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PSYCHOLOGICAL AND EDUCATIONAL FACTORS IN TRANSFER OF TRAINING, PHASE I. QUARTERLY REPORTS 2 AND 3.

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DESCRIPTORS- *LEARNING PROCESSES, *TRANSFER OF TRAINING, *PSYCHOEDUCATIONAL PROCESSES, INSTRUCTIONAL TECHNOLOGY, *AUTOINSTRUCTIONAL METHODS, PROBLEM SOLVING, INDIVIDUAL DIFFERENCES, INSTRUCTIONAL MATERIALS, PILOT PROJECTS, TASK PERFORMANCE, CONCEPT FORMATION, MODELS, REINFORCEMENT, *PROGRAMED INSTRUCTION,

PSYCHOLOGICAL AND EDUCATIONAL FACTORS INVOLVED IN THE TRANSFER OF TRAINING WERE STUDIED BY USE OF PROGRAMED SELF-INSTRUCTION USING TEACHING MACHINES. THIS MEDIUM WAS CHOSEN BECAUSE IT PROVIDES LABORATORY-LIKE CONDITIONS SUCH AS STABILIZED METHODS, AND STIMULUS CONTROL INCLUDING CONTROL OF TEACHER PERSONALITY, PLUS A STEP-BY-STEP RECORD OF THE STUDENT'S BEHAVIOR. THIS REPORT COVERS THE ACTIVITIES OF THE FIRST 7 MONTHS OF A 10-YEAR PROJECT. THE PRIMARY OBJECTIVES OF THE 2-YEAR PERIOD OF PHASE I WERE (1) TO DETERMINE THE RELATIONSHIPS BETWEEN TRANSFER AND LEARNING, PROBLEM SOLVING, AND INDIVIDUAL DIFFERENCES, (2) TO DETERMINE THE IMPLICATIONS OF EXISTING KNOWLEDGE OF TRANSFER FOR EDUCATION AND EDUCATIONAL MEDIA, (3) TO CONDUCT PILOT EMPIRICAL RESEARCH ON TRANSFER, AND (4) TO PREPARE A RESEARCH PLAN FOR PHASE 2. REPORTS OF PROJECTS UNDERTAKEN IN THE 2-YEAR PEROD OF PHASE 1 WERE INCLUDED. THEY WERE (1) A STUDY OF THE TRANSFER EFFECTS OF WRITTEN INSTRUCTIONS TO TASK PERFORMANCE AND OF TASK PERFORMANCE TO TASK PERFORMANCE, (2) LEARNING HOW TO LEARN UNDER SEVERAL CUE CONDITIONS, (3) THE EFFECTS OF SEQUENCE AND STRUCTURE ON COMPLEX CONCEPT FORMATION, (4) THE USE OF A MODEL AND A GENERALIZED PREVIEW TO FACILITATE THE LEARNING AND RETAINING OF COMPLEX SCIENTIFIC MATERIALS, AND (5) SOCIAL REINFORCEMENT IN A PROGRAMED LEARNING TASK. (GD)

TRL TRAINING RESEARCH LABORATORY

UNIVERSITY OF ILLINOIS, ROOM 24 LINCOLN HALL, URBANA, ILLINOIS

PSYCHOLOGICAL AND EDUCATIONAL FACTORS IN TRANSFER OF TRAINING

PHASE I

Contract Support by U.S. Office of Education.

TRAINING RESEARCH LABORATORY

University of Illinois
Urbana, Illinois

PSYCHOLOGICAL AND EDUCATIONAL FACTORS IN TRANSFER OF TRAINING

Phase I

Quarterly Reports 2 and 3

Periods:

October 1, 1962 - December 31, 1962
January 1, 1963 - March 31, 1963

Principal Investigator:

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Project Sponsor:

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Title VII

Project No. 2-20-003

Chapter One

Nature of Project

General Purpose

This project is concerned with the psychological and educational factors in Transfer of Training. In spite of its importance and pervasiveness, transfer, as a psychological and educational process, has not been studied with the vigor and systematic determination that is required.

One of the potentially more important instructional media for efficient study of transfer of training is programed self-instruction using the teaching machine. This educational medium provides laboratory-like conditions such as stabilized methods, stimulus control including the control of teacher personality, plus a step-by-step record of the student's behavior. These recordings are an important source of data which can be used for the continuous improvement of the instruction. There is, therefore, an advantage to be gained from research on transfer of learning with this new concept of instruction. Such research could be particularly useful in contributing to the development of new psychological knowledge about school related instruction.

The background of thinking and research on transfer that is pertinent to the new media and, in particular to teaching machines and self-instructional programing needs to be summarized and evaluated. The theoretical positions of transfer such as the following need to be related to one another and to these developments in instruction: Thorndike and Woodworth's identical elements, the concept of mental discipline, current conceptions of mediation, and the cybernetic theorizing grounded in models that include a feedback mechanism such as that of Simon, and of Miller, Gallanter, and Pribram.

Objectives

This proposal to study transfer is for a long range program to accomplish the following objectives in Phase 1, the first two years.

The primary objectives of Phase 1 are: (1) to relate and crystalize existent information on transfer by determining its relationship to learning, problem solving, and individual differences in abilities and aptitudes, (2) to determine the implications of the existent knowledge for education and in particular for the educational media, (3) to conduct pilot empirical research on transfer, and (4) to prepare a research plan for Phase 2.

Sub-goals for the project are to develop reports which (a) summarize and analyze the pertinent research, (b) examine theoretical issues and concepts, (c) analyze the relationships between transfer and learning, (d) study the relationships between transfer, abilities and aptitudes, and (e) examine the relationships between transfer and the development of cognitive structures and strategies.

It is anticipated that some comparative educational studies will be conducted to see if the principles derived from existent research can be used in educational settings where different cultural and/or language factors are operating. An effort will be made to conduct studies of cumulative transfer, longitudinal in nature.

General

1. Sample plan.

2. Treatments. Variations in the programs used for learning will probably include such treatment comparisons as (a) inductive vs. deductive, (b) cognitive grouping vs. spiral sequencing, (c) systematic deletion with terms constant vs. with terms varied. Reliable treatment effects will be re-examined to determine their potential generalizability by introducing cultural and language differences in groups. The initial studies will use programed materials in logic, mathematics and statistics since materials of this type are designed to teach cognitive structures that could have the widest possible transfer potential.

3. Controls. Programed instruction procedure employing printed texts, paper transport type of machine or a film device will be used as the means of presenting the treatments. Socio-economic and intellectual differences will be studied in relation to the intercultural and inter-language differences and transfer effects of instructional strategies.

Data-types to be gathered and methods to be used

Two types of instruments will be used to measure performance: (a) written tests and (b) performance tasks. Evaluations will be made to determine the dimensions of transfer as well as to estimate the amount and direction of the effects. Some dimensions are: (a) learning new and related material, (b) problem solving in which knowledge taught is directly relevant and sufficient, (c) problem solving where the knowledge is not necessary but the strategy required is relevant and useful, and (c) inferring and extending the knowledge taught to new materials.

Methods of statistical or other analysis

The analyses of variance will be used to determine the relative effects of the different treatments, and the correlational analyses will be used to determine the relationships between the ability measures and performance on the learning and transfer tasks.

Approximate time schedule

This proposal is to cover the work outlined above which will constitute Phase 1 of the 10-year program. Phase 1 is to take two calendar years (24 months).

Publication plans

The results of the studies completed in Phase 1 will be prepared as technical reports and possibly as monographs and articles.

Quarterly Reports 2 and 3 Covering Periods
October 1, 1962 to December 31, 1962
January 1, 1963 to March 31, 1963

Lawrence M. Stolurow -- principal investigator

Research Assistants	% Time	Period of Employment
Kenneth Pahel	25%	1 Oct 62 - 31 Mar 63
Daniel Davis	25%	1 Oct 62 - 31 Mar 63
Henry Lippert	50%	1 Oct 62 - 31 Mar 63
James Zartman	25%	1 Oct 62 - 31 Mar 63
Louis Xhignesse	25%	1 Oct 62 - 31 Mar 63
Clark Himmel	25%	Feb 63 - 31 Mar 63
Thomas McHale	25%	1 Oct 62 - 31 Mar 62
Clerical		
Freda Blecher	50%	3 Oct 62 - 31 Mar 63
Verna Vaughn	50%	23 Oct 62 - 31 Mar 63
Linda Mead	50%	1 Oct 62 - 21 Dec 62
Dolores Fairbanks	50%	1 Feb 63 - 31 Mar 63
Hourly		
Valerie Anderson		1 Oct 62 - 31 Mar 63

Chapter Two

Study of the Transfer Effects of Written Instructions to Task Performance and of Task Performance to Task Performance

L. M. Stolurow and T. J. McHale

A series of three studies which investigated the effects of various types of transfer in concept-formation tasks were conducted. Only two different tasks were used, and they were different only in minor aspects since each was generated from the same multiple-correlational model (See Azuma, 1960; Cronbach and Azuma, 1961 A&B). Two basic types of transfer were studied: (1) transfer to task performance from written instructions giving various amounts of information, and (2) transfer from one task to the other where the relationships between tasks are specified.

Experiment 1

Amount of Information Conveyed by a Knowledge of Either the Principle or Cues Given in Algebraic or Geometric Form

Purpose

Pilot work suggested that the task information principle is no better than no information, whereas information about the critical cues does facilitate performance. Furthermore, in a written questionnaire administered at the end of the task, many Ss verbalized a geometric approach to the solution of the task, whereas the original information was given in algebraic form. These verbalizations suggested that information given in algebraic form would be more beneficial since the geometric approach seemed a more natural way to attack the problem.

Hypotheses

The following specific hypotheses were tested:

1. The rank-order of performance will be 1) full-information, 2) cue-information, 3) principle information and no information.
2. Whenever two groups are given the same information in different form, the group given the information geometrically will perform better than the group given the information algebraically.
3. Though cue-information will lead to better overall group performance than principle-information, a knowledge of the principle is a requisite for criterion performance. Therefore, more _Ss_ in the principle-groups than in the cue-groups will attain criterion performance.

Task stimuli. Each stimulus presentation consisted of a 2.5 inch by 2.5 inch square with a small red cross and a small green cross drawn inside it. The left side of the square and the bottom of the square represent coordinate axes. The location of each cross is specified by its distance from the left side and the bottom of the square. These distances are its coordinates.

In the task stimuli, each of the four coordinates, x', y', x'', and y'', may take on one of four values, 3, 6, 9, or 12. These four values correspond to actual distances of .5, 1.0, 1.5 and 2.0 inches. The number of possible combinations of the coordinate values is 4^4, or 256. However, since the crosses were not allowed to occupy the same location in any stimulus presentation, only 240 (16 x 15) combinations were actually possible. Not all of these possible stimuli were used.

Presentation of stimuli. Stimuli were presented in a booklet, each page showing six different stimuli. The booklet consisted of 160 stimuli or trials. Subjects responded by marking with an X one of 10 possible response categories. On the answer sheet there were 10 numbers for each trial, one number for each of the 10 possible numerical answers. An X was drawn through the appropriate number. Subjects were allowed 20 seconds for each trial, and verbal feedback was given at the end of each trial.

The 160 learning trials can be considered as 10 sets of 16 presentations each. Within each set of 16 possible combinations of x' and x'' appear once each. This automatically made $r_{x'x''} = .00$. The distributions of y' and y'' were very close to rectangular. $r_{x'y'}$, $r_{x'y''}$, $r_{x''y'}$, and $r_{x''y''}$ did not exceed .12 in any block. Thus, for practical purposes these variables can be considered to be uncorrelated.

Criterion k. The formula used by E to define the correct response k is (2x' + x'')/3. Since x', y', x'', and y'' are uncorrelated within our set of stimuli, the definition of k determined their validities as follows: $r_{x'k} = .89$, $r_{x''k} = .45$, $r_{y'k} = .00$, and $r_{y''k} = .00$. Though the actual correlations of x' and x'' with k are exactly .89 and .45 respectively in each block of trials, the actual correlations of y' and y'' with k vary between -.12 and +.12. Since the 10 discrete response categories are exact numerical answers, S had to use precisely a 2:1 weighting to receive 100% reinforcement.

Measure of performance. The basic measures of performance were the criterialities[1] of the individual cues and of the construct k: product-moment correlations coefficients of the actual responses of each S with the responses he would give if he were to make his judgments solely in terms of x', x'', y', y'', or k. This yields a 5 x 5 matrix of correlations for each S: rows for x', x'', y', y'', and k; columns for each block of 32 trials which were analyzed separately. Correlations were computed over blocks of 32 trials -- 1-32, 33-64, 65-96, 97-128, 129-160.

Subjects. The Ss were college students from the University of Illinois from the introductory psychology class. Their participation was a class requirement. The task was administered to Ss in groups that ranged in size from 3 to 20. With the larger groups, at least two, and sometimes three, Es helped with the administration. There were 15 Ss in each experimental group for a total of 120 Ss.

Experimental Design

There were seven groups in the basic design of this study. (An eighth group was run in an auxiliary experiment which will be discussed.) There was a no-information group as a control, and two sets of principle-, cue-, and full-information groups. One set was given information in algebraic form; the other in geometric form. This design allowed a comparison of principle-vs. cue-information, and algebraic vs. geometric information.

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[1] Criteriality according to Bruner (1956) means how much a cue is actually used by an S.

Results. The correlational analysis of the data has been completed, but statistical analyses have not yet been completed. These analyses plus a full report of the study are scheduled to be completed this summer.

Experiment 2

A Comparison of Transfer Effects From Written Instructions Under Paced and Self-Paced Conditions

Purpose

This study is basically a replication of some of the groups in Experiment 1. The main difference is that in this experiment, each S worked at a teaching machine and consequently was self-paced. Comparisons are therefore possible between a paced and a self-paced condition, with major emphasis on two variables: 1) trials to criterion, and 2) time to criterion.

Hypotheses

The following specific hypotheses were tested:

1) Since the self-paced condition allows each S to proceed more slowly in the early trials when time to think is more necessary, Ss in this study should attain criterion performance in less trials than comparable Ss in Experiment 1.

2) Time to criterion should also be facilitated in the self-paced condition, though the difference between pacing and self-pacing should not be as large here as in trials to criterion.

Task stimuli. Only one minor change distinguishes the task stimuli from those of Experiment 1. Instead of using red and green crosses, the red cross was replaced by a black circle and the green cross by a black cross. These changes facilitated filming for the teaching machine, and also eliminated the difficulty encountered by color-blind Ss.

Presentation of stimuli. Stimuli were presented on a teaching machine. Only one stimulus frame was seen at a time by S; the correct answer for each frame was given on the following frame. The S could return only to the immediately prior frame to investigate any discrepancy between his answer and the correct answer. Therefore, the presentation of stimuli was equivalent to a straight linear program.

Subjects. The Ss were college students from the University of Illinois from an introductory psychology class. Their participation was a class requirement. Subjects were run in groups of not more than five each. There were 15 Ss in each experimental group for a total of 60 Ss.

Experimental design. There were four groups in this study; three of the four were replications of the no-information and full-information (both algebraic and geometric) groups of Experiment 1. The fourth group, also a full-information group, is comparable to the column-group in Experiment 3.

Results. Not all of the Ss have as yet been run. Enough Ss to complete the design will be run during the 1963 summer session; the statistical analyses and final report will be completed by the end of this summer.

Experiment 3

Various Aspects of Transfer from One Task to Another Generated From the Same Model

Purpose

In Experiment 1, Ss who solved the task verbalized their solutions in various ways that seemed to be systematically related to the type of instructions they had been given. These verbalizations ranged from the general and abstract to a very task specific rule. Intuitively, transfer from solution to the first task to another generated from the same model would seem to be facilitated by a less task specific and more generalizable mediating rule. This study was designed to test whether differences in transferability of training can be demonstrated on the basis of verbalizable mediating rules even though all Ss have solved the training task. It was designed to show, therefore, that solution of the training task is not as relevant to transfer as an S's verbalizable solution of the training task. It was also designed to study the transfer effects of various perceptual elements from a first to a second task.

Hypotheses

The following specific hypotheses were tested:

1) By comparing the mediating rules used by Ss in Task 1 with the mediating rule they must attain to solve Task 2, rank-order predictions of the speed of solving Task 2 can be made.

2. Perceptual similarity of the cues in each task should lead to faster solution of Task 2 than perceptual dissimilarity of the cues.

3. When the stimuli of two tasks are not obviously similar so that Ss will not automatically suspect that the two tasks might be related, instructions stating that the two tasks are related should facilitate the speed of solution of Task 2. This facilitation should occur over and above any other transfer effects that might be found.

Task stimuli. The training task in this study was the same as the task used in Experiments 1 and 2. The only change was the use of a small black circle and a small black square within each stimulus. The transfer task used a 3 x 5 stimulus cards on which a circle, square, rhombus, and triangle appeared. Either the number 1, 2, 3, or 4 appeared within each geometrical figure. The numbers within the figures replaced the four coordinates used in the training task. Only two of the four figures were relevant; the correct rule to obtain k (criterion response) was 2 (number in the circle) + 1 (number in the square) for some Ss, 2 (number in the triangle) + 1 (number in the rhombus) for others.

Presentation of stimuli. After S read one of three sets of full-instructions, he was given stimuli for Task 1 by E one at a time. The S gave his numerical response and the rule he was using on each trial in both tasks. After attaining criterion in the training task, E switched the formula by reversing the weightings of the two relevant cues. The same type of switch was made in the transfer task. In neither task was S informed that a switch was being made, nor was he allowed to ask questions of E at this time. This switching of rules was done to investigate two phenomena: 1) transfer from one task to a perceptually similar task, 2) the equivalent of two simultaneous reversal shifts administered to the same Ss in the same experimental situation. After solving the first task and its accompanying switch, S was read the instructions for Task 2 and began it immediately.

Experimental design. Three sets of instructions for Task 1 were varied orthogonally with three types of transfer task. The three sets of instructions were: 1) full-information algebraic, 2) full-information column (*k* = 2 column of the circle + 1 row of the square). The three sets of instructions were suggested by verbalizations of *Ss* in Experiment 1. The three types of transfer tasks were differentiated by 1) correct formula, and 2) knowledge of the relatedness of the two tasks. There were two types of correct formula: 1) 2 (number in circle) + 1 (number in square), 2) 2 (number in triangle) + 1 (number in rhombus). The third group, also given Formula 1, was told that the training and transfer tasks were related.

Subjects. Five *Ss* were run in each cell for a total of 45 *Ss*. This number may be doubled to allow a comparison of individual cells besides the comparison of rows and columns. A control group of 10 *Ss* was also needed. This group was allowed to warm-up on a neutral card-sorting task and then attempted to solve Task 2. Half of these *Ss* had to discover Formula 1; half had to discover Formula 2.

Results. 45 experimental *Ss* have been run in this study. The control *Ss* will be run during the 1963 summer session. Statistical analyses and a full written report will be available at the end of the present summer session.

Chapter Three

Learning How to Learn Under Several Cue Conditions

Dale Mattson[2]

This was an experimental study with two major purposes. The first objective was to determine the effects of several kinds of training on the subsequent mastery of a modified form of a problem solving task developed by Azuma (1960). The second major purpose was to evaluate the usefulness of cue-response criterialities in explaining transfer effects.

The design of this study was a factorial design involving two degrees of similarity between training tasks and the criterion task, and three degrees of similarity between the cues used for the training task and those used for the criterion task. In addition to the six groups (16 *Ss* per group) necessary for this design, an additional group of 16 *Ss* was used as a control group. These control *Ss* performed only the criterion task. The entire experiment was duplicated - once using large group testing procedures and once testing groups of either 7 or 14 at a time.

The *Ss* for this experiment were all undergraduate college students. For the first experiment in which large group testing procedures were used the *Ss* participated in the experiment as a part of a course requirement either in psychology or in educational psychology. For the second experiment all *Ss* volunteered to take part.

The results of the study may be summarized as follows:

1. A learning to learn effect was identified. Those *Ss* that received training on a series of training tasks similar to the criterion task solved the criterion task in fewer trials than *Ss* for whom training

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[2] This study is being done in partial fulfillment of the requirements for a Ph. D. degree.

tasks were not similar to the criterion task.

2. No transfer effect was found for the similarity of cues between the training tasks and the criterion task. For some Ss relevant and irrelevant cues remained constant for all tasks; for some Ss relevant and irrelevant cues were reversed on the criterion task; and for some Ss completely new cues were introduced during the criterion task. The number of trials needed to solve the criterion task was not affected by any of these three cue conditions.

3. A warm-up effect was identified. Subjects who performed a series of four tasks quite different from the criterion task, using four cues unlike those used on the criterion tasks solved the criterion task in fewer trials than Ss in a control group.

4. The use of the same two cues in the solution of a number of training tasks resulted in an increased use of these cues on the first trial of the criterion task. The criteriality (correlation) between cues and responses was higher on the first trial of the criterion task for cues which had previously been relevant than for cues which had been irrelevant.

Since no differences were found between experiments for all tables data from both experiments was combined.

Table 1

Schematic Description of Training

and

Transfer Conditions for Each Group

Group	Training tasks		Criterion task	
	Cues present	Type of task	Cues present	Type of task
WS	abcd[a]	W	abcd	W
WO	abcd	W	abcd	W
WN	efgh	W	abcd	W
XS	abcd	X	abcd	W
XO	abcd	X	abcd	W
XN	efgh	X	abcd	W
Control	No training tasks		abcd	W

[a]Underlined cues relevant.

Table 2

Description of Relevant and Irrelevant Cues for the Ss of Each Group

Groups	Ss	Training tasks		Transfer tasks	
		Relevant cues	Irrelevant cues	Relevant cues	Irrelevant cues
S (same cue)	1-4	circle and square	triangle and rhombus	circle and square	triangle & rhombus
	5-8	square and triangle	rhombus and circle	square and triangle	rhombus & circle
	9-12	triangle & rhombus	circle & square	triangle & rhombus	circle & square
	13-16	rhombus & circle	square & triangle	rhombus & circle	square & triangle
O (oppo. cue)	1-4	triangle & rhombus	circle & square	circle & square	triangle & rhombus
	5-8	rhombus & circle	square & triangle	square & triangle	rhombus & circle
	9-12	circle & square	triangle & rhombus	triangle & rhombus	circle & square
	13-16	square & triangle	rhombus & circle	rhombus & circle	square & triangle
N (new cue)	1-4	beaker & funnel	flask & jar	circle & square	triangle & rhombus
	5-8	beaker & funnel	flask & jar	square & triangle	rhombus & circle
	9-12	beaker & funnel	flask & jar	triangle & rhombus	circle & square
	13-16	beaker & funnel	flask & jar	rhombus & circle	square & triangle
Control	1-4	No training tasks		circle & square	triangle & rhombus
	5-8			square & triangle	rhombus & circle
	9-12			triangle & rhombus	circle & square
	13-16			rhombus & circle	square & triangle

Table 3

Analysis of Variance for Transformed[a] Error Scores for the Fourth Training Task

Source	SS	d.f.	F
Blocks[b]	.01498	1	.121
Rows	.69603	1	5.645[c]
Columns	.13198	2	.535
B x R	.11916	1	.966
B x C	.28429	2	1.152
R x C	.02967	2	.120
R x C x B	.08347	2	.338
Within	22.19092	180	
Total	23.55049	191	

[a]Scores transformed by using the common logarithm of X + 1.

[b]Blocks refers to experiments, rows to type of training task, and columns to cue conditions.

[c]Significant at .05 level.

Table 4

Means and Standard Deviations of Transformed[a] Error Scores on the Criterion Task

Type of Training Task		Cue Condition S	C	N	Total
W	M =	.6512	.7467	.5894	.6625
	S.D.=	.4372	.3112	.3534	.3728
	N =	32	32	32	96
X	M =	.8414	.7713	.8430	.8186
	S.D.=	.3341	.4403	.4847	.4213
	N =	32	32	32	96
Total	M =	.7464	.7590	.7162	.7405[b]
	S.D.=	.3977	.3784	.4398	.4044
	N =	64	64	64	192

[a]Scores transformed by using the common logarithm of X + 1.

[b]Statistics for control group: M = 1.2671, S.D. = .4404, N = 32.

Table 5

Analysis of Variance for Transformed[a] Error Scores for the Criterion Task

Source	SS	d.f.	F
Blocks[b]	.00262	1	.016
Rows	1.17045	1	7.245[c]
Columns	.06194	2	.191
B x R	.12185	1	.754
B x C	.05664	2	.175
R x C	.44700	2	1.383
R x C x B	.29463	2	.911
Within	29.07663	180	
Total	31.23184	191	

[a]Scores transformed by using the common logarithm of X + 1.

[b]Blocks refers to experiments, rows to type of training task, and columns to cue conditions.

[c]Significant at .01 level.

Table 6

Criterialities of Relevant and Irrelevant Cues on the First Trial of the Criterion Task

Group	N	Relevant Cues on Criterion Task	Irrelevant Cues on Criterion Task	Difference
WB	64	.27	.07	.20
WO	64	-.02	.44	.46[a]
WN	64	.27	.11	.16
XS	64	.68	-.17	.85[a]
XO	64	-.04	.29	.33[b]
XN	64	.25	.14	.11
Control	64	.35	.04	.31

[a]Difference significant at .01 level.

[b]Difference significant at .05 level.

Table 7

Total Number of Errors by Trial for the First 32 Trials of the Criterion Task

Trial	Groups						Control
	WS	WO	WN	XS	XO	XN	
1.	21[a]	28	20	24	26	25	22
2.	21	27	18	25	22	23	26
3.	12	21	15	23	18	23	24
4.	15	17	12	18	20	17	24
5.	12	14	9	20	19	17	26
6.	11	12	8	17	13	15	23
7.	6	12	6	12	14	16	25
8.	8	13	3	17	13	13	26
9.	6	11	3	13	12	9	21
10.	7	10	4	15	10	10	24
11.	7	6	4	15	9	10	22
12.	6	4	4	9	8	7	24
13.	6	5	5	9	8	7	20
14.	4	3	4	9	9	7	20
15.	3	1	4	10	8	7	18
16.	3	1	2	8	4	8	19
17.	3	1	3	4	5	5	15
18.	3	1	3	4	5	4	17
19.	3	1	2	2	5	5	17
20.	3	1	2	4	4	6	14
21.	4	1	3	3	6	5	14
22.	1	1	2	1	2	5	14
23.	1	0	2	2	4	5	13
24.	3	0	1	2	3	3	12
25.	2	0	1	1	2	4	13
26.	1	0	0	1	3	4	12
27.	0	0	0	1	2	4	13
28.	0	0	1	1	1	4	13
29.	2	0	1	0	2	4	8
30.	2	0	1	0	2	3	11
31.	2	0	1	0	1	3	10
32.	1	0	1	0	2	4	9

[a]Since there were 32 Ss in each group when the two experiments were combined, the maximum number of errors possible for any trial would be 32.

Table 8

Average Relevant and Irrelevant Cue Criterialities for Blocks of Two Overlapping Trials--Both Experiments (Figures 1, 2, and 3)

Blocks of Trials	Same Cue Groups		Opposite Cue Groups		New Cue Groups	
	Relevant	Irrelev.	Relevant	Irrelev.	Relevant	Irrelev.
1-2	34.00	19.44	11.75	35.06	28.88	20.03
2-3	35.88	22.94	18.19	27.88	29.81	22.81
3-4	36.94	20.00	18.50	23.69	43.62	18.31
4-5	39.25	17.75	28.50	26.88	48.12	15.69
5-6	42.44	16.69	38.56	19.31	46.44	17.00
6-7	43.25	14.94	43.56	17.94	44.12	14.75
7-8	48.12	18.44	45.38	15.19	49.81	11.69

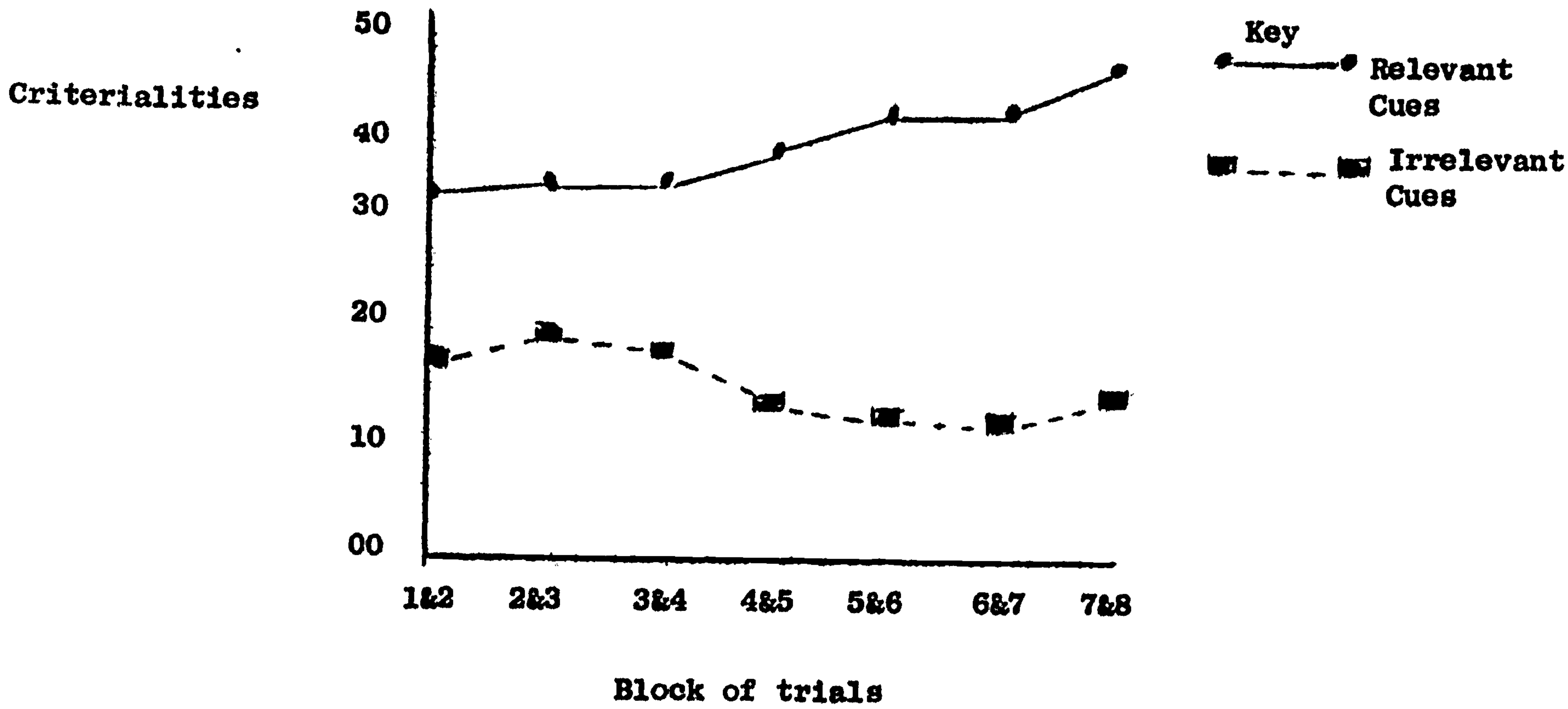

Figure 3

Average Relevant and Irrelevant Cue Criterialities for Blocks of two Overlapping Trials on the Criterion Task--Same Cue Groups.

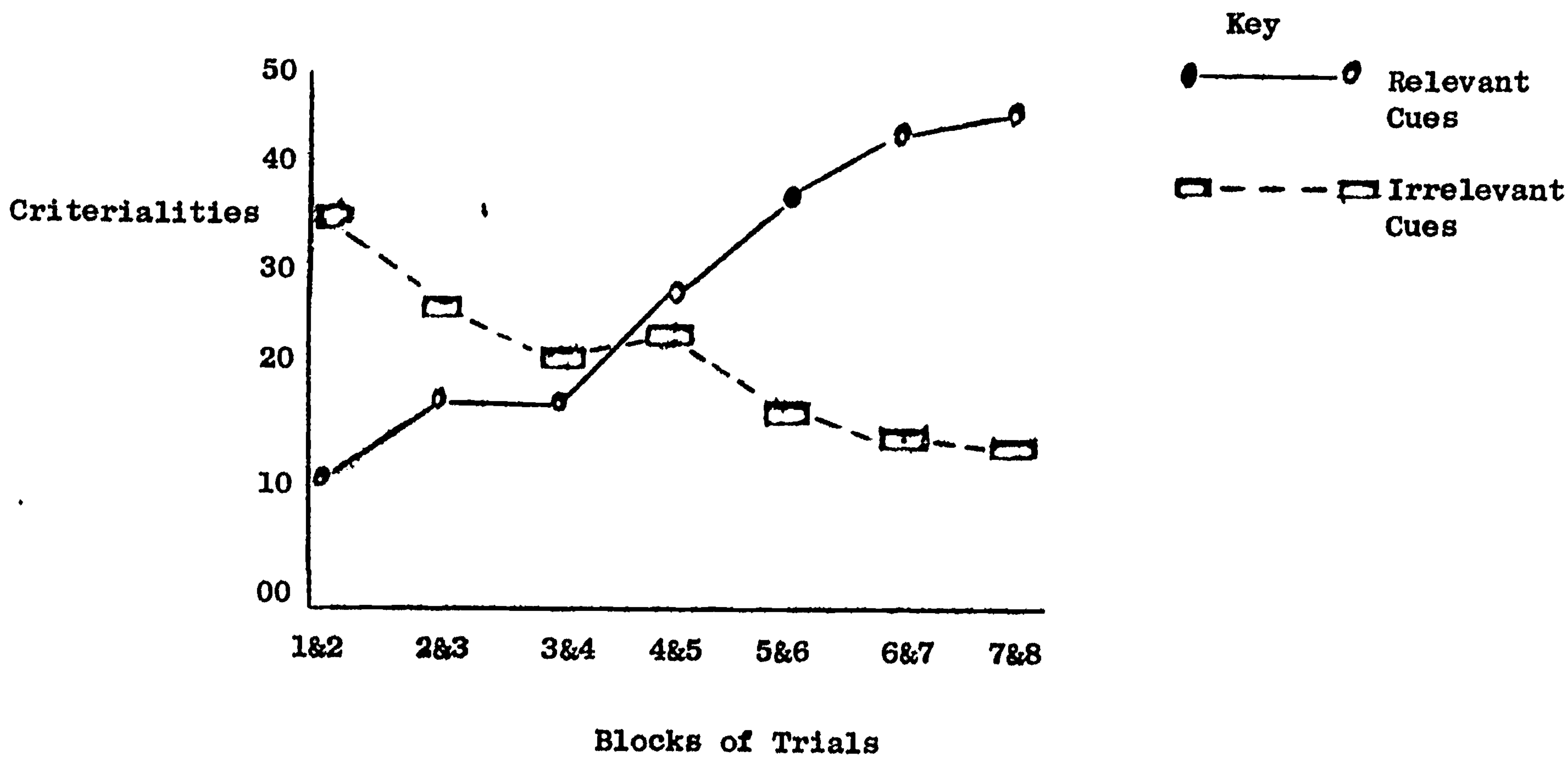

Figure 2

Average Relevant and Irrelevant Cue Criterialities for Blocks of Two Overlapping Trials on the Criterion Task --Opposite Cue Groups.

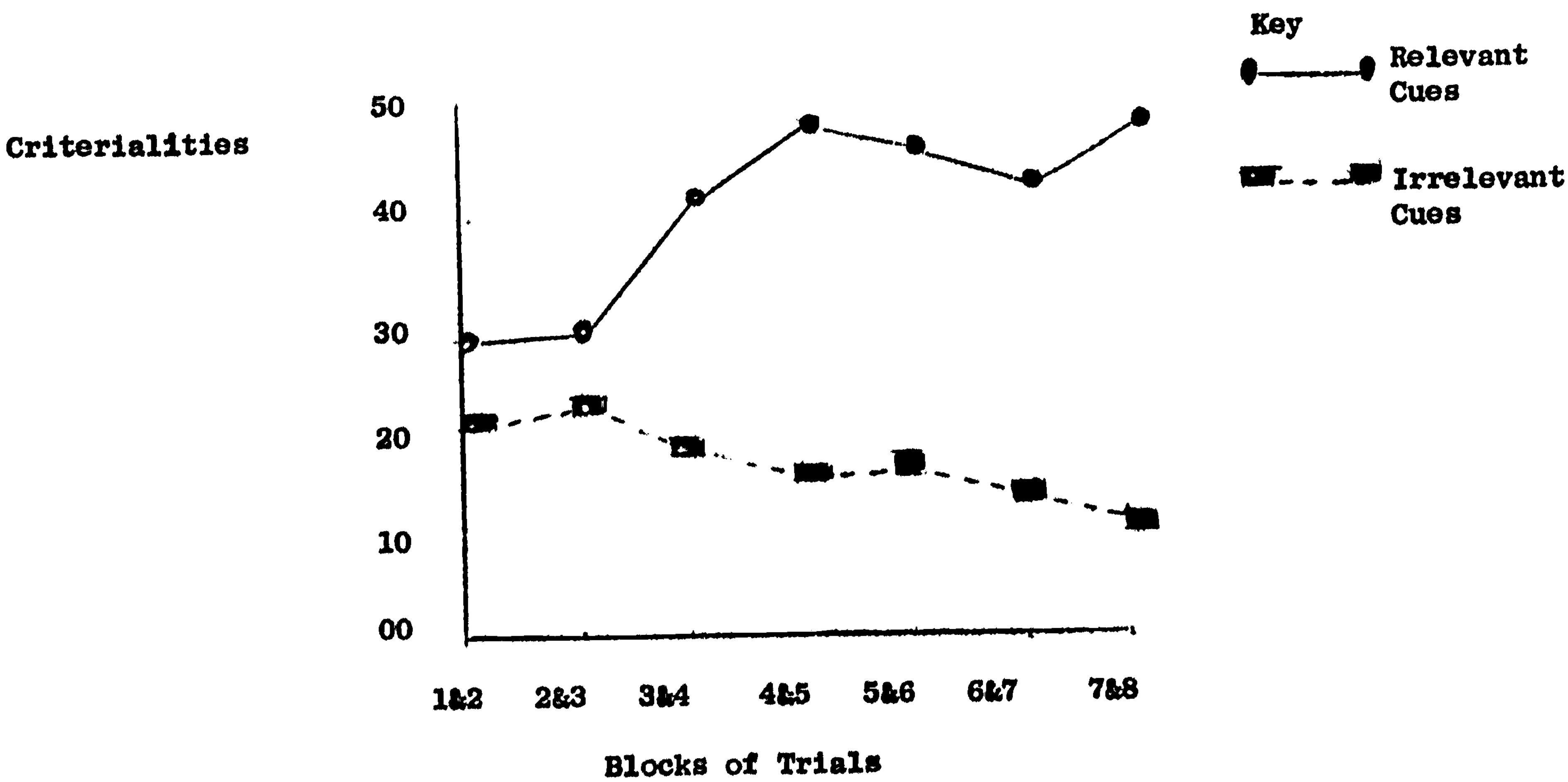

Figure 3

Average Relevant and Irrelevant Cue Criterialities for Blocks of Two Overlapping Trials on the Criterion Task--New Cue Groups.

Chapter Four

The Effects of Sequence and Structure on Complex Concept Formation

Research Proposal

Daniel Davis

Background

Consider a concept formation task in which there are two cues which are relevant to the solution and two cues which are not. Also, of the two cues which are relevant, one is more relevant than the other. That is, solutions based _only_ on the more relevant cue will be closer to the correct solution than those based _only_ on the less relevant one.

For such a task it has been found that subjects can learn the relevance of stimulus parameters simultaneously. Through selective reinforcement they learn to ignore the irrelevant cues and to weight and combine the relevant cues into a complex concept (Azuma, 1960; McHale and Stolurow, 1962).

For a similar task in which there was one relevant cue and two irrelevant cues, Detambel and Stolurow (1956) showed that sequencing is an important factor in the effectiveness of training. In particular, great improvement results when the following conditions are met:

a. When the value of the relevant cue changes on adjacent trials, the values of the irrelevant cues remain fixed.

b. When the value of one or both of the irrelevant cues changes, the value of the relevant cue remains fixed.

The above conditions determined what they called "asynchronous trials" as compared to "synchronous trials" in which all cues were free to vary simultaneously.

Purpose

The purpose of this study is to compare several ways of structuring and sequencing the early trials of a complex concept formation task. The comparison will be made on the basis of transfer to later trials which are completely unstructured or synchronous.

The training trials will be divided into two main segments:

1. Asynchronous segment (A) -- one relevant and one irrelevant cue are held constant while one relevant and one irrelevant cue are free to vary.

2. Synchronous segment (S) -- all cues are free to vary.

The asynchronous segment will be divided into two parts:

1. MAX. -- The more relevant cue is free to vary.

2. MIN. -- The less relevant cue is free to vary.

The four possible orders of presenting the above conditions will be compared with each other and with a control condition in which only synchronous trials are given during training. In doing this, it is hoped that the following questions will be answered:

1. What is the effect of adding the synchronous trials?

Based on the study of Detambel and Stolurow it is expected that during training the asynchronous groups should do better, but it is not at all certain that they will transfer to the synchronous situation. Whether they do or not would seem to depend on how they form the concept. If they operate on each cue independently and then combine them, there should be positive transfer. The reason for this is that on asynchronous trials they can direct all their attention to one cue at a time and later try to combine them. If, on the other hand, they use relationships between the cues, the asynchronous trials should be of no help.

2. What is the best order of presentation of the asynchronous (A) and synchronous (S) training trials?

It is expected that the order S-A is better than A-S. In the former case, the subject is familiarized with the situation to which he must eventually transfer. Therefore, on the A-trials he has a reference on which to base his hypotheses.

3. During the asynchronous trials is it better to present the more relevant cue varying first?

Based on some preliminary work there are indications that the MAX-MIN order is better than MIN-MAX. The subject can account for more of the variation of the solution during the MAX. condition, and, it seems easier to build a complex concept when most of the variation is explained by the main construct.

Task

The task to be used is the same as the one used by McHale and Stolurow in their 1962 report. Since the materia.'s used and method of presentation are the same, they will not be described in detail here. The stimuli consist of a red cross and a green cross presented in 2.5 inch by 2.5 inch squares. Each cross can appear in four horizontal and four vertical positions. The two relevant cues are the horizontal positions of the crosses and the irrelevant cues are their vertical positions. The concept 'k' is defined as follows:

$$k = \frac{2x' + x''}{3}$$

where: x' is the horizontal position of the red cross

x'' is the horizontal position of the green cross

The positions are valued 3, 6, 9, and 12.

In this case the position of the red cross is weighted twice as much as that of the green cross.

The following additional instructions will be given prior to the two types of asynchronous trials: "On the following presentations the red (green) cross will always appear in the same position. Therefore, changes in the value of 'k' will be caused by changes in the position of the green (red) cross".

Design

Each group will get 160 presentations in five blocks of 32 trials. The first two blocks are the training trials and the last three are the task trials.

Table 1

Experimental Procedure

	Training (1-32)	Training (33-64)	Task (65-160)
Exp. 1	A(MIN-MAX)	S	S
Exp. 2	A(MAX-MIN)	S	S
Exp. 3	S	A(MIN-MAX)	S
Exp. 4	S	A(MAX-MIN)	S
Control	S	S	S

The criterialities (Pearson product-movement correlation coefficients) of each cue and 'k' will be completed for each block of trials. For purposes of analysis, these will be transformed into Z' scores.

The four experimental groups will be compared in a 2 x 2 analysis of variance. Each of these groups will then be compared with the control group.

Table 2

2 x 2 Design for the Experimental Groups

	MIN-MAX	MAX-MIN
A-S	Exp. 1	Exp. 2
S-A	Exp. 3	Exp. 4

Subjects

Subjects will be taken from the Introductory Psychology course at the University of Illinois. There will be ten subjects in each treatment.

Status

Data have been collected and are in the process of being analyzed. The computer analyses should be completed during summer 1963 and the report drafted.

Chapter Five

The Use of a Model and a Generalized Preview to Facilitate the Learning and Retaining of Complex Scientific Materials

M. David Merrill[3]

Purpose

The present research is concerned with the question: Are some methods of organizing complex scientific materials more effective than others in facilitating a student's ability to retain the facts and principles and his ability to use these facts and principles in solving scientific problems?

Hypotheses

It is hypothesized that retention and problem solving ability can be enhanced in two ways. First, if the main generalizations of a science are presented to the student before the complex details are presented, then he should be able to relate each new fact and principle he learns to the general skeleton, and hence more clearly see their interrelationship. This should increase his understanding of the science, and hence his ability to remember and use the science for solving problems. Second, if the student first learns some model (in this case not mathematical), which is formulated in terms of concepts he already knows and which parallels the science sufficiently to allow him to relate aspects of the science to the model, then he should be able to remember the model more easily because of its former familiarity and hence be able to better retain the science.

[3]This study is being done in partial fulfillment of the requirements for a Master of Science degree in Education.

Other questions are of interest and should be answered, in part at least, by this research. For example: Does learning a generalized preview and/or learning a model benefit a bright student as much as it does an average student or is the bright student able to learn the material regardless of the method of presentation? Does learning a generalized preview and/or learning a model enable students with lower scientific aptitudes to score as high as students with high aptitudes on a test of retention and problem solving? These questions and various other interaction effects can be determined by the present design.

Design

These two conditions are combined in the following ways to produce the design of this experiment:

Group I is taught both the model and the generalized preview before learning the details of the science.

Group II is taught the model before learning the details of the science, but not the generalized preview.

Group III is taught the generalized preview before learning the details of the science, but not the model.

Group IV serves as a control group and is taught the science in a "conventional" way. Most text books and most teachers present scientific materials by means of a topical presentation, i.e., the student is taught one aspect of the science, then another aspect, and possibly some interrelated material from both of the previous topics as a third unit. "Conventional" in this research refers to this type of presentation.

The research design is summarized in Table 1 below:

Table 1

Design[a]

TOTAL N = 128

Level	Group I Model & Preview	Group II Model	Group III Preview	Group IV Conventional
Gifted	n=16 8 boys 8 girls	n=16	n=16	n=16
Average	n=16	n=16	n=16	n=16

[a]Test 1 was followed by Test 2 after approximately a two-week interval.

Procedure

Dr. Carl Bereiter, Training Research Laboratory, University of Illinois, developed a complex imaginary science in 1962 to study interdisciplinary research. In his experiment one group of subjects was taught one aspect of the science, a second group was taught another aspect, and then the two groups came together and tried to solve a common problem. The science consists of two main topics and a problem which requires laws from each for its solution. If one subject learns the entire science, he is learning material which approximates very closely real scientific instructional materials.

It was decided to use this imaginary science for several reasons. First, it presented typical scientific instructional materials. Second, it was constructed on the basis of a simple model which could, in turn, be used as a teaching device. Third, it was found to have a great deal of intrinsic interest for students. A large group of students who participated in a creativity institute during the summer of 1962 were taught the science as one of their activities. Without exception, all of them were fascinated by the science and were highly motivated to solve problems connected with it. Fourth, because it is imaginary and does not parallel any known system in the real world, it is not possible that any student will already have some knowledge of its principles. In most educational research, inability to equate previous experience with the material to be learned has had a contaminating influence on the results. Fifth, because it is a complete system, the entire science can be learned in a short period of time and it is not necessary to sample only some incomplete portion of a science for presentation.

Method

This science has been converted to programed instructional form for the present research. Programed instruction allows one to control such variables as teacher, attention, feedback, etc. Also, one of the great advantages for this design is the ability of programed instruction to balance and equate the groups in this study on all but the variables under consideration. This is done by presenting exactly the same frames to all students. For one student, a statement represents a generalization which is being presented before the details of the science while for another, this same frame is presented as a review statement following the presentation of the details, etc. By such equating, one is able to more clearly isolate what variables are contributing to the differences that are obtained.

Procedure

The imaginary science was taught to two groups of subjects in two three-hour learning sessions. Immediately following the completion of the programed learning material, each subject was given a two-part test, the first requiring solution of some simple problems using the concepts of the science, the second an objective multiple-choice test requiring recognition of terms, principles and relationships learned in the science. Two weeks later all subjects were given a parallel form of the test as a measure of retention.

Subjects

One hundred twenty students in the tenth and eleventh grades of a suburban high school[5] served as subjects. From previous records, IQ scores, reading scores, and science scores were obtained on each subject. Ss were divided into two levels, above IQ 125 and below IQ 125. The Ss in each level were randomly assigned into the four experimental groups. Figure 1 summarizes the design.

Results and status

The statistical analysis of the results are in progress. Tabulation of the mean scores on the tests indicate that on the immediate posttest, the low IQ group means are in the predicted relationship to one another, i.e., model + preview > preview = model > conventional. The high IQ group scores on the posttest differ only slightly and the differences will obviously not be statistically significant. This finding confirms one expectation that use of models and preview is more beneficial to the low or average IQ student than to the bright student who learns about as well regardless of presentation method.

The tabulation of the retention test scores does not indicate such a clear-cut relationship. Analysis of errors during learning the program and correlation of aptitude and test scores is currently under way in an attempt to explain the relationships obtained.

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[5] Appreciation is extended to LaDue School District and Hortin Watkins High School for cooperating in this study.

Chapter Six

Social Reinforcement in a Programed Learning Task

Lawrence T. Frase

Background

Experiments dealing with the effect of social reinforcers (such as "good") upon student performance are by no means a recent addition to psychological literature. Experimenters have demonstrated that the spoken word "right" or "wrong" may be reinforcing.

Three main criticisms can be offered against previous experiments in social reinforcement which deal with classroom behavior. The first is simply that experimental conditions and methods are usually somewhat removed from direct classroom tasks.

The second criticism concerns the distinction between social reinforcement and information. Is telling a student that he is "right" a social reinforcement or is it merely information which increases the probability of the occurance of the appropriate response? If social reinforcement is defined as any contingent stimulus event arising out of interaction with other individuals, in groups, institutions, or printed communication which increases the probability of a given response, then both social reinforcement and information can be reinforcing.

The third criticism of previous experiments relates to the lack of control of teacher variables. Programed learning tasks overcome this difficulty.

Purpose

One of the purposes of the present experiment was to distinguish social and information (feedback) functions of reinforcement. In terms of transfer of training, social reinforcement (and a student's learned sensitivity to it) is a class of stimulus events which applies to a broad range of educational situations which might be an extremely useful variable in research with programed materials.

Hypotheses were formulated with the aim of defining the usefulness of social reinforcement in programed research:

1. Subjects' performance in a programed learning task will be unrelated to social reinforcement conditions incorporated in the material.
2. Subjects' personality characteristics will be unrelated to performance under varying social reinforcement conditions.
3. Subjects' attitudes toward programed materials will be unrelated to the reinforcement conditions occuring in the learning task.

Various interpretations of the underlying mechanisms of systematic performance changes can be given in terms of single-stage and mediational stimulus-response psychology.

Method

Subjects for the experiment were 48 students enrolled in a freshman course in leadership for NROTC students.

Book I of a programed logic course developed at the Training Research Laboratory, University of Illinois, was used as the learning task. The book was modified into four maximum reinforcement conditions: only positive reinforcement ("good", etc., after each correct response), only negative reinforcement ("bad", etc., after each incorrect response), both positive and negative reinforcement, and neither.

Groups[4]

1	2	3	4	
n-12	n-12	n-12	n-12	reinf. cond.
				n-48

Subjects were given a pretest to determine their knowledge of elementary deductive logic and their attitude toward programed materials. Subjects were assigned to one of the four groups on the basis of SCAT scores. The Edward's Personal Preference Schedule was used to obtain subjects' scores on 15 personality variables.

Difference between the performance of the four groups will be analyzed by means of a one-way analysis of variance. Performance and personality variables will be correlated to ascertain useful variables for further experimentation. In addition, differences in subjects' attitudes toward programed materials will be related to the four experimental conditions.

The experiment has been completed and data are being analyzed.

[4]Group 1 - positive; group 2 - negative; group 3 - positive and negative; and group 4 - neither.

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