, hits, and three times home runs minus the number of errors $[R + H + 3(HR) - E]$. This index was generated by means of pilot data and recommendations from some of the coaches. The index yielded values ranging from -1 to $+9$. For purposes of data analysis, this continuous variable was also classified as a three-category variable (high - moderate - low). The results revealed that individual performance defined by the coach and that inferred from scorebook data were correlated positively (.62). Since the significance of results did not depend upon which index was employed, only results of analyses based on the scorebook index will be reported.

Subjective performance was obtained from a question on the questionnaire: "How good do you think your own performance was today?" (5-point scale from very good to very bad).

RESULTS

General Analysis

The results were analyzed in two broad categories. First, in order to get an overall picture of the causal judgments, the correlations between attributional variables were calculated (Table I). To determine the underlying relations and patterns among attributional variables, the intercorrelations were factor analyzed, and canonical correlations were computed. Secondly, in order to assess how much of the total variance in each attribution could be accounted for by the independent variables, multiple regression analyses were performed. (In the second set of multiple regression analyses, the above analysis was turned around so that team performance was now used as a criterion variable to be predicted by attributional variables.) Unweighted-means ANOVAS and covariances were employed as supplementary techniques for confirming the results obtained by multiple regression analyses.

Table I - Correlations Among Attribution Variables for Win and Loss Conditions Separately and as Combined ("Total")

		Team effort			Team luck			Team ability			Team task			Self effort			Self luck			Self ability		
		W	L	T	W	L	T	W	L	T	W	L	T	W	L	T	W	L	T	W	L	T
SELF ATTRIBUTIONS	Effort																					
	Luck	−.08	.17	.03																		
	Ability	.36*	.19	.48*	−.17	.49*	.12															
	Task	.13	.13	.13	.12	.08	.09	−.01	.02	.03												
TEAM ATTRIBUTIONS	Effort	.18	.07	.36*	.13	.32*	.15	.01	.30*	.51*	−.07	.26	.11									
	Luck	.06	.21	.09	.67*	.65*	.66*	.06	.53*	.19	.22	.21	.21*	.16	.40*	.19						
	Ability	−.03	.05	.23*	.25	.15	.14	.01	.35*	.45*	.27	.38*	.30*	.25	.28	.46*	.19	.40*	.22*			
	Task	.00	.14	.14	.32*	.26	.28*	.15	.14	.20	−.02	.25	.12	.17	.23	.24*	.34*	.34*	.32*	.23	.14	.22*

* $p < .01$ W = Win L = Loss T = Total

Table I (see also Figures 1 and 2) shows the relationships between team- and self-attributions for win and loss conditions separately and combined ("total"). Thus, in the analysis, the immediate outcome was broken down into two (win and loss) rather than into four categories.

The above correlations indicated that subjects use four self-attributions in explaining group outcome in a somewhat similar fashion with the same four team-attributions (or use team-attributions similarly with self-attributions). However, it seemed that this relationship varies as a function of winning and losing.

Table II - Orthogonally Rotated (Varimax) Factors for the Attribution Variables in Win and Loss Conditions Separately and as Combined

	Factors of Win and Loss Combined			Factors of Win Condition				Factors of Loss Condition		
Variable	**I**	**II**	**III**	**I**	**II**	**III**	**IV**	**I**	**II**	**III**
Team effort	.70	−.04	.12	−.05	.78	.11	.12	.22	−.22	.67
Team luck	.00	.88	−.02	.82	−.20	.10	.15	.80	.00	.21
Team ability	.82	.14	−.09	.08	.79	−.14	−.14	.81	.10	−.06
Team task	−.02	.12	.91	.08	.08	−.01	.90	−.09	.74	.36
Self effort	.75	.18	.06	.09	.11	.84	−.20	.43	.48	.08
Self luck	.06	.87	.11	.85	.07	.01	.19	.78	.27	.24
Self ability	.55	.21	.37	.22	−.10	.60	.38	.29	.75	−.07
Self task	.25	.51	.12	.65	.16	.20	−.23	.22	.22	.52
Attribution to coach	.49	.00	.52	.00	.56	.42	.33	−.09	.27	.73
Eigenvalue	**2.99**	**1.57**	**1.06**	**2.31**	**1.71**	**1.15**	**1.04**	**3.01**	**1.38**	**1.08**
Of Total Variance Explained	**33%**	**17%**	**12%**	**26%**	**19%**	**13%**	**11%**	**33%**	**15%**	**12%**

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In order to further clarify the above intercorrelations and see the possible basic dimensions behind the attributions, principal component analysis was performed and then rotated by the varimax method (Table II). The results are presented in the win and loss conditions separately and also both conditions as combined. An eigenvalue cutoff of 1.0 was used for defining the number of factors. When one examines the three factors of the combined condition, it is readily apparent that internality vs. externality is the dimension underlying subjects' thinking about causal attributions: the first factor ("overall internality") was highly loaded by team-effort, team-ability, self-effort, self-ability, and attribution to the coach; the second factor ("overall externality") was highly loaded by team-luck and self-luck; the third factor ("externality") was highly loaded by team task difficulty and by attribution to the coach. When looking at the win condition alone, this same dimension of internality and externality emerged. The first factor indicated "overall externality" (team-luck, self-luck, and self-task difficulty highly loaded), while the second factor revealed "team-internality" (team-ability and team-effort obtained the highest loadings). The third factor was in the nature of "self-internality" (self-effort and self-ability most highly loaded), while the fourth factor ("externality") emerged nearly the same as the third factor in the combined condition. On the first factor of the loss condition, team-ability, team-luck, and self-luck provided the highest loadings, thus somewhat ambiguously indicating the external nature of this factor. The second factor of the loss condition ("externality") was similar to the third factor of the combined and to the fourth factor of the win condition, self-ability and team-task difficulty loading most highly. Attribution to the coach, team-effort, and self-task difficulty obtained the highest loadings on the third factor of the loss condition, therefore suggesting the "external" character of causal attributions on this factor. It is of considerable interest to note that "team-internality" and "self-internality" appeared as different factors in the "win" condition, whereas in the overall analysis, they did not (but merged into one factor, see Factor I). Interestingly, the proportion of variance accounted for by Factor I in the overall analysis was identical to the combined variance explained by Factors II and III in the "win" analysis. In sum, factor analysis showed very clearly that subjects' causal attributions for team outcomes were based upon the internality vs. externality dimension. Therefore, the "stable" and "variable" attributional patterns did not emerge important. The differences between the win and loss conditions were not considerable even though externality tended to be more dominant in the loss than in the win case. The important finding seemed to be that *effort*-attribution was loaded highly with internal attributions (ability) in the "win" situation, whereas in the "loss" condition, effort-attribution tended to load highly with external attributions (luck, task-difficulty, and attribution to coach).

Specific Analysis

The above results constitute a basis for understanding more specifically the nature of internality vs. externality in causal attributions. Multiple regression was employed as a major tool for further elaboration of the previous results. In the first set of analyses, each attribution variable served as a criterion variable (Table III), while in the second stage, the attribution variables were used as predictors for the immediate outcome variable (Table IV). While factor analysis yields the basic dimensions underlying persons' causal attributions, multiple regression allows a user to be more elaborate in his analysis because of the possibility to employ one attribution variable (or performance) as a dependent variable to be predicted by the performance (or attribution) independent variables.

Table III - Standardized Regression Coefficients for Fixed Regression Analyses: Team- and Self- Attributions (for success and failure as combined) Predicted by Performance Variables

Predictor	Dependent Variable: Team-Attribution: Effort (P)	Team-Attribution: Luck (P)	Team-Attribution: Ability (P)	Team-Attribution: Task (P)	Self-Attribution: Effort (P)	Self-Attribution: Luck (P)	Self-Attribution: Ability (P)	Self-Attribution: Task (P)	Self-Attribution: Attribution to Coach (P)
Immediate Outcome	.311 (.02)	.014	.250 (.02)	.122	.318 (.01)	.110	.249 (.05)	.206	.468 (.01)
Past Success	.144	−.039	.392 (.01)	−.068	.248 (.02)	−.173	.145	−.083	−.230 (.05)
Individual Performance	.038	−.150 (.10)	.025	.077	.121	−.097	.134	−.034	.188 (.05)
Subjective Performance	−.042	.117	.080	−.162 (.10)	.025	.156 (.10)	.006	.168 (.10)	.037
R	.43 *	.16	.64 *	.15	.59 *	.21	.44 *	.26	.45 *
R^2 (Total Variance Explained)	18%	3%	41%	2%	35%	4%	19%	7%	20%

~~Note. (P) indicates the probabilities determined by t tests (Edwards, 1967, p. 252)~~

* $p < .01$.

Explaining Attributions by Performance Variables

Table III shows the results obtained by multiple regression for success and failure conditions together. In addition to each multiple "R", the data in Table III show the standardized regression weights associated with each predictor. On an a priori basis, four continuous independent variables (immediate outcome, past success, individual performance, and subjective performance) were forced to serve as predictors. Because the correlation between subjective and individual performance (for the difference between the meanings of these variables, see p. 8) was "only" .35, these variables did not appear to be redundant, and thus, both individual and subjective performance were included in this analysis.

Table III reveals that *effort* and *ability* in both self- and team-attributions are very significantly predicted (R) by the four independent variables in the linear model. It clearly appeared that the *immediate outcome* was accounting for most of the total variance in significant multiple R's. Team-effort was predicted by the independent variables (18% of the variance explained): $F = 8.12$, $df = 4/145$, $p < .01$; team-ability predicted by them (41%): $F = 25.35$, $df = 4/145$, $p < .01$; self-ability predicted (19%): $F = 8.61$, $df = 4/145$, $p < .01$; self-effort predicted (35%): $F = 19.63$, $df = 4/145$, $p < .01$. The multiple R for task difficulty (self-attribution) was also significant (7%): $F = 2.74$, $df = 4/145$, $p < .01$. In order to look further at the variables which were responsible for the above significant R's, standardized beta-coefficients of the predictors were tested (EDWARDS, 1967, p. 252) using t tests. Closer inspection of the dependent variables which had significant multiple R's reveals that team-attribution to effort was significantly ($p < .02$) explained only by the immediate outcome. Team-attribution to ability was significantly accounted for by both immediate outcome of the game ($p < .02$) and by past success of the team ($p < .01$). Self-attribution to effort was significantly explained by the immediate outcome ($p < .01$) and by past success ($p < .02$). Self-attribution to ability was significantly explained by the immediate outcome ($p < .05$).

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Surprisingly, individual performance did not have a statistically significant effect on the dependent variables. Only in the case of team-attributions to luck, did individual performance approach significance ($p < .10$). Similarly, and contrary to expectations, subjective performance did not significantly add to the total variance for any dependent variable. In the cases of team-attributions to task difficulty, and self-attributions to luck and task difficulty, subjective performance approached statistical significance ($p < .10$). The attribution assigned for success and failure to the coach, however, was significantly predicted by the immediate outcome ($p < .01$), past success ($p < .05$), and individual performance ($p < .05$).

Explaining team performance (immediate outcome) by attributions

Table IV presents the results of multiple regression in which immediate outcome (team performance) and individual performance are explained by the attributional variables. A closer inspection shows that the high R (.70) of immediate outcome is due to attributions to team-ability, self-effort, and attributions to the coach, and the significant R of individual performance due to attribution to coach and self-effort. This finding then suggests that a team's ability, "my" own efforts, and the coach are mostly seen responsible for the team performance. The results in Table IV were confirmed also by *canonical correlation analysis*, in which immediate outcome and individual performance were used as one set of variables while team and self-attributions formed another set (see TATSUOKA, 1971). Of the two resultant canonical variates, the first one was significant ($p < .001$). It was found that immediate outcome from the first variable set and team-ability and self-effort from the second variable set were most highly loaded on this canonical variate. Even though these above results are quite consistent, one should be cautious in comparing the relative importance of team and self attributions.[1] This is so because the predictors were not orthogonal to one another. One common way of avoiding hasty and perhaps erroneous conclusions in this situation is to enter *factor score* estimates into a regression equation as independent variables. This method then employs the factors extracted in the factor analysis as predictors in multiple regression; the factors are uncorrelated, thus allowing the direct comparison between them as to the variance accounted for by the factors. For this reason, the so-called Method III (see TUCKER, 1971) was utilized with the three

Table IV – Standardized Regression Coefficients for the Fixed Regression Analyses: Team Performance (Immediate Outcome) and Individual Performance Predicted by Different Attribution Variables

Predictor	Criterion Variable: Immediate Outcome	Criterion Variable: Individual Performance
Team effort	.084	−.031
Team luck	−.056	−.141
Team ability	.326***	.093
Team task difficulty	−.076	−.048
Self effort	.275***	.187*
Self luck	−.111	−.058
Self ability	.109	.132
Self task difficulty	.063	−.005
Attribution to coach	.151**	.195**
R	.70 ***	.43 ***
R^2	49%	18%

* $p < .06$
** $p < .05$
*** $p < .01$

factors of the "combined" condition (Table II) serving as predictors in multiple regression analysis. Immediate outcome was the dependent variable. The results revealed that Factor I ("overall internality") of the "combined" condition was the only one with a significant regression weight (.68, $p <$ .001) for immediate outcome. The multiple R of .68 (F = 43,40, df = 3/146, $p < .001$) indicated that the second and third factor's contribution to the total variance was zero. Therefore, Factor I accounted for all the variance (46%) of immediate outcome. One may recall that team-ability, team-effort, self-ability, self-effort, and attribution to coach were the highest variables to load on Factor I. Consequently, these variables have the most explanatory power for immediate outcome. In sum, it was first found that e team's ability, self-effort, and the coach are mostly regarded responsible for the team performance. However, the further analysis revealed that all the four internal factors (self-ability, self-effort, team-ability, team-effort) and the coach are the most important attributional determinants of team performance.

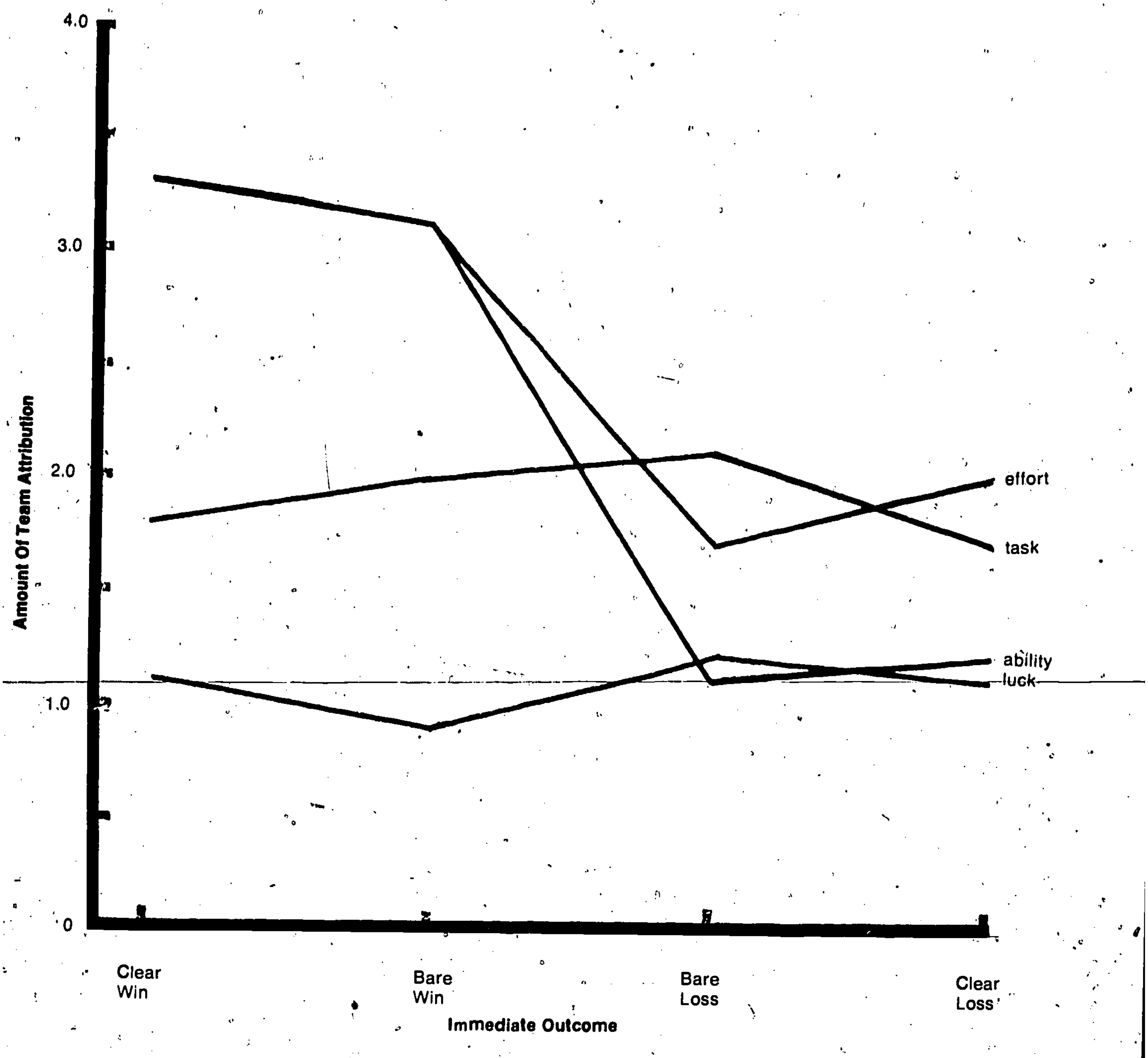
Supplementary analysis

Since multiple regression does not yield interactions, unweighted-means ANOVAS (WINER, 1962, pp. 224-227) were utilized. A 4 × 3 factorial design (immediate outcome × individual performance) was used. When one compares the results by ANOVAS with those of multiple regression, the findings are entirely parallel in respect to statistical significance of the variables. In other words, effort- and ability-attributions were determined by immediate outcome, but not by individual performance. Immediate outcome appeared to be highly significant for team effort ($F = 12.62$, df = 3/138, $p < .001$), for team ability ($F = 27.29$, df = 3/138, $p < .001$), for self-effort ($F = 17.05$, df = 3/138, $p < .001$), for self-ability ($F = 9.43$, df = 3/138, $p = .001$), and for attribution to the coach ($F = 5.35$, df = 3/138, $p = .001$). The individual performance variable did not reach significance with regard to the above variables except for attribution to the coach (F = 3.22, df = 2/138, $p = .04$). No significant interactions existed between these two independent variables. The result of post hoc analyses pertaining to these main effects are presented in the following paragraphs.

Since the above results may be confounded with a team's past success, the effect of past history was covaried out by *covariance analysis*. It appeared that no changes occurred in respect to statistical significances. Immediate outcome was still highly significant for team-effort ($F = 6.90$, $p < .001$), for team-ability ($F = 7.86$, $p = .001$), for self-effort ($F = 10.14$, $p <$ .001), for self-ability ($F = 5.45$, $p < .001$), and for attribution to coach ($F = 9.01$, $p < .001$). The main effect of the individual performance on attribution to coach dropped from $p < .04$ to $p < .07$. Otherwise, the results remained nonsignificant. This then suggests that immediate outcome overrides past success in determining attributions for success and failure.[2]

2. It would be very important in the future research to investigate the effects of individual past success in a group on the attributions of success and failure. Overall, there is a need for the studies that take simultaneously into account all the four "structural" determinants of the group attributions: a team's immediate outcome; its past success; a team member's immediate performance in the group; and a member's past performance in the group.

Figure 1. Attributions for team performance (immediate outcome) to team-effort, team task-difficulty, team-ability, and team-luck.



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Team attributions and immediate outcome

While the previous analyses revealed the general patterns of attributions and the main effects with respect to attributions, it is a purpose of the following five sections to specifically demonstrate where the differences pertaining to the main effects are located. Therefore attributions are examined as a function of all categories of immediate outcome (clear-win, bare-win, bare-loss, clear-loss). As indicated in Figure 1, clear-win as well as bare-win were quite explicitly attributed to high team effort and to high team ability. Effort and ability differed very significantly from luck and from task difficulty in both clear-win and bare-win conditions. Attributions to luck and task differed from each other both in the clear-win ($p < .05$) and bare-win conditions ($p < .01$).

If team success was quite exclusively attributed to ability and effort, the same was not true for failure attributions. First, ability and effort decreased markedly ($p < .01$) from bare-win to bare-loss, leaving task difficulty and low effort as prime factors in explaining team failure (both bare- and clear-loss). Task difficulty and effort did not differ from each other significantly in either of the loss conditions as did not ability and luck in either condition. But task difficulty departed significantly from luck and from ability in both bare-loss ($p < .01$) and clear-loss ($p < .05$) conditions. Effort-attribution did not differ significantly from luck, but approached significance ($p < .10$) with respect to ability in the bare-loss condition. However, when losing was clear, effort emerged as a prime factor to account for team failure, departing significantly from luck and from ability.

In sum, ability and effort were quite exclusively seen as being responsible for team success while effort and task difficulty were more important attributions in explaining team failures than ability and luck. But more important, luck and task attributions did not change as a function of immediate outcome; only ability and effort tended to change from success to failure. These results for the win conditions lend full support to the second hypothesis, and partial support for the loss conditions.

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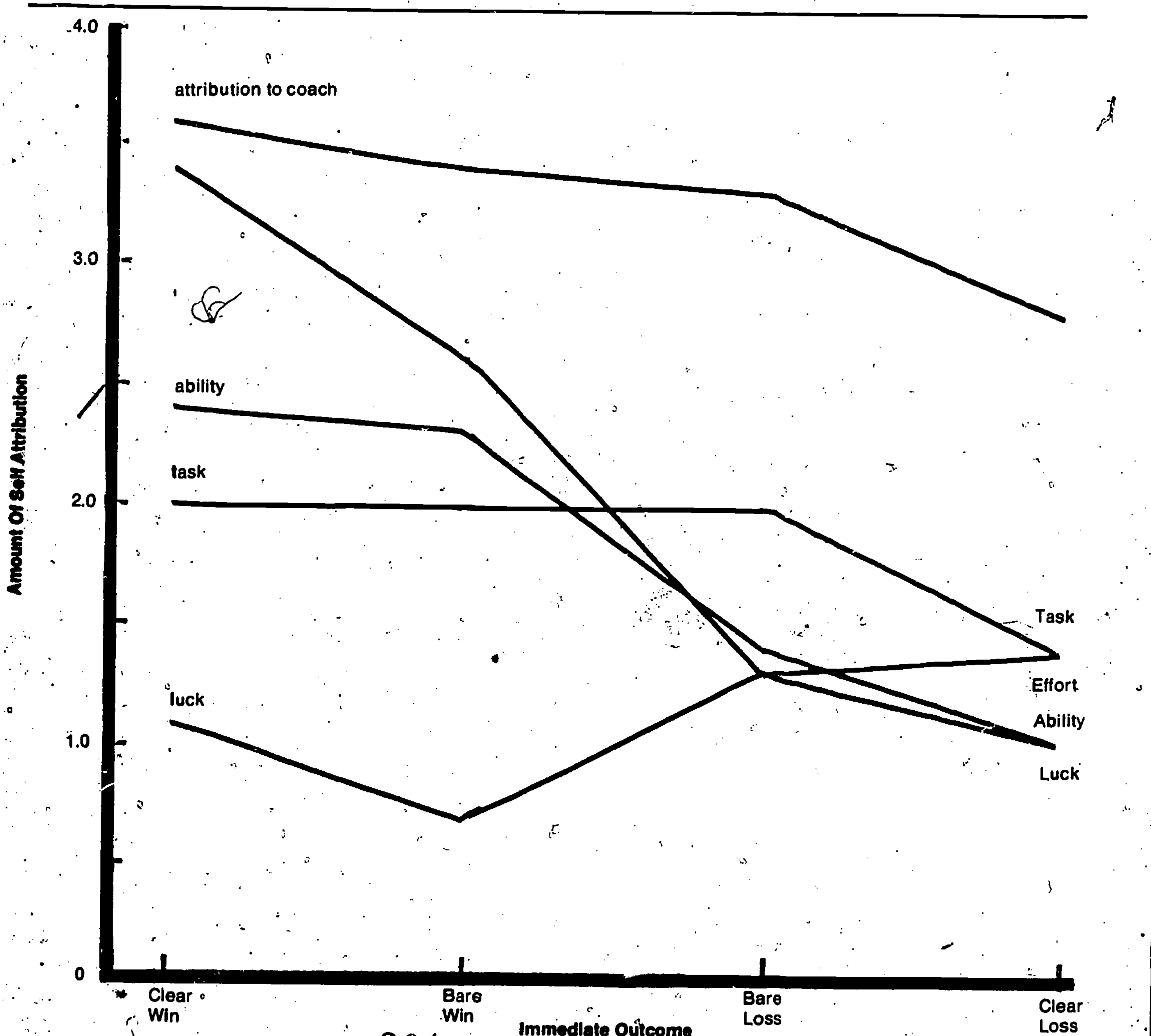
Figure 2. Attributions for team performance (immediate outcome) to self-effort, self-ability, self task difficulty, self-luck, and coach.



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Self-attributions and Immediate outcome

Figure 2 reveals the results with respect to self-attributions for group performance, i.e., how much each individual saw himself as being responsible for team success and failure expressed by the four attributional variables.

In the clear-win condition, high self-effort was significantly ($p < .01$) more important than ability, task, and luck in explaining team success. Ability and task were equally important, while luck emerged as being less important ($p < .01$) in players' causal judgments. In the bare-win condition, self-efforts differed significantly from luck ($p < .01$) and from task ($p < .02$), but not from ability. On the other hand, ability and task difficulty did not depart significantly from each other but did so with respect to luck ($p < .01$). It was also found that attributions to effort dropped significantly ($p < .01$) from clear- to bare-loss, while other declines *within* attributional variables remained nonsignificant between these two classes.

There was a highly significant ($p < .01$) decrease for effort and ability from bare-win to bare-loss while luck attributions increased significantly ($p < .05$) and task remained the same between these two classes. This meant that the personally difficult task was regarded as the factor most responsible for a team's bare failure, with the difficult task being more important than ability ($p < .10$), more important than effort ($p < .05$), and more important than luck ($p < .10$). Task difficulty, however, dropped significantly ($p < .05$) from bare-loss to clear-loss. This meant that task joined effort as a main attribution for clear-loss. A difference between effort and task vs. luck and ability approached significance ($p < .10$).

In sum, the internal self-factors (especially effort) were regarded as being most responsible for team success. The order of these two variables remained the same in the bare-win condition, but differences between these self-attributions were reduced strongly from clear-win to bare-win. The team bare-loss was primarily assigned to individual task difficulty in the field and batting while the other three attributional variables were seen as less important in causing group performance. A team's clear-loss was attributed both externally (task) and internally (effort). These factors were more important than luck and ability as explanations of team failure. These results, quite similarly to team attributions, lend some support for the second hypothesis of ego-centered causal ascriptions.

Attributions for Success and Failure to a Coach

Subjects were also asked the extent to which they attributed their team success and failure to their coach. The upper graph in Figure 2 indicates "how good a coach was in helping their team performance." It is evident that the coach received the most "roses" for the win, but on the other hand, the coach was also regarded as the greatest reason for team failures. The decrease of this attribution in absolute value was significant from bare-loss to clear-loss ($p < .01$). Attribution for success and failure to the coach was significantly greater than for the other four attributional variables in the cases of bare-win, bare-loss, and clear-loss for self-attributions, but only in the cases of bare- and clear-loss ($p < .01$) for team attributions. Importantly, self-efforts were assessed to be as valuable as good coaching in regard to a team's high success.

Individual Performance and Immediate Outcomes

It was found by t tests that on no occasion did the differences with respect to attributions between good, moderate, and bad performers reach significance. It seemed that those who performed poorly in the game tended to be slightly more ego-offensive (success attributed to high efforts and good ability) than good performers when winning. But on the other hand, the poor performers did not show greater tendency toward ego-defensive behavior than the good performers when losing. It appeared than the best players imputed team success to their coach to a greater extent (nonsignificant) than the moderate and the worst players. No support for the third hypothesis is presented by these data.

Past Success and Immediate Outcomes

Because of failure to get all of the observations needed, past success could not be categorized in all the classes of immediate outcome. In other words, the teams which had high past success did not lose and the teams which had low past success did not win games included in the random sample. Hence, only the extreme results can be offered. It was found that attributions to both team- and self-efforts, ability, task, and luck as a function of a team's past success (high-low) follow precisely the line of the same attributions assigned as a function of the mere immediate outcome of the game. Exactly as the immediate outcome, past success had signifi[illegible] ($p < .001$) main effects for team effort and ability, for self-effort and ability, and for attribution to coach.[3] Subjects of teams which had succeeded highly in the past (from 75% to 82%), predominantly attributed their team successes to high team efforts (3.4) and to high team ability (3.1) rather than to easy task (1.7) or good luck (1.1); effort and ability differed significantly ($p < .01$) from task and luck. Correspondingly, the same subjects attributed their team's success to their own self-efforts (3.1) and to their own ability (2.4) (effort vs. ability: $p < .05$). Attributions to easy task in the field and in batting (1.7) and good personal luck (0.9) were negligible (effort vs. task and luck: $p < .01$; ability vs. luck: $p < .01$).

Those subjects whose team had been losing almost continuously (7% to 27% successes) attributed team failures more to lack of team effort (2.2) and to the task difficulty (2.1) than to their team's low ability (1.2) or bad luck (1.3) ($p < .05$). Similarly, team failure was seen to be due somewhat more to lack of self-efforts (1.7) and the personal difficulty of the task (1.8) than to lack of personal ability (1.4) or to bad personal

3. This is no wonder, because there were five teams with "high past success" in the analysis, and of these five teams, three constituted the category of "clear-win" on the immediate outcome variable. The remaining two teams of high past success were located at "bare-win" conditions of immediate outcome. There were three teams in the category of "low past success." One of these teams "lost clearly," while the remaining two teams "lost barely" according to the immediate outcome continuum.

luck during the game (1.4); however, these latter differences were non significant. Unfortunately, these data do not provide information about causal attributions when the immediate outcome and past success are not entirely consistent with each other. However, the effects of past success on the attributions of immediate outcome were covaried out. In that analysis, it was found that the differential effects of immediate outcomes on attributions occur over and above the effects of past success upon these attributions.

DISCUSSION

The first hypothesis was that high success and high failure would be internally attributed to ability and effort, whereas bare-win and bare-loss would be externally attributed to task and luck. The results clearly supported this hypothesis for the clear-win condition, and partially supported it for the clear-loss condition which was both internally (effort) and externally (task) ascribed. This same result appeared to hold for self- as well as team-attributions. However contrary to the hypothesis, bare-win was also internally attributed (both team and self-attributions). This same hypothesis concerning bare-loss was partly supported (team-attributions) because task difficulty was regarded as the factor most responsible for team loss. Overall, as expected, self-attributions followed the same patterns as team-attributions, the latter being usually somewhat higher in their absolute values. The correlations between team- and self-attributions tended in general to suggest that members use the quality of their group performance as an indicator of their own performance and their personal contributions to the outcome (see ZANDER, 1971, p. 137). When considering the confirmation of the first hypothesis (which was derived from FEATHER's findings, 1969), it should be borne in mind that FEATHER defined externality only by "luck" and internality only by "ability." If the results of this study are reconsidered in this light by being only one of the external and one of the internal factors at a time, the first hypothesis would receive more complete support.

The second hypothesis, which was an alternative to the first one, suggested that subjects are ego-centered in their causal judgments. Specifically, it was hypothesized that those subjects who performed poorly tend to be more ego-centered than those performing best on the team (the third hypothesis). The results revealed no support for the third hypothesis. Similarly, it was found that subjects' feelings of their own performance could not significantly predict and explain variance among the dependent variables. These findings tend to be in conflict with the propositions made by ZANDER (1971). On the other hand, it should be noted that ZANDER was talking about "competent" and "noncompetent" members, and not good or bad performers in a group on one occasion. It might have occurred that "good performers" just happened to have a "good day" and "bad performers" happened to have a "bad day." The results might have been in accord with those of ZANDER if the players were classified as good and bad performers on the basis of *consistent* performance scores for each individual. Therefore, it is important that the effects of not only a team's past success, but also the effects of an *individual* past success on causal attributions are carefully studied in the future research. Also, objective and subjective performance as independent variables certainly need further verification.

Even though there were no differences between good and bad performers, overall, a tendency for ego-defensive attribution behavior emerged among those players whose team lost. This meant that the reasons for team failure were predominantly based on situational factors. The good qualities of players on the opposing team (task difficulty) were stressed and low team- and self-efforts were interpreted as high in importance in accounting for failure. The ego-defensive hypothesis derives further support from the fact that the players in this study saw their coach as extremely poor in helping their team performance in the case of losing. The negative consequences can also be avoided by viewing failure (or the whole task) as trivial or unimportant. The importance of this kind of denial was, however, not examined.

Why should effort-attributions for failure (effort is typically said to be an *internal* factor) indicate that subjects were self-protective in their causal judgments? This would be the case when effort is used in an external manner. When an individual or a team loses, it is often claimed by the players that "a referee was so lousy that I did not even see any point for trying to play." Therefore, lack of effort as a factor causing failure is guided by external influences.

If it seems obvious, on the basis of the results, that ego-defensive strategies were employed by players while losing, what strategies are then used in accounting for team success? It was found that high effort and high ability were assigned as the foremost attributional factors for team success. These two variables are typically labeled as "internal" factors in the attribution literature, meaning that persons tend to gather all the glory of success for themselves. This interpretation is also adopted here, even though it may first seem to be somewhat contradictory to treating effort as an external factor in the case of losing. It is therefore proposed that *effort* has a different meaning to persons who fail and to persons who succeed. When losing, persons tend to rationalize the lack of effort by means of external reasons, like a "lousy referee." But when there is success, high effort is rationalized by internal stimuli or factors; i.e., one may say that "good ability makes it possible and easy to exert high efforts." Validation for this hypothesis is obtained by the data of this study. First, one may recall from Figures 1 and 2 that ability was highly associated with effort in team-attributions for team success. The same relationship was also revealed for self-attributions, but more so in the case of bare-win. On the other hand, effort was *not* associated with ability at all in the case of losing, but rather closely related to task difficulty (i.e., exaggerating good qualities of opponent players) which is clearly an external factor. Secondly, effort-attribution (both team and self) was correlated most highly with ability-attribution in the case of win, whereas in the loss condition, it was correlated equally low with ability, luck, or task (team-attributions), or most highly with luck (self-attributions). Thirdly, this same tendency was most clearly illustrated by factor analysis; effort attributions were loaded highly with ability-attributions in the win condition, while they tended to load highly with external factors in the loss condition. Therefore, these notions lead to the following hypothesis to be verified by further research. *Effort has a different at-*

tributional meaning in the case of experiencing success and failure: when individuals succeed, they interpret their outcome internally so that the main cause for success is effort which is enhanced by interpretation of the presence of personal abilities. When individuals fail, they interpret their outcome externally so that one of the main causes for failure is lack of effort which is seen to be tied to external environmental stimuli.

The fourth hypothesis that subjects on teams with consistent and repeated past success or failure attribute their team outcomes to stable factors (ability and task difficulty) was not fully supported by these data. In cases of continuous success, self- and team-efforts and ability were assigned as prime factors for winning, while lack of effort and task difficulty were seen most responsible in the case of repeated failure. Thus, this result partly contradicts the above hypothesis which was derived from WEINER's work (1971, p. 100). However, it should be borne in mind that these two sets of findings are not entirely comparable because: (a) FRIEZE and WEINER (1971) obtained their results in a "simulation experiment" in which subjects were to respond to the hypothetical information with a paper and pencil; (b) in a baseball situation, there are many factors which are available for attributions, e.g., ongoing task, importance of activity, future aspirations, knowledge about the game; and (c) there was a failure to completely represent all combinations of immediate outcome and past success; i.e., the classes of past success were not represented in every category of immediate outcome.

There is one further point to be considered. Subjects were asked how much help their coach was in their team performance. The finding that the coach was perceived as being highly useful when winning and in contrast, highly useless when losing, indicates that several informational cues were employed by subjects in their causal judgments. In other words, task difficulty and luck might not be sufficient to reveal the real picture of subjects' thinking of external factors in causing group outcomes. It may well be that on some occasions luck is regarded as the most relevant situational variable while sometimes several factors are needed (e.g., task, a "lousy referee," bad weather). Perhaps the results concerning the relationship between internal and external attributions depend on which, and how many informational cues are provided for subjects to be judged on the questionnaires. When the results are viewed in this light, a more definite answer concerning tendencies of ego-centered causal judgments may be obtained with a broader informational approach taken toward internality vs. externality. Then, for example, the S-V-O model by GOLLOB (1974) and the subjective probability model by WYER (1973) might prove to be fruitful.

In conclusion, this study clearly indicates that the young players' judgments of their team success and team failure are quite ego-centered. The players are inclined to view team success in such a manner that their own natural conditions and capabilities become well recognized. They like to collect "roses" on the dispositional bases (ego-offensive). Team failure is in turn conceived to be determined by environmental stimuli which does not take anything away from an individual's capabilities. When losing, they like to give "thorns" to others. This agrees with the suggestion of HASTORF et al. (1970, p. 79) "that the perceiver has increasing need to attribute responsibility to someone as the outcomes become more severe."

If ego-centered behavior is a dominant feature for the youngsters at this age, one can only ask how common this subjectively biased interpretation of success and failure is among older people. Are these results obtained because boys are in the middle of a strong and important social comparison process (VEROFF, 1967) at that age? Do all people with different personalities tend to interpret success and failure in a similar manner? What, if any, are the situations which tend to bring about more ego-biased rationalizations of success and failure compared to "usual" real life situations? How necessary is it to make subjectively biased judgments of group and individual performances for surviving in the achieving society? How much is the modern educational system responsible, if at all, for producing individuals who are very ego-centered in their causal judgments? Certainly, these and many other important questions in the attribution process call for further examination.

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MOTIVATION ET SPORT

NEED FOR STIMULATION: SOME POSSIBLE ANTECEDENTS OF INDIVIDUAL DIFFERENCES AND ITS RELATIONSHIP TO SPORT INVOLVEMENT

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INTRODUCTION

The concept of stimulus-seeking or need for stimulation first appeared in McDOUGALL's (1923) proposed instinct of undirected curiosity, and in PAVLOV's (1927) description of the investigatory or orienting reflex. The first general description of the need for stimulation of the nervous system was given by NISSEN (1930), who compared the nervous system to the muscular system. He proposed "a fundamental tendency in all living tissue towards the expression of its characteristic activity; a basic drive towards functioning" (NISSEN, 1930: 373). The nervous system was purported to need stimulation just as the muscular system needs exercise, and if functioning ceased the nervous system would atrophy just as the muscular system. PAVLOV eventually developed a theory of typological differences in, what he termed, strength of the nervous system and research on differing reactions to similar stimuli continued in Russia in TEPLOV's laboratory (GRAY, 1964).

However, the concept of need for stimulation received little attention in the West until the 1950's, perhaps largely due to the development of the learning theory concept of drive reduction. Drive reduction theories suggest that the goal of behavior is the reduction of cyclical needs such as hunger, thirst, and sex, and the avoidance of pain — the reduction of stimulation. All other behaviors were believed to be derived from the need to reduce these "primary drives". The more recent cognitive consistency theories also appear to be diametrically opposed to the concept of need for stimulation. They suggest that individuals prefer stability, familiarity, and the confirmation of expectancy, while avoiding the new and the unpredictable. Stimulus-seeking theories infer that behavior is based on a different set of motivations. They posit that an individual has an exploratory drive, curiosity, takes pleasures in the unpredictable and the unexpected, and finds novelty rewarding.

Since 1950, a great deal of empirical evidence has been generated which tends to support the view that organisms seek stimulation, although the field has suffered from a lack of concerted effort. Supporting evidence has come from a variety of research traditions including vigilance and attention, sensory deprivation, pain tolerance, perception, and environmental psychology, as well as from researchers who are immediately concerned with stimulus-seeking behavior. Unfortunately, the several investigators or teams of investigators have carried out their research from their own particular theoretical and methodological perspectives and have tended to ignore or overlook the work of other researchers investigating the same phenomenon. The divergent research has led to some twenty-five measures of need for stimulation and to ten theories which are, directly or indirectly, related to stimulus-seeking behavior (LOY and DONNELLY, 1975; DONNELLY, 1975).

ZUCKERMAN (1969) has proposed an "optimal level of stimulation theory" based on his research on sensory deprivation, and SCHULTZ's (1965) theory of "sensoristasis" is also based on sensory deprivation research. These two theories and SALES, (1971) theory of need for stimulation each subscribe to the view that individuals have an optimal level of stimulation, and that individuals may differ with respect to their optimal level of stimulation. The optimal level of arousal produced by being in an environment which provides an optimal level of stimulation is a pleasing state, and therefore the goal of a great deal of behavior is to maintain that state. Environments which produce an arousal level which is "too low" for an individual (e.g. sensory deprivation) or "too high" (e.g. sensory overload) are considered to be aversive.

SALES, (1971) theory is based on PETRIE's (1967) work on perceptual reduction and augmentation. PETRIE classified individuals into three types with regard to their modulation of sensory experience. The "reducer" tends to subjectively decrease that which is perceived e "augmenter" to increase that which is perceived; an. ie "moderate" tends to perceive the sensory environment fairly accurately. The classification derived from PETRIE's observations of the different degrees of pain felt by people with similar injuries, but the tendency has since been shown to generalize to a variety of behavioral responses. By linking the concepts of optimal level of stimulation and perceptual reduction and augmentation SALES concluded that the optimal level of stimulation was the same for all individuals. Because reducers decrease stimulation they would need more stimulation to maintain an optimum level, while augmenters would need less stimulation to maintain the same optimum level. SALES (1971, 1972) found support for this proposition with a series of experiments which showed that reducers and augmenters differed markedly in their preferred level of stimulation.

In his more recent work, SALES abandoned the concept of perceptual reduction and augmentation in favor of PAVLOV's typology of "strong" and "weak" nervous systems (GRAY, 1964). Although the two dimensions are extremely similar in terms of definition, the latter was favored because of the more reliable measures which have been developed in order to assess strength of the nervous system. Research in Russia on PAVLOV's topology led TEPLOV to formulate his own "strength of the nervous system theory" (GRAY, 1964), and GRAY (1964) derived a "theory of arousability" from the Russian research. A more popular version of stimulus-seeking theories has been presented by MORRIS (1969), who proposed six principles of the "stimulus struggle".

Several related theories have been found which are not immediately concerned with stimulus-seeking behavior, but which are useful in helping to describe and understand stimulus-seeking phenomena. ELLIS (1973) has proposed a theory of play behavior which contains a strong stimulus-

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seeking component. MEHRABIAN and RUSSEL (1974) include stimulus-seeking in their theory of environmental psychology, and EYSENCK (1955) related PAVLOV's behavioral work to KÖHLER's Gestalt theories to derive a "cortical inhibition theory" of extraversion, of which stimulus-seeking is a component.

PURPOSE

The twofold purpose of this study was to examine the relationship between need for stimulation and preferred environmental dimensions of sport, and to examine the effect of selected early environmental factors on individual differences in need for stimulation. Sport was considered to be an ideal context for the study of individual differences in need for stimulation since it is primarily a voluntary activity offering many different forms of stimulation, and providing a wide range of degree of stimulation. The second objective was considered because so little evidence is available regarding the causes of individual differences in stimulus-seeking behavior. A great deal of the related research indicates a neurophysiological basis for individual differences and there has been a tendency to assume that the differences are genetically determined. However, both PETRIE (1967) and ZUCKERMAN (1973) have both suggested that genetic predispositions may be greatly altered by environmental conditions. Early environmental factors considered in this study include birth order, sibling sex status, family size and density, and parent-child relations.

Sport is a readily available and socially acceptable means of achieving stimulation, but there have been surprinsingly few research studies which have employed sport as a medium for the examination of varying needs for stimulation. Apart from one study using ZUCKERMAN's (1964) Sensation-Seeking Scale, all of the relevant studies have considered the relationship between sport and need for stimulation in terms of perceptual reduction and augmentation. RYAN and FOSTER (1967), in a study of male high school athletes, found that contact athletes tend to be reducers, non-athletes tend to be augmenters, and that non-contact athletes fall between these two extremes and may be classified as moderates. NEALON (1973) replicated the RYAN and FOSTER study using female subjects and found similar though non-significant results. Both studies employed the kinesthetic after-effects and time estimation tasks as measures of perceptual reduction and augmentation. The results of both studies are predictable in terms of need for stimulation. BIRRELL (1974) has suggested that augmenters, and possibly moderates, would prefer greater "personal distance" and would avoid contact sports because of the excessive tactile, auditory, olfactory, and visual stimuli elicited by closeness and contact. On the other hand, reducers may enjoy the high-stimulus environment provided by contact sports.

Pain tolerance has been shown to be a major correlate of need for stimulation (PETRIE, 1967; VANDO, 1969) and may further explain why reducers prefer contact sports. RYAN and KOVACIC (1966) found that among male high school athletes, contact athletes showed the highest pain tolerance and non-athletes the lowest. Non-contact athletes again fell between these two extremes and showed an intermediate level of pain tolerance. WALKER (1971) found support for these results in a study of female athletes and non-athletes; the female athletes demonstrated a higher tolerance for pain than the non-athletes.

Two studies using self-report measures of need for stimulation have also shown relationships between participation in high-stimulus sports and high need for stimulation. BERGER (1970) found that participants in sports involving a high probability of physical harm and temporal/spatial uncertainty tended to be reducers as measured by VANDO's (1969) Reducing-Augmenting Scale. HYMBAUGH and GARRETT (1974) found that skydivers scored significantly higher than non-skydivers on ZUCKERMAN's (1964) Sensation-Seeking Scale.

The relationship between an individual's early environment and his or her need for stimulation has not previously been examined, although many studies suggest that such a relationship may be found. THOMPSON and SCHAEFER (1961), in their review of research, have shown that early environmental stimulation has a critical effect on later behavior. Studies of birth order and sibling sex status indicate that later-borns tend to participate in high-stimulus activities, including sports, to a greater extent than first-borns. Several investigators have suggested that parental child-rearing practices may affect a child's need for stimulation, and there are some indications that family size and density may be relevant variables in determining an individual's need for stimulation.

In studies reviewed by DONNELLY (1975) and LOY and DONNELLY (1975), first-borns have been shown to differ from later-borns in expressed fear and avoidance of dangerous situations, pain tolerance, juvenile delinquency, and athletic participation. In all cases, the later-borns tend to be more involved in sports, and particularly those with a high probability of physical harm, to show less fear in dangerous situations, higher pain tolerance, and more involvement in delinquent activities. PETRIE (1967) has noted that juvenile delinquents tend to be reducers. LEVENTHAL's (1968) "sibling-similarity hypothesis" suggests that second-born children will model their behavior on that of the older child, regardless of the sex of the first-born sibling. In terms of sport participation, it would be expected that first-born males would show more interest in sport than first-born females, and that their male or female sibling would reflect the first-born's orientation. PORTZ (1972) noted that females with an older brother are highly represented among college physical education majors, and SUTTON-SMITH and ROSENBERG (1970) found that male college students with an older brother tended to be involved in sports including contact sports. However, a study by LANDERS (1970) provides conflicting evidence. He found that second-born boys with an older sister were more likely to compete in varsity and junior varsity sports at junior high and high school than boys with different "ordinal-sibling sex statuses".

MADDI (1961) has suggested that a child reared in a sheltered environment with overprotective parents, parents who may themselves be wary of the unexpected, may come to regard the possibility of the unexpected as threatening and unpleasant. The child has not been prepared for stimulating situations and may have a low need for stimulation. Casual or neglecting parents do not prepare a child cognitively for a range of stimuli, and consequently, the ordinary course of events may appear to be boring and monotonous. This may lead to risk-taking behavior, searching for "kicks" and other radically novel experiences in order to avoid beredom. STEINHAUS (1961) has also noted that overprotective parents may produce offspring who are unwilling to take risks in adult life, while those parents who encourage risk-taking in their children, either consciously or through neglect, may develop a high need for stimulation in their children.

Further evidence for the effects of early environment is provided by SALES *et al.* (1974) who found that individuals with a high need for stimulation were more likely to have been raised in a (presumably stimulating) urban environment. By extending SALES' finding to an individual's home environment, one might assume that larger and more dense families, in terms of closeness in age of the children, would provide a more stimulating early environment for the individual and lead to a higher need for stimulation.

Hypotheses

Two sets of hypotheses were tested in order to establish the relationship between sport participation and need for stimulation, and the early environmental antecedents of need for stimulation. On the one hand, it was assumed that individuals express their need for stimulation by voluntarily choosing to participate in sports which best meet that need, and thus specifically hypothesized that:

1. Need for stimulation is directly related to preferred sport environments.
2. Need for stimulation is directly related to preferred type of competition.

On the other hand, it was assumed that individuals' expressed need for stimulation is directly related to their early childhood environment, and thus specifically hypothesized that:

1. Individuals from large and/or dense families will tend to have a higher need for stimulation than those from smaller and/or less dense families.
2. Later-born individuals will tend to have a higher need for stimulation than those who are first-born.
3. Individuals with an immediately older brother will tend to have a higher need for stimulation than those with an immediately older sister.
4. Individuals whose parents were overprotective will tend to have a low need for stimulation.
5. Individuals from more permissive homes with less parental control will tend to have a high need for stimulation.

METHOD

Subjects

A total of 309 subjects were tested, 135 males and 174 females. All of the subjects were enrolled in General Physical Education Program courses at the University of Massachusetts. Students take two of the courses as a requirement, so the sample represents a broad spectrum of the student body and a range of sport interests.

Instrument

A composite questionnaire was devised to obtain the data required for this study. The questionnaire was printed in two forms which differed for males and females only with regard to the Parend-Child Relations Scale. It is composed of 150 items arranged into four parts. Part I deals with birth order, sibling sex, family size and density, and preference for environmental dimensions of sport. The sport dimensions, which such items as "high risk — low risk" and "fast — slow", are set at opposite ends of a five-point scale except for one multiple choice item pertaining to preferred type of competition. These items are derived from several sport typologies including those by KENYON (1968), McINTOSH (1963), CAILLOIS (1961), LOY (1968), and BERGER (1970). The dimensions are common to sport in general, but every dimension does not necessarily correspond to every particular sport. The dimensions were considered preferable to simple statements of sport preference since, in order to establish the arousal producing properties of individual sport experiences, many more details would be required and these appeared problematic in terms of quantification.

Parts II and IV are the mother-child and father-child scales respectively of ROE and SIEGELMAN's (1963) Parent-Child Relations Questionnaire. They contain items relating to the "attention" and the "casual-demanding" factors identified by ROE and SIEGELMAN. The "attention" factor pertains to overt concern for the child and reflects overprotectives parents. The "casual-demanding" factor represents a dimension between those two extremes. The scale is the only one found which may be used with college students to retrospectively assess their parents' child-rearing practices.

Part III of the questionnaire contains the 54 items of VANDO's (1969) Reducing-Augmenting Scale. The scale was selected from among the many available measures of need for stimulation because of its convenience for use when testing large groups, and because it has shown a strong relationship with several established correlates of need for stimulation. It has also previously been used in a sport study where it successfully differentiated between a variety of sport groups.

Data Collection

Subjects participated in the study voluntarily and completed the questionnaire during a class meeting with the permission of the instructor. A debriefing explaining the purpose of the study was given after each testing session.

RESULTS

The hypotheses were originally formulated for the whole sample with a view to controlling for sex during subsequent analysis. However, the findings proved to be quite different for males and females, particularly with respect to the sport dimensions. The difference between mean scores on the Reducing-Augmenting Scale for males and females almost achieved significance ($t = 1.78$; 1.96 is needed for the 5 per cent significance level for a two-tailed test) and a further search of the literature supports the finding that males and females do tend to differ in their scores on measures of need for stimulation (ZUCKERMAN, 1964; PETRIE, 1967). These differences justified the treatment of males and females as two separate samples. All of the reported relationships are zero-order product-moment correlation coefficients (Pearson correlations).

Table I presents the relationships between need for stimulation and the environmental dimensions of sport for both males and females. It provides reasonably strong support for the first hypothesis since the dimensions which assess the most stimulating aspects of sport (e.g. risk, vertigo, and probability of physical harm) achieved the highest relationships for both sexes. Most of the relationshisps appear in the negative direction because the environmental dimensions are set on a five-point scale, and in most cases the high-stimulus choice is '1' and the low-stimulus choice is '5'. The only dimensions which showed no significance in their relationship with need for stimulation for either sex were those which were not clearly dichotomized in terms of stimulus level. The one exception to this is "catharsis", although even with that dimension the relationships are in the predicted direction.

Table I – The relationships between need for stimulation and environmental dimensions of sport.

Environmental Dimensions	Males (N = 135)	Females (N = 174)
Team/Individual	−.02	−.17*
Contact/Non-Contact	−.20**	−.35***
High/Low Risk	−.37***	−.54***
Playful/Serious	.00	.06
Fast/Slow	−.25***	−.49***
Great/Little Skill	−.27***	−.45***
Vertigo/No Vertigo	−.33***	−.64***
Physically/Not Physically Tiring	−.31***	−.38***
Explosive Effort/Endurance	−.07	−.13*
High/Low Probability of Physical Harm	−.31***	−.34***
Aesthetic/Non-Aesthetic Experience	−.05	−.11
Outdoor/Indoor	−.19*	−.14*
Ascetic/Non-Ascetic Experience	−.13	−.32***
Formal/Informal	−.14	−.24***
Catharsis/No Catharsis	−.09	−.12
Great/Little Strength	−.22**	−.38***
Great/Little Agility	−.16*	−.35***
Combat/Non-Combat	−.22**	−.19**
With/Without an Audience	−.06	−.28***
With a More/Less Skillful Opponent	−.06	−.33***
Health and Fitness Important/Not Important	−.36***	−.17*
Environmental/Non-Environmental	−.09	−.19**
Chance/Skill	−.05	.12
Complex/Simple Strategy	−.07	−.24***
High/Low Social Interaction	−.08	−.15*
High/Low Level of Competition	−.18*	−.41***
Great Deal/Minimum of Equipment	−.17*	−.10
Play/Work	.05	−.15**

* $p < .05$.
** $p < .01$.
*** - < .001.

Table II shows the relationships between need for stimulation and preferred type of competition. Only two of the types show marginal significance, direct competition for females and competition versus an animate object for males, and therefore the second hypothesis cannot be considered to have been supported.

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Table II – The relationships between need for stimulation and preferred type of competition.

Type of Competition	Males (N = 135)	Females (N = 174)
Direct	.02	.13 *
Parallel	−.04	−.05
Standard	−.13	−.05
Vs. and Animate Object	.17 *	−.05
Vs. an Inanimate Object	.01	−.07

* $p < .05$.

The hypotheses regarding early environmental factors were also without support. The relationships between need for stimulation and family structure variables are presented in Table III. Again, only two of the variables achieved marginal significance in the predicted direction; having an older brother and sister for males, and family density for females. The hypothesis regarding overprotective parents received some support for males, the results indicating that males with an overprotective mother tend to have a lower need for stimulation than those with a less protective mother. However, the relationship is not strong and none of the other predicted relationships between need for stimulation and parent-child relations achieved any degree of significance.

Table III – The relationships between need for stimulation and family structure variables.

Family Structure Variables	Males (N = 135)	Females (N = 174)
First Born	.10	.01
Second Born	−.03	.02
Third or Later Born	−.08	−.03
Having an Older Brother	.05	−.02
Having an Older Sister	−.03	−.01
Having an Older Brother and Sister	.14 *	.02
Family Size	−.06	.05
Family Density	−.08	.12 *

* $p < .05$.

Table IV – The relationships between need for stimulation and parent-child relations.

Parent-Child Relations Factors	Males (N = 135)	Females (N = 174)
Mother-Attention	−.20 **	−.12
Father-Attention	.04	−.04
Combined-Attention	−.09	−.09
Mother-Casual/Demanding	.01	.00
Father-Casual/Demanding	.08	−.06
Combined-Casual/Demanding	.05	−.04

* $p < .01$.

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DISCUSSION

The results presented here represent the preliminary findings from a study examining the relationship between need for stimulation and sport environmental dimensions, and some early environmental antecedents of need for stimulation. Of the seven hypotheses tested, only one received substantial support. Four of the remaining hypotheses received marginal support in the predicted direction for males in two cases and for females in the other two cases. The marked differences between males and females, particularly in terms of the stronger relationships between need for stimulation and the sport dimensions for women, may indicate that a social desirability effect is present for one of the sexes in terms of their scores on either the Reducing-Augmenting Scale or the preferred sport dimensions. A subsequent factor analysis of the two scales may provide some clue to this unexpected result. Social desirability, together with the fact that few of the sample were athletes, may have led to the non-significant results for the hypothesis regarding type of competition.

Previous studies showing a relationship between need for stimulation and sport participation, and between birth order and sport participation, indicate that a relationship possibly exists between need for stimulation and birth order. However, the previous studies have been carried out with athletes, and again the lack of athletes in the sample may have led to the non-support for the hypothesis regarding birth order. A similar case may be made for the hypothesis regarding sibling sex. In this initial analysis, family size and density do not appear to be significant variables in determining need for stimulation.

The Parent-Child Relations Questionnaire, while the best instrument available for the purposes of this study, depends on memory in eliciting retrospective data, and is also prone to socially desirable responses. The finding that males with overprotective mothers have a lower need for stimulation supports the hypothesized relationship and also indicates the traditional importance of the mother-son relationship. While in the predicted direction, the mother-daughter relationship did not achieve significance. Casual parental childrearing practices do not appear to have a significant effect on the child's need for stimulation.

Subsequent analysis of the data will include factor analyses of the various scales, and partial correlations of the data controlling for such variables as birth order and sibling sex. A preliminary examination of several partial correlations appears to indicate that the early environmental hypotheses receive more support when birth order and sibling sex are controlled.

The significance of the results of this study may be considered in two areas. In the study of sport the finding that specific high-stimulus sport factors are related to a generalized measure of need for stimulation indicates that need for stimulation may be an important motivating factor related to sport participation. Further examination of the effects of early environmental factors on differences in need for stimulation may lead to a modification of the view that need for stimulation is genetically predetermined.

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ACHIEVEMENT MOTIVATION AND LEVELS OF SPORT PERFORMANCE

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It was concluded that there were significant relationships between performance levels on the task needs (need to do well at a task) of achievement motivation, but that the supporting evidence was tenuous. In addition it was concluded that an 'alternate channel' view, as perceived by adolescent athletes, may be operating in sport.

WEBB (1969) has postulated that the major values inherent in the ideology of society's economic structure, such as equity, skill, and success, would be reflected in an evaluation of the game situation, and that the relative position of these values would change over time as the child's interest and involvement progressed from the play of the very young to the games and organized sport of adolescence. Increasingly more values would be placed on skill and success... a process which Webb labelled the professionalization of play attitudes. His hypothesis was borne out. Webb attributed the fact that male adolescents are socialized into an acceptance of an achievement orientation to facilitate their effective participation in economic life.

The concept of achievement motivation has been developed by McCLELLAND, ATKINSON, CLARK, and LOWELL (1953) and is defined as "concern over competition with standards of excellence," for example, winning or doing as well as or better than someone else. These standards of excellence and the behavior which involves either 'competition' with those standards of excellence or attempts to meet them, if successful, produces positive effects or, if unsuccessful, negative effects. It follows that these cultures which stress competition with standards of excellence or which insist that the child be able to perform certain tasks well by himself should produce children with high achievement motivation (ROSEN and D'ANDRADE, 1959).

Research (COLEMAN, 1961; FRIESEN, 1969) demonstrates that sport achievement is far and away more important as a value among adolescent boys than achievement in other spheres of their life. On the basis of his findings, COLEMAN concluded that the image of the sport star is most attractive for boys. Achievement is made most visible by the adolescent sport structure.

Assuming adolescents desire to be successful, known and recognized, and the aforementioned studies do indicate such, then one consequence of the visibility of achievement in sport would be the desire to achieve in these particular areas. Perhaps what we need to know are those relationships which exist between the adolescent's level of achievement motivation and the level of performance that he attains in sport. A common assumption appears to be that a prerequisite for attaining a high level of performance is a high level of need achievement (McCLELLAND, 1955; SMITH, 1964; WILLIS and BETHE, 1970; SINGER, 1972).

CRATTY perhaps, best represents those writers who hold the conviction that a specific combination of personality traits, with achievement motivation as the focal characteristic, differentiates the superior performer from others in the same activity. CRATTY (1970) feels that the world class athlete, in particular, possesses extraordinarily high needs for achievement. Such a stand, however, needs clarification (RUSHALL, 1970).

It is becoming increasingly clear that our society requires large numbers of highly trained, achievement-oriented people to perform the numerous specialized roles found in a complex social system. ROSEN (1959) believes that for our society to function smoothly, or to even continue to operate at all for very long, will depend in part on our willingness and ability to provide talented and motivated people with adequate training and sufficient opportunity to utilize their skills and achieve their goals. ROSEN admits that these goals will vary of course with the individual. Yet in most cases an individual's goals will reflect to some degree the norms and values of the society in which he lives. Two values which are relevant to goal striving are achievement and success. Achievement refers to exceptional accomplishment — doing a task well; success emphasizes social rewards. It is reasonably clear that in our society one would like to believe that achievement and success, though different, are related and that one will follow the other. Which is to say, that achievement will be recognized and bring with it the social rewards associated with success.

There is speculation that the motives which regulate and energize an individual's life pattern are transferred to specific behavioral situations; thus, given the existence of a great many factors, success-oriented individuals may seek to fulfill their achievement needs through sport, especially the competitive variety. Paul WEISS (1969) suggests that one of the few ways in which youth may exhibit excellence is through physical endeavours, using their bodies as the vehicle for acquiring a measure of greatness.

Just as people differ markedly with respect to their aptitudes, they also vary widely with respect to the maximum level of performance that they achieve (KELLY, 1967). In general, one's aptitude sets a limit both on the rate of learning and on the maximal level of accomplishment, but there is far from a one-to-one relationship between aptitude and level of performance. Skills and knowledge are acquired only through practice and study, and one must be motivated to apply one's aptitudes to the acquisition of game skills and strategy knowledge. Resulting as they do from the combined effect of aptitude and practice, individual differences in levels of performance and achievement are likely to be even greater than differences in aptitude (KELLY, 1967).

The competitive sport situation requires a top level adolescent performer to spend a considerable proportion of time in training and competitive situations. For example, three young Edmonton figure skaters recently stated that they each respectively spent 40, 65, and 75 hours per week on the ice (Edmonton Journal, January 24, 1975). Though the proportion of time given to the sport programme will vary with the intensity of the situation, this is still perhaps a greater amount in proportion to time spent in other specific environments. If one accepts that achievement is primarily environmentally determined (McCLELLAND, 1965), it could be asserted that the dominant environment of sport for an aspiring adolescent would have a marked effect upon achievement.

The behavior of people with high achievement motivation is characterized by persistent striving and general competitiveness (ROSEN and D'ANDRADE, 1959). It would follow from this, other things being equal, that boys with high achievement motivation would perform better than those with low motivation. In other words, there is a presumed relationship between the score of nAch and the results of the activity of the athletes, for example, the progress in a sports career.

MORGAN (1972) claims a review of the sports research literature reveals little as to the effect of the various types of incentives on physical performance. The measurement of achievement needs in athletic activities is still in its infancy according to CRATTY (1973). In general, the more familiar measures of achievement needs do not always differentiate athletes from non-athletes or superior from moderately successful athletes.

BETHE and WILLIS (1968) in two independent studies investigated the possible function of achievement in success in beginning handball and inter-collegiate wrestling. Though they concluded that success in inter-collegiate wrestling and beginning handball were not related to achievement motivation for the subjects investigated they recommended that additional research examine the possible relationship of achievement motivation and success in different sport activities and among different skill levels. VANEK and HOSEK (VANEK and CRATTY, 1970) hypothesized that the need for achievement is present in all individuals to varying degrees. This study attempted to ascertain, to what degree achievement motivation is present in adolescent soccer players at different performance levels.

METHOD

Subjects — Fifty-four male adolescent soccer players who ranged in age from fifteen to eighteen years were the subjects for this study. The players were placed in one of three treatment groups depending upon the performance level attained. Eighteen boys who were members of the Canadian National Youth team were group 1 (National) subjects. The eighteen players comprising the Alberta Youth team were group 2 (Provincial) subjects. The remaining eighteen subjects were drawn from two Edmonton youth teams, and were included in treatment group 3 (Club).

Experimental design — A four by three cell design was set up so that the results could be treated by a one-way analysis of variance. The two independent variables were three performance levels of soccer comprised of groups of adolescent boys and four self-report questionnaires.

Instruments — The Two Scales to Measure Achievement Motivation devised by Costello (1967) and two scales Task Soccer Specific and Success Soccer Specific, modified from Costello's scales by the author to measure achievement motivation in a specific sport situation were administered. Costello's Scale 1 is a ten-item questionnaire that measures the need to do well at a task. Scale 2 is a fourteen-item questionnaire that measures the beed to be a success.

Results and Discussion

The data collected consisted of the scores for each subject on four self-report questionnaires. The four questionnaires provided scores for each subject on the need to do well at a task (GN), the need to be a success (GS), the need to do well at a task specific to soccer (TSS), and the need to be a success specific to soccer (SSS).

Table I – Cell means matrix.

	GN	GS	TSS	SSS
National	5.7778	5.779	7.0556	7.3333
Provincial	7.6667	7.2222	8.4444	7.0556
Club	7.0000	7.0556	6.8333	

Table II – Summary of the one-way analysis of variance of the GN scores between the three groups.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between groups	33.036	2.	16.52	7.58 *
Within groups	111.11	51.	2.18	

* $p < .001$.

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A one-way analysis of variance using a DERS computer package (Anova 15) was performed on the data. The information output by the programme is summarized in Tables I-VII. Tables II, IV, V, and VII present summaries of the one-way analyses of variances (Anova 15) between the three experimental groups on each of the four scales. Of the four one-way analyses of variance only the one-way analyses of variance of the GN scores (Table II) and TSS scores (Table V) found that significant differences existed between the experimental groups. A Scheffé multiple comparison (Ferguron, 1971, p. 270) of the GN and Tss group means revealed that both Provincial and Club groups had significantly higher level of achievement motivation (need to do well at a task) than the National group (Table III), and the Provincial group had significantly higher levels of achievement motivation specific to soccer (need to do well at a task specific to soccer) than both the National and Club groups (table VI).

Table III – Probability matrix for Scheffé multiple comparisons of means between groups on the GN scale.

	National	Provincial	Club
National	1.0000	0.0015	0.0543
Provincial		1.0000	0.4058
Club			1.0000

Table IV – Summary of the one-way analysis of variance of the GS scores between the three groups.

Source of Vairation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between groups	18.777	2.	9.39	1.09
Within groups	440.72	51.	8.64	

Table V – Summary of the one-way analysis of variance of the TSS scores between the three groups.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between groups	21.444	2.	10.72	3.30 *
Within groups	165.88	51.	3.25	

* $p < .05$.

Table VI – Probability matrix for Scheffé multiple comparisons of means between groups on the TSS scale.

	National	Provincial	Club
National	1.0000	0.0790	1.0000
Provincial		1.0000	0.0790
Club			1.0000

Table VII – Summary of the one-way analysis of variance of the SSS scores between the three groups.

Source of Vairation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between groups	5.5925	2.	2.80	0.34
Within groups	423.38	51.	8.30	

The failure of the National group to score significantly higher on the GN scale may be explained in any one of the following ways. To begin with, although Costello spent a great deal of time developing his questionnaire it still may not be a valid or sensitive enough device to measure an individual's need for achievement. If one rejects this explanation then it may well be that the National experimental group does not truly represent that specific performance category. If one rejects both of these explanations for the results found using this questionnaire, then it may be concluded that the common assumption that one needs a high level of nAch to attain a high level of performance (McCLELLAND, 1955; ROSEN and D'ANDRADE, 1959; SMITH, 1964; WILLIS and BETHE, 1970; SINGER, 1972) is not tenable. This conclusion is further supported by the non-significant differences from the scores obtained between the provincial and club experimental groups.

If one is unable to accept this conclusion then perhaps we must concur with the speculation that the motives which regulate and energize an individual's life pattern are transferred to specific behavioral situations, such as sport. If we accept this explanation then it may be improper to measure the achievement needs of athletes on scales that are not devised to tap specific needs.

The analysis of the TSS scores found a significant difference between the Provincial group and both the National and Club groups.

The analysis of the TSS scores found a significant difference between the Provincial group and both the National and Club groups.

The failure of the National group to score significantly higher than the other two experimental groups presents a rebuff to CRATTY (1970) and OGILVIE and TUTKO (1967) who feel that achievement motivation, as a focal characteristic, differentiates the superior performer from others in the same activity. Though RUSHALL (1970) and the data presented here tend to disagree with CRATTY, and OGILVIE and TUTKO, there may be explanations to support their thesis.

An explanation for the findings of the lower TSS scores for the National group may be attributed to a shift in behavior from 'instrumental' to 'consummatory' (BIRCH and VEROFF, 1966). In other words, having attained a position on the National team the members have achieved their goal, and hence are no further motivated to strive intensely to perform well. If one accepts this explanation then perhaps one can speculate that those members of the Provincial group have not yet reached their level of aspiration and thus are involved in instrumental behavior, according to the BIRCH and VEROFF paradigm. It may also be true that the Provincial group have not, as yet, reached their maximal level of skill accomplishment.

We must also avoid the mistake of assuming *a priori* that the strength of the achievement motive may be inferred simply and directly from some particular type of behavior (McCLELLAND, 1961, p. 39). We must therefore consider that actual achievement is not a safe index of the strength of the need to achieve.

The analyses of the GS and SSS scores found no significant differences between the three experimental groups.

Two values which are considered to be relevant to goal striving are achievement and success. Achievement refers to exceptional accomplishment — doing a task well: success emphasizes social rewards. It seems to be reasonably clear that in our society one would like to believe that achievement and success, though different, are related and that one will follow the other. If one agrees that they are different and related then we might expect to see a high, negative correlation coefficient.

The analysis of the scores between the GN and GS scales revealed that there was no significance in the correlations, either positive or negative.

The proposition forwarded by VANEK and HOSEK (1970) is that the motive for achievement is deeply established in the human personality and thus is relatively unspecific. That is, it will also be expressed in sport. This thesis is partly supported by the analysis of the data for the GN and TSS scales. A significant positive correlation was found between these two scales in both the Provincial and Club performance categories. If one accepts the thesis of VANEK and HOSEK, then perhaps, as the results of this study partly indicate, it may be acceptable to measure an athlete's nAch on non-specific achievement motivation items.

But, as WEISS has suggested, physical endeavour is one of the few ways in which youth may exhibit excellence. His view is supported by both COLEMAN and FRIESEN who, as was indicated earlier in the paper, have demonstrated conclusively that sport achievement is far and away more important as a value among adolescents than achievement in other spheres of their life, and the data illustrated in Table I tends to be supportive.

If one rejects the stand of VANEK and HOSEK and accepts the suggestion that achievement is primarily environmentally determined (McCLELLAND, 1965), that is, that sport achievement is determined in a sport environment, then we could expect the data analysis to reveal a high, negative correlation between the GN and TSS scales.

A study by BROVERMAN, JORDAN, and PHILLIPS (1960) demonstrated an inverse relationship between day-to-day achievement striving and achievement in a specific environment, such as sport, and thus suggests an alternative channels view of the expression of achievement motivation. Essentially they are saying that persons who are blocked in expressing achievement motivation in 'real life' might be expected to show a great deal of striving on a task which might be more relevant for them. One might extend this thought even further and argue that those subjects in this study who are able to express their achievement needs in life should have no need to exert themselves on tasks which may be considered apart from real-life concerns. Such persons might be expected to show little striving in the soccer sphere.

A negative correlation coefficient was found between these two scales within the National performance category but it was not significant. This finding gives slight support to the alternate channel view of BROVERMAN and his colleagues.

If one accepts the position put forth in the discussion under the GN and GS scales then one might also accept a similar position for the TSS and SSS scales. That is, the variables 'task' and 'success' as they relate to soccer are related but different. Therefore, we would expect to see a high, negative correlation coefficient evolve from the result of the analysis. Such, however, does not materialize.

The National and Club performance categories reveal a significant, positive relationship between the TSS and SSS variables. One might speculate that, for these subjects, attaining success in soccer is equated with excellence in performance. If one accepts an earlier suggestion that the

Provincial group have not yet attained their mean level of aspiration, and are still engaged in instrumental behavior then one might interpret the data to indicate that they, as a group, are more concerned with achieving a standard of excellence in the performance of a soccer task than they are with the success connotations that may be attached to that performance. One might also speculate that this striving for excellence could be the result of environmental conditioning in those subjects whereas the subjects of the other two experimental groups might interpret good performance and success as being one of the same.

The analyses of the data revealed that each performance category obtained a significant, positive correlation coefficient for the two variables, GS and SSS. The Provincial and Club performance levels both received high correlation coefficients ($r = .803$ and $.835$ respectively). The raw scores of the National group, though indicating a significant coefficient ($r = .450$), suggested that success in soccer was more important than general success.

It is recommended that further study of the achievement-motivation-performance level theory is required to clarify the degree and direction of the differences in achievement motivation scores between performance categories. It is also suggested that further study be undertaken to develop sport-specific achievement motivation items that will possess the sensitivity required to accurately measure the athletes' achievement motivation in a sport environment. A further suggestion is that future measures of achievement motivation be compared to scores of other incentive systems that may be operating for the athletes and that the information gained be used in more paractical diagnostic and prognostic terms.

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PRE AND POST PERFORMANCE FACTORS IN ORIENTEERING

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Orienteering is a physical activity which requires decision-making, physical speed, endurance and strength but involves a low risk factor for the participant. Its rules allow both competitive and recreational participation, consequently participants exhibit innumerable qualities and quantities of movement. It is also characterized as an indirect competition since the participant struggles against an objective standard rather than a face-to-face opponent. These characteristics may make orienteering unique as a sport and to understand the pre-performance influences, the movement itself and the post performance characteristics would seem to necessitate an interdisciplinary holistic study. The purpose of this paper is to explore the portion of a holistic study specifically related to the values, activation, personality and social behaviour of adults and children participating in orienteering in Ontario.

In keeping with the need for a theoretical basis for experimental research the following paragraphs briefly cover several theories and the literature which may assist in explaining performance in the four areas investigated in this paper. Particular emphasis is given to activation levels preceding the movement and post activation levels since it is assumed that the movement experience is in part responsible for changes in the activation levels and that the performance activation level reflects the quality and quantity of the movement.

Theoretically one's most extensive movements are in those physical activities which one believes are most important or meaningful. The perceived value of an activity would be a pre-performance factor influencing the quality and quantity of the subsequent activity. Using the "instrumental value" concept KENYON (1968a) developed the Attitude Toward Physical Activity Inventory (ATPA) which indicates six subdomains of possible values of physical activity. Reviews of studies utilizing KENYON's ATPA Inventory (DOTSON and STANLEY, 1972) indicated inconsistency as to the extent of the value of the six characteristics of activity. It was found that general agreement existed for the health, catharsis and aescetic scales whereas there was disagreement on the social scale between various studies. DOTSON and STANLEY suggested that the perceived values of activity seem dependent upon such factors as athletic achievement and type of activity rather than such factors as sex. In an additional study by HIGGS (1972) no differences in attitudes were found between good and average female athletic competitors on the six ATPA scales. However, in another study the ATPA scale scores given before and after eight weeks of physical activity recorded a significant difference in total attitude toward activity for a small group of male and female university students in a group therapy program (WATTS, 1971).

A second pre-performance factor is the personality of the participant. "Since personality is a basic determinant of behaviour, numerous sport psychologists have investigated possible relationships between personality and physical performance but to date no theories have been developed.

HARDMAN (1973) extensively reviews the 16PF personality data on male athletes and concludes that sport performance is associated with such traits as dominance, low tension, emotionality, anxiety and independence. He states that with the exception of intelligence the trait scores show greater deviation from the general population mean for less-able athletes than for international athletes. "The personality profile for this latter group shows greater personal adjustment than that of the less competent players but it is not superior to that hypothesised for the general population" (p. 99).

In depth studies comparable to HARDMAN's (1973) but on female athletes have not been undertaken. However, BIRD (1971) has noted a consistency among female athletes on the traits of high abstract-thinking, tough-mindedness and assertiveness. GERBER, FELSHIN *et al* (1974) provided guidelines for additional indepth and longitudinal studies of female athletes so that possible relationships between personality and performance may be seen. MARTENS (1975) discussed past research weaknesses and suggests directions including the disposition — situation interaction approach for future research in sport personology.

LOCKHART (1971) administered the ATPA, Wear Physical Education Attitude Inventory and the 16 PF (Form A) to 200 university women students. Sixteen of the personality factors related significantly to positive attitudes toward physical activity.

No studies on the personality of orienteerers were located in the literature.

A third factor which may influence movement and which is of interest during the pre-performance, performance and post-performance periods is activation. It has been suggested that activation is an integral part of personality and motivation. FISKE and MADDI (1968) hypothesize that the core tendency of a person's personality is his "customary level of activation". DUFFY (1962) states that more specifically it is the fluctuations in activation that correlate with behaviour. She reports a positive relationship between ease of activation and unstable or neurotic behaviour. In addition, FISKE and MADDI (1968) suggest that attempts to maintain one's customary level of activation causes one to engage in impact-decreasing or increasing physical activity.

The terms "arousal" and "activation" are generally used in the literature to refer to the same phenomena. "Activation" is employed in this paper to refer to the total organismic energy release (DUFFY, 1962) or "one's level of alertness, tension, excitement, arousal, or energy" (ALDERMAN, 1974).

HARDMAN (1973) discusses the literature on arousal in terms of neural response and the YERKES-DODSON inverted — U hypotheses and indicates the influence of various personality traits upon the performance curves of persons possessing these traits. He concludes that the research suggests that:

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1. The more introverted person has a lower threshold level than the extroverted person.
2. The more introverted person would perform better under conditions of lowered arousal and worse under conditions of higher arousal.
3. The more extroverted person would perform worse under conditions of lowered arousal and better under conditions of higher arousal (p. 108).

OXENDINE (1970) summarizes the literature on activation in terms of motor skills and makes the following generalizations:

1. A high level of arousal is essential for optimal performance involving strength, endurance and speed.
2. A high level of arousal interferes with performances involving complex skills, fine muscle movements, coordination, steadiness, and general concentration.
3. A slightly-above-average level of arousal is preferable to a normal or sub-normal arousal state for all motor tasks.

The question follows as to what is the optimal level of activation for maximal performance in orienteering and which assessment tools are most valid.

THAYER (1967) suggests controlled self-report as an r-native measurement form of activation to the ual physiological assessment of groups of participants. The factor analysis of the Activation-Deactivation Adjective Check List (AD-ACL), developed by Thayer to measure the extent of activation and deactivation, yielded four factors representing different points on a hypothetical continuum. According to THAYER (1971) these factors correlated substantially with physiological variables and reflected significant activation changes from diurnal sleep-wakefulness variations and from an impending college examination.

The only other studies using Thayer's Activation-Deactivation Adjective Check List (AD-ACL) found in the literature have been conducted at the University of Guelph. TONG *et al* (1973) using the AD-ACL in a study on smoking reported that the Check List showed that the Ss became more sleepy, tired and drowsy after nicotine ingestion. LYON (1974) however, in a subsequent study of ethanol and nicotine effects, found no significant differences on the subjective ratings of Thayer's Check List. SMITH (1975) found that the Ss' scores on the General Activation scale of the AD-ACL recorded an effect after his Ss ingested nicotine and caffeine.

TONG and LEIGH in research in progress at the Department of Psychology, University of Guelph, found physically inactive male university subjects who, responding to the AD-ACL, recorded activation scores of less than 60% and deactivation scores as high as 66%.

No studies were found which reported the use of the AD-ACL with physical activity.

A fourth theory which may explain the movement patterns and behaviour of orienteers before, during and after performance may be the need or drive for self-esteem and self-evaluation through social comparison, which in turn influences affiliation (FESTINGER, 1954). MASLOW (1970) states that esteem needs can be divided into two categories: first, are needs involved with achievement and mastery and secondly, are needs involved with prestige and recognition. More specifically ALDERMAN (1974c) explains that:

> People have a uni-directional drive upwards in terms of improving or changing their ability levels in the Western world. It's important to perform well in our society. Social comparison with respect to ability evaluation, is the process participants in sport engage in for this evaluation. (p. 49)

In one of the few psychosocial orienteering studies reported in the literature PEEPRE (1974) gathered the opinions of novice orienteerers in order to evaluate and improve courses and competitions. He noted that, "The vast majority of participants realize that orienteering exists as the activity which the individual creates according to personal desires" (p. 3). Competition and self-evaluation motives appeared to exist in these beginners since over 50% indicated that they tried to complete the course as quickly as possible and over 70% indicated a desire to place well at the finish. A desire for social acceptance, self-esteem, mastery or an increase in aspiration level may be present in the frequently expressed intent of the novice orienteerers to move into more difficult courses and elite classifications. Half of the respondents experienced a feeling of "pressure" associated with competitiveness. This pressure may be related to an unaccustomed or undesired level of activation and may be evident when activation level or tension traits are assessed. A sentiment frequently expressed by the respondents was that, "once in the woods the orienteer is on his own; he may feel pressured, but that is essentially a personal choice" (p. 4). PEEPRE concluded that orienteering is one of the few sports flexible enough to accommodate both competitive and recreational opportunities.

PURPOSE

This study investigated pre-performance factors influencing human movement and factors subsequent to the movement from which one might infer movement processes. The study attempted to:

1. Investigate the relationship of participation to perceived values of physical activity.
2. Assess the influence of movement upon activation level through the following investigations:
   (a) The comparison of activation levels of male and female participants.
   (b) The comparison of experienced elite and inexperienced elite competitors.
   (c) The comparison of activation levels of elite (competitive) and open class (recreational) participants.
   (d) The comparison of activation levels of individuals in a vigorous outdoor activity to those of laboratory subjects involved in passive tasks in previous studies.
3. Assess the discriminatory ability of the Activation — Deactivation Check List for vigorous physical activity groups.

4. Determine the personality traits of male and female, successful and less successful elite and open class participants.
5. Determine the criteria of a satisfying day's experience in orienteering.

METHOD

The completed study will be limited to 225 male and female subjects from the ages of 14 years and upward. The subjects will be participants in "A" class orienteering meets held in Ontario and will be selected from persons competing in the Guelph Spring Festival meet, the Ontario Championship and the Canadian Championship.

A minimum of 10 males and 10 females in each elite and open category and a minimum of 25 men in the elite blue course will provide the minimum of 225 respondents. The portion of the investigation reported in this study contained data from the Guelph meet held in May, 1975. As entries for the Guelph meet were received a letter requesting the orienteerer to participate in the study, a background information sheet and the KENYON ATPA were sent to men and women, boys and girls 14 years and over in each of the elite and open classes. The THAYER AD-ACL was completed at the meet by each S in the pre-start area of each course and the same check list was repeated immediately upon crossing the finish line. Each subject then received a mailing envelope containing the 16 PF (Form A) or the Jr. — Sr. High School Personality Questionnaire to be completed at home.

All self-report measures were hand scored as prescribed by the test directions. General population norms were used with the 16PF. The AD-ACL scoring system is a Likert-type five point scale from which raw scores were converted to percentages. A priori weights were used to score the ATPA since NUNNALLY (1967) recommends the unweighted summation of item scores.

RESULTS

Observation of the movements of orienteerers during the meet showed that some Ss ran, others walked, some went in family groups, some chatted and even stopped to help others who were lost. At check points some sighed with relief, some fell to their knees and a few looked confused as to the direction in which to continue. At the finish line some were exhausted, some were happy to find the gate but regardless of what happened on the course the majority of Ss seemed to immediately compare their problems and successes with another orienteerer.

Gross observations of this type made in the field stimulate questions related to movement but are impossible to accurately record and do not provide data on why the Ss participate in this movement experience nor the processes involved in the movement. Consequently as a starting point for the study of orienteering self-report measures were undertaken.

The number of respondents to each of the self-report instruments is shown in Table I. Response to pre-meet forms was greater than to either meet or post meet forms. A total of 56 Ss took part in this portion of the study. The small sample size in some of the orienteering classes necessitated placing the Ss in only four groups and precluded statistical analyses at this time, consequently only percentages and trends were discussed.

Table I – Number of Respondents to Each Self-Report Instrument Within Each Group.

Group	Demographic Questionnaire	ATPA	AD-ACL	16PF or JR.-SR. HSPQ
Adult Males	27	28	18	18
Adult Females	11	13	8	6
School boys	10	9	9	6
School girls	5	3	1	3
TOTAL	53	53	36	33

The demographic information indicated that 71% of the adult orienteerers were in professional occupations and 84% had formal education beyond Grade Thirteen. These orienteerers, particularly the men, were quite experienced competitors since they had participated in an average of 20 meets. Seventy-six per cent of all Ss stated that a successful day of orienteering implied an improvement in the time it took them to complete the course and that they found the control points more easily. The next largest percentage, 41%, indicated that meeting friends made the greatest contribution to a successful day. Only 18% felt that winning was the most important criteria of a successful day.

In response to the Attitude Toward Physical Activity Inventory both the adults and school children of both sexes were most positive to the cathartic value of activity (table II). All four groups also expressed positive attitudes toward the social and health values of activity. Adult males were the most positive toward the aesthetic aspects of activity whereas females and school boys were negative to this factor. Physical activity did not have ascetic value for the adults but it did have a limited value for the school children. The school children expressed a more positive attitude toward the presence of vertigo in activity than did the adults.

Adult males and females seemed to differ in their self-reported values only in that females were more positive to the social value and males more positive to the aesthetic and vertigo values of activity.

There appeared to be no great differences in attitude toward the six factors of the ATPA held by the male elite as compared to the male open class participants. The number of females and school children was too small to warrant statistical treatment at this time.

Table II – ATPA (DW) and ATPA (DM) Sub-domain mean and rank scores for each group.

Sub-domain		Social	Rank	Health	Rank	Vertigo	Rank	Aesthetic	Rank	Catharsis	Rank	Ascetic	Rank
Group	N												
Females	13	36.23	1	46.93	3	36.70	6	34.37	4	40.77	2	28.23	5
School girls	3	38.33	3	48.66	4	45.00	1	36.66	6	43.33	2	34.33	5
Males	28	41.03	4	42.68	2	37.28	5	42.60	3	40.32	1	36.07	6
School boys	9	47.33	2	43.44	4	43.77	3	36.11	6	44.00	1	41.00	5
Total	53												

The 16 PF profile of 18 male adult orienteerers based upon general population norms indicated that this group was bright (B), affected by feelings (C), sober (F), shy (H), self-sufficient (Q_2), and tense (Q_4) in comparison with the average range of sten scores. Dividing the scores of this group of male orienteerers into 9 elite and 9 open class participants resulted in profiles which seemed to indicate that the elite were higher in abstract-thinking, tender-minded, suspicious and less self-sufficient than the open class participants.

The six females adult orienteerers' profile scores based upon college norms showed them to be reserved, bright, emotionally stable, assertive, conscientious, venturesome, suspicious, imaginative, apprehensive, self-sufficient and controlled in comparison with the average range of sten scores.

The profile scores of the 6 school boys responding to the Jr.-Sr. HSPQ all fell within the average range except for a higher score on enthusiasm. Too few female school girls completed their personality inventories to warrant drawing a profile at this time.

THAYER (1971) considered the General Activation (G.A.) factor to best represent moderate activation feelings which did not particularly describe feelings associated with anxiety or high stress. In addition, this factor correlated more consistently with physiological composites than the other three factors. The pre and post activity G.A. scores for each sex showed a similarity in pre-activation levels but a much lower post-activation score for school boys and females than for males (fig. 1). THAYER (1971) indicated that the Deactivation-Sleep factor had been stable on all factor analytic analyses and that there was a possible inverse correlation with the General Activation factor. This would appear to be true for this sample of orienteerers since the pre-activity scores were very similar and the school boys' and to a lesser extent the females' post activity scores rose to a greater extent than did the scores for males (fig. 2).

The same characteristics for each group were also evident on the High Activation scale (fig. 3). THAYER (1971) indicated that the General Deactivation factor had been the least stable of all factors. This factor did not appear to differentiate between groups nor between pre and post activation levels for this group of orienteerers (fig. 4).

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Figure 1 - Pre and post scores for each group on the general activation scale.

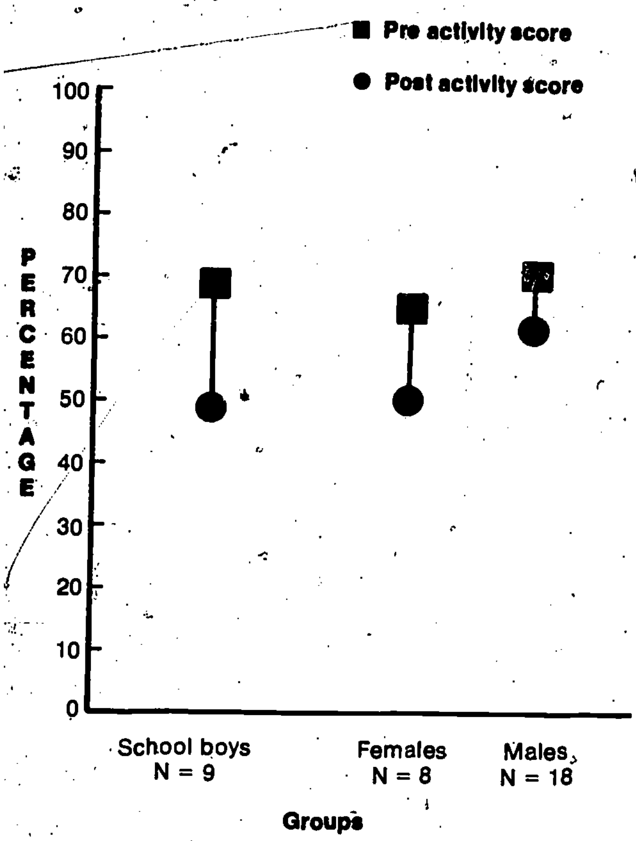


Figure 2 - Pre and post scores for each group on the deactivation-sleep scale.

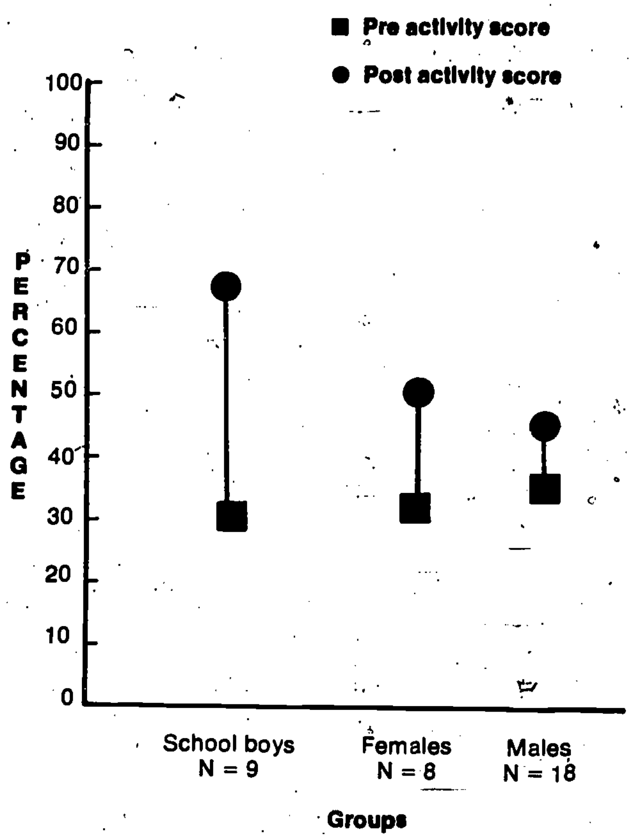


Figure 3 - Pre and post scores for each group on the high activation scale.

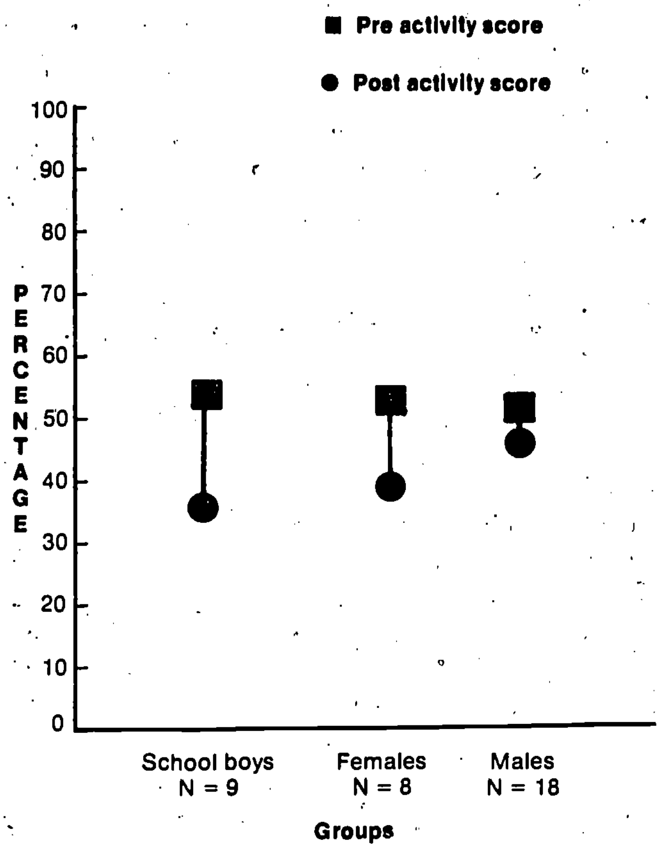
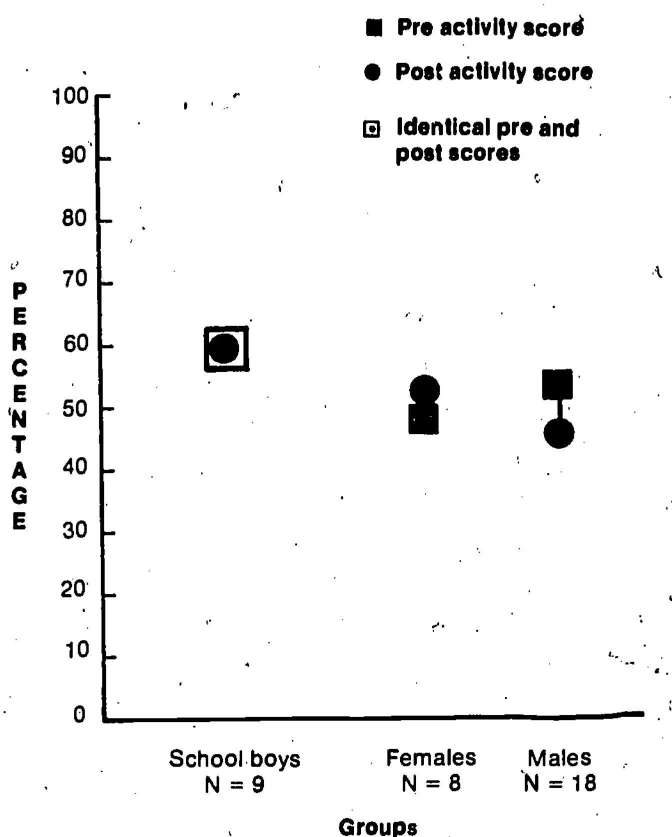


Figure 4 - Pre and post scores for each group on the general deactivation scale.



Only the scores of the male orienteerers were divided into open and elite classes for further analysis in this preliminary report. The General Activation scale showed the greatest differentiation between the open and elite classes to the extent that the post activation score of elite competitors dropped 16.3% as compared to only 2.3% for the open group (fig. 5). The elite group appeared to be a little less activated or anxious than did the open class participants (fig. 5).

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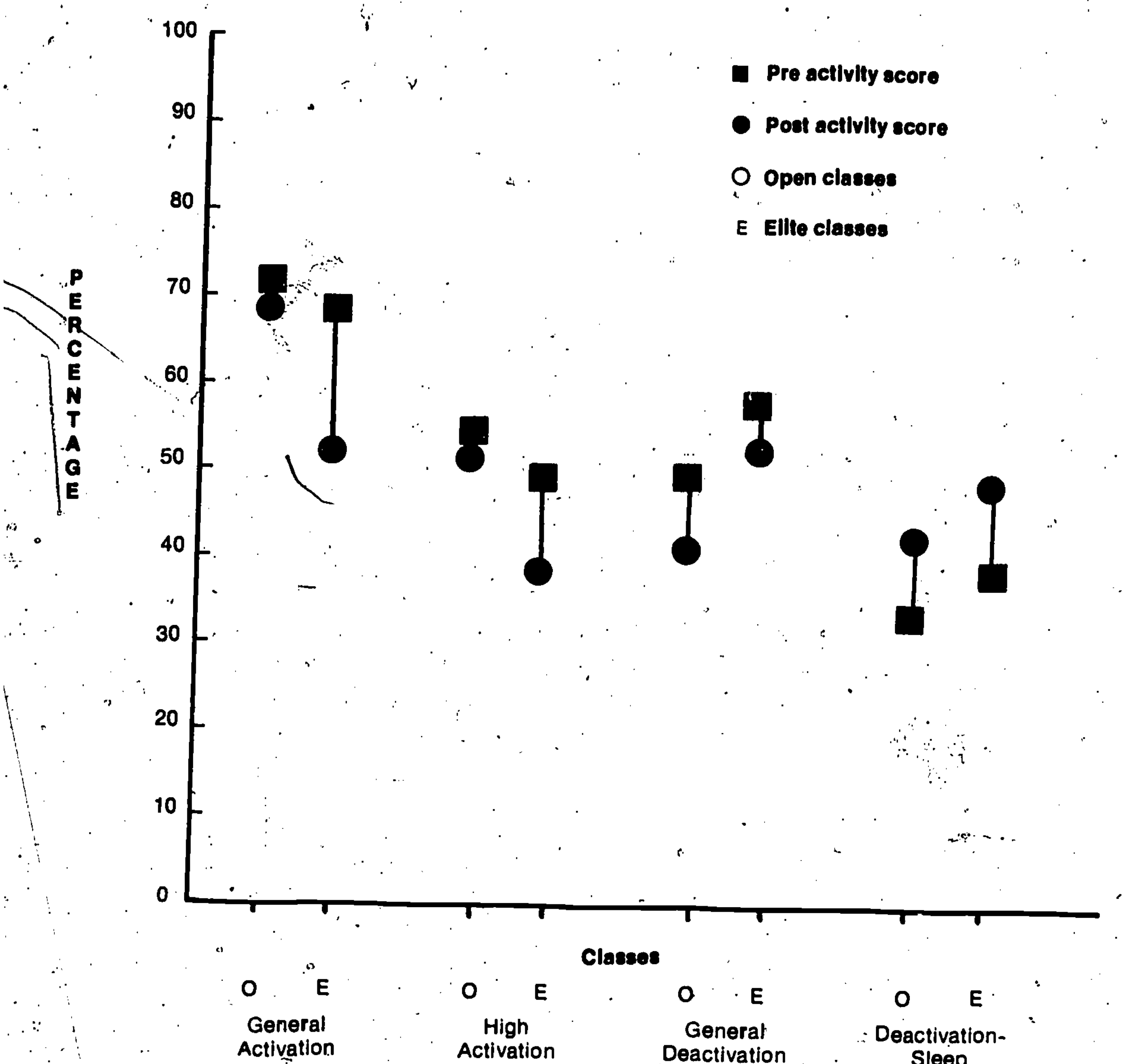
Figure 5 - Male pre and post AD-ACL scores for the elite and open classes.



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DISCUSSION

With the high educational and professional qualifications of this group of participants one would assume a high level of self-perception and introspection and consequent validity of self-report measures. The striving to improve one's time on the course as expressed in the questionnaire and the movement of participants to increasingly difficult courses and classes seems to be in keeping with the upward drive in Western society. The behaviour of discussing one's movement experience immediately upon finishing the orienteering course would seem to be explained by FESTINGER's (1954) social comparison theory which states that "there exists, in the human organism, a drive to evaluate his opinions, abilities [and emotions]" (p. 117) (ALDERMAN, 1974, p. 252).

The Ss expressed positive attitudes toward physical activity as a cathartic and healthful experience and ranked the ascetic experience last among the perceived values as have athletes in other studies. The adult females, as in some other studies (ANASTASIA, 1958), showed a greater social orientation than did adult males.

Pre-performance activation levels were not higher for females and youngsters as hypothesized but were strikingly similar in all groups. The dissimilarities occured in post-performance levels where the activation and deactivation-sleep levels showed a greater decrease for females and school children than for adult males. The General Deactivation Scale did not show this trend and may, therefore, as THAYER (1971) suggested, have the least power of discrimination. The greatest differences in pre and post activation levels were found on the Deactivation-Sleep Scale and General Activation Scale; therefore, these may be the most sensitive scales to activation changes or to measure the self-perceptive activation characteristics most completely or accurately. Further study using these scales may be warranted.

The noticeable decrease in the post-performance activation level of elite males on the GA and HA scales as compared to the male open participants may indicate a return to a more normal level of activation for these persons after their response to a competitive and physically vigorous activity. This may be worthy of further analysis and a comparison of the experienced elite with the inexperienced elite competitor. The decrease in activation level may not occur to the open competitor or may occur some time later. Activation levels as high as 60-70% have not been found in laboratory situations, therefore, those recorded on the pre-performance G.A. scale may be presumed to fall sometime after the performance. The H.A. scale indicates, according to THAYER, some stress and anxiety and here again one notes that the elite performer exhibits a decrease in activation after the movement experience but the open performer does not. The D-S scale may have an inverse correlation with the G.A. scale, according to THAYER, and one again there was some indication that the elite were less activated.

The AD-ACL scores of the non-active male subjects reported by TONG and LEIGH showed at least 10% lower pre-activation and deactivation levels and at least 16% greater post-activation-deactivation levels than was shown by the male orienteerers. This would seem to indicate some test validity for differentiation between active and non- ctive subjects.

The questions of the relationships betwe... perceived value of physical activity and the type and quality of the movement, between value and activation level and ! ,tween personality traits and activation level must remain unanswered until further data have been compiled. The influence of the movement experience upon the pre-performance state as inferred through post-performance analysis remains as the most interesting question to those concerned with human movement since the movement experience capsulizes all the pre-performance factors and brings them into play in one performance and then radiates into new interactions and is restructured before the next movement experience.

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PSYCHO-SOCIAL PARAMETERS IN YOUNG FEMALE LONG DISTANCE RUNNERS

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In recent years there has been a dramatic upsurge in female participation in areas of endeavor, previously considered as bastions of male superiority. BROOM and SELZNICK (5) have noted that in western society, masculine and feminine roles are associated with sharp differences in temperament. The female is seen as naturally non-aggressive and passive. ULRICH (30) has noted that the female plight is augmented in America by the tradition that it is "American" to be aggressive and competent. MEAD (23) however has pointed out that sex roles are primarily cultural and not universal.

BARDWICK (4) has commented on the characteristics of dependence found in the American female:

> An independent sense of self with a resulting sense of self esteem can only evolve when the individual, alone, sets out to attain goals and with reasonable frequency, achieves them. For many reasons... the American girl rarely achieves an independent sense of self and self esteem.

BARDWICK (4) has inferred that in some respects the male sexual identity and sense of self is easier to achieve due to the cultural ambivalence surrounding appropriate female behaviors. Perhaps, in no area of endeavor is this ambivalence more prevalent than in the area of sport.

Historically, women were excluded from sport because of the alliance between sports and war (12). Gradually, in this century they have become more active in sport to the point where females are now seen in nearly all areas of sport but not without cultural ambivalence. METHENY (24) has noted that in our culture, socially acceptable areas of sport involvement for the female is associated with those activities involving projection of the body through space in aesthetically pleasing patterns, using force through a light implement or overcoming the resistance of a light object with skill manipulation. Traditionally, sports involving body contact, application of force to a heavy object or projection of the body through space over long distances have been considered socially unacceptable.

A relatively small number of females have dared to enter these "socially unacceptable" areas of sport. Since they are so few in number their accomplishments are notable. A 17 year old woman presently holds the English Channel record by 26 minutes, while a 33 year old woman was the winner of the 1973 100-mile AAU open supermarathon run. In 1967, the first female ran in the Boston Marathon against the wishes of several meet officials. In 1975, 40 women started and all but a few finished. We know little of these champions and less of those young female athletes who may be the champions of tomorrow. GARAI and SCHEINFELD (11) have noted the general lack of research into the psychology of the female athlete. The purpose of the present study was to determine selected psycho-social factors associated with a group of teenage female long distance runners.

1. Data were collected when Dr. Burke was visiting professor of physical education, Department of HPER, Syracuse University.

METHOD

The subjects in the present study were limited to 13 post-pubescent females, ages, 13–18 yrs. ($\bar{X}$ = 15.77; SD = 1.74). All were members of the Syracuse Chargers Track Club under the sponsorship of the city of Syracuse and Syracuse University. The 2½ year old program is coached by the head track coach from the University and is open to all citizens of the greater Syracuse area (population, 350 000).

Anthropometric and psysiological measures have been reported in another paper (6). To summarize, these females have a bone structure ideally suited for long distance running; they are low in percent body fat; and extremely high in VO_2 max which is possibly the most important limiting factor for success in middle and long distance running. The group includes 5 members of the 1974 U.S. National Cross Country Championship team, the current American record holder in the 15-mile run and a medal winner in the mile at the 1975 AAU National Junior Olympics.

All psychological data were collected over a 3-month period from May to July of 1975. The subjects met for three one-hour testing sessions. The initial session was used to administer the California Psychological Inventory (CPI). The second session was used to administer the Nowicki-Strickland test for locus of control (26). The last session was used to administer an open-ended questionnaire consisting of 16 questions designed to assess motives, attitudes and beliefs of the group.

RESULTS AND DISCUSSION

Questionnaire

Each of the questions will be listed followed by a discussion of the findings:

What do you like best about running?

The most common response to this question dealt with the feeling of individual freedom associated with running e.g. "I guess the thing I like the most is that it's something individual — it's my body and it's all mine alone, my running efforts and rewards are things I've achieved by myself (coaching excluded). There is so much satisfaction in running and running well — it builds your confidence and makes you a better person." A corollary theme expressed was "feeling good" such as: "I feel good when I run" or "I like the feeling of being in good shape." These responses agree well with the observation of HARRIS (14) who reported that female athletes "feel better, without exception" as a result of sport participation. This sense of feeling better may be a function of both psysiological and psychological interaction. The anthropometric and physiological characteristics of these subjects are ideally suited for running. There is abundant research (1) to indicate the VO_2 max and body type are

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powerfully influenced by heredity. Thus, these individuals possessed the potential to become outstanding runners. MASLOW'S (22) theory of self actualization — to become all that one is capable of becoming is self fulfillment — may, in part, explain the sense of "feeling good" due to running.

List the factors which influenced your decision to join the Chargers. To continue running for the Chargers.

When asked why they joined the Chargers, the reasons most commonly expressed were: (1) the coaching, (2) the opportunity for competition, and (3) socialization responses. Due to the lack of opportunity for coaching and competition, it is not surprising that the opportunity to run for a university level coach and compete with similar athletes around the country were motivating factors.

In response to the second question, only 2 subjects failed to include some remark which indicated close friendships among team members. Typical remarks were: "Closeness of team members (like a family)" or "kids are great." These responses are consistent with earlier reports which have indicated that socialization is a major factor in athletic involvement for females (20, 28). Other common responses were: (1) travel opportunities[2] and (2) the coaching. Four subjects expressed the opinion that they "have to run". One stated simply, "It's something to do instead of sitting around". This comment was expressed more frequently in a group of national class age group swimmers (7).

Make a list of the most important things in your life.

Only one subject failed to include track as one of the most important things in her life, while only two failed to include school or a similar response involving preparation for later life. MACCOBY (19) has pointed out that in high school there is a tendency for females to withdraw from competitive, aggressive behavior which may be interpreted as unfeminine. CRATTY (8) has noted that most girls drop athletic endeavors in early adolescence around age 15 or 16. It may be inferred that these subjects were independent and have "seen through" such cultural road blocks.

In a few words, how do you feel after winning a race? After you lose a race?

Uniformly, the responses to these questions reflected the importance of achievement in running. Most subjects gave responses to the first question which included the positive connotations associated with winning. Typical of the responses were: "I feel happy, proud, like I've accomplished something," or "I feel satisfied, confident, positive," or "there's a happy feeling inside me". Approximately 40 percent, however, responded by indicating the importance of comparison with their own "best" time. Similarly, in response to the question concerning losing, over 60 percent indicated that the "time" is the basis of satisfaction. This finding may be partially due to the lack of ambiguity in standards of track performance. In addition however, it may be noted that MALUMPHY (21) has found that women were reported to lose and win well. They are concerned with level of competition and how well they play the game. Nevertheless, the remainder of the subjects responded with comments such as: "When I run bad I feel disgusted or "frustrated, disappointed, lack confidence."

Have you ever participated in team sports? In a sport requiring extensive training?

All but one of the subjects had participated in team sports prior to involvement in running. These sports included: basketball, volleyball, touch football, field hockey, gymnastics and swimming. Four subjects had previously trained for swimming, while one had trained for gymnastics. All are now participating exclusively in running. Is it not possible that there are numerous young females who now participate in more traditional sports who would become runners if the opportunity was available?

Make a list of your heroes

Three subjects said that they had no heroes. All others listed female athletes with the exception of one individual who included in her list the late Steve Prefontaine, the long distance runner, recently killed in a car accident. Of interest, was the finding that almost half of the respondents listed a college-aged, highly successful fellow club member as their hero.

Of the individuals you associate with most often, approximately what percentage shares your interest in running? What percentage participates regularly in a sport other than track? What percentage do not participate in sport?

The subjects reported that approximately 75 percent ($\bar{X}$ = 74.8) of the people with whom they most often associate are fellow track athletes (over half of the subjects reported 90 percent or greater, while one subject reported only 25 percent). Approximately fifteen percent ($\bar{X}$ – 15.2) of their friends participated in sports, other than track, while only 10 percent participate in no sport. These findings indicate a possible method for reducing the cultural ambivalence associated with the female who participates in long distance running. These results agree with the observations of SHERIF (29) who noted that the best way to predict sports involvement is to observe who the girl regularly associates with in and out of school. KANDEL and LESSER (16) found that a reference group of peers comes to be the most potent source of influence on adolescents' decisions.

2. Certain members of the team were soon to travel to San Francisco to defend their National Cross Country Championship.

Sibling Order

No pattern could be discerned concerning sibling order. First borns and second borns were approximately equally represented, with one subject the third in a family of 3 and another subject the fourth in a family of 4. Four subjects had older brothers with only 2 of these older brothers participating in sport. PORTZ (27) reviewed the recent literature and concluded that sibling status is not the primary determinant of personality. Neither LANDERS (17) nor GERBER *et al* (12) could find a sibling hypothesis for sport participation and interest.

Did either or both of your parents play a role in your decision to be a runner?

Only 2 subjects (sisters) reported the influence of a parent; their father. All others stated that the family had no role in their decision. One subject reported parental concern with consequent pressure to drop her running. This finding is in sharp contrast with reports of a group of national class female age group swimmers (7). These differences may be due to the greater social acceptability of swimming for the female, at present. With the greater publicity given, there is possibly greater vicarious involvement by the parent.

What are the most important factors to be a successful runner?

The runners seemed to feel that there are 3 primary factors which contribute to running success. They were: (1) determination and dedication, (2) training, and (3) being competitive.

What factors affect your goals for future performance?

The factors involved in future performance were (1) their future attitude toward running (2) the college which they attend and the (3) possibility of injury.

Test Data

Locus of control or what some authorities refer to as internal versus external orientation (I-E) may be defined as the control which individuals perceive they have in shaping their own destiny. "Internals" believe that they are in charge of variables which affect their lives while "externals" perceive their world as controlled by forces outside themselves (26). Although numerous research studies have been conducted to determine the orientations of individuals from various cultural, ethnic and situational environments, there is a dearth of research dealing with locus of control in athletes (9, 15, 18) in general and female athletes in particular.

I-E scores were: $\bar{X} = 9.25$, $SD = 5.55$. When compared with norms for females of similar age and grade in school, the subjects in the present study are shown to be significantly ($p < .025$) high in internality. Intuitively, this would seem to make sense. It would seem appropriate that an individual who runs 6-8 miles daily in snow, rain and heat, gradually seeing her reference performance (run time) improve, would believe that she has some degree of control over her world. An intriguing question left unanswered concerns the degree to which these runners were internal prior to formal training and the effect of training in altering one's view of the world.

The only scale of the CPI found to be significantly different ($p<.01$) from high school aged female norms was achievement by way of independence (Ai). GOUGH (13) has described individuals high in this trait as being "independent and self reliant; and as having superior intellectual ability and judgment". Furthermore, MINTON (25) has found a significant relationship between internal control and need for achievement. That these individuals would be high in independence could have been predicted by the comments of Bardwick (4):

> It seems to me that independence is achieved when the child is able to see himself as generally successful in achieving goals... what matters is not so much the content of the goal as the nature of the resolution.
>
> Independence in achievement behaviors results from learning that one can accomplish by oneself, can rely upon one's abilities, can trust one's own judgment and can become invested in a task for its own sake.

Although no formal test was made for the presence of achievement motivation (N_{ach}), the evidence for the presence of such a construct in these individuals is overwhelming. Atkinson (2) has defined N_{ach} as a motive to be competent in a situation in which there are standards of excellence. Such an individual takes pride in his work when he is held responsible for his actions. The person with a high achievement motive has developed internal standards of excellence, is independent, persistent, undertakes realistic tasks, performs well academically, and has clearly understood goals. The subjects in the present study train long hours daily with the goal of achieving success in running (Table I) and do well in school (Table II). Nearly all place track and school in a first

Table I – Means, Standard Deviations and Range for Training and Performance Data.

	$\bar{X}$	SD	Range
Age when subject recalls discovering that « running is enjoyable »	12.70	2.91	8–17
Age when formal training began	14.10	1.79	11–17
Months of Continuous Formal Training to date *	26.40	5.06	18–36
Typical Training Days per week	7.0	—	7.0
Miles Run in a « Typical Week »	57.83	14.02	42-90
1 mile run time (sec) **	308.5	22.45	249-331

* Injury time included.

** While the athletes prime event ranged from the 1/2 mile to 15-mile run, all had run in a competitive mile.

Table II – Psychological and Scholastic Data.

	Teenage X̄	Female SD	Runners Range	Teenage X̄	Female SD	Norms p
Grade in School Completed	10.10	1.37	8–12			
Average in School *	89.80	3.99	85–95			
I-E (26)	9.25	5.55	1–19	13.02	5.32	<.025
CPI-Ai (13)	21.42	5.35	15–33	15.50	4.20	<.01

* 70–79, C; 80–89, B; 90–100, A.

** Studentized t-test.

of their most important things in life. FEATHER (10) has stated that those with high N_{ach} usually direct and take responsibility for outcomes while those with low N_{ach} tend to regard outcomes as beyond their control. That these subjects were independent and high in internality seems to fully support this contention.

Commenting on the lack of research in N_{ach} with females, BARDWICK (4) maintains that in women, N_{ach} is inextricably linked with another need — that of affiliation. The runners in this study tend to support this hypothesis. As a motive for continuing to train, they tend to include the close personal friendships with team members.

Summary

This study has described a young female who trains daily and achieves some measure of success in track and in school work. She has hereditarily based characteristics which make success in running possible. She enjoys running and has apparently "seen through" the myth that females are supposed to act in certain culturally prescribed ways. She begins to train partly because of the joy of running, the coaching and competitive opportunities and continues to run for the same reasons with the addition of the close personal friendships with team members. Although independent she associates primarily with other athletes. She believes that she has the ability to control her world. She is probably high in achievement motivation striving to be competent in situations where standards of excellence exist.

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SPORT PARTICIPATION: In Pursuit of Psychological Androgyny A Study of High School Athletes and Non-Athletes *

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Some recent efforts in psychology have been directed at reassessing the effects of sex-typing, as it relates to psychological well-being and behavioral flexibility (BEM 1972; BROVERMAN, 1970; MACCOBY 1966). Research on highly sex-typed individuals has provided evidence which supports the notion that a high level of sex role development is not conductive to behavioral flexibility and does not necessarily facilitate general social or psychological well-being (BEM, 1974).

MUSSEN'S (1961) study of high and low masculine boys generally concluded that masculine boys did seem to have better social adjustment during the teen-age years. However, his follow-up study with this same group of males twenty years later showed that the high masculine group exhibited less dominance, less self-acceptance, less capacity for status and more need for abasement (MURREN 1962). While highly masculine men were found to be more adaptive to stress and more self-sufficient they were also rated as less self-assured, less sociable and less likely to be leaders (MUSSEN, 1962). In another study by HARFORD (1967), high masculinity was positively correlated with guilt proness, neuroticism, tough poise and anxiety.

Studies on females have shown that high femininity is generally associated with poor adjustment, low social acceptance and high anxiety (GRAY, 1957; COSENTINO and HEILBRUN, 1964; WEBB, 1963). MACCOBY'S (1966) summary of the effect of sex-typing on intellectual development concludes that greater intellectual development seems to be associated with cross-sex typing. As BEM states, "Boys and girls who are less sex-typed have been found to have higher overall intelligence, higher special ability, and higher creativity... in girls, impulsiveness and aggressiveness are positive factors, whereas fearfulness and passivity are negative factors. In boys, the pattern of correlations is exactly the reverse." (BEM, 1972, p. 6)

Further investigation into the evidence on cross-sex typing led to the conceptualization of a new psychological rubric i.e. androgyny. Because typical measures of masculinity and femininity tended to polarize male and female attributes, making it difficult to recognize individuals who possessed more androgynous psychological frameworks BEM (1974) constructed a sex role inventory which placed masculinity and femininity on a single dimension thus allowing for the identification of the androgynous individual.

Recent research by BEM (1975) on the behavioral flexibility of individuals whose psychological frameworks are androgenous, as opposed to sex-typed, has provided evidence which supports the contention that androgeny facilitates behavioral flexibility and may reflect a more desirable state of psychological and social adjustment.

In accordance with the situation — specific theory of behavior (MISCHEL, 1968) a psychologically androgynous individual is one who has incorporated within his or her psychological framework a balance of tradition masculine (instrumental) and feminine (expressive) attributes and is thus able to respond to situations with the appropriate behavior required regardless of sex role expectations. BEM's research (1975) in this area found that sex-typed individuals tend to exhibit defensive, tract-like consistency in their response to situations which called for behavior in conflict with their perceived sex role expectations. Androgynous individuals however, were able to respond effectively to situations regardless of whether the appropriate behaviors required were in or out of their sex-role expectations. In summary, BEM asserts that the concept of psychological androgyny is a reliable one, and that highly sex-typed individuals do not reflect a general tendency to respond in a society desirable direction (BEM, 1975)

The evidence which supports psychological androgyny as a preferable alternative to sex-typing, raises the issue of determining what activities might facilitate androgynous development. One possible approach is suggested by self-perception theory which states, "Individuals come to 'know' their own attitudes, emotions and other internal states partially by inferring them from observations of their own overt behavior and/or the circumstances in which this behavior occurs (BEM, 1972, p. 2)." Attitudes may thus be viewed as the result, as well as the motivations for individual behavior.

THE PROBLEM

Applying this theory of attitudes resulting from behaviors patterns to a specific-professional issue involved investigating the attitudes of female athletes and non-athletes toward sport and physical activity. Taken together these two theories illucidate the psychological effects of the growth of girls' sport programs on adolescent females. Girls who participate in cross-sex type behavior (in this research sport) should, according to self perception theory display cross-sex type attitudes toward sport and physical activity. A female's overall psychological androgyny would thus be enhanced by her ability to incorporate cross-sex typed attitudes into her psychological framework (self-concept). The author hypothesized that in comparing female athletes and non-athletes, athletes would entertain significantly more positive attitudes toward physical activity by reflecting a higher degree of both sex neutral motivations and masculine motivations for physical activity.

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PROCEDURES

A questionnaire was devised which assessed the degree of personal involvement and personal motivation experienced by participation in physical activity. (DUQUIN, 1974). The eight motivations studied included physical activity as:

(1) a social experience;

(2) maintenance of health and fitness;

(3) catharsis;

(4) an aesthetic experience;

(5) pursuit of vertigo;

(6) an ascetic experience;

(7) a chance to compete and

(8) physical efficacy.

Four of these motivations were considered sex-neutral and four were considered to be masculine motivations for physical activity (i.e. vertigo, ascetic, competition, physical efficacy). KENYAN (1970) found in previous research, that males rank physical activity as the pursuit of vertigo and as an ascetic experience more often than do females. The author included physical efficacy (feelings of strength and powerfulness) and sports-as-competition as additional masculine motivations based on Bem's Sex Role Inventory (BSRI). (BEM, 1974)

Athletes were defined, in this study, as those females who had participated on an interscholastic or community sports club team during their high school experience. Non-athletes were defined as those females who had not had such previous experience. The questionnaire was given to samples which included 1000 (one-thousand) non-athletes and 300 athletes from ten suburban (Bay Area, California) schools and 1004 non-athletes and 620 athletes from 11 city (Pittsburgh, PA) schools.

The statistical procedure used to treat the data, was the Cochran and Cox method of computing the t for unequal N's and unequal variances. Significance for this study was set at the .001 level.

RESULTS

Tab. I illustrates the differences found between city athletes and non-athletes and suburban athletes and non-athletes. As hypothesized, significant (.001) differences were found on all eight motivations. Rank orderings of these differences are also supplies in Table I. It is interesting to note that the two highest significant differences appeared in two masculine motivations, (i.e. competition and vertigo).

Table I – Rank order of t values for differences between athletes and non-athletes in city and suburban environments on eight motivations for physical activity.

Motivation	City t values	Motivation	Suburban t values
Competition	12.58 *	Competition	13.38 *
Vertigo	10.49 *	Vertigo	9.71 *
Health/Fitness	8.81 *	Social	9.53 *
Aesthetic	8.42 *	Health/Fitness	8.97 *
Ascetic	8.32 *	Ascetic	7.72 *
Physical Efficacy	7.75 *	Aesthetic	5.63 *
Social	7.54 *	Catharsis	4.49 *
Catharsis	7.32 *	Physical Efficacy	3.90 *

In corroboration with previous studies (MALUMPHY, 1968; RECTOR, 1971) the results of this research also support the belief that female athletes do not necessarily see their participation in sports as being in conflict with what they perceive girls ought to do. Additional statements on the questionnaire inquired as to whether the girls believed sport participation was an important activity *for girls*. Athletes were significantly more positive in their belief in the importance of physical activity and sport, both for themselves (city $t = 10.69$, suburban $t = 13.56$, $p < .001$) and for girls in general (city $t = 6.01$, suburban $t = 0.09$, $p < .001$).

No significant differences were found between city and suburban athletes over all eight motivations. However, city athletes were found to rank physical efficacy significantly ($t = 6.06$ $p < .001$) higher than suburban athletes while suburban athletes ranked physical activity as a social experience higher ($t = 3.88$ $p < .001$) than the city sample. The author suggests that the more aggressive nature of city life may justify the sanctioning of strength and powerfulness in city females more than in suburban females. This notion is supported by the fact that city non-athletes also ranked physical efficacy significantlv hinher ($t = 6.12$ $p < .001$) than suburban non-athletes.

CONCLUSIONS

This research tends to support the notion that the growth and increased status of girls sport programs may help to facilitate androgynous development in adolescent females. Because sport participation is culturally viewed as a male sex-typed activity and is associated with such masculine attributes as competitiveness, aggressiveness, risk-taking, etc., females who participate in sport, come to adapt those attributes (while not necessarily rejecting the feminine attributes they perceive in themselves) thus increasing their potential for an androgynous self-concept.

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PHYSICAL EDUCATION DROP OUTS: SOME RELATED FACTORS

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INTRODUCTION

For the past eighty-five years physical education has been a compulsory subject for high school students in Ontario (COSENTINO & HOWELL, 1970). However, it became a completely optional subject for the first time in 1972. Since that time there has been a decrease in the number of students participating in physical education even though there has been a province-wide increase in the total student population. Approximately 29 percent of the total population in Ontario public high schools (175,000 students) were not enrolled in physical education in 1973-74 (Ministry of Education, Ontario, 1974).

Why do students opt out of physical education when they have a choice? ORLICK (1972) investigated the participation and non-participation of eight- and nine-year olds in sport. He concluded:

1. Participation was largely dependent upon environmental factors, particularly family sports environment.
2. Three major factors within the child's environment appeared to account for his attraction to, or avoidance of sports participation, (a) the significant sport role models which were available to the child, (b) the expectancies the child had regarding sports participation and (c) the sport-related reinforcement contingencies to which the child was exposed (ORLICK, 1972, p. 151).

Elsewhere, in a paper on the athletic dropout he found that young children dropped out of sports because of lack of exposure (i.e., playing time) and because of a lack of success in the sports environment. "For many children competitive sport operates as a kind of failure factory... For the majority of the children the goals and rewards in terms of positive outcomes are consistently out of reach" (ORLICK, 1973). SCOTT (1973) stated that high school football dropouts, if they are in a situation where there is no "cutting" recognize the coach's devaluation and drop out on their own accord. The dropouts quite often reported that the cause for dropping out was lost interest. From the sports related literature it appears that the main factors related to participation are available sports role models, the expectancies the child had regarding participation and the sports related reinforcement. The main reasons for sport dropouts were found to be lack of playing time, lack of enjoyment, and lack of success.

PERCEPTION OF SELF AND PARTICIPATION

There are several characteristics of people with low self esteem which might account for their opting out. They are highly sensitive to criticism, ridicule, failure and inadequacy. They feel threatened by others and doubt that they have much worthwhile to offer. They feel self conscious about performing in front of others and awkward when trying new tasks (ROSENBERG, 1965). Several studies have shown a strong relationship between feelings about the body and feelings about the self (SECORD and JOURARD, 1953; ROSEN and ROSS, 1968; FELKER, 1968, ZION, 1965). It seems that body image influences the way people feel about themselves and the way people feel about themselves influences their behavior. Consequently, it is probable that the way a student perceives his physical self and total self will influence his participation or non-participation in sport related activities.

PURPOSE OF THE STUDY

The purpose of this study was to investigate some factors related to participation and non-participation in high school physical education by students entering grade nine. The subjects were selected from 295 male and female grade eight students in the Carleton Roman Catholic School Board in the Province of Ontario. Twenty-four grade eight students indicated that they would not take physical education in grade nine. These 24 non-participants were randomly matched by age, sex and school with a group of participant subjects. Thus, a sample of 48 students, along with their physical education teachers was used in the study.

Questionnaires were used to assess participants and non-participants in the following areas:

(1) self esteem,

(2) perceived physical ability, and

(3) perceived body.

Reasons grade eight students give for participating or not participating in grade nine physical education and reasons teachers give for student participation or non-participation in grade nine physical education were also explored.

RESULTS AND DISCUSSION

Self Esteem

The results were analysed non-parametrically by means of the Kruskal-Wallis Test (KEITH and COOPER, 1974). An analysis of the data from the Rosenberg Self Esteem Test showed a significant difference existed in self esteem between participants and non-participants. ($H = 5.85$, $p < .05$). When the self esteem results were further analysed by sex a significant difference was also found between male participants and male non-participants ($H = 5.96$, $p < .05$) and between female participants and female non-participants ($H = 4.96$, $p < .05$). In all cases the participant groups had higher self esteem scores than the non-participants groups.

The results support the findings of ROSENBERG (1965) who found that the lower an individual's self esteem the less likely he will be to become involved in activities. The study also supports SCHENDEL's (1970) study which found that participants in athletics had a higher sense of personal worth and self acceptance than non-participants at both the grade 9 and grade 12 level. This difference, in terms of statistical significance, was greater at the grade 9 level than at the grade 12 level and in an earlier study SCHENDEL (1965) noted that this gap was eliminated for college students and in some cases was reversed.

However, ORLICK (1972) found so significant difference in general self concept of eight- and nine-year old participants and non-participants in organized sports. Perhaps this relates to the fact that not participating on a community team is less drastic than not seeing oneself as good enough to make the grade in physical education class.

The question of how self esteem is related to participation is still largely unanswered. Is physical education and sport in its present form a contributor to high self esteem or low self esteem? What happens to the overweight child, the uncoordinated child or the child who lacks confidence when he enters the environment of the gymnasium? Generally he or she receives only negative reinforcement. He is often ridiculed or embarrassed and when it comes time to select teams he is often rejected by his peers or made to feel unworthy. Could this threatening environment be a factor which enhances one's self esteem? Perhaps for some it is but for many others it would appear to be a factor contributing to low self esteem.

Perception of Physical Ability

To assess perceived physical ability Orlick's adaptation of the Thomas Self Concept-Values Test was utilized. ORLICK (1972) adapted this instrument for sport and found it to be valid for separating eight- and nine-year old participants and non-participants in organized sports. The results of the perceived physical ability evaluation showed that there was a significant difference in perceived physical ability between the groups of participants and non-participants ($H = 23.12$, $p < .05$).

This finding supports ORLICK's (1972) study which found that eight- and nine-year old sport participant children had more positive perceptions of their sports ability than the children who had elected not to participate in sports. The implication is that if a child perceives himself as being good at gym he is more likely to enroll in physical education than the student who perceives his ability as being not very good. This is supported by SCOTT (1973) who stated that:

> The person strives to maintain congruency within his interpersonal perceptual matrices. Thus, once a person establishes a self perception relative to some role, he will strive to maintain that perception by seeking out others and activities which will confirm that self description (p. 15).

ROSENBERG (1965) also wrote that adolescents tend to participate in activities in which their self evaluation is reinforced or confirmed.

Perception of Body

The method used to assess perception of body replicated the format from the perceived ability instrument (HYLAND, 1975; ORLICK, 1972). There was a significant difference in the way in which the participant students perceived their bodies when compared with non-participant students ($H = 7.60$, $p < .05$). Participants had significantly more positive images of their bodies than did non-participants. However, when broken down by sex, although the male participants perceived their bodies in a more positive way than did the non-participants, ($H = 5.5$, $p < .05$) there was no significant difference between female participants and non-participants in terms of body perception ($H = 3.7$, n.s.).

From the present study we have seen that the participants had higher self esteem and higher body perception than the non-participants. The literature does support a relationship between self perception and body perception. SECORD and JOURARD (1953) noted a relationship between feelings about the self and feelings about the body. In addition, they reported people with poor body images to be overconcerned about bodily injury. ROSEN and ROSS (1968) also found that satisfaction with self and satisfaction with body are related. ZION (1965) reported that there was a linear relationship between self concept and body concept.

PERCEIVED REASONS FOR PARTICIPATION AND NON-PARTICIPATION IN PHYSICAL EDUCATION

In response to a request to list the reasons why some grade eight students will take physical education in grade nine the results presented in Table I were obtained.

In response to a request to list the reasons why some grade eight students will not take physical education in grade nine the results presented in Table II were obtained.

Table I – Summary of the perception of the reasons for student participation in grade 9 physical education.

Students (N=48)		Elementary teachers (N=4)		High School teachers (N = 10)	
Reason	Percent	Reason	Percent	Reason	Percent
1. Enjoyment	63	Enjoyment	75	Enjoyment	80
2. Ability	40	Ability	75	Parental Pressure	50

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Table II - Summary of the perception of the reasons for student non-participation in grade 9 physical education.

Students (N=48) Reason	Percent	Elementary teachers (N=4) Reason	Percent	High School teachers (N=10) Reason	Percent
1. Inability	54.2	Inadequate Skills	100	Poor Elementary Program	80
2. Dislike	52	Poor Self Concept	75	Parental Influence or Attitude	50

CONCLUSIONS

From the results and within the limitations of this study the following may be concluded:

1. The self esteem of the participants was significantly higher than that of the non-participants.
2. The perceived physical ability of the participants was significantly higher than that of the non-participants.
3. The perceived body of the participants was significantly higher (i.e., more positively perceived) than that of the non-participants.
4. The students' perception of the main reasons for participation were enjoyment and ability. Their main reasons given for non-participation were inability and a dislike for the subject.
5. Elementary teachers' perception of the main reasons for participation were enjoyment and ability. Their main reasons given for non-participation were inadequate skills and poor self concept.
6. High school teachers' perception of the main reasons for participation were enjoyment and parental pressure. The main reasons given for non-participation were poor elementary program and parental pressure or attitude.

To ensure that more children elect to participate in and benefit from physical education it should above all be enjoyable. There should be a variety of activities and goals, some of which are obtainable and rewarding for all the students. As far as possible, embarrassment or negative feedback in the gym should be minimized. Teams should be selected in a manner which ensures that no one is left out or put in an embarrassing situation by being picked last, and attempts should be made to keep the teams even in ability.

If the teacher is to act as a significant sport role model, he or she must understand that physical education can be a frightening experience for some children. It is important that programs and approaches be devised to alleviate rather than add to these children's problems, particularly with reference to self perceptions.

Studies are needed which focus on the design, assessment and implementation of programs which are both enjoyable and beneficial for the students who are opting out.

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BEHAVIOUR INTENTIONS AND ATTENDANCE OF AN EXERCISE PROGRAM: A FIELD TEST OF FISHBEIN'S MODEL [1 2]

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Empirical research has not found attitudinal measures to be highly related to degree of primary involvement in physical activity (e.g. HICKMAN, 1963; KEOGH, 1963; KENYON, 1970; BUGGEL, 1970; SCOPELITIS, 1971). Similar low and mostly nonsignificant attitude-behaviour relationships have characterized other areas of attitudinal research (c.f. WICKER, 1969; FISHBEIN, 1973, LISKA, 1974). Fishbein (c.f. FISHBEIN, 1973; AJZEN and FISHBEIN, 1973) has suggested that these low relationships may largely be attributable to the practice of relating general attitudinal measures to specific behavioural measures. To overcome this problem FISHBEIN has proposed a model for the prediction of specific behaviours which utilizes more specific attitudinal variables.

According to FISHBEIN's model the most immediate determinant of behaviour (B) is the individual's specific behaviour intention (BI), that is, his intention to perform a specific act in the given situation. This intention in turn is determined by the individual's attitude toward performing the act (Aact), his normative beliefs about performing the act (NB), and his motivations to comply with these perceived norms (Mc). Thus behaviour intentions are contingent upon both personal predispositions (Aact) and social influences (NB and Mc). In operationalizing the model, behaviour intentions, normative beliefs and motivations to comply are typically assessed by the use of Likert-type scales. Attitudes toward the act, which are viewed within an expectancy-value framework as being a function of the act's perceived consequences and their values to the person, are measured by summing the scores on four evaluative semantic differential scales. The model can be symbolically represented in the following form:

$$B \sim BI = [Aact]\omega_0 + [\xi NB\ (Mc)]\omega_1 \quad , i = 1$$

where ω_0 and ω_1 are empirically derived weights through regression analysis.

The behavioural prediction model has gained strong empirical support in a number of laboratory studies carried out by Fishbein and associates (AJZEN and FISHBEIN, 1973). The average multiple correlation of Aact and NB (Mc) with BI in ten separate studies was .808. In six of these same studies the average correlation between BI and B was approximately .70. Recent studies conducted within field settings, however, have not consistently found such high correlations. In a study of employee absenteeism and turnover in a nursing home situation, NEWMAN (1974) found that the multiple correlation between the attitudinal and normative components of the model and BI was .45 for absenteeism and .70 for intent to resign. Behaviour intention correlated only .10 with actual absenteeism and .39 with employee turn-over. BHAGAT *et al.* (1974) found a multiple correlation of .47 between BI concerning buying a new car and the relevant attitudinal and normative measures. DAVIDSON and JACCARD (1975) on the other hand, in their study of family planning intentions, found multiple R's exceeding .7 when the two predictor variables were correlated with a number of BI measures. No behaviour measures were obtained in the later two studies so no B-BI relationships could be calculated.

The current study was designed to test FISHBEIN's model in another field situation and more specifically to determine its utility for explaining attendance of a voluntary adult physical fitness program.

METHOD

Subjects

The subjects were volunteer male participants in an adult physical fitness program. Although questionnaires were originally administered to 164 subjects, incomplete data reduced the final sample to 118 for the organized exercise program aspect of the study and 126 for the independent exercise aspect. The men were employees from industrial, service, and academic institutions in a small Canadian city. Although employees from a full range of occupational levels were eligible for participation in the study a self-selection process resulted in a predominantly professional class sample.

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2. Appreciation is expressed to R. Schlegel for his critical comments on an earlier manuscript.

Instruments

The information pertaining to the BI and predictor variables for the study were obtained from a questionnaire. BI with respect to attending the exercise program was measured by the following item:

I intend to attend the organized exercise program offered by the University of Waterloo at least twice a week.

extremely probable ______ : ______ : ______ : ______ : ______ : ______ : ______ : extremely improbable

Aact was assessed by summing the scores on four evaluative semantic differential scales:

Attending the organized exercise program is:

foolish ______ : ______ : ______ : ______ : ______ : ______ : ______ : wise
good ______ : ______ : ______ : ______ : ______ : ______ : ______ : bad
beneficial ______ : ______ : ______ : ______ : ______ : ______ : ______ : harmful
unpleasant ______ : ______ : ______ : ______ : ______ : ______ : ______ : pleasant

Three separate NBs with respect to attending the exercise program were assessed by seven point Likert type scales:

(a) Most of my work colleagues think I should attend the organized exercise program:

extremely probable ______ : ______ : ______ : ______ : ______ : ______ : ______ : extremely improbable

(b) My best friends think that I should attend the organized exercise program:

extremely probable ______ : ______ : ______ : ______ : ______ : ______ : ______ : extremely improbable

(c) My spouse (nearest kin) thinks that I should attend the organized exercise program:

extremely improbable ______ : ______ : ______ : ______ : ______ : ______ : ______ : extremely probable

Mc measures corresponding to the three NB measures were also assessed on seven point Likert- type-scales:

(a) With respect to attending the organized exercise program:

I want very much to ______ : ______ : ______ : ______ : ______ : ______ : ______ : I want very much not to

: do what my work colleagues think I should.

(b) With respect to attending the organized exercise program:

I want very much to ______ : ______ : ______ : ______ : ______ : ______ : ______ : I want very very much not to

: do what my best friends think I should.

(c) With respect to attending the organized exercise program:

I want very much to ______ : ______ : ______ : ______ : ______ : ______ : ______ : I want very much not to

: do what my spouse (nearest kin) thinks I should.

BI, Aact, NB, and Mc measures with respect to exercising regularly on one's own, outside of the organized program were also measured according to the above formats. "Exercise" for these measures was defined as "jogging, calisthenics, and vigorous sports" while "regularly" was operationally defined as "at least twice a week".

Seven point Likert-type scales were also included to derive information concerning the subjects' perceptions concerning the strength of their habits to exercise regularly, and the likelihood that their work demands would interfere with (i) their intentions to attend the organized exercise program or (ii) to exercise on their own:

How strong do you feel your habit of exercising regularly is?

extremely strong ______ : ______ : ______ : ______ : ______ : ______ : ______ : extremely weak

How likely is it that work requirements (e.g. shift work, business trips) will affect your intentions to attend the organized program?

extremely likely ______ : ______ : ______ : ______ : ______ : ______ : ______ : extremely unlikely

How likely is it that work requirements (e.g. shift work, business trips) will affect your intentions to exercise regularly on your own outside of the organized program?

extremely likely ______ : ______ : ______ : ______ : ______ : ______ : ______ : extremely unlikely

All scales were scored from 1 through 7, with 7 representing the positive end of the continua in all cases except for the probability of work interference scales on which "extremely unlikely" was scored high.

Procedure

The behavioural prediction questionnaire was administered, as part of a battery of tests, to the subjects in a group setting prior to the initiation of the organized exercise program. Due to the logistics of administering a large number of tests to a large sample and organizing exercise groups when subjects were available, there was approximately a four week time lapse between obtaining the questionnaire data and initiating the exercise program.

The behavioural data, attendance of the organized program over the eleven week period, were obtained from records kept by exercise leaders in the program. The raw data (frequency of attendance) was reduced to a seven point scale for purposes of data analysis.

Results

The means and standard deviations for the predictor and criterion variables are presented in Table I while the inter-correlations of the pertinent variables are given in Table II. From Table I it can be seen that attitudes toward the act of attending the organized exercise program were strongly positive ($\bar{x}$ = 24.92) as were expressed intentions to attend the exercise sessions ($\bar{x}$ = 6.15)[3]. The corresponding measures for the exercising on one's own condition although also positive were markedly less so ($\bar{x}$'s = 22.95 and 4.24).

Table I - Means and standard deviations for predictor and criterion variables.

	(a) Organized exercise program N = 118		(b) Exercising on one's own N = 126	
Measure	$\bar{x}$	S.D.	$\bar{x}$	S.D.
Aact	24.92	2.80	22.95	3.68
NB_1	4.70	1.58	3.80	1.59
NB_2	5.11	1.52	4.00	1.62
NB_3	5.34	2.06	5.11	1.64
Mc_1	4.49	1.15	4.05	1.09
Mc_2	4.35	1.19	4.26	1.03
Mc_3	5.14	1.29	5.00	1.22
NB_1 (Mc_1)	21.74	10.03	15.89	8.46
NB_2 (Mc_2)	22.80	10.18	17.65	9.31
NB_3 (Mc_3)	27.71	14.10	26.19	11.84
BI	6.15	1.27	4.24	2.06
B (raw data)	16.30	8.56	16.22	8.64
B (7 point scale)	3.74	1.83	3.75	1.87
Habit	4.03	1.79	—	—
Job Interference	4.37	1.96	5.12	1.81

Note: Aact = attitude toward the behaviour in a given situation; NB_x = normative beliefs, i.e. perceived expectation of others; BI = behavioural intention; B = behaviour, i.e. attendance of the exercise program; Habit = strength of habit for exercising; Job interference = probability of job requirements interfering with intentions to exercise.

3. Although all individual scales have a range from 1 to 7, because attitude scores represent the sum of four separate scales they have a possible range from 1 to 28, and as NB (Mc) scores represent the multiplication of the scores on two scales they have a possible range from 1 to 49.

Normative beliefs concerning attending the organized exercise sessions and the motivations to comply with these beliefs were moderately positive ($\bar{x}$'s = 5.05 and 4.66). Comparable measures for the exercising on one's own condition were marginally smaller ($\bar{x}$'s = 4.30 and 4.44). Mean scores of 4.37 and 5.12 respectively were found for the probability of work demands interfering with intentions to attend the organized program and to exercise on one's own. The mean score for the habit strength for exercising variable was 4.03.

Although for both conditions subjects reported their wives to be the reference group most strongly favoring their involvement in exercise and the group whose wishes they were most strongly motivated to comply with (Table I), this NB (Mc) combination was not the best predictor of BI (Table II). The NB (Mc) measure pertaining to "best friends" [i.e., NB_2 (Mc_2)] was the best normative group predictor of BI in both conditions (r = .20 and .28 respectively). Neither NB_1 (Mc_1) or NB_3 (Mc_3) accounted for sufficient variance to be entered into the multiple regression equations for predicting BI.

Table II – Intercorrelations of predictors and criteria.

Measure	1	2	3	4	5	6	7	8
(a) Organized Exercise Program								
1. Σ Aact	1.0							
2. NB_1 (Mc_1)	.22	1.0						
3. NB_2 (Mc_2)	.26	.64	1.0					
4. NB_3 (Mc_3)	.27	.26	.28	1.0				
5. Job interference	.23	.15	.13	.11	1.0			
6. Habit	.17	0.0	0.0	− .04	.07	1.0		
7. B.I.	.21	.12	.20	.11	.11	− .06	1.0	
8. B.	− .03	.16	.01	.17	.22	.04	.11	1.0
(b) Exercising On One's Own								
1. Σ Aact	1.0							
2. NB_1 (Mc_1)	.18	1.0						
3. NB_2 (Mc_2)	.27	.73	1.0					
4. NB_3 (Mc_3)	.25	.32	.43	1.0				
5. Job interference	.15	.12	.18	.09	1.0			
6. Habit	.27	.05	.10	.03	.05	1.0		
7. B.I.	.43	.23	.29	.22	.15	.40	1.0	

Note: Aact = attitude toward the behaviour in a given situation; NB_s = normative beliefs, i.e. perceived expectation of others; BI = behavioural intention; B = behaviour, i.e. attendance of the exercise program; Habit = strength of habit for exercising; Job interference = probability of job requirements interfering with intentions to exercise.

The multiple correlations between the predictor and criterion variables are presented in Table III.

With respect to the organized program, the multiple correlation of the sum of the four attitude measures and the NB_2 (Mc_2) measure with BI was .26. The regression weights for the attitudinal and normative components were both .17. For the "intent to exercise on one's own" condition the multiple R between Aact + NB_2 (Mc_2) and BI was .47. The derived regression weights for the attitudinal and normative components were .37 and .12 respectively.

The simple correlation between BI and attendance frequency was .11 for the "organized exercise" condition. No measures of actual amount of exercising outside of the organized program were obtained so no BI-B relationship could be derived for this condition.

Controlling for probability of work requirements interfering with behavioural intentions did not appreciably alter any of the correlations with BI. A correlation of .06 was found between self-rated habit strength for exercising and frequency of attendance of the organized program.

Table III – Multiple correlations between predictors and criteria.

	Predictors	Criteria	R	R^2
(a) Organized Exercise Program	Aact + NB_2 (Mc_2)	BI	.26 *	.07
	BI	B	.11	.01
	Aact + NB_2 (Mc_2)	B	.04	.002
(b) Exercising On One's Own	Σ Aact + NB_2 (Mc_2)	BI	.47 **	.22

Note: Aact = attitude toward the behaviour in a given situation; NB = normative beliefs, i.e. perceived expectations of others; BI = behavioural intention; B = behaviour, i.e. attendance.
* $P < .05$
** $P < .01$

DISCUSSION

The very small multiple correlation (R = .11) of Aact + NB (Mc) with BI for the "organized exercise program" aspect of the study is in marked contrast to the substantial R's generally reported between these measures. Also, although the multiple correlation (R = .47) between the predictor variables and BI for the "exercise on one's own" condition is comparable to those reported in some field research (e.g., BHAGAT *et al.*, 1974; NEWMAN, 1974 — absenteeism variable) it is smaller than those reported in laboratory research (cf. AZJEN and FISHBEIN, 1973) as well as some other field studies (NEWMAN, 1974 — resignation variable; DAVIDSON and JACCARD, 1975). The very low multiple correlation of Aact + NB with BI for the organized exercise program condition may largely be attributed to a lack of variance in the Aact and BI measures. From Table I it can be seen that the lack of variability in these measures is associated with very high mean scores indicating the probable presence of ceiling effects. This interpretation is supported by the observation that the better prediction of BI for the "exercise on one's own" condition was paralleled by less positive and more variable scores for the Aact and BI measures for this condition.

The fact that the subjects for this study were volunteers for an exercise program can at least partially account for the extremely positive Aact and BI scores. Thus, it might be expected that the utilization of a more heterogenous sample (e.g., a random sample) would considerably improve the prediction of BI from the attitudinal and normative measures. It should be noted, however, that previous research has indicated that nonparticipants as well as participants generally have positive attitudes toward physical activity (cf. KENYON, 1971; ALBINSON, 1975). This research however has involved attitudes toward the *object* "physical activity", or some type of physical activity, rather than a specific *act* concerning physical activity such as is appropriate in following FISHBEIN's approach. It might be expected that attitudes toward a general object such as physical activity might be more uniformly positive than toward some specific act concerning physical activity. This specificity question may be another problematic issue in the current study. FISHBEIN has frequently asserted that for best prediction from his model, very specific measures should be taken. The specified actions for the various measures in this study may have been too general. Also there was some inconsistency in the wording of the measures as the Aact and NB measures just referred to "attending the organized program" and "exercising regularly on one's own"; whereas the BI measures added the specification "at least twice a week". In sum, several methodological problems hindered this attempt to test the utility of FISHBEIN's model for predicting BI in a physical activity setting thus, no firm conclusions can be drawn.

The previously discussed lack of variance in the BI measure may also help to explain the low simple correlation ($\gamma = .11$) between BI and actual attendance of the organized program (B). The considerable time lag between the derivation of the BI and B measures would also tend to attenuate the BI-B correlation by allowing other sources of information to alter the BI's before the actual behaviour occurred.

Also related to this question of available information is the fact that the data for the predictor variables were obtained before the subjects had any experience with the exercise program which may have led to unrealistic BIs concerning the program. Better predictions may have resulted if the BI measures were taken after the subjects had been involved in the program for some time.

In view of the poor relationships between BI and B and between the predictor variables and both BI and B, no practical significance can be attached to the relative size of the attitudinal and normative regression weights derived in this study.

In conclusion, although attitudinal and normative variables did not effectively predict BI and in turn B in this study, the current results may help to delineate directions for future research in this area. It would appear that the simple substitution of specific measures of attitude and normative beliefs for traditional attitude measures is not adequate for improving the predictions of active involvement in physical activity programs. In fact, it would seem unlikely that the taking of any particular measure at one point in time would be a highly effective predictor of behaviour at a later time. Rather, attempts should be made, as KELMAN (1974) has emphasized, to place attitudes within a "context of action" in order to effectively relate them to behaviour. Although FISHBEIN's model is to some extent an attempt to do this by deriving measures specific to a given act and by incorporating a social influence factor, it would appear that for the model to be effective it must be placed firmly within the context of the behaviour to be predicted. As AJZEN and FISHBEIN (1973) suggest, this would involve deriving BI measures in close temporal proximity to the B measures after giving subjects sufficient information about the situation so as to enable them to effectively predict the consequences of their behaviour. The utilization of more specific BI and attitudinal measures, together with the provision of more information to the subject concerning the situation should help to alleviate the serious problem of lack of variability in attitudinal measures pertaining to physical activity.

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AUTRES PARAMÈTRES PSYCHO-SOCIAUX ET SPORT

STRATEGIES USED BY WOMEN ATHLETES TO COPE WITH ROLE STRAIN *

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> The historical choice has been simple: woman or athlete? To choose the latter meant risking censure... (LOGGIA, 1973)
>
> ...the young woman who participates in physical activities risks her feminine image. (HARRIS, 1971)
>
> We seem to see sport as a field for men and female homosexuals. (HART, 1971)

So speak—three prominant writers on women in sports, acknowledging the social attitudes toward women's sport participation that place women athletes in a continual state of role strain. This strain is not only in response to the reactions of others to them as athletes but also partly created by their own perceptions of what is properly feminine. Learning and internalizing feminine role expectations is a central part of the socialization of female children in our society and women athletes are no exception.

GOODE (1960) has conceptualized role strain as the condition that results when an individual finds herself occupying two significant social roles, each of which requires a different and opposing set of values and behaviours.

Gender roles have long been recognized as a key area in which social differentiation occurs in most societies. The feminine role in dominant North American cultures is a role associated with weakness, softness, passivity and slowness (McCLELLAND, 1953). The socialization process to females is based on a conception of a feminine role which requires the rôle incubent, ideally, to be submissive, gentle, nurturant, dependent, and obedient. The athletic role, however, is very different. Roget's Thesaurus (1961 : 29) supplies the following synonyms for "athletic" "vigorous, strapping, brawny, muscular." Management of the athletic role requires such qualities as strength, speed, toughness, aggressiveness, ascendency, leadership, autonomy and emotional control. It is immediately obvious that these are the very qualities that are associated in Western society with masculinity. The socialization of the male child is not only a preparation for the masculine role but also preparation for the athletic role, a role that is similar to and not in conflict with masculine role requirements. The female athlete, however, is an anomaly. Our society defines achievement, aggression, strength and toughness as masculine attributes, and considers the possession of masculine attributes to be unacceptable in females. It is no wonder, therefore, that women athletes experience role strain. GERBER, *et. al.*, (1974) refer to a survey by FOREMAN (1972) where people were asked to classify seventy-five sports according to whether they were masculine or feminine sports. Of the seventy-five, only two were classified as exclusively feminine: field hockey and ballet. Of the rest, fifteen were classified as exclusively masculine and the remaining fifty-five were classified as primarily masculine.

The pressures created by the disparity between the conduct required for successful performance of the athletic and feminine roles have resulted in the development of a number of rationalizations and strategies that enable women athletes to cope with the strain that results from their commitment to the two conflicting roles. These strategies must enable the athlete to compete and to win; to develop strength and endurance; to spend long hours in practice; to have goals that require dedication and perseverance without invalidating the gender role which has been learned and is accepted as the basis for personal identity. Women in our society have learned that "competition in traditionally male activities (as sports) is widely believed to require sacrifice of feminine attractiveness, and sex appeal that attracts males" (HARRIS, 1972). ROSSI (1965) and KOMAROVSKY (1953) have documented the same attitude in women who compete in mental activities and professions that have, like sports, been defined as areas for men only. BOSLOOPER and HAYES (1973) outline the rules women learn in order to play what they call the "femininity game." They say, "The rules are simple: You win the game by losing all others — tennis, volleyball, chess, you name it..." GERBER (1974) goes even further contending that competition itself "violates ancient taboos against women entering into overtly aggressive behaviours on a large public scale." Although HALL (1972) has found that women athletes perceive less difference between their conceptions of the athletic and ideal woman, GERBER (1973) has shown that women athletes are, themselves, aware of the stereotypes. As GERBER (1973) says:

> One can't compete in sport and be non-competitive; one can't shoot for goals and be non-aggressive; one can't practice for two physically demanding hours a day and be physically weak; one can't put one's skill on the line against an opponent and be too afraid to take risks; one can't come out on the court, field or pools against opponents who have demonstrated their superiority and be wanting in courage; one can't give up many hours a week to train for competition and not have self-discipline; one can't accept the results of the contest as proof of who's best for the moment and be unobjective; one can't strive to win, win, win and not be achievement oriented.

Indeed, FELSHIN (1974) points out that "it is possible that female athletes are, as some evidence suggests, as aggressive, achievement oriented, dominant and committed to sport as male athletes."

THE CONCEPT OF INTERACTION STRATEGIES

A strategy, according to GOFFMAN (1969), is a plan of action that takes into account "one's thoughts about the other's thoughts about oneself." Strategies are developed in interaction primarily for the purpose of selectively concealing or revealing certain information about oneself in order to modify or control the way one's character or actions are perceived by

* The strategies described in this paper are drawn from interviews and participant observations.

others. A strategy consists of a series of moves or tactics that are intended to create a particular impression and evoke a certain type of response. Impressions formed by others are managed by the use of verbal and non-verbal behaviour which are used tactically in a way that the strategist considers will allow her to control the other's impression of her and lessen the importance of other conflicting information or cues. Strategies may be developed individually or collectively. For example, most college students learn a number of strategies that they expect to result in their getting better marks in their courses. These strategies are usually intended to create the impression that the student is hard working and scholarly. They involve such tactics as using non-verbal cues such as sitting near the front of the class, maintaining eye contact with the instructor and carrying their text to class. They also involve such behaviours as raising questions about the work in class, references to the professor's research and making frequent office appointments. While the purpose of the strategy, which is often to conceal the fact that the student is not doing sufficient studying, and the general impression to be conveyed is often the same for all course, a particular strategy will be developed for each class based on available information about a specific professor and information about her responses to certain tactics that is learned through observation and interaction.

STRATEGIES USED BY WOMEN ATHLETES

The strategies that are described in this paper are those which have been observed to be commonly used by women athletes. Specific tactics that we have associated with one strategy are sometimes, in real situations, used independently or in other combinations. The awareness of the female athlete of her own use of these strategies or of their use by others varies. In some cases the strategic behaviour has been learned as part of socialization into a sports group. In other cases the strategies are deliberately developed by the athlete and are evaluated by her after trying them out as to their effectiveness, specific situational variations in responses, and her ability to carry them off successfully. Before we examine the strategies themselves, we should mention that many women resolve the problem of role strain by simply abandoning the athletic role at adolescence when the pressure to conform to the feminine role begins to make them uncomfortable. Occasionally an athlete will reject the feminine role and adopt a masculine role that seems more in keeping with the athletic role. Although the first resolution of the strain is common, the second is rare and in these cases the athletic role may have developed as part of a masculine role identity rather than the reverse. The strategies being focused on in this paper are those that are used by women athletes who are committed to both roles and who need to cope with the resulting strain if they are to be able to function continue to play both roles.

Ostrich

The rationale for the Ostrich strategy is that if conflict between the roles is not admitted then the individual does not have to deal with it. It is a "head-in-the-sand" strategy based on denial of the problem.[1] The Ostrich strategy involves creating the impression that involvement in athletics is not a deviation from the norm for females. Since negative social attitudes are not acknowledged, any discussion or recognition of them is impossible.

Tactics used in the Ostrich strategy are:

(1) ignoring or misinterpreting of pejorative remarks,

(2) responding to questions about inconvenience of practice schedules, interference with social activities with incredulity,

(3) denying any knowledge of suspicions of homosexuality among female athletes or suggestion of lack of femininity.

These tactics are all designed to convey the impression that there is no problem, no negative attitudes and, thus, no role strain.

Just-a-Hobby

The Just-a-Hobby strategy is based on a concealment of the importance of the athlete role so that, because it is not viewed as a major role, it doesn't conflict with the important feminine role. Just-a-Hobby does not involve a strategy that minimizes the problem, but rather one that minimizes the importance of the athletic role to reduce the threat of it undermining femininity.

The tactics used with the Just-a-Hobby strategy are similar to those used by deviants such as the alcoholic or drug addict who attempts to convey to others that she can quit any time she wants to. Some tactics used in this strategy are:

(1) implying that participation is a result of doing others a favour — "they couldn't get enough players so they asked me to play so they could field a team,"

(2) appearing to forget about practice or contests and just remembering at the last minute,

(3) pretending not to know scores or results of contests,

(4) ridiculing coaches or teammates who take things too seriously,

(5) implying that she never practices.

We do not mean to suggest that all athletes have the same motives for engaging in sports activities or the same degree of involvement, but simply to draw attention to this as a strategy when it does not realistically reflect actual motives. LUNDREGREN (1974) examined the motives of women for participating in physical activities. Given the low evaluation of the role of women athlete even among university students (GRIFFIN, 1973), the stated motives in the Lundegren study may have been those that were perceived to be acceptable.

Peter Pan

The rationale for the Peter Pan strategy is based on the recognition, by the athlete, that while there is differential gender socialization that begins immediately after birth, the real peer and parental pressures to conform to the feminine role becomes progressively greater as adolescence advances into adult status. Prior to adolescence, athletic activities of girls are tolerated as "tomboy" behaviour. Girls are warned and parents are reassured by the frequent repetition of such statements as "just wait until she discovers boys, then she'll forget about football." This is particularly true for middle class girls. Working class girls and boys of all classes learn and conform to role "appropriate" toy and activity selection earlier than middle class girls. Boys of all social backgrounds are encouraged to be and are, in fact, more consistently in conformance to gender rôle expectations (OAKLEY, 1972). This may account for the preponderance of

1. Sykes and Matza (1957) have discussed this type of rationalization as used by delinquents to neutralize objections to deviance.

middle class girls (balck American girls being a special case) that persist in athletic roles. Since middle class girls are allowed to participate in sport activities without much pressure for a longer period, they are likely more reluctant to give it up. Boys, on the other hand, from their earliest years are rarely given an opportunity to sample activities designated for females.

Peter Pan is a strategy intended to convince others that the athlete is still young enough to be allowed to continue participation. The implication is that she will relinquish these activities sometime in the not-too-distant but usually unspecified, future. Some women manage to use this strategy well into their late teens.

Tactics used in the Peter Pan strategy involve:

(1) continuing juvenile hair and clothing styles,

(2) wearing clothing that conceals rather than accentuates breasts and hips,

(3) refusing to use make-up, perfume or other artifacts that announce readiness to enter into the adult feminine role,

(4) associating with younger children rather than age peers,

(5) focusing on present time activities and not openly indicating plans for next year, or saying each year, "This is my last season,"

(6) avoiding situations that require or create expectations for heterosexual courtship behaviours.

The Peter Pan strategy provides an easy bridge into another strategy we will call "Daddy's Girl."

Daddy's Girl

The rationale for the Daddy's Girl strategy is that by denial of or disassociation from the responsibility of decision-making related to athletic role activities, the strain is reduced. The individual shrugs off all comments or strain producing questions by indicating that "Daddy" (coach-parent) is responsible for her participation. This strategy involves establishing the impression that the athlete is totally dependent on "Daddy" who controls her life and who will not let her do some things and who makes her do others. The Daddy's Girl strategy serves the double function of denying her ability to choose for herself and of associating her with a powerful dominating male figure which conforms to the feminine role expectations.

Tactics used to accomplish this strategy are:

(1) constant reference to coach/parent in refusing invitations as, "No, I have to get to bed early. Coach wants me to get lots of sleep,"

(2) complaining about how the coach/parent makes her swim a mile before doing sprints, etc.,

(3) associating all actions that might indicate autonomy, aggressiveness, etc., with reasons why the coach/parent wants it, e.g., "Coach wanted me to learn to drive so I could get to practice before the others."

Pseudo-Nympho

The rationale for the Pseudo-Nympho strategy is based on the recognition that our societal definition of the feminine rôle is based on the belief that women are sex objects. "Physical," where women are concerned means "sexual" (BOSLOOPER and HAYES, 1973). The strategy involves establishing a pattern of heterosexual sexual relations which reduce the suspicion of lesbianism and allow continued participation in athletics without too much strain since femininity has been affirmed.

A Pseudo-Nympho strategy of using sexual activities to validate the feminine rôle involves such tactics as:

(1) indiscriminate sexual relations with a series of male partners,

(2) passive acquiescence when approached to engage in sexual relations,

(3) convincing partners that the sexual acts are pleasurable,

(4) making known that sexual relations are engaged in and enjoyed,

(5) avoiding serious involvement with any partner who would object to or interfere with the athletic activities,

(6) being undemanding of relationships with sexual partners so that non-exclusive, non-romantic relations with males can be maintained and these male associations will balance associations with other female athletes.

One-of-the-Boys

The rationale for this strategy is somewhat similar to that of the Pseudo-Nympho. It is based on the society's acceptance of cross-sex friendships as having sexual connotations and of heterosexual sex relations as proof of femininity. There is some basis for this rationale even without sexual relations since there tend to be few friendships between heterosexual males and homosexual females. The explanation by the female athlete that she "likes boys/men" tends to be equated with "normal" femininity. The One-of-the-Boys strategy involves maintaining the athletic role by being accepted into a male group as part of the group. This strategy allows women to participate in "masculine" activities with the group because she's "just like one of the guys." She retains her feminine identity, however, because

(1) this strategy is open only to those wo[illegible] perceived as heterosexual, and

(2) because both the group and the w[illegible] herself, recognize that she really isn't one of the [illegible] and they reaffirm this in a number of ways.

She may be permitted to practice with them, but League Rules prevent her from actual team membership. (This is beginning to change with some teams but not enough yet to see how this will effect the use of this strategy.)

The tactics used in the One-of-the-Boys strategy are:

(1) initially establishing a special relationship with the group usually through a brother, cousin or boyfriend who can tolerate a physically competent woman,

(2) ingratiating herself by running errands, e.g., keeping score, turning in time sheets, providing transportation,

(3) demonstrating at[illegible]etic skills in a service situation, e.g., warming up the pitcher, filling in for late players in practice, etc.

Gorgeous Female

The rationale for the Gorgeous Female strategy is based on the idea that the feminine role requires consciousness of appearance and interest in clothing (SONTAG, 1972). It has also been noted that society tends to equate beauty with femininity (HARRIS, 1971). The Gorgeous Female strategy is the one most often noted by researchers in women's sports probably because the tactics involved make it the most visable. One aspect of the Gorgeous Female strategy is similar to the Pseudo-Nympho and One-of-the-Boys strategies. Since men are attracted to beautiful women and the presence and admiration of men in potential heterosexual relationships acts to reduce role strain by reaffirming the feminine role both for the women athlete and for others, the Gorgeous Female strategy is one that creates the impression that the socially accepted feminine role has been learned and accepted. It is intended to convince people that the athletic role does not interfere with or detract from the feminine role.

The tactics used in the Gorgeous Female strategy are both verbal and non-verbal. Some are:

(1) use of make-up, earrings, feminine hairstyles and hair ornaments, unnecessary decoration on clothing such as frills, lace, and embroidery,

(2) expressing non-aggressive, non-competitive reasons for engaging in the athletic role,

(3) controlling walk and gestures to minimize appearance of muscular development and freedom of movement,

(4) deferential treatment of male athletes, coaches,

(5) not competing outside of specific contest stituations and only against other women.

Schizo

The Schizo strategy is basically the Gorgeous Female strategy but is extended so that it includes the women for whom the Gorgeous Female strategy is not too effective. While to Gorgeous Female strategy involves bringing the feminine role behaviours and accoutrements as far as possible into the athletic situation, the Schizo strategy is based on the *separation* of the roles completely so that the conflict is not evident. The Ostrich strategy is designed to convince the self and others that the problem does not exist. The Schizo strategy is to compartmentalize the athletic role and the feminine role and create two discrete identities. In the Schizo strategy, the athletic role which requires competitive, aggressive behaviour is non-gender related. By the separation of the athletic role from any gender association, conflict is reduced. Using the Schizo strategy requires having two discrete and unrelated sets of behaviours. The individual identity is submerged and the feminine role and the athletic role are played as the situation demands, but never at the same time. The self is a third aspect or "real me" not dependent on or related to either role. "It appears the athletic female must assume the role of the chameleon..." (HARRIS, 1971).

The tactics used in the Schizo strategy are designed to prevent any overlap or relationship between the two roles. They involve:

(1) having different sets of associates so that each can be related to in terms of separate role expectations,

(2) keeping feminine role partners away from sport situations,

(3) associating aggressiveness, competitiveness with the sport activity as comparable to a motor skill rather than as a personal characteristic.

Ball Crusher

The Ball Crusher strategy is basically derived from the rationale of any oppressed group, that by defeating the oppressor one can take over their position, be in power, and control policy. The oppressed group identifies with the oppressor and identifies behaviours of the dominant group with the power status. The Ball Crusher strategy involves taking over the male role and defeating males in contests that involve masculine identified pursuits. Women who adopt this strategy are labeled "Castrators" or "Ball Crushers" as they are perceived as emasculating their competitors by forcing them into a position where they have been beaten by a woman!

This strategy involves tactics such as:

(1) bragging about defeating men in contests,

(2) any act that undermines the myth of male superiority,

(3) challenging less skilled males in public situations.

These tactics are effective because the masculine role does not allow for differentiation of individuals (size or skill) in cross-sex contests. All men, as such, are expected to be stronger, faster, and better than all women.

Liberated Woman

The Liberated Woman strategy[2] is one that utilizes the Women's Liberation Movement provided literature and polemic to convince the self and others that the activities and behaviours that have been defined as masculine have no relationship in fact to masculinity or femininity. The strategy involves politicizing the cultural definitions of "masculine" and "feminine" and separating them from biologically based sexual identity. The strategy is intended to demonstrate how and why the cultural definitions originated and thus question the validity of masculine and feminine roles.

The tactics used are:

(1) mastering the literature and using it to provide enlightenment regarding gender roles,

(2) developing and using dominance tactics and political action tactics to gain control of the power positions.

Cecil B. Rabbit

The name for this strategy is taken from a TV puppet character, Cecil B. Rabbit — The World's Greatest Anything. The Ceci B. Rabbit strategy is based on the rationale that the outstanding individual is apart from the crowd and, therefore, does not have to abide by rules created for ordinary mortals. The Cecil B. Rabbit strategy involves creating an impression of overall excellence in a variety of activities, including those that are designated as masculine. The strategy depends on associating the athletic role performance with other activities in which the individual also excels. By embedding the athletic role in a talent framework, it is less likely to create a great amount of social and mental pressure since it does not force the recognition of two conflicting roles.

Tactics used in the Cecil B. Rabbit strategy are:

(1) referring to sports activities coupled with dancing, painting, writing or other activities not so specifically associated with the masculine role,

(2) demonstrating the same level of proficiency in feminine rôle associated activities, such as sewing,

(3) reference to sport activities in terms of physical development and associating this with social, mental and total development.

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2. See Felshin (1973) for an analysis of the relationship of women athletes to the women's movement and the impact of legislation on the status of women in sport. *Woman Sport* (1975) magazine provides specific discussion of tactics that can be used in this strategy.

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SELF-ACTUALIZATION AND THE COLLEGE ATHLETE

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The study of personality and athletes has traditionally been centered on the problem of specifying particular traits that distinguish athletes from non-athletes or other athletes. The results of these studies have yielded what KROLL (1970) called an "entangling web of conflicting results." Perhaps some of this confusion is related to the use of a wide range of personality inventories in these studies. A review of personality of athletes research (*e.g.*, COOPER, 1969; MORGAN, 1972, 1974) quickly points out this problem. The conflicting results appear inevitable as this myriad of inventories cannot and has not been tied to any substantive theory of personality (MORGAN, 1972). A basic need then is to first establish a conceptual base from which to work for the development of personality theory that relates to athletes.

A theoretical view of personality that has merit for the study of athletes is one developed by MASLOW (1970). Further thinking and development of this theory has been presented by ROGERS (1961) and SHOSTROM (1964). This view pictures man as striving to become a self-actualizing person, or a person who is more fully functioning and lives a more enriched life than does the average person. This person, according to MASLOW (1970) has the full use of his or her talents, capacities, and potentialities.

Viewing the athlete in light of the self-actualizing person presents an interesting portrayal as many of the traits or qualities of the self-actualizing person are those traits that are desirable for the athlete. For instance, the self-actualizing person has a more efficient perception of reality; is less characterized by severe anxiety; is generally problem- rather than ego-centered; is generally self-motivated and dependent on his own potentialities and latent resources for personal growth rather than on external forces. Although there are other qualities of the self-actualizing or fully-functioning person described by MASLOW, these few will suffice as an overview description to provide a basis on which to relate this theory to the study of athletes.

The characteristics of the self-actualizing person must be considered as relative. Each person, according to MASLOW (1970) is somewhere in the development of the qualities like those just described. MASLOW stated, however, that few people achieve the fully-functioning state prior to adulthood. In fact, in one study MASLOW (1970) screened 3000 college students to find subjects to qualify as self-actualizing persons, and only one was determined to be immediately usable. Thus, in the college student is found an individual that at best, is developing qualities towards becoming the self-actualizing person.

A question that logically follows then, is related to the rate of that development and what might affect or be related to it. Of particular interest for this study was the possible relationship between this rate of development and the involvement by the college student in athletics. Are college athletes any different from the average college student in their development towards self-actualization? One further question was also of interest. Is the degree of success attained by the athlete related to his development toward self-actualization?

For this study, the college athlete was delimited to baseball players. Thus, the specific purpose of this study was twofold:

(1) to compare varsity and B-team college baseball players in their relative development toward self-actualization; and

(2) to compare college baseball players and the average college student in their relative development toward self-actualization.

METHOD

Subjects

Twenty-three varsity and 19 "B" team members of the 1972 baseball team at Florida State University took and completed the POI. Mean ages of the teams were 20.4 years for the varsity team and 18.5 years for the "B" team.

Personality inventory

The Personal Orientation Inventory (POI) was developed by SHOSTROM (1964). It consists of 150 two-choice comparative value judgments. The items were selected from observed value judgments of clinically healthy and clinically troubled patients as seen by therapists at the Institute of Therapeutic Psychology in Santa Ana, California.

The POI consists of 12 scoring categories or scales. Two of these categories, Time Incompetence/Time Competence (Ti/Tc) and Other/Inner-directed (O/I) are basic ratios of personal orientation. Ti/Tc refers to whether the person is living in the past and future or in the present, as the self-actualizing person would. The O/I ratio is a measure of the degree to which the person is directed by sources outside or within himself. The self-actualizing person seems to have liberated himself from responding primarily to social pressures, goals, and expectations.

The other 10 sub-scales each measures a conceptually important element of self-actualization. These scales and their meanings can be seen in Table I.

Procedure

The POI was administered by the investigator to the varsity baseball team just prior to a regular afternoon practice one week before the team's opening game of the season. The test was administered to the "B" team on the day that practice equipment was issued, two days before their first formal practice.

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Table I - Sub-Scales for Personal Orientation Inventory.

Symbol	Label	Meaning (SA vs. Non-SA)*
SAV	Self-Actualizing Value	Holds or rejects values of SA people
Ex	Enstentiality	Flexible or rigid in application of values
Fr	Feeling Reactivity	Sensitive or insensitive to own needs and feelings
S	Spontaneity	Freely expresses or fearful of expressing feelings behaviorially
Sr	Self Regard	High or low self-worth
Sa	Self Acceptance	Accepts or unable to accept self in spite of or with weakness
Nc	Nature of Man	Sees man as essentially good or evil
Sy	Synergy	Sees opposites of life as meaningfully related or antagonistic
A	Acceptance of Agression	Accepts or denies feelings of anger or aggression
C	Capacity for Intimate Contact	Has or has no difficulty with warm interpersonal relations

* SA = Self-Actualizing.

RESULTS

Mean scores were determined for each of the 12 scoring categories of the POI for the varsity and "B" team players. These data for the teams and for the college norm are presented in Table II. The norm is based on data reported by SHOSTROM (1966) and is based on 2 046 college students.*

Discriminate function analysis of the scores for the varsity and "B" teams indicated that these teams could not be distinguished on the basis of the POI test scores for any of the scales (Wilks Lambda = .732, F = .883, p = .573). Thus it was not possible to establish from these results that development toward self-actualization is related to the degree of success an athlete experiences in college baseball.

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Table II - Means, Standard Deviations, and t-Test Results for POI Scales.

POI	Varsity		B Team		Norm		Varsity & B Team		t - Tests
Scales	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	Varsity/B team vs. Norm
TC	16.0	2.71	16.5	3.13	15.1	2.9	16.19	2.88	2.414*
I	83.1	11.10	82.0	8.25	75.6	8.9	82.64	9.82	4.647
SAV	19.7	2.11	20.8	1.98	18.8	2.6	20.24	2.10	4.444
Ex	19.9	4.06	19.1	4.21	16.7	4.4	19.52	4.10	4.455*
Fr	16.1	3.46	15.4	2.42	13.8	2.9	15.81	3.04	4.286*
S	12.9	3.33	12.7	2.36	9.7	2.2	12.76	2.90	6.830*
Sr	12.2	1.83	12.7	1.44	11.5	2.2	12.45	1.67	3.682*
Sa	14.5	3.96	14.4	4.55	13.7	3.1	14.45	4.19	1.159
Nc	11.5	1.68	11.8	1.46	11.6	2.0	11.64	1.57	0.165
Sy	6.6	1.24	6.9	1.10	6.3	1.4	6.71	1.17	2.265*
A	16.2	3.19	16.8	3.22	15.1	3.0	16.50	3.18	2.851*
C	18.2	3.45	17.6	2.60	15.6	3.4	17.93	3.07	4.916*

* $p < .05$.

The scores for the varsity and "B" teams were then combined and compared against the college-age norms. Since only means and standard deviations were available for the norms, independent t-tests were calculated for each of the 12 scales to determine differences between the baseball players and the average college students. The results of these t-tests are presented in Table 2. With alpha = .05 for each test, the analysis indicated that the baseball players were more like the self-actualizing person than the average college student on 10 of the 12 scales. The only two scales on which no significant differences were obtained were for the scales of Sa (self acceptance) and Nc (view of the nature of man).

DISCUSSION

The major findings of this study relate to the personality differences existing between the college baseball player and the average college student. Although results indicating athlete, non-athlete differences are more the rule than the exception (*e.g.*, SCHENDEL, 1965; 1970) it must be remembered that the comparison in this study was not athlete vs. non-athlete but athlete vs. average college student, which group can be assumed to have included athletes and non-athletes. Also, the present study was not designed to consider unique traits of athletes but rather how the athlete compared to the average college-student in his development towards self-actualization.

The results of this study clearly indicate that the baseball players tested had developed more self-actualizing qualities than had the average college student. The interesting logical extension of these descriptive results is to understand what the implications are of these results as well as why better attainment of self-actualization was exhibited by the baseball players on 10 scales and not on 2 scales.

The first problem one encounters with such an attempt is the problem of "which came first, the athlete or the personality characteristics?" This problem must certainly be kept in mind, as the implications of results such as these are considered. MORGAN (1972) developed a theoretically supported argument that for the most part, personality traits remain largely unaffected by participation in athletics. Traits are enduring in nature and should therefore be expected to vary little as a result of external influences. However given the nature of the self-actualization theory and its development demand on the organism, it should be expected that individuals would change over time on the qualities or characteristics measured by the POI. Thus it appears that through the use of the POI, possible positive, negative, or neutral psychologic effects of athletics on the individual may be seen. If these are to be seen with any type of supportive evidence however, that evidence must be longitudinal in nature. For the present study, then the implications of the results must be considered speculative.

The baseball players were shown to be living more in the present than in the past or future, according to the results of the Time Competence Ratio (Tc). Perhaps the age-old expression of coaches "Play one game at a time" has real-life meaning for the players. In reality, they may live more by that code than might be suspected.

To develop and maintain excellence, the athlete must be self-motivated or inner-directed to a great degree. LAPLACE (1954) reported that this quality was characteristic of both major and minor league baseball players and was a distinguishing quality from the norm. It would appear, then, that the player who strives for excellence must either have or develop the ability to be dependent on himself to a large extent for the development of his own potentialities. Given the results of the I/O Support Ratio in this study, the college baseball players exhibited this quality more than did the norm.

The scales SAV and Ex complement each other. SAV indicates the degree to which an individual holds and lives by the values of self-actualizing people. Ex indicates the degree of flexibility one has for applying these values. It is in a sense a measure of one's judgment for the application of a personal value system. The athletes exhibited qualities for each of these that were more aligned with the self-actualizing person than the average college student. The implications of these results for college athletes or coaches appear to relate to the success a coach might expect in attempting to have an athlete consider or evaluate his own value system in relationship to what it should be for his own development as an athlete.

Athletes exhibited a higher sensitivity to their own needs and feelings (Fr) than did the norm. They were also more able to express those feelings behaviorally (S) than the average college student. Given the emphasis placed on the individual by self-actualization theory the results of these two scales are encouraging for the coach. The coach cannot know what every team member feels or needs and must depend on those members to provide him with that information.

The next two scales, Self-Regard (Sr) and Self-Acceptance (Sa), are related in the POI as measures of self-perception. The athlete showed a stronger ability to like himself as a person because of his strengths but was no different than the average college student in his ability to accept himself as he is. The subtle distinction between these two characteristics have interesting implications. Athletes are generally taught that they should have a good positive attitude toward themselves as people and athletes. Conversely, they are usually told not to be complacent about their present performance but to continually strive to be better. Whether the Sr and Sa qualities results are the result of athletics or not, these results certainly appear to reflect general practices in sport.

The concept of awareness is reflected in the Nature of Man (Nc) and Synergy (Sy) scales. The athletes were similar to the average college students in their view of man as essentially evil rather than good. However, the athletes showed a better ability to see the opposition of life as meaningfully related, according to the Sy scale. An example SHOSTROM (1966) gave for the Sy scale related seeing work and play as not really opposites. This may very well be the result of many years of hard work at something the general public calls a game. Although such a statement cannot be supported on the basis of these results, the implications in this direction appear to be warranted.

The final two scales, Acceptance of Aggression (A) and Capacity for Intimate Contact (C), are paired to reflect the general area of interpersonal sensitivity. The athletes again showed higher qualities on these scales than did the average college student. These qualities appear to be especially necessary for the production of a successful athlete as well as a successful team. The successful athlete must be willing to accept anger or agression within himself as natural. To deny those feelings would obviously create performance difficulties. The ability to develop meaningful relationships with other people also appears necessary for success. The concepts of team cohesion, *esprit de corps*, etc. are all related to this quality.

When considered as a whole, the results of this study provide interesting insights into the personality structure and development of the college baseball player. Whether these results are indicative of all college athletes is a problem currently under investigation by this investigator. The approach to the study of the personality of athletics based on self-actualization theory, appears to be a fruitful direction, especially as a means of determining possible psychological effects of sport. However, longitudinal studies are a necessity if definitive statements are to be established concerning this problem. It is apparent that the study of personality and sport would be greatly enhanced if it were based on a theoretical model. Self-actualization theory provides a means to accomplish that end.

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A SUBJECTIVE STUDY OF THE ATHLETES' GREATEST MOMENT IN SPORT

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"Everything was so perfect, everything so right, that it couldn't be any other way," stated a skier describing his most wonderful moment while skiing. He revealed further, "I used to think of it as me and the mountain for it was a solitary encounter. At first it was me and it was as if there were two of us and it was both of us. I did not attempt to master it, beat it, finesse it or cheat it. The closest thing I can say about it was that there seemed to be tracks in the snow that my skis were made to fit in... It was no longer me and the hill, but both of us, it was perfect, I belonged there." At the end of his run he stated, "I felt like I was radiating in every direction, not with pressure but with joy. I felt a tremendous amount of heat. I was totally filled up with joy like a helium balloon, and it was fantastic." He was attempting to describe his experience while skiing. This particular run down the mountain was more than good, clean exercise, for within it he experienced a unique harmony between the mountain and himself.

What this particular athlete described may be termed a peak-experience, a phenomenon conceptualized by psychologist Abraham MASLOW. A peak-experience is the most intense, most joyous, most memorable moment in an individual's life. Its foundation is a personal subjective experience from which abstract knowledge may be built; these experiences are often difficult to communicate since our language doesn't possess the vocabulary to connote the incredible emotional qualities experienced by the individual involved. MASLOW found that at these particular moments, the individual experiences total happiness; equally as important, he often loses all fear, inhibitions and weaknesses. Peak experiences are also the moments of an individual's greatest maturity and fulfillment; it is as if man's humanity is reaching its furthest possible reaches of development.

MASLOW did considerable research on the peak-experience and outlined its most common characteristics; however, in his writings, he did not specifically discuss the peak-experience as it relates to sport. I decided to study the reports of those peak-experiences which occurred when the athlete was actively participating in sport, as distinguished from a peak-experience that is a result of participation, i.e., a medal for one's performance in a race.

Traditionally the emphasis of sport research has been on training the athlete, with the goal of improving performance which is objectively measured in the actual contest. Indeed, as a result of this emphasis, much progress has been made in understanding the human body and how it functions in relation to specific sport movements. Researchers have also developed scientific and effective techniques to improve the athlete's physical performance. Many of our training programs for athletic teams and physical education classes tend to overlook the fact that we are working with more than just a physical body. We are actually concerned with a total and complete individual. Limited research has been conducted on the subjective or personal feelings that the athlete experiences while participating in sport. I contend that we can further develop new dimensions in the study of sport if we examine it from a total perspective.

This study has shown that sport possesses a meaning and purpose that transcends the everyday view of it. One way to have this new perspective on sport is to explore the subjective domain of the peak-experience.

The purpose of this study was not to generalize for all people engaged in sport, but to draw conclusions about the nature of the peak-experience from the descriptions provided in an attempt to determine what qualities are to be found in the peak-experience.

THE INTERVIEW

When one attempts to explore an emotional phenomenon such as the peak-experience, one must employ techniques other than the usual quantitative methods of research. Therefore, my study focused on the personal experiences of 20 athletes, all of whom I interviewed in depth. The subjects included 16 men and 4 women, ranging in age from 19 to 40 years; eleven of the athletes described experiences that occurred while participating in team sports (football, volleyball, lacrosse, hockey), and nine described experiences that occurred in individual sports (cycling, swimming, track and field, jogging). Twelve of the athletes were playing or had played on college varsity teams, three participated on the intramural level in college, two participated in recreational activities, specifically, skiing, and three of the athletes were members of the 1972 Olympic Team.

Because many of the athletes had never previously shared this experience with anyone, I began by attempting to move in the direction of a meaningful rapport with each of the individuals. The interviews were conducted in a relaxed atmosphere so that the individual interviewed was more apt to be comfortable and share his experience with me. During the first part of the interview (usually about twenty minutes) I attempted to share my mutual interests with the subject in an attempt to "break the ice." The interview proceeded as soon as the individual revealed he or she was at ease and willing to converse freely with me. I discussed with each athlete his general sports background. Next I asked them to name some of their great experiences while participating in sport. After discussing some of the athlete's great experiences, I focused on my major questions: "What has been your single, most joyous, happiest, blissful, wonderful moment in your sport experience while participating?" From this point, other questions were asked in no particular order and not necessarily in every case, to stimulate discussion of the experience. These included: "How did you feel differently about yourself?" "How did the world look differently?" "How did you change?" The emphasis was on flowing with the experience as it was being reflected upon. I used questions as they applied to the immediate situation and not because I had previously deter-

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mined that they needed to be asked. Since the purpose was to have the subject freely recount his experience, I asked as few questions as possible so the interview would be non-manipulative.

Other athletes' accounts were presented in this study in order to reveal to the respondent that it was acceptable to have these types of experiences and that it was acceptable to share the experience with another individual. Sharing another athlete's experience helped to stimulate the respondent in expressing himself. In short, expression of the respondent's experience was encouraged as much as possible by confirming the subject's experience, by making him feel at ease, and by reflecting some understanding of his experience.

Since all interviews were composed of open-ended questions, each interview was unique. In order to maintain uniformity between interviews, I devised a checklist of specific issues that I wanted for comparison. These questions were not asked until the end of the interview and only in those cases where the issues had not been raised during the course of the interview.

RESULTS

I discovered that the sport environment provides an ambiance which is conducive to the peak experience. Sport provides man with a freely chosen opportunity to focus all his energy upon a specific task within the specific rules and regulations of that sport. The athlete does not have to worry about the usual mundane problems of daily existence, but instead man is free to go all out, to totally immerse himself in the activity, and experience his unique self at the outer limits of his sport participation.

DISCUSSION

The chief results of this inquiry are summarized in Table I. The column at the left lists qualities used by subjects to characterize their experience. The column at the right reflects the percentage of subjects who shared each of the given qualities to characterize their "greatest moment". Briefly, the major finding is that there are general features of this experience which were shared by at least 80% of the subjects (qualities 1-16) and other features which were used by less than 45% of the subjects to characterize this experience (qualities 20-31).

Eighteen of the twenty athletes described what MASLOW would consider a peak-experience. Frequently during the peak-experience, each of the athletes recalled, he was so involved in the experience that he lost sight of his "normal" conscious self. Some athletes went further — their involvement caused them to become one with experience. A woman discus thrower explained, "I became motion, for all purposes I was motion." In presenting my findings, I wish to describe what I concluded are the basic characteristics of the peak-experience in sport. There are eleven qualities that characterize it.

Table I – Characterization of "Greatest Moment".

Qualities	Percentage of Subjects
1. Loss of fear *	100%
2. Ability to execute basic skills	100%
3. No thinking of performance	95%
4. Individual gives full attention * (total immersion in activity)	95%
5. Narrow focus of attention	95%
6. The experience is perfect *	95%
7. Temporary phenomenon	95%
8. Feeling of being godlike (In Control) *	95%
9. Self-validating experience *	95%
10. Non-voluntary experience	90%
11. Unique experience	90%
12. Perception of the universe as integrated and unified *	90%
13. Passive perception (Effortless) *	90%
14. Time-Space disorientation *	85%
15. Awe and wonder of the experience *	80%
16. Transcendence of ordinary self *	80%
17. Fusion of the individual *	60%
18. Unique being of the individual *	55%
19. Rich perception during experience *	55%
20. Unity of the world *	45%
21. Athlete in good physical condition	45%
22. Accomplished goal	45%
23. Premonition of experience	45%
24. Non-Classifying perception *	45%
25. Important to have spectators	20%
26. Fusion of dichotomies *	20%
27. Awareness of the absolute *	15%
28. Abstract perception *	15%
29. Nature of the object in itself *	15%
30. Meaning to life in general	15%
31. Discussed experience with others	15%

* Represents qualities MASLOW (1968, pp. 74–96) discussed in relation to peak-experiences.

1. Unique Experience for the Athlete

The sport peak-experience is always unique — it stands apart from "normal" daily living. This uniqueness may be attributed to the intensity of the experience. A sampling of the athletes' comments shows a wide diversity of experiences, and yet, at the same time, a remarkable similarity; a surfer reporting his feeling of oneness with a wave said, "There is no way this could happen twice." A swimmer noted: "This was a whole new experience for me. I never did anything to this degree before. There is no way this could happen twice." A football player said, "I haven't been able to duplicate it or even come close to it in eight years of football."

It is important to point out that the circumstances or sport environment need not be out of the ordinary in order for a peak-experience to occur. The uniqueness lies in the way that one *experiences* the phenomenon. For example, winning a game or achieving a record (stop watch) time are not necessarily unique experiences. In fact, they are quite common. It is the quality of uniqueness which causes the participant to regard it as a personal treasure, greater than any trophy.

2. **Non-Voluntary**

The athlete cannot control or determine the experience; it is always involuntary. One likened it to a sudden breeze on a calm and sultry day, stirring the garments and refreshing the spirit, but nothing one consciously does can make it return. For example, a swimmer revealed how he had attempted to repeat the experience again, but as he discovered, "I can't force it, although I wish I could." The athlete may be able, however, to *set the stage* for the phenomenon to occur by establishing the necessary physical and mental condition. This he does by totally immersing himself in the experience, doing whatever he needs to in order to be open to the experience. Yet, even this will not guarantee a peak-experience. An athlete provides this explanation: "I am a vehicle for this. I initiate the performance and then the experience takes over."

3. **Temporary**

The sport peak-experience is a temporary phenomenon. Like the wind, it comes and it goes. The individual undergoes a peak-experience, and after a period of time his heightened awareness returns to normal. If the Experiences were frequent, much of the fascination would disappear. This state, if permanent, would be what MASLOW calls transcendence, in which the individual experiences a constant or unchanging intense state or feeling in contrast to the transient experience just described.

4. **Temporary Transcendence of Self**

An essential characteristic of the sport peak-experience is a temporary transcendence of self. In this sense, transcendence means that the athlete experiences himself in a manner different from his usual, mundane self, because he finds a harmony, a oneness, and a totality that is normally lacking in the sport experience. A characteristic of this harmony or oneness is the individual's union with an object, the environment, or the self.

The majority of the athletes I interviewed presented explicit descriptions of this ego-transcendence, i.e., becoming so involved with the experience itself or the object of the game (bat, ball) that a union is formed with the experience or object. A cyclist described this harmony: "I am at one with everything. There is no distinction between myself, the bicycle, track, speed or anything. There is a oneness with everything." Some talked about it in terms of temporal and spatial changes, while others mentioned feelings of oneness, harmony, and being all together. A football player explained, "You forget who you are for a while... Have you ever been so high while doing something that you forget where you are? It's almost like you're someone else." A runner also mentioned this feeling: "It is like looking at somebody else's body running, which is really weird! You think that's not really me down there running. Almost like my head is watching above my body — a calm observer, watching his physical body."

During a peak-experience, the athlete is no longer a separate self looking at the world. Rather, he merges with the phenomenon and forms a oneness with a larger self or experience.

5. **Total Immersion**

I discovered that the individual found himself completely absorbed in the experience during this experience. This total immersion resulted in the truest kind of visual perceiving, listening, or feeling. This total attention did not encompass a vast area or a wide perspective; instead, this attention was manifest as an intense concentration or feeling of presence in the situation. This total involvement should be differentiated from an all-out effort because, the experience itself is often felt to be effortless. When the athlete is consciously thinking about how to catch a football, or the feelings he is having while catching the ball, he cannot be totally involved with the experience because part of himself is remaining on the periphery of the experience, cognizing about what is happening and thereby distracting him from the experience.

A football player referred to this centering of his attention when he said, "I concentrate my whole being on one thing; this is one of the few times I have done this... I am just hitting him (the ball carrier) and nothing else." Of making a key block, another football player stated, "I get my mind hooked up with his (the man blocked)... I get my contact. If I get my concentration on him there is no way he will get away." This example illustrates a kind of prophetic certainty and constitutes a total concentration upon the specific activity as well as narrowing down of the athlete's view.

Another aspect of total immersion is the fact that in the peak-experience the athlete's focus of attention is very narrow; many of the usual thoughts of the athlete such as, what the score is, or how well he is doing, are absent. Thus, the athlete narrows his focus upon the sport activity and involves himself in the experience and is in harmony with it.

The athletes described how they focused their total energy and awareness on the particular movement experience and became an integral aspect of the activity. A lacrosse player explained, "It is a world within a world — focused right there — I am not aware of the external... My concentration is so great I don't think of anything else."

6. **Perfection of the Experience**

A feeling of euphoria, of perfection, contributes to the temporary transcendence of self. During the peak-experience in sport, everything is experienced just as it should be; all 20 of the athletes claimed they would not change anything. The sport peak-experience is perceived primarily as memorable, worthwhile and beautiful; repeatedly, it was described as a sacred experience. A football player explained, "Everything is right, everything is in line, everything is clicking, nothing is opposing me." As revealed by a woman javelin thrower, "Nothing is wrong, everything is right."

7. **Control**

During the sport peak-experience, the individual was at his or her fullest potential and felt in total control of the situation. All 20 athletes reported this quality of being in control of the situation. The accounts, however, differ in two ways. First, some of the athletes felt a control of the situation and made references to its importance. A swimmer stated: "There was a complete and fluid control of my body. It seemed like in the last part of the race I was in total control. There was no pain, I was in control of the water and my total bodily actions." A football player revealed: "Things were under control; my body could do anything... it was almost like my body was not there. Everything out there could no way affect me. I could do anything I wanted." This feeling of being at the height of one's power, as if invincible, provides the athlete with a feeling of control over whatever may confront him. Another football player stated, "Everything rotates around you; you don't rotate around it. You are on top." The player is in the center and controlling the situation which is pertinent in the territorial game of football. Another football player discussed the control he had of the crowd: "I felt completely in control of the crowd; I could push a button and make it go wild."

The second way that the athlete experiences control was explained best by a hockey player: "Since you are in control of the situation, you don't think about it; it just happens." A cyclist explained, "I don't think about it or attempt to control it." It is pertinent to take note that this cyclist experiences a total blackness during his peak-experiences. I asked him how he kept his bike on the track if all he observed was blackness and he explained, "I just can tell where I am... The situation is in control, not me. I experience a freedom in that I do nothing because it is happening."

A skier described this lack of concern to control the situation in the following statement, "It didn't make sense to control the situation. The dimensions of control were irrelevant. I didn't even think about it." A runner revealed: "Things are right; it does it on its own. I am not too concerned with controlling it. It is so enjoyable there is no need for control. I let it be because it is so great."

Of the athletes interviewed, those athletes who participated in team sports generally discussed control in regard to a complete control of the situation. Those athletes who participated in an individual sport generally exhibited a lack of concern for control of the situation, perhaps because they were independent of anyone else.

8. Loss of Fear

Associated with this perfection and control is a total loss of fear. Because the "normal" self is transcended, all of the problems, fears and difficulties of one's everyday life are also transcended. All but one of the athletes interviewed revealed that there was absolutely no fear during their sport peak-experience. A football player said, "I knew what I was doing; there was nothing to be afraid of." A skier described, "Yes, many times I'm afraid while skiing, but this time I flew through it without being afraid as usual." The usual fear or pressure that an athlete experiences is transcended in the peak-experience. There are many possible explanations for this phenomenon. It might be because, as all of the athletes stated, they were in such control of the situation, or so on top of it all, that there was nothing to fear. There was one exception: a football player who revealed during his discussion of making six blocks in one play, that the sport experience is not necessarily logical. "I wanted to stop... it was too perfect... I was too afraid to let it all go through." In this instance, the play was going so well that it was too much for him to handle, probably because blocking six men on one play is not supposed to happen.

9. Effortlessness

Since the individual transcends himself, the movement becomes effortless. He no longer has to consciously move himself; he just moves. Every athlete surveyed stated that there was absolutely no conscious deliberation in executing the skill. The skier did not think, "Now I do this, then that, and finally this." Many of the athletes interviewed referred to this as reacting or muscle memory. A football player reflected upon the incredible ease of a particular block: "So many times I put everything into it but nothing happens. But this time I hit him just right and everything went perfectly. Just right... effortless... I hit him and he just flew. Physically, I didn't put as much as usual in it..." A hockey player explained, "It is just like a dream. You seem to be doing everything right with no problems. Everything is going for you. You have the physical under total control." A butterfly swimmer who usually experienced agonizing pain at the end of all his previous races revealed that after going all out, "I couldn't feel any pain which is really weird, for me... take away the pain and it is effortless. I had hardly any feeling of my arms and legs... my whole body was doing it with ease.

Pain which may be associated with an all-out effort was not recalled by the athletes in describing their great experience. A football player, in recounting a key tackle, states "There is a feeling of total effortlessness. There is a hit where the person feels like air and you feel no pain."

10. Self-Validating Experience

All of the athletes interviewed agreed that the sport peak-experience is a self-validating phenomenon. The experience is total, complete, self-validating and independant of the external circumstances. A woman volleyball player said it best: "The experience is in the process while participating. It sometimes happens that the end result may distract from it, but it is still valid." In all cases, the athlete knew he had a great experience. Even if the contest or game was lost the particular experience, all the athletes stressed, had a beauty, wonder and uniqueness that superceded the final score.

11. Basic Skill Level

Essential to the sport peak-experience is the ability of the athlete to execute the basic skill without having to worry about or contemplate his technique. The athlete must have complete control of the basic skills; if he must think of his next movement, then it is impossible for him to merge into a union with the experience.

The athlete does not have to be an expert with years of experience although in some sports it might take that long to develop the necessary skills. Briefly, the athlete just has to be comfortable with an in control of the fundamental techniques. For example, a beginning skier must be very conscious of every shift in body weight and must constantly be anticipating his next movement. Only after the individual no longer has to be thinking and mentally contriving his next movement can the sport peak-experience occur.

CONCLUSION

From this study it was discovered that the peak-experience while participating in sport is a unique, non-voluntary and transient experience. During the peak-experience the athlete experiences a transcendence of his ordinary self and related to this are the qualities of being totally immersed in the activity, the movement is perfect and effortless to perform. The athlete also is in total control of the situation and there is a loss of the usual fears associated with the activity. Finally, the experience is a self-validating phenomenon and a basic skill level is mandatory for the athlete to have this type of ecstatic experience.

The relationship between winning and the sport peak-experience remains unclear. Although it is safe to say that winning frequently entails a total immersion of the athlete into the activity, I hesitate to advocate that athletes be encouraged to win in hopes that a peak-experience will be more likely to occur. In the sport world today, there is already more than sufficient emphasis on victory as revealed by the popular axions: "Losing is worse than death, because you have to live with it," and "Winning isn't everything, it is the only thing." Many people feel that learning the values of competition, hard work, discipline and victory are the major reasons why one should engage in sport. There are other attributes involved in sport besides winning such as the joy of the participation, the possibility of a peak experience, and many individual connotations one may derive from sport that may occur even if one's team loses. The sport environment can be more than a competitive battleground on which individuals prove themselves or learn the values of our society. It can provide the athlete with an environment whereby the individual can totally focus all his energy on one specific task and totally immerse himself in the activity to the degree of becoming one with the experience.

From this study it is apparent that the sport environment may provide the athlete with more than just exercise, competition, and a physical release. At times it provides the athlete with an awareness of the further reaches of his or her unique self.

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SOCIAL FACILITATION: MERE PRESENCE OR EVALUATION APPREHENSION

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Traditionally, one of the central problems of social psychology has been the effect of present others on individual behavior. The study of such effects had an equivocal empirical history until ZAJONC (1965) elegantly reconciled the apparently contradictory findings of previous experimentation. Relying upon Hull-Spence drive theory, Zajonc proposed that the presence of others, either coactors or audience members, serves to arouse drive. Since generalized drive energizes habits, the dominant response peculiar to that particular social environment is facilitated. The emission of well learned responses is therefore facilitated. However, if the responses are novel and unlearned, the generalized drive energizes all responses which inhibits the individual acquiring the particular novel correct response for that task. In conventional psychological language, learning is inhibited, performance is facilitated by the arousal engendered by the present others. ZAJONC and SALES (1966) confirmed the above in that subjects who were well trained in a pseudo-recognition task (dominant response) benefited from the presence of audience members, while subjects who were minimally trained (subordinate response) suffered from the presence of audience members. Subsequent investigations have confirmed these results (e.g., MARTENS, 1969; COTTRELL, RITTLE & WACK, 1967; COTTRELL, 1968; GRANZER, 1968; MARTENS & LANDERS, 1969).

COTTRELL (1968, 1972), however, profers a greatly sharpened theoretical analysis of the effects of present others on performance. Cottrell argued that the physical presence of others is neither a necessary nor sufficient condition to produce the social facilitation effects. To Cottrell, the presence of others is a learned source of drive in that arousal is a function of anticipating positive or negative outcomes from the present others. The presence of others arouses the conditioned stimulus of evaluation apprehension on the part of individuals and it is this learned source of drive that facilitates the response of greater habit strength. COTTRELL (1968) supported his contention with an elegant extension of the ZAJONC and SALES (1966) experiment. Cottrell merely added a blindfolded audience condition to the alone and attentive audience of two. Zajonc's findings were replicated, but the blindfolded audience (merely present others) had the same effect as the alone treatment. Cottrell concluded that physical presence per se is insufficient to produce social facilitation effects. Cottrell's reformulation of Zajonc's original hypotheses has had recent empirical support (e.g., COTTRELL, *et al.*, 1968; HENCY & GLASS, 1968; KLINGER, 1969; MARTENS & LANDERS, 1972; PAULUS & MURDOCK, 1971; HAAS & ROBERTS, 1975).

ZAJONC (1972), however, has disputed Cottrell's modification of social facilitation theory. Zajonc maintains that the evaluative potential possessed by the present others is not necessary to observe social facilitation effects. This is supported by COHEN and DAVIS (1973). Cohen and Davis found that an audience labelled neutral produced the effects associated with social facilitation and that evaluative audiences merely exacerbated these noted effects. But one must question the effect of present others labelled neutral in Cohen and Davis' study. The audiences were designated as passively watching, but this is the same condition as some studies terming the situation evaluative (e.g., COTTRELL, *et al.*, 1968). Hence, as Cohen and Davis admit, the subjects may have attributed evaluative potential to the audience. This is plausible particularly when the subjects were informed that the audience members were psychology students (or psychology professors) and the students were participating in a psychology experiment. It is easy to see that the subjects may have imputed evaluative overtones to the audience.

RAJECKI *et al.* (1974), however, found that merely present others (blindfolded audience) produced the social facilitation effect. Rajecki *et al.* led either a blindfolded confederate or a regular confederate into the presence of the subject and found that both produced the same facilitative effect. Rajecki *et al.* interpret this as evidence to support ZAJONC (1965) and they seriously call into question the contentions of COTTRELL (1968, 1972). Thus, the issue remains unresolved: Is the social facilitation effect a function of the presence of others or is the effect a function of the evaluation potential inherent in the situation? The present experiment attempted to determine the effect of presence of others and evaluation potential on learning a complex motor task. Presence and evaluation potential were investigated in a 2 × 2 (Presence × Evaluation Potential) factorial design. It was hypothesized that Cottrell would be supported if a main effect of evaluation potential materialized, and that Zajonc would be supported if a main effect of presence materialized.

METHOD

Subjects

The subjects were 40 female university students recruited from the Department of Physical Education at the University of Illinois. Each was assigned at random to one of four experimental conditions with the restriction that an equal number of subjects appear in each condition.

The task was a motor maze. The subjects directed a ball bearing through the maze while altering the angles of the maze top by means of two control handles. The left hand altered the side to side slope, the right hand controlled the front to back slope of the maze. The maze consisted of a series of pathways with cul-de-sacs which the subject attempted to avoid in order to optimize performance. The experimenter electronically recorded the time it took the subject to complete the task.

The experimental setting consisted of two adjoining rooms. The subject, and confederates when appropriate, were in one room while the experimenter was always in a separate room visually and auditorially removed from the subject.

Mouvement. Actes du 7e symposium en apprentissage psycho-moteur et psychologie du sport. Octobre 1975.

Procedure

The subject came to the testing site at a prearranged time. The experimenter met the subject at the door and escorted the subject to the experimental room down a small corridor that opened up into the testing site. She brought the subject to face the task and explained that she was interested in testing women on learning motor tasks in order to establish learning norms for women on such tasks. The experimenter explained that little work had been done on women in the past and it was essential to establish norms for females.

The experimenter then sat the subject down in front of the task. The stool was adjusted so that the subject could reach the handles at ease and felt comfortable. The experimenter then explained the task to the subject. The subject was instructed on the correct procedure to hold the handles and given a demonstration how the handles altered the slope of the maze top in order to propel the ball bearing along the maze. The subject was informed that the essential element of the task was to get the ball bearing around the maze as quickly as possible.

The subject was instructed how to shift the ball bearing at the completion of each trial. The subject lifted the ball bearing from the end cul-de-sac and placed it into the begin cul-de-sac at the completion of each trial. The subjects were told to begin each trial in their own time. The act of lifting the ball from the end cul-de-sac and placing it into the begin cul-de-sac was sufficiently long to allow the experimenter to record the time and to clear the clock before the subject began a subsequent trial.

The experimenter then went into the next room ostentatiously to ensure that the equipment was ready. The experimenter then triggered a switch that lit a signal light outside the experimental site which informed the confederates that they were to enter at that particular moment. In all treatments the experimenter feigned surprise as the confederates entered the room. Unknown to the experimenter, confederates randomly chose whether the presence of others was evaluative or mere presence.

For the evaluative audience treatment the confederates asked the experimenter if they could observe the experiment. This was the first time the experimenter knew which treatment the confederates were to administer. The experimenter replied "But I have already started." The confederates looked at each other and remarked that it was of no consequence. The experimenter then brusquely motioned the confederates to the two chairs and informed them they could watch from "over there." The experimenter then explained to the subjects that the students were from a motor learning class and had requested to observe a motor learning experiment. The experimenter then directed all her comments to the subject. The confederates took up evaluative postures in the two chairs by the table and put notebooks on the table in order to write comments.

In the merely present condition the confederates informed the experimenter that they were to prepare "themselves for a perception experiment in another laboratory." The experimenter then motioned the confederates to the two chairs and stated that the apparatus was "over there." The experimenter then explained to the subject that the confederates were in a perception experiment and had to prepare themselves for the experiment. While the experimenter was explaining this to the subject, the confederates feigned switching on the noise from the noise maker to the earphones and adjusting the volume while each holding an earphone to an ear. They nodded satisfaction and sat down with the earphones and then placed blindfold goggles on. The experimenter then directed all comments to the subject.

If the confederates did not enter on cue, this was a signal to the experimenter that the treatment was a no-audience condition and the experimenter then randomly selected whether the treatment was evaluative or not. If the treatment was evaluative, the experimenter came in and informed the subject that she was going to videotape the rest of the experiment for future reference. The experimenter then brought out and set up a portable video camera in full view of the subject. The video camera was directed at the subject and the top of the maze. The experimenter then feigned focusing the camera, checking recording apparatus, asking the subject to move the table top, etc. in order to convince the subject that the experimenter was actually recording the trials. In actuality, no recordings were made. If the treatment was non-evaluative, then the experimenter did not give any instructions to the subject but merely continued with the experiment.

Once the confederates were in place, or the video-camera was set up, the experimenter then asked the subject to fill in a questionnaire on "how you feel" right now. The SPIELBERGER (1970) state anxiety questionnaire was given to the subject and she filled in the questionnaire.

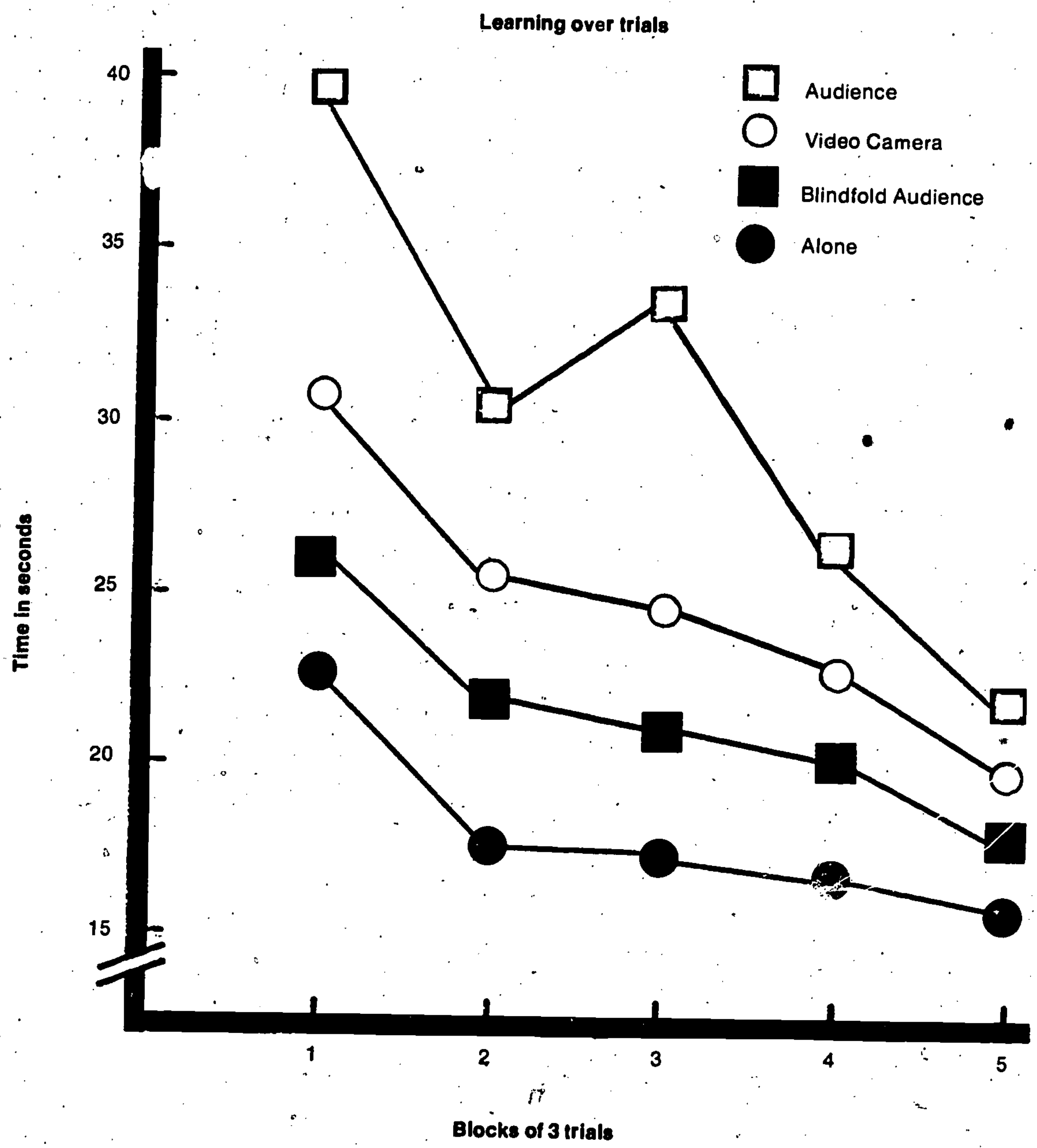
When the subject had completed the questionnaire the subject then began the 15 learning trials in one of the four conditions. This created a 2 × 2 factorial design with 10 subjects in each cell. Immediately upon completing the trials, the confederates in the presence conditions left. In the video camera condition, the experimenter "switched off" the camera. The experimenter then completed the next phase of the experiment which was to give the subject a post experimental questionnaire in which there was a second Spielberger state anxiety scale.

All subjects were then fully debriefed and requested not to discuss the experiment with anyone for the duration of the experiment.

RESULTS

Figure 1 presents the time in seconds each of the 4 groups took to complete the task over the 15 trials. The 15 trials have been blocked into 5 blocks of 3 trials for ease of presentation.

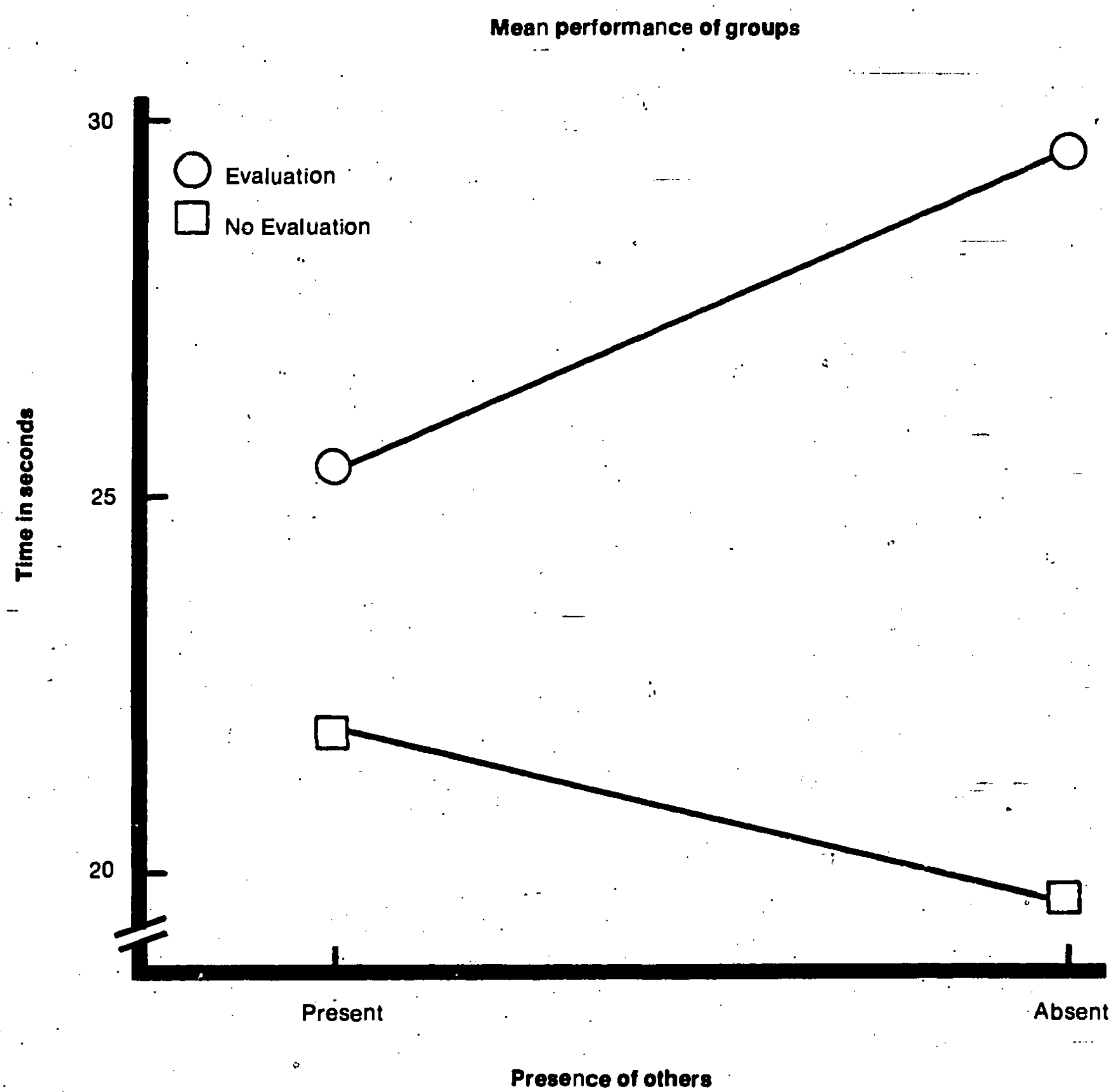
Figure 1 – Learning over trials.



The data presented in Figure 1 were submitted to an analysis of variance with two levels of evaluation, two levels of presence of others, and five levels of blocked trials. The analysis of variance revealed that the main effect for trials was significant which indicated that subjects learned the task over the 15 trials ($F [4, 144] = 14.31, p < .001$). There were no significant interactions.

Figure 2 presents the time in seconds each group took to complete the task when the means were averaged over the 15 trials. Analysis of variance results pertinent to this data revealed that the main effect of evaluation was significant, ($F[1, 36] = 15.03, p. < .001$). There was no significant main effect for presence of others ($F [1, 36] = 1.34, p > .05$). This may be interpreted as supporting the hypothesis emanating from COTTRELL's (1968, 1972) interpretation of social facilitation effects. However, a significant interaction of ($F [1, 36] = 4.99, p < .05$) warranted analysis of the simple main effects.

Figure 2 - Mean performance of groups.

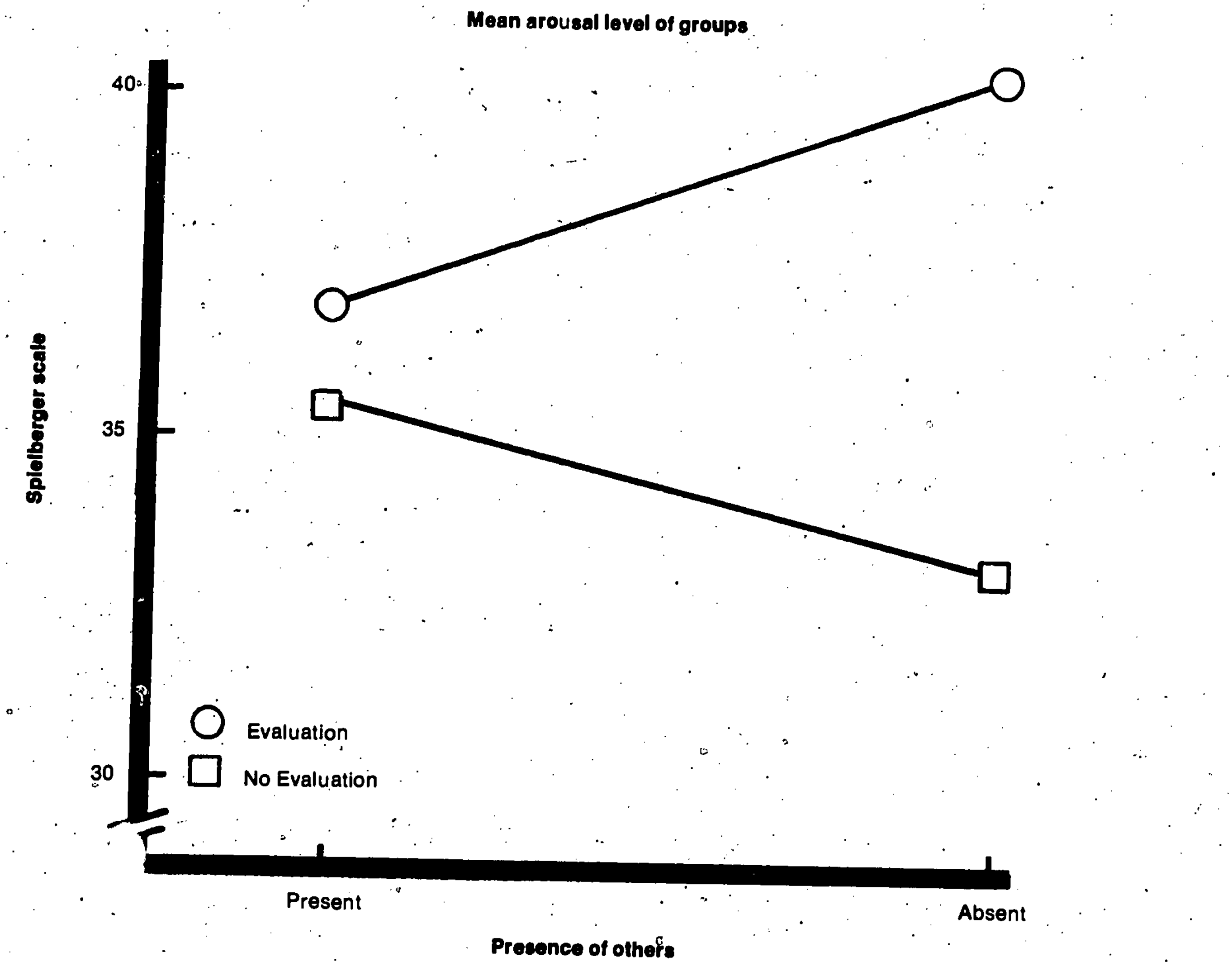


Individual comparison F tests were conducted on the data and revealed the following reliable effects: Video group compared to the alone group ($F[1, 18] = 18.73$, $p < .001$); video group compared to the evaluative audience ($F[1, 18] = 4.69$, $p < .05$); video compared to the blindfolded audience ($F[1, 18] = 9.69$, $p < .01$); and the evaluative audience group compared to the alone group ($F[1, 18] = 5.63$, $p < .05$). Failing to achieve significance on the individual comparisons were the alone group compared to the blindfolded group ($F = 1.46$), and the evaluative audience group compared to the blindfolded group ($F < 1$).

An analysis of within subject variability was also conducted. The main effect of evaluation was the only significant effect ($F[1, 36] = 5.99$, $p < .01$). This revealed that subjects who were evaluated had reliably greater within subject variability than the non-evaluated groups.

In terms of the arousal measure, analysis of the Spielberger State Anxiety Scale revealed that no reliable differences in arousal occurred. However, the evaluation main effect was marginally significant ($F[1, 36] = 2.88$, $p = .09$). Interestingly, the pattern of the arousal measures is very similar to the performance measures as can readily be seen by comparing Figure 2 and Figure 3.

Figure 3 - Mean arousal level of groups.



DISCUSSION

The present experiment was predicated upon ZAJONC's (1965) explanation of the social facilitation phenomenon and COTTRELL's (1968, 1972) learned drive reinterpretation of Zajonc's original formulations. Zajonc stated that the mere presence of others is a source of arousal and sufficient to reliably interact with task performance. Cottrell, on the other hand, hypothesized that the mere presence of others is not the source of arousal in social facilitation research. Rather, the source of arousal resides in the anticipation of positive or negative outcomes of performing in the presence of others.

The ordering of the groups in the present experiment conforms to the predictions of social facilitation theory — the greater the arousal, the greater the inhibition of learning. The order of arousal of the groups was as follows: Video taped; evaluative audience; blindfolded audience; and alone group. The order of inhibition of learning followed the identical pattern. Thus, it may be concluded that the results of the present experiment support social facilitation theory. However, whether the results support either ZAJONC (1965) or COTTRELL (1968, 1972) is somewhat more enigmatic.

Certainly, the results of the present experiment seem to make clear that those social situations which were labelled evaluative reliably inhibited learning of the motor maze when compared to the alone group. The blindfolded audience, the mere presence condition, did not reliably inhibit learning. However, the fact that the blindfolded audience did not reliably differ from the evaluative audience cautions against premature generalizations supporting either the explanations of Zajonc or Cottrell.

COHEN and DAVIS (1973) attempted to reconcile the Zajonc and Cottrel explanations when they concluded from their study that mere presence does affect task performance in the way anticipated and that evaluation apprehension merely exacerbates the effect. However, other explanations may also account for the social facilitation effect. One possible explanation of the phenomenon may reside in the social predictability of the present others. ZAJONC (1972) refined the definition of "mere presence" of audience members. Zajonc maintains that in the presence of others some degree of alertness or préparedness is expected of subjects because the subject does not know what novel or unique responses will be required of him in the next few moments. The subject is therefore aroused as a function of the degree of predictability of the audience. Blindfolded audiences are more predictable than sighted audiences and thus are less arousing. The above is speculative but support has been furnished by RAJECKI *et al.* (1974).

However, RAJECKI *et al.* (1974) had another interesting finding in that blindfolded and unblindfolded mannequins had the same general effect as blindfolded and sighted audiences. One would venture to assume that a mannequin presents a totally predictable audience, yet the subjects became aroused. Likewise, COHEN and DAVIS (1973) and the present study had a video camera present in the room in certain conditions. The video camera is also predictable in operation, yet both studies witnessed increased arousal and social facilitation effects. A second explanation of the social facilitation effects thus presents itself — the degree of possible distraction inherent within the social environment. RAJECKI *et al.* (1974) and LAUGHLIN (1975) suggest that such a distraction hypothesis may be viable to explain the findings of traditional social facilitation research.

An interesting finding in the present study is the result of the video camera group. The video-camera was very reactive in that subjects were most aroused and inhibited in their motor responding compared to the other groups. Why should this be? In subjective terms, the production of a camera in social situations, whether family gatherings or teaching situations, certainly changes behavior, sometimes markedly. If we may accept for the moment that the presence of the camera is distracting to the individuals present, for whatever reason, then it is plausible to reason that the powerful effect of the video camera in the present study, and the COHEN and DAVIS (1973) study, is due to the distraction engendered by the camera. The effect of the mannequins in the study by RAJECKI *et al.* (1974) would also be predicted by such a distraction hypothesis. Certainly, neither Zajonc nor Cottrell could adequately explain both the mannequin and camera effects.

The above is somewhat speculative, but at least is plausible given the extant literature. The so-called theory of objective self-awareness (WICKLUND & DUVAL, 1972) would also be more parsimoniously explained within a distraction hypothesis framework. It would seem that new procedures and new directions are needed in order to determine more fully the phenomenon traditionally termed social facilitation.

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LONGITUDINAL STUDY OF THE SOCIAL PSYCHOLOGICAL PROFILE OF FEMALE BASKETBALL PLAYERS

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Research studies on the personality of female sports participants have become numerous in the past decade; however, no definitive personality profile has been identified. Studies show that generally athletes differ from the normative population and some differ according to sport but the traits upon which they differ appear inconsistent from study to study. The apparent conflicting findings may be due to differences in the tests used, ages of participants, regionality of subjects, skill levels, and treatment of the data. The answer to these questions will not be forthcoming until longitudinal studies, psychological theories and comprehensive comparisons such as HARDMAN (1973) and BIRD (1971) have undertaken are completed.

BELL (1955) used the California Personality Inventory (CPI) to compare Iowa basketball players with their high school non-basketball peers. The female players were found to be more impulsive and dominant, and less feminine, but had higher self-acceptance and social presence scores than the non-players. A questionnaire revealed that the basketball players participated in more interscholastic activities, held more elective offices and were selected more often as friends than their non-playing counterparts.

A later report on Iowa high school athletes by KELLEY (1970) showed that female athletes had higher CPI scores on the measures of poise, ascendency and self assurance than non-athletes. The non-participants were more feminine and showed higher scores on measures of intellectual and interest modes. Trait scores among the golf, softball, basketball and track and field groups showed several significant differences with the general finding that golfers scored more positively on more measures than the other three groups. Basketball players had the highest femininity score among the athletic groups.

College modern dancers' CPI traits were compared to basketball players' by BIRD (1965). The basketball players scored higher on the communality scale while the dancers' scores were higher for flexibility and femininity.

LEVY (1970) studied 5 female sports groups and a non-participant group and found no significant differences among the 5 sports groups on any of the 18 traits. Only 7 differences were found when the non-participants were compared with each of the 5 sports groups across all 18 traits. The only significant difference for the basketball players was that they were less feminine than the non-participants.

Another study of college sports participants who qualified for regional or section tournaments was conducted by JOHNSON (1972). Intragroup comparisons of bowlers, golfers, basketball and fieldhockey players revealed 12 of 18 significant CPI trait differences. The basketball group had the lowest scores on every one of the 12 significant traits when compared with the other three groups. Johnson summarizes the basketball player in this study as "a self-centered, socially awkward, and intellectually and socially inhibited person."

The purpose of this study is to ascertain the personality characteristics of a group of young basketball enthusiasts and assess their involvement and interests in activities other than basketball. The group will be studied for 9 years in an attempt to determine changes over time.

METHOD

In June 1970 at the Patsy Neal Basketball School, (PNBB), 63 girls, voluntarily completed a CPI inventory and a demographic questionnaire. The test was administered by the investigator during the late afternoon in a group setting. The Ss came from the Southern states of the United States and had a mean age of 14.8 years. The national norms for high school girls used as research (GOUGH, 1971) showed no differences between national and regional norms for the Southern states.

The CPI and another demographic questionnaire were mailed to the home address for each of the original participants in June 1973. Only 23 Ss, 36.5%, returned the material completed. Over one-third of the original Ss in the sample had packets returned due to no forwarding address with the remaining 30% not responding.

RESULTS

The trait scores from the CPI questionnaire for the 63 Ss from the 1970 PNBB school were compared with the national norms by utilizing a two-tailed t-test.

The CPI trait scores for the 1973 sample of 23 Ss were compared with their own 1970 trait scores. A two-tailed t-test was used with the .05 level of confidence accepted for both analyses.

Information tabulated from the 1970 and 1973 demographic questionnaires was reported in percentages.

The means, standard deviations and t-ratios for the CPI trait scores for all groups are presented in table I.

Table I – Means, Standard Deviations, t-tests for PNBB Groups.

	Scale	1970 PNBB N = 63 Mean	SD	Norms N = 4065 Mean	SD	t-test	1970 PNBB N = 23 Mean	SD	1973 PNBB N = 23 Mean	SD	t-test
Class I[3]	1. Dominance	28.5	5.3	23.7	6.1	7.00[2]	30.5	4.5	31.4	5.1	0.65
	2. Capacity for status	18.2	3.7	16.0	4.9	4.80[2]	19.2	4.1	20.1	3.7	0.72
	3. Sociability	25.7	4.3	21.4	5.7	7.85[2]	27.2	3.8	27.7	2.6	0.59
	4. Social Presence	34.4	4.7	31.1	5.8	5.48[2]	36.7	3.9	36.7	4.6	0.00
	5. Self-acceptance	21.2	3.3	18.9	4.4	5.54[2]	21.7	3.2	23.5	3.2	1.85
	6. Sense of well being	33.3	4.9	34.6	5.7	-2.07[1]	34.1	4.0	35.8	3.3	1.57
Class II[4]	7. Responsibility	30.4	4.1	30.0	5.6	0.78	29.8	3.8	30.7	4.7	0.75
	8. Socialization	39.1	5.1	39.4	5.6	0.51	39.1	5.8	39.4	5.9	0.17
	9. Self-Control	22.5	7.6	27.6	8.5	5.32[2]	22.4	7.5	26.9	8.4	1.91
	10. Tolerance	18.3	4.2	18.7	5.5	0.74	18.7	3.7	22.5	3.8	3.46[2]
	11. Good Impression	13.6	5.2	15.7	6.2	3.22[2]	13.2	5.7	15.7	6.5	1.35
	12. Communality	25.8	3.9	26.1	1.9	0.63	26.2	2.9	26.2	1.6	0.00
Class III[5]	13. Achievement via conformance	24.2	4.3	24.1	5.3	0.22	25.3	4.0	27.8	4.5	2.03[1]
	14. Achievement via independence	15.6	3.8	15.5	4.2	0.19	15.4	3.7	18.7	3.0	3.31[2]
	15. Intellectual efficiency	35.0	5.4	34.4	6.5	0.92	36.4	4.7	39.4	3.8	2.38[1]
Class IV[6]	16. Psychological mindedness	10.0	2.6	8.7	2.6	4.22[2]	10.6	2.3	11.6	2.7	1.28
	17. Flexibility	9.6	3.6	8.9	3.2	1.54	9.7	2.9	8.9	3.5	0.82
	18. Femininity	21.4	3.9	24.1	3.5	3.85[2]	20.2	3.7	20.8	3.6	0.50

1. $p < .05$ level.
2. $p < .01$ level.
3. Measures of poise, ascendancy, and self-assurance.
4. Measures of socialization, maturity, and responsibility.
5. Measures of achievement potential and intellectual efficiency.
6. Measures of intellectual and interest modes.

Table I highlights the fact that 10 of 18 traits for the 1970 PNBB School Ss were significantly different from the national norms. When the 23 Ss original CPI trait scores were compared with their 1973 scores four traits showed significant differences.

The CPI profile of the 63 original Ss as compared to the national norms for the same age group is illustrated in figure 1.

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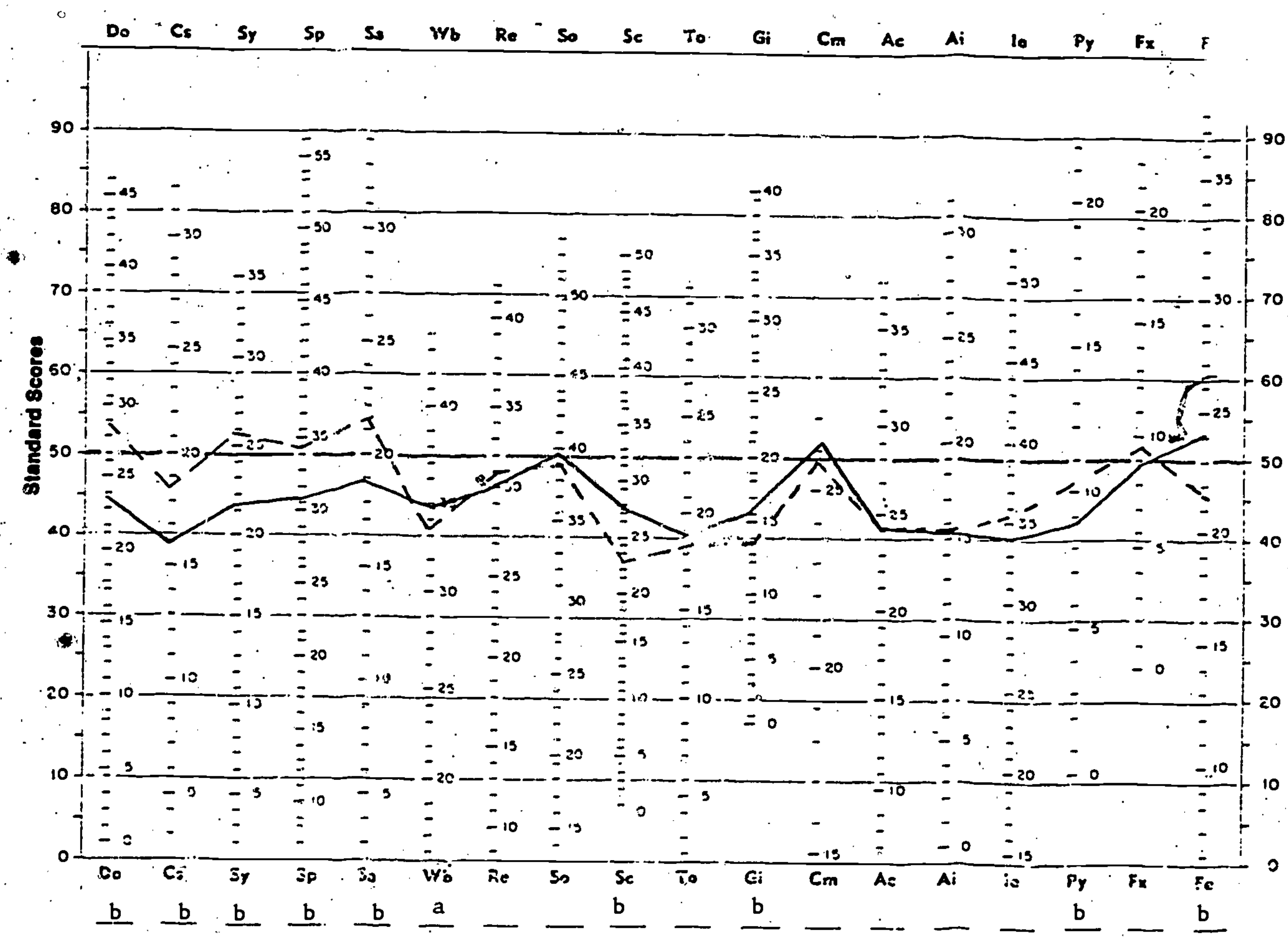
Figure 1 - CPI Profiles of 1970 PNBB Group and National Norms.



Key

———— High School Norm

-------- Patsy Neal Basketball Group

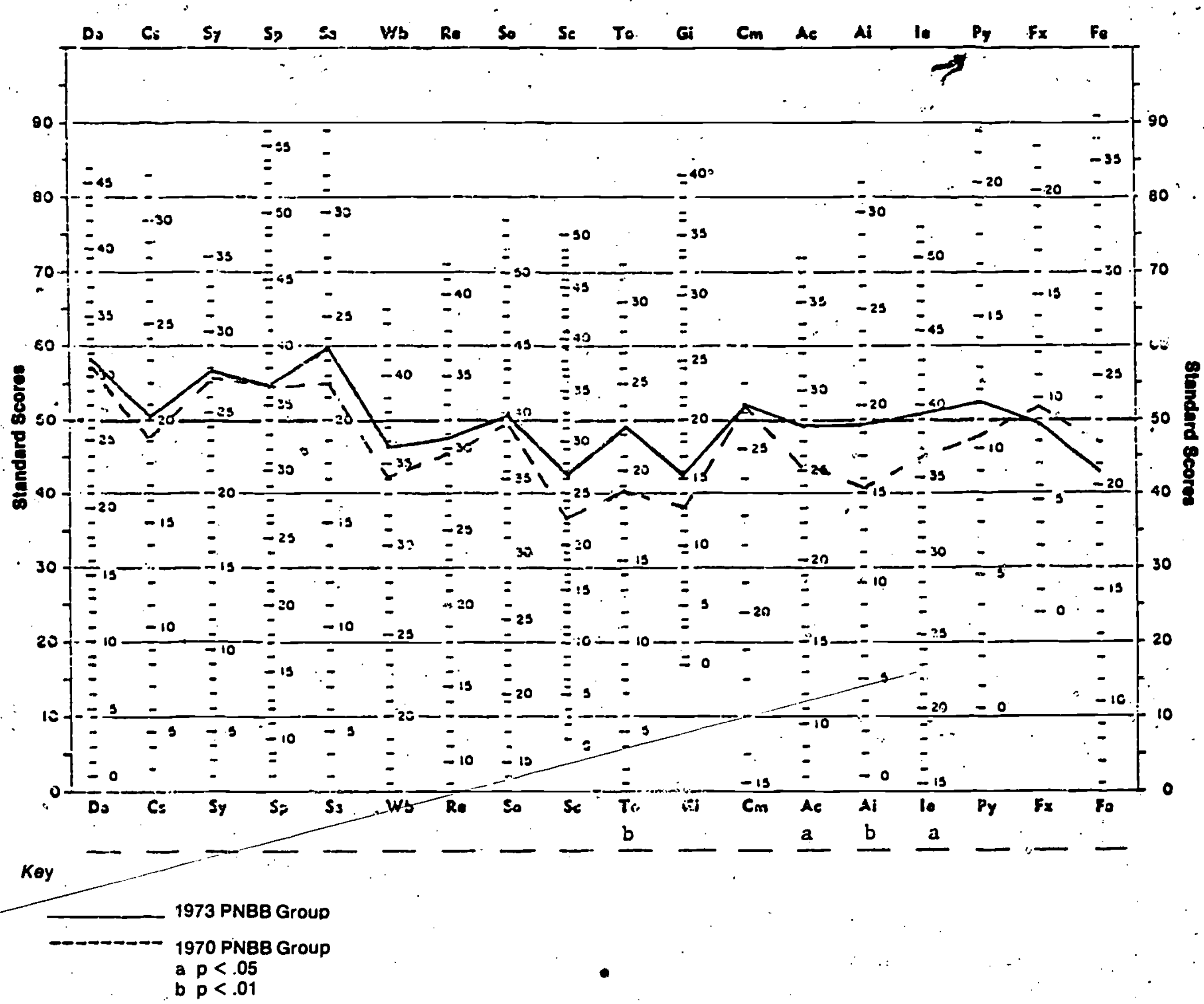
a $p < .05$

b $p < .01$

The PNBB Ss were significantly higher than the norms in the traits of dominance, capacity for status, sociability, social presence, self-acceptance and psychological mindedness. They were significantly lower in the CPI traits of well-being, socialization, good impression and femininity.

Upon retesting three years later, the 23 Ss CPI profiles were compared with their original profile and are illustrated in figure 2. Retesting showed significantly higher scores on the traits of tolerance, achievement in settings requiring conformancy, achievement in settings requiring independence, and intellectual efficiency.

Figure 2 – CPI Profiles of 1970 PNBB Group and 1973 PNBB Group.



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A summary of the 1970 demographic questionnaire is presented in table 2.

Table II illustrates that the 1970 PNBB Ss were active in other sports and notes that male members of the family were involved in the teaching of basketball skills to the girls.

A summary of the results from the demographic questionnaire returned by the 23 Ss in June 1973 is presented in table III. Highlights from the 1973 questionnaire revealed that the Ss remained very active in interscholastic basketball with approximately one-half of the Ss playing on a championship team and/or being selected as an "all-star." They were also very active in other extramural activities and reported numerous honors and awards in scholastic endeavours.

Table II – Summary of the 1970 PNBB School Demographic Questionnaire.

1. Age Range	12–17	Mean	14.5
2. Number of Siblings in the family:			
1	6.3%	4	17.5%
2	31.7%	5 or more	6.4%
3	28.6%	No Answer	9.5%
3. Age when you first started to learn to play basketball:			
under 6	6.4%	13–15	17.5%
7–9	20.6%	No Answer	11.1%
10–12	46.0%		
4. Who first taught you to play basketball?			
Teacher or coach	57.7%	Girl friends	6.2%
Fathers	16.5%	Mothers	3.1%
Brothers	10.3%	Sisters	0.0%
Boyfriends	6.2%		
5. Where did you learn to play basketball?			
School	42.3%	Church	1.3%
Home	34.6%	Other	7.7%
Recreation Department	14.1%		
6. What other sports do you regularly participate in?			
Swimming	23.0%	Badminton	9.3%
Softball	21.6%	Bowling	6.4%
Tennis	12.3%	Gymnastics	5.4%
Volleyball	11.8%	Others	10.2%

Table III – Summary of 1973 PNBB School Demographic Questionnaire.

1. Did you participate on the following basketball teams during the past three years?

	Intramurals			Interscholastic			Recreation or AAU		
	Yes	No	No Answer	Yes	No	No Answer	Yes	No	No Answer
1970-71	26.1%	47.8%	26.1%	82.6%	13.1%	4.3%	8.7%	73.9%	17.4%
1971-72	30.4%	47.8%	21.7%	78.3%	21.7%	0.0%	26.1%	86.6%	13.0%
1972-73	47.8%	34.8%	17.4%	65.2%	26.1%	8.7%	30.4%	36.5%	13.0%

2. Have you been selected as an "all-star" in basketball during the past three years?

Yes 47.8% No 52.2%

3. Have you participated on a "championship" basketball team during the past three years?

Yes 56.5% No 43.5%

4. Have you been selected as an "all-star" in any other sports during the past three years?

Yes 21.7% No 78.3%

5. Have you participated on a "championship" team in any other sports?

Yes 21.7% No 78.3%

6. What other honors, awards or recognitions have you received during the past three years?

Only 2 Ss responded that they did not receive awards or honors. The remainder of the Ss, reported a varied and impressive list of awards and honors ranging from who's who in American High Schools, a professional singer, a student council president, a drum majorette award and a beauty contest winner.

DISCUSSION

The 1970 CPI profile for the PNBB Ss showed the group to be significantly different in a positive direction from the normative population and confirms the findings of BELL (1955), KELLEY (1970) and BIRD (1965) and is in direct opposition to the results obtained from JONHSON's (1972) sample. The differences may be accounted for by the fact that the PNBB Ss and those of Bell and Kelley are high school students and live in areas where basketball for girls is a positive socially-reinforced activity. The differences in age and skill level of the samples may also account for the profile differences. However, 11 of the PNBB Ss were selected as highly skilled "all-stars" by their peers and coaches and their profile was not significantly different from that of the total sample.

The profiles of the 23 Ss who were retested changed in those traits that one would expect to change over time (achievement potential and intellectual efficiency). The lack of change on the other traits may be even more important if one interprets them as being relatively stable measures of personality. If this remains true on future testing, it suggests that the personality factors, as measured by the CPI, were developed and stabilized earlier than age 15. Thus, it would be interesting to know at what age these Ss first appeared as being different from the normative population.

The 1970 demographic questionnaire revealed the expected finding that most girls learned basketball skills from coaches and teachers but it may be noteworthy that it was fathers and brothers who also participated in teaching skills while mothers and sisters generally were not involved. This is rather unexpected as one would expect their mothers or sisters to have participated in basketball due to the long time span that basketball for women has remained an important social function. The popularity of the sport in the Southern states probably explains the relatively young age of initial participation. The PNBB Ss also participated in a number of other sport activities indicating less "specialization" than one might anticipate for this region.

The 1973 follow-up questionnaire further supports the idea that these Ss were "activists" in that over one-half played on championship basketball teams, over 20% were on championship teams or "all-stars" in other sports as well as an extremely impressive list of honors in scholastic and non-sport extramural activities. The diversity ranged from professional musicians to Who's Who in American High Schools to cheerleading awards.

The Ss in this sample appear to be a well-adjusted group with capabilities in many diversified activities.

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