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DISCRIMINATION LEARNING, PROBLEM SOLVING, AND CHOICE PATTERNING BY CHILDREN AS A FUNCTION OF INCENTIVE VALUE, MOTIVATION, AND SEQUENTIAL DEPENDENCIES. FINAL REPORT.

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THE EXTENT TO WHICH INCENTIVES INFLUENCE CHILDREN'S LEARNING WAS STUDIED BY INVESTIGATORS AT THE UNIVERSITY OF CONNECTICUT. BOTH VERBAL AND MATERIAL REWARDS WERE OFFERED TO SELECTED GROUPS OF CHILDREN WHICH VARIED IN NUMBER FROM 48 TO 80 CHILDREN. A DIFFERENTIAL METHOD PERMITTED THE CHILDREN TO EXPLORE THE RANGE OF REWARDS SO THAT THE COMPARATIVE VALUE OF DIFFERENT INCENTIVES COULD BE DETERMINED. RESULTS SHOWED THAT INCENTIVES AFFECTED LEARNING POSITIVELY AND THAT CHILDREN WOULD PREFER VERBAL TO MATERIAL REWARDS WHEN GIVEN RELEVANT MOTIVATIONAL INSTRUCTIONS AND A FAVORABLE INCENTIVE SCHEDULE. THE NOVELTY OF UNEXPECTED REWARDS PROVIDED GREATER LEARNING INCENTIVE. HOWEVER, A DELAY IN RECEIVING REWARDS GENERALLY IMPAIRED LEARNING. ADDITIONAL STUDIES, USING THE SAME DIFFERENTIAL METHOD, SHOULD FURTHER CONSIDER THE SPECIFIC RELATIONSHIP OF REWARD TIMING AND TASK-RELEVANT INSTRUCTIONS TO MOTIVATION. DOCUMENT ED 010 530 WAS AN INTERIM REPORT OF THIS PROJECT. (MS)

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June 30, 1967

U.S. DEPARTMENT OF
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Office of Education
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Discrimination Learning, Problem Solving, and Choice Patterning by Children as a Function of Incentive Value, Motivation, and Sequential Dependencies

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Sam L. Witryol

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University of Connecticut

Storrs, Connecticut

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I. Introduction

A. Final Report Organization

The three experiments, the three pilot studies, and the dissertation reported here deal with the conditions and laws under which positive rewards influence children's learning. Lynn Lowden and Joseph Fagan were co-authors of the experiment in Chapter II on incentive effects upon fundamental dimensions of problem solving, our most exciting discovery. Fagan was the collaborator for the study in Chapter III which describes how the generally impairing effects of reward delay upon learning can be mitigated by orienting instructions. While this investigation was not a formal part of our original grant proposal, Fagan's hypothesis was derived from obvious relevance to our project dealing with incentive conditions for maximizing problem solving. Fagan and Lowden, assisted by an undergraduate participant, were again collaborators for the study on verbal and material rewards tested in competition under different schedules and orienting instructions, reported in Chapter IV. With the assistance of Jerome Feldstein and Lynn Lowden, children's choice strategies for accumulating incentives were examined in the pilot study in Chapter V; this investigation had been projected as a pilot, conditional upon completing the earlier studies, and our exploratory objectives were satisfied. Jerome Feldstein conducted the pilot research for Chapter VI, which summarizes findings related to reduction of uncertainty as an incentive construct in children's learning. The preliminary investigation of reinforcement timing when massing or spacing trials during children's problem solving appears in Chapter VII via the combined aid of Fagan, Feldstein, and Lowden. Chapter VIII is a summary of Donald Tyrrell's dissertation in which he showed that differential delay-of-reward pretraining was superior to non-differential pretraining in enhancing the probability of observing a relevant dimension in children's problem solving.

Each of the major studies in Chapters II, III, and IV is reported in full as an integrated package with footnotes indicating publication status, and/or papers for delivery at professional meetings. Exploratory studies in Chapters V, VI, and VII are more briefly summarized, as is Tyrrell's thesis in Chapter VIII. The final chapter represents an integration of the reported studies together with theoretical and practical implications.

B. Previous Research Programs

1. Early Origins of Present Program

More than 20 years ago the major investigator became interested in motivational influences affecting social values and cognitive training in school children. This resulted in a dissertation in which 3410 children gave questionnaire protocol, subsequently scaled by the method of paired comparisons, on cognitive-social variables influenced by teachers in their administration of verbal reward and punishment (Witryol, 1950; 1954). The data from paired comparisons yielded a remarkably stable hierarchy of cultural-social value categories over a wide age range in Grades 6 to 12, reflecting increasing discrimination with age. In a companion study, observers studied administration by teachers of verbal reward and punishment in the natural setting of the classroom, and developed a scale in which children identified peers (de Groat & Thompson, 1949) who were recipients of teacher approval-disapproval.

These research experiences derived from the classroom influenced the investigator in two ways. First, they indicated the significance of socially administered rewards and punishments in the modification of important cultural values. Second, the power of paired comparisons as a research tool for scaling complex human behavior was demonstrated. In paired comparisons, the stimuli to be scaled are paired in all possible combinations so that the child makes a preferential choice, two at a time. Under these circumstances the child can respond reliably on difficult discriminations where the pairs might be, as examples, drawn from lists of social values, friendship choices, or verbal and material incentives. The choices can be transformed to a rather sophisticated scale for groups of children, or they can be taken as reliable measures of individual differences. Like any scale, however, a further interesting problem remained to show how these preferences might influence behavior in a social or cognitive setting.

The data obtained by the techniques described above were taken from the "natural setting" of the classroom, but, while significant, suffered from lack of controls necessary for understanding basic processes underlying the behavior identified. A doctoral dissertation directed by this investigator provided an opportunity to extract certain relevant features from the classroom for closer scrutiny under laboratory conditions (Alessi, 1957). Verbal reward and punishment were administered to 110 second grade children tested individually on a series of simple arithmetic speed addition tests. No contrast, elevation, or depression effects were found from a predetermined schedule of 11 different reward-punishment-neutral, rational combinations. However Alessi commingled the social motivation sequence, the dependent variable, speed of addition, was responsive to the drive enhancing conditions of punishment, reward, and neutral independent variables in that order; punishment and reward were very close together in efficacy. Alessi's thesis is an excellent example of an experiment stimulated, indeed, mandated from observation of classroom behavior. While his findings were provocative and enlightening, they suggested a number of further inquiries into the basic problems of drive-reward interactions when studying children.

2. Recent Origins of Present Program

Our earlier research had been generated directly from motivational problems of children originating in the classroom. Studies by other investigators had been limited in number, and not entirely congruent. While reinforcement values had a long history of research at the animal level (Harlow & Meyer, 1952) application of such findings to children constituted extravagant extrapolation yet to be tested. One constructive possibility to bridge this gap was presented by Siegel and Foshee (1953) in an article called "The Law of Primary Reinforcement in Children," but surprisingly few studies involving children had been published. It became increasingly and obviously apparent to this investigator that a basic program, laboriously and carefully examining incentive-motivation parameters with children was required to bring coherence to scattergun, applied efforts and to utilize direction provided by theoreticians in the animal and adult human domain.

Training children to develop intellectual and social skills and values is generally instrumented by verbal rewards in the classroom, but children, especially young children, are influenced by material rewards available in the extramural world. In the typical laboratory situation material rewards have most commonly been more effective than verbal rewards as reinforcers. This might be true for three reasons: (a) material rewards are relatively more "primary" reinforcers, (b) material rewards may be more relevant than verbal reinforcers mechanically dispensed in a contrived laboratory situation; (c) material rewards are infrequently dispensed in the "real world," compared to verbal reinforcers, so that the former maintain novelty and/or arousal value. The differences also may be artifacts of experimental contexts as prototypes of "natural" settings with respect to task relevance, instructional set, general availability, and economy of implementation. Four more studies directed by the major investigator are pertinent to these problems.

Fischer (1963) was interested in exploring the process by which children attain cultural values of the type scaled in the Witryol dissertation (1950). He noted that many investigators had scaled values and invoked developmental learning assumptions about how they were attained, but very few specific experiments demonstrating processes were available. Fischer compared verbal and material incentives as determinants of two levels of "sharing" behavior in nursery school children. Only half of his subjects reached sharing criterion, and they were mainly influenced by material rewards. Intelligence did not discriminate between sharers and non-sharers, but was positively related to amount of sharing in the former group. The task required subjects to share material rewards with a child surrogate. Fischer's dissertation is salutary in demonstrating reinforcement influences on a segment of a basic value, generosity, but it also suggested complexity of laws related to task relevance, age, and intellectual competence. The study did not rule out the relevance of verbal rewards; it showed highly competitive features from material rewards in training very young children to a complex social value.

In another dissertation Hall (1960) had investigated the effects of two levels of verbal reinforcement interacting with two levels of instructional set on verbal learning in college students. Here is an example where both task and age level were relevant to verbal incentives.

Hall found the higher verbal incentive effective under ego and task orientation, but the low verbal reward worked only under the ego instructional set. In this study the orientation set may be viewed as inducing motivational level, with the verbal rewards as incentive values. Hall's results were neatly in accord with theories from animal work and from personality. A dissertation by Felix (1965) was another investigation of two levels of motivation arousal interacting with verbal reward and punishment as determinants of time estimates by college students working on a verbal task. Under ego orientation "time flew" for subjects verbally rewarded and punished, but time estimates were raised when no feedback was given. The task orientation--less motivating than ego--led to a small influence upon time estimates under praise-reproof conditions.

Berkowitz (1964) guided by hypotheses in child psychology from Gewirtz and Baer (1958a, 1958b) conducted a dissertation to examine the relationship between three types of motivation and social approval given to schizophrenic and normal controls performing on a reaction-time task. Motivation was manipulated by contact with the experimenter over three successive interviews prior to administration of verbal reinforcement in the reaction time task. Subjects were assigned to three treatment groups where they experienced relationships with the experimenter objectively defined as "warmth," "rebuff," and "no contact," respectively. On reinforcement test trials, schizophrenics were more sensitive to antecedent treatment conditions than normals; they were less responsive to social reinforcement after experiencing a "warm" preexperimental treatment, i.e., accepting and friendly. In short, they showed social satiation as did children in the Gewirtz-Baer studies. Findings for normal adults were more complex: on unreinforced trials they were responsive to both "warmth" and "rebuff" treatments, but with verbal reinforcement they responded like the "no contact" group. Consistent with findings in developmental psychology, schizophrenics like young children responded to social approval on the basis of frustrated or satiated social dependency needs, but normals like older children seemed to be guided by verbal reinforcers as strong incentive signals to an achievement need. Berkowitz's results for schizophrenics are generally in accord with the motivation manipulation programs of Stevenson and Zigler (Stevenson, 1965) in assessing children's verbal approval values.

3. Scaling Children's Incentives

From our pastresearch experience there appeared a host of rational generalizations along with some discomfiting complexities, not, however, unamenable to further systematic analysis. From the natural classroom setting children had systematically reported to us (Witryol, 1950) that important cultural values were differentially reinforced by teachers. Classroom observations and peer ratings had indicated that teachers dispensed reward and punishment in a polar distribution to a selected few to induce cognitive and social achievement (de Groat and Thompson, 1949). Material rewards appeared to "work" better (Fischer, 1963), but verbal reward values had differentiating effects when task relevant (Berkowitz, 1964; Felix, 1965, Hall, 1960).

At this point we were ready to define some basic problems about incentive values of rewards, verbal or material, and about relevant antecedent motivation conditions. Why, we asked ourselves, was research on the influence of incentive values on learning in the classroom so equivocal? An intensive review of research and theory at the animal level might explicate the basic processes to be considered as a first approximation. In Spence's theory (1956) an incentive is defined as anticipation of reward or reinforcement. Reward value is determined by quantity, such as size and number of food pellets, under relevant drive or motivation conditions like hunger. The incentive value of any particular size or quantity of pellets is a function of drive defined in this case as number of hours of food deprivation. With drive held constant, variation in size or amount of pellets determines incentive value which then adds to (some people have thought multiply) drive or motivation to determine behavior. What kind of behavior? Not the associative features of learning, Spence demonstrated; it was a performance variable like maintenance of behavior, speed, or energy output. What does directly influence associative learning? Only practice or number of trials for the relevant S-R connection, Spence indicated.

Spence's notions were helpful in delineating learning-drive-incentive relationships, but how could one apply the animal controls in a human setting? Stevenson and Zigler (Stevenson, 1965) had provided one approach working with normal children and mental retardates. They held verbal reinforcement constant and manipulated social drive deprivation and satiation. Here is another excellent example of starting from basic propositions in animal behavior for application to children. Stevenson and Zigler have demonstrated that drive generally operates as suggested from learning theory, but they also explored numerous personal, interpersonal, and environmental parameters influencing complex motivation in children, and they have invoked theories by Lewin and Freud, among others, to comprehend their findings. Their programs represent a salutary marriage of basic, social, and applied psychology.

We turned our attention, at first, to the problem of differential incentive values, rather than motivation manipulation. How could we find standard verbal and material rewards for children analogous to objective reward values like size of food pellets for rats? This problem was faced when Fischer was designing his dissertation proposal. He needed a material reinforcer with enough incentive strength to balance the incentive values of marbles which his nursery school children could either share or hoard. A reinforcer could have a range of incentive values for different children as a function of unknown, complex learning history peculiar to each child. A solution to this problem suggested the application of the method of paired comparisons, and a number of parametric studies followed.

In the first study (Witryol & Fischer, 1960) nursery school children were asked to indicate their preferences for five incentive objects presented for choices in 10 pairs; the objects were bubble gum, balloons, charms, marbles, and paper clips, and they turned out to be ranked in that order. These young children demonstrated high reliability in their choices as individuals and substantial agreement in their choices as a group. This first application of the method of paired comparisons to scaling the values of incentive objects in children suggested to us that this approach might provide an objective definition of reinforcement strength for rewards employed in learning experiments. The scale seemed to have enough power so that one might reason from differential values in the manner that animal researchers estimate the strength of, let us say, one pellet versus four pellets of food. This meant that regardless of antecedent and varied motivational histories of children, i.e., however a particular object had attained incentive value for a particular child, the method of paired comparisons yielded a stable contemporary value for each child. Spence, furthermore, had left room in his theory for possibilities that qualitative differences in reward properties might yield differential incentive values. Harlow and Meyer (1952) had employed paired comparisons in scaling reinforcements for animals.

Paper clips had been inserted in our scale simply as an anchoring reference point, and, although these choices were few in number, there were enough of them to merit close scrutiny. Lock washers have been used as anchors in the Siegel and Rieber experiments (Bisett & Rieber, 1966; Siegel & Forman, 1967; Siegel, Forman & Williams, 1967). Some children preferred paper clips, and exploration of the natural environment revealed that a few mothers exchanged group, babysitting sessions during which one ingenious young woman had her charges string paper clips as necklaces and bracelets! In subsequent studies we found individual children who preferred dried beans, which we had assumed to be of smaller incentive value than paper clips. Our experimental spies (the major investigator's young son and daughter) informed us that one child planted the beans, and another ate them! These natural phenomena seemed worthy of exploration, so that in a followup study (Witryol & Alonzo, 1962) another sample of nursery school children ranked five reward objects by paired comparisons. The paper clip was least preferred, and 9 - 20 days later the children rated the objects a second time with instructions, "All the other children liked the paper clip best." The other incentives maintained relative rank, but the paper clip rose from last in the first administration to second preferred with the added instruction. This sensitivity of children's incentive values to antecedent history, including instructional set, taught us never to assume that all children will value a reinforcer in the same way, and always to check assumptions by having our subjects rate reinforcements. We also learned that it is easier to find incentive objects of high value for children than of clearly low value. This surprised us since we had initially assumed the opposite.

In spite of the individual differences we consistently found in children's incentive values, we were also impressed by modal agreements. Using almost the same incentive objects employed by Witryol and Fischer (1960), Tyrrell, Witryol, and Silverg (1963) tested mentally retarded children comparable in mental ages to nursery school children in the earlier study. Scale values were almost identical in rank order between the two studies, and the mental retardates ranked the reinforcements identically over two administrations. We seemed to have developed a tool to identify stable modal values of incentives for children and to detect individual differences at the same time.

Given the promise of the method of paired comparisons as a technique to scale incentive objects ranked by children, we next explored putting verbal incentives in competition with material reinforcements in a developmental study (Witryol & Ormsby, 1961). Six incentives included bubble gum, a nickel, M&M candy, and two verbalisms: "you are doing better than anyone else," and "you are doing better than you did before." These were presented in pairs for choice preferences as described before; the experimenter, an experienced school teacher, asked, "Now if you had done something very well indeed, would you rather have your teacher or mother give (or say to) you ________________ or ________________?" The two verbal incentives ranked last in Kindergarten, but were first in Grades 3 and 6. The two verbalisms were scaled close together in the two younger grade levels, but in Grade 6 "better than before" seemed higher than "better than anyone." Individual and group consistency in scaling the incentives were substantial at all grade levels, but increased with age, demonstrating superior choice discrimination with age as in the Witryol dissertation (1950) on cultural values. In interpreting these findings, one should note carefully the nature of the instructions because they trigger relevant and irrelevant drives as has been demonstrated in the dissertations reviewed above. It should always be remembered that motivation partially determines incentive value, and in this study our directions seemed to favor verbal choices in the upper grade levels, although young children were oriented toward material incentives.

4. Learning Tests of Children's Incentives

Having explored some parameters relevant to defining an objective scale for children's verbal and material incentives, the next step was to test differential scale values on some learning functions in children. We embarked on our first large-scale experiment, with the support of the Office of Education, to test children's incentive values, initially scaled by paired comparisons, on an important learning function. The following questions were posed. Do children's <u>scaled</u> incentives show parallel values when tested in a <u>learning</u> situation? What learning outcomes result from reinforcers sampled from the commonly employed incentive categories: edibles (chewing gum), manipulatables (small charms), tokens (money) and verbalisms (verbal reward)? The dependent variable chosen was performance on a five-choice discrimination learning task for a number of reasons. Research evidence and theory were accumulating in studies employing normal children and mental retardates to indicate that two-choice discrimination learning models reflected not only basic simple associations, but also more complex learning processes akin to "problem solving" and "thinking." Learning theorists were shifting their emphases from simple peripheral processes to central mediating processes like verbal mediation, attention, transposition, etc. In short, they were beginning to sound quite "cognitive," a word for some time in ill repute, and they seemed to be approaching the more complex intellectual skills required in training children in the classrooms. This shift in emphasis was already becoming apparent, as in two highly arbitrary and selected examples, from the work of Dr. Sheldon White (1963 ; 1965) now of the Harvard School of Education, and in the experiments of my colleagues, Dr. David Zeaman and Dr. Betty House (1963a; 1963b). These developing approaches had the dual merits of providing carefully devised experimental analogues and of generating applications to complex human learning processes. Furthermore, the only contemporary research on children, showing verbal and material incentive differences on what appeared to be associational learning, employed discrimination learning paradigms (Terrell, 1959; Terrell, Durkin, & Wiesley, 1959; Terrell & Kennedy, 1957).

In simultaneous two-choice discrimination learning the child is typically presented with two geometric objects differing in color and/or form and/or shape etc. One of the two stimuli is consistently reinforced over trials. Depending upon the complexity of the design, the child may find the correct cue in a dimension of color, form, size, position, alternation sequence, etc. The problem can be quite simple as in presenting only two different shapes of the same color (randomly assigning position to eliminate or minimize that possibility as a cue), or the problem can be very complex by compounding dimensions, as in red triangle or red square. The paradigm is made to order for testing problem solving at simple to complex levels of abstraction, induction, and deduction, although learning theorists prefer other terms. The word dimension has special significance within this framework; it really refers simply to an empirically derived category or generalization. For example, geometric form or shape is a dimension; a particular form or shape is a cue; i.e., triangle is a cue within the dimension of clearly recognizable forms. A "recognizable" form is empirically determined from children's learning. Verbal and mathematical dimensions and cues might be similarly operationally defined, given empirical study. Of course it is easier for discrimination learning theorists to define stimulus characteristics physically in the geometric domain, but even so, the subject's response remains the final ordering criterion.

Our five-choice discrimination learning experiment represented a daring gamble we would not have taken if we had been more sophisticated, but it worked. Considering the intellectual complexities already suggested in two-choice learning, five-choice learning could have been impossible. Each child was presented five different stimuli and under each in turn was placed (out of sight) bubble gum, a small plastic cow, penny, "fine" or "good" (emitted by experimenter), and nothing (as a control). On each of 80 trials the child could pick one of five geometric stimuli and keep the reward he obtained. The task was made more difficult from the fact that four of the five stimuli were reinforced as above, and previous scaling would suggest that incentive values of the rewards were closely spaced. As a consequence we maximized differences in stimuli by making each different from the other in dimensions of color, form, and size. Interesting also was the fact that instead of "getting hung up" from primacy of an early valued incentive, the vast majority of children explored (another motive) all five possibilities within the first five or ten trials, and incentive learning differentiations were apparent by the end of 40 trials. Prior to the discrimination task, the incentives were presented by the method of paired comparisons under two different conditions: first, by the child's preference indication (pointing); second by his cumulation of the rewards (consummation).

There were two further methodological reasons why we employed a complex, five-choice, discrimination learning task. First, we had anticipated we might find satiation effects so that if a child tired of cumulating a favored reward, e.g., bubble gum, he might switch off and start cumulating an originally lower preferred incentive. As a matter of fact, animal researchers typically run their subjects one trial a day in order to control for this possibility. Such strategies did not appear in our data from the nature of our design, but enough were suggested to warrant closer study in later research. On the other hand, satiation effects were not generally apparent, and Siegel (Siegel & Forman, 1967; Siegel, Forman, & Williams, 1967) has commented about this from his comparable work with mental retardates. Second, our design was already complex, including eight different populations arranged by age, sex, and socio-economic status. Had we used the so-called "absolute" method by testing each child in two-choice discrimination where a correct choice for one of the paired stimuli would have included each of the four incentives opposed to no reward, the number of populations would have expanded by a multiple of four, totalling 32. Our "differential" method, in which each child serves as his own control by responding to all five stimuli with their associated rewards, was not only more economical, but it followed a crucial stricture that incentive effects are more easily demonstrable when the subject experiences the range of rewards to be compared.

From 160 children tested in Grades 1, 3, and 5, the discrimination learning results confirmed the paired comparison scale values with one exception: the verbal reward ranked higher in the preference scale than on the experimental task (Witryol, Tyrrell, & Lowden, 1964; 1965). We had made one bad mistake (at least). The instructions on the preference scale were similar to those used by Witryol and Ormsby (1961), but it was hard to make them compatible with our discrimination learning machine which spewed out material rewards nicely, but was not responsive to the verbal incentive. Some of our children conveyed skepticism when, after selecting a stimulus,they found an empty tray, whereupon an experimenter enthusiastically boomed, "fine!" We adjusted for this problem in our next grant supported research. Nevertheless, there was an increasing trend toward verbal choices with age, and this was particularly true for two polar socio-economic samples of females in Grade 5. Surprisingly, no differences in incentive rank by scale or learning task was found for two contrasting samples of high and low socio-economic status. The major hypothesis of scale and learning congruity was confirmed. The children learned to identify or work at discriminative stimuli as a function of initially preferred scaled incentive values. We knew children had to learn where the incentives were (position was randomized of course), because of the shape of the learning curves over 80 trials, and because we inserted a terminal test identification series, but we could not separate the dependent variable into incentive enhanced learning versus learning to find a preferred incentive. In technical terms, we had demonstrated performance preference differences, but not differential learning efficiency as a function of reward values.

C. Rationale for Current Program

In the ensuing and current Office of Education supported grant period, we set ourselves two major goals and one subsidiary one. First, we had not been satisfied in our own efforts and in the research of others that a reasonable, relevant, practical, and fair test had ever been made of children's relative preferences for verbal vs. material rewards in learning. For one thing, except for our immediately preceding research, the differential method, in which each child experiences both verbal and material rewards, had not been employed. Next, was the problem of experimental set and task relevance in a laboratory learning situation; as with our discrimination learning machine, material incentives seemed more natural than verbal reinforcements. Finally, how are verbal reinforcements employed in a natural child training setting? As already indicated, relevantly, but mainly they are used in abundance. Verbal reinforcements are easy to carry about in huge reservoirs in the "mouth," than are material reinforcers available in, let us say, pockets or tote bags. We conducted an experiment with these considerations in mind.

Second, we still stubbornly maintained that different incentive strengths might influence learned associations differentially. Neither research nor theory was consistent with that notion. Spence's theory (1956) suggested an indirect, but not direct, relationship. Terrell's positive results (Terrell, 1959; Terrell, Durkin, & Wiesley, 1959; Terrell & Kennedy, 1957) were unusual and hard to explain. Such relationships had not generally obtained in the animal domain, but there were enough positive results to puzzle investigators and plague theorists. It should be recalled that incentive effects have been commonly obtained on measures of energy output, but not on association learning. We tested a number of these possibilities before discovering an exciting finding. Third, we explored in pilot studies children's incentive choice strategies over large and small trial sequences, factors in reinforcement timing, and uncertainty reduction as incentive.

To test the effects of task-motivation-relevance interacting with reinforcement schedules on children's relative preference for verbal or material incentives a total of 240 first, third, and fifth grade children were divided equally into a 2 x 2 factorial design, varying the two levels of instruction-induced-motivation ("skill" vs. "chance") and two reinforcement schedules (100% verbal vs. 100% material; 100% verbal vs. 50% material). Each child was given 80 two-choice discrimination preference trials in which one stimulus yielded verbal praise, the other a material reward. This time when a child selected a stimulus to be reinforced verbally ("very good" or "fine" etc.) the receptacle under that stimulus contained a card with the word "good" printed on it, and he could put it in his bag along with his material rewards (small charms). Under the "skill" instruction, the children were told that they would be informed when they were "playing the game well;" in the "chance" instruction, they were told, "it's all a matter of luck." The 2 - 1 verbal ratio was a modest one compared to real life circumstances, and the instructions were designed to orient toward the verbal reinforcer as is commonly done in the "natural" world, where children are enjoined to "be good," "get good grades," "behave nicely," etc. (see Chapt. IV).

The following questions were posed. When verbal and material values are competing, does a larger ratio of verbal rewards work to overcome instruction differences? Given the nature of the incentive conflict choices in our experiment, the demonstration by Edwards (1961) that, "costs and payoffs are instructions," might be controlling. However, might instructions control some of the variance and represent important constructs for this study and others to follow? The skill-chance conditions were developed by Rotter (1966; Lefcourt, 1966) within the framework of his social learning theory where probability of expectancies for reinforcement represent a central construct. Rotter's expectancy of reinforcement is in the most general sense the same as Spence's incentive--the anticipation of reinforcement--but Rotter's mediating constructs are different, and he theorizes in the human context which demands approaches to complex social-personal parameters. More recently, he and his students have translated skill-chance to internal and external locus of control via experiments and test instruments to measure these orientations as characteristic motivation-personality styles. Results have indicated that the effects of reward more likely follow when the individual is guided by internal locus of control, where he perceives events as contingent on his own behavior (skill), than when he is guided by external locus of control, where he perceives events to be a function of chance, luck, fate, or powerful others. These motivation dispositions have been experimentally induced.

Returning now to the problem of incentive influence upon "learning" or "problem solving," rather than "performance" or energy output, we devised several pilot studies before we controlled for the crucial factors in demonstrating incentive effects (see Chapt. II). In this part of our program, we were more interested in the process rather than in individual differences parameters which accounted for incentive variance in learning. Since both precedent and theory argued against us, we wanted to exercise maximum controls to show incentive effects. We decided not to employ verbal rewards at this point because they were so sensitive to multiple conditions influencing individual differences. Within the range of incentive objects we had scaled in the past, the differentiation values were so closely, albeit reliably, spaced that it seemed critical to employ polar incentive values. We started with penny as a high reinforcement and paper clip as a low one, but discovered by paired comparison testing that a small white dried bean yielded a smaller polar value. In any kind of association learning, sheer information (signals like penny or bean) might well serve as the sufficient reinforcement. The important question is: what does incentive motivation add to signal values of reinforcement in problem solving? In our training procedure it was also crucial for all children to receive the same number of rewarded trials and to experience the range of rewards at the same time. With these considerations in mind, let us now examine the theoretical basis for our major hypothesis.

The Spence theory (1956) to which we have referred may be characterized as "single link," i.e., it accounts for learning to attach the relevant instrumental response to the correct stimulus. As indicated earlier, this system cannot account for a direct relationship between incentive value and associative learning. Zeaman and House (1963a; 1963b), however, have presented a two-link theory which might be more amenable to an incentive-motivation hypothesis, although such an hypothesis had not previously been tried within this system. The two links in the Zeaman-House theory consist of a sequence in which the child first identifies the correct dimension (category, generalization, etc.), and then learns to respond to the correct stimulus or cue within the relevant dimension. The first link is called the attention or presolution phase; the second, the instrumental response association. Zeaman and House had furthermore demonstrated that retardates differed from normals in the attention phase, the first link, but that association cue-response learning was exactly the same for the two groups in the second phase. Backward learning curves clearly depict the phenomenon by showing that normals have a shorter presolution phase (attention to and discovery of relevant dimension) than retardates, but once cue learning starts, slopes and asymptotes are exactly the same. The theory has obvious relevance to complex problem solving and to a major responsbility of the teacher in the classroom. Apart from rote learning, the teacher's task is to call the pupil's attention to the major dimensions of a complex problem. Once the child has mastered the major dimensions or categories or inductions, finding the correct cue inside the dimension is a comparatively simple training problem. The Zeaman-House research on mental retardates compellingly overdetermines this generalization. Finally, the classroom teacher directs attention by manipulating rewards. She uses verbal reinforcements, grades, tokens, symbols, promises, a whole host of incentives peculiar to her style in maximizing motivation. Yet, it had never been demonstrated that different incentive values differentially influence dimensional salience. We used two material incentives for experimental convenience, but we had already demonstrated the conditions under which verbal and material incentives could be scaled for individuals and groups. The important objective was to show how different values, whatever the specific incentives employed, influenced learning. Teachers are undoubtedly smarter than psychologists in their ingenuity to maximize incentives consonant with their objectives. Our hypothesis was that a high incentive, as compared to a low one, would facilitate the attention value of a relevant dimension in discrimination learning.

We did find time during the present contract period to explore incentive sequence choice strategies by children (see Chapt. V). In the animal laboratory, when investigators are studying differential reinforcement influences on learning processes, they typically run one trial a day. Since reinforcement value is a function of drive, then drive must be held constant to assess incentive effects. Thus, if an animal is deprived of food for four hours and then tested with two food pellets, his drive is somewhat reduced, so that on an immediately consequent trial, the value of the two pellets would be reduced. The experimenter typically waits a day, returns the animal to four hours complete deprivation and runs his second trial. It would be hard to find a school which could "deliver" children for so many sessions. Besides, children are typically run under social or intellectual motivation, and it remains to be demonstrated that these drives have the simple point to point relationship to reinforcement as in the animal domain. The Stevenson and Zigler (Stevenson, 1965) programs have been based on this relationship in more complex social form, and have variously hypothesized social and sensory deprivation, and also anxiety. In the classroom, as in the laboratory, teachers are unlikely to return to a deprivation schedule after reinforcement administration to children, and the consequences, with the exceptions of the programs noted above, have been largely unexplored. The effects of massing reinforcements over trials have not merited comment in Terrell's work (Terrell, 1959; Terrell, Durkin, & Wiesley, 1959; Terrell & Kennedy, 1957), and have been reported from casual observation as relatively insignificant by Siegel (Siegel & Forman, 1967; Siegel, Forman, & Williams, 1967) and by us. No direct test, however, has previously been available.

The simplest basic approach for initiating inquiry into this problem, it seemed to us, was to present two reward objects in pairs to 40 first grade children, who could select one from two relatively high incentive objects, or, from one high and one low, object. For this inquiry incentive objects rather than verbal reinforcements were more feasible as a starting point. The independent variable was incentive value; the dependent variable was choice selection over trials. Choice strategies over trials were analyzed in terms of (a) incentive preference, (b) incentive alternation, (c) incentive runs (a sequence for picking the same incentive), (d) position preferences, (e) position alternations, and (f) position runs. So far as we know this is the first attempt to examine strategies for children's incentive cumulation in choice behavior.

A by-product of our studies on the effects of incentives upon learning dealt with the <u>timing</u> of rewards (see Chapts. III and VII). In the natural setting of the classroom, it is not always feasible to administer reinforcement immediately upon the demonstration of correct responses by children. What are the consequences of <u>delay of reward</u>? In general, research has showed such a delay to have adverse effects on problem solving as reflected in discrimination learning. One prominent theory has been that during the reinforcement latency period, attention wanders, and the child becomes oriented toward irrelevant dimensions or cues, thus impairing problem solving. The reinforcement we used in a discrimination problem with third-grade children was a light flash, and we found that instructions, orienting the child toward the signal goal, minimized the adverse effects of reward delay so that children in this condition responded as well as children reinforced immediately (Fagan & Witryol, 1966). It was in this study that we first became interested in the total length of a trial when one compared immediate and delayed reinforcement. If the intertrial interval is constant, the total time taken from presentation of the stimuli in trial 1 to trial 2 is longer in the delay condition. Definition of a trial depends upon temporal length of both pre- and post-reinforcement intervals during which relevant dimensions and cues could be confounded. We explored this problem.

In the course of our studies, we had explored the nature of children's incentives, material and verbal incentives, motivation determinants, timing of rewards, and incentive sequences. We had speculated about reward deliveries in various combinations and this suggested surprise as one possible incentive element. This general notion together with accumulating theory about novelty and curiosity led us to consideration of uncertainty reduction as an incentive property, and this was explored in another by-product to our major studies, reported in Chapter VI.

In recapitulation the major aims in our project were to investigate incentive conditions and laws in children's learning with respect to: (a) verbal versus material rewards, and (b) problem solving as determined by reward values. Minor objectives were related to (a) conditions affecting reward timing in influencing learning (b) incentive accumulation effects, and (c) undertainty reduction as an incentive property.

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II. Incentive Effects upon Attention in Children's Discrimination Learning

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A. Abstract

Following a 40-trial training procedure in which high and low incentive values were conditioned to stimulus dimensions, 276 children in Grades 2, 4, 5, and 6 were tested on an 80-trial, two-choice discrimination learning test. Differential, incentive associated, dimension preferences from training were hypothesized to facilitate or impair test performance by altering observing responses to the relevant dimension in which the correct stimulus cue was found. After exploring boundary conditions of instructions, incentive type, definition of samples as learners or nonlearners, and mode of stimulus presentation in training, the hypothesis was clearly confirmed for males in the second grade. Equivocal support was found for girls and for older children under varying experimental conditions. Results, taken together with backward learning curves, strongly suggest that differential incentive values influence the point at which learning starts, rather than slope or asymptote. The application of attention theory under certain conditions was commended as a possible explanation for some past findings of acquisition differences as a function of different reinforcement values.

II. Incentive Effects upon Attention in Children's Discrimination Learning[1]

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This experiment was designed to test the influence of differential incentive values in two-choice simultaneous discrimination learning within the framework of an attention theory. Zeaman and House (1963) have developed an attention theory to account for differences in discrimination learning ability when more than one stimulus dimension is present. Their two-link learning model includes (a) a presolution phase during which S must discover the correct dimension, and (b) an acquisition phase when S makes appropriate instrumental responses to the relevant cue in the correctly observed dimension. Observing responses in the first link are inferred from chance performance until the point at which acquisition rises steeply in the second link. Backward learning curves clearly depict the phenomena, showing parallel slopes and asymptotes and different starting points under various experimental treatments. Attention theory suggests that the higher the initial probability of observing the relevant stimulus dimension, the earlier will be the onset of acquisition in discrimination learning. It would follow, then, that any alteration of this initial probability (P_o) would be reflected in earlier acquisition onset. We hypothesized that the initial P_o for a particular stimulus dimension would be altered by association with incentives of varying magnitudes, and that the greater the magnitude of an incentive associated with a particular stimulus dimension, the greater will be the initial probability of observing that dimension as a basis for making a choice in discrimination learning. Thus, if the initial P_o for a relevant stimulus dimension has been enhanced by association with a valued incentive, learning will be facilitated. Conversely, if an irrelevant stimulus dimension has been enhanced, learning will be retarded.

The influence of differential incentive values on the learning process has been conventionally studied in the past within a motivational theoretical framework accounting for effects upon energy output. Research using subjects at various phylogenetic levels has confirmed Spence's (1956) theory concerning the incentive motivational construct K added to drive D and interacting with habit H to account for reaction potential. Since Spence's system explicitly stated that motivation does not operate directly on the associative or habit factor H, most of the differential incentive studies have been concerned with "performance" measures characterized by Pubols (1960) as time dependent, rather than with "learning" or time independent variables such as errors or trials to criterion in acquisition. High versus low reinforcement values have most often been tested on measures reflecting energy output, maintenance of behavior, perseveration, preference, asymptotic level etc., but only relatively infrequently on acquisition in instrumental conditioning.

Probably the only programmatic research with children successfully testing acquisition as a function of reward values has been published by Terrell and his associates (Terrell, 1959; Terrell, Durkin, & Wiesley, 1959; Terrell & Kennedy, 1957). There also exists a relatively recent substantial domain in the animal literature where acquisition differences have been related to incentive strength (Allison, 1964; Clayton, 1964; Cross & Boyer, 1964; Fowler, Blond, & Dember, 1959; Furchtgott & Salzberg, 1959; Hill, Cotton, & Clayton, 1962; Ison, 1964; Lawson, Cross, & Tambe, 1959; Pubols, 1961; Wike & Farrow, 1962). While speculating about the significance of parametric acquisition results, researchers seem to have been very careful not to invoke a direct motivational influence of K upon associative learning H. This restraint is salutary since acquisition measures strongly suggest, but do not necessarily always reflect, the operations of H directly. Ware and Terrell (1961), employing delay of reward to which Spence attributed ambiguous incentive status, ingeniously attempted to distinguish associative from motivational responses with equivocal success. More recently Mitchell, Perkins, and Perkins (1965) invoked Wyckoff's attention theory to explain differential reinforcement influences upon acquisition in an animal learning experiment. Our pilot research experience, together with findings from Terrell *et al.* and the animal literature, indicated that the incentive might influence habit in some way, but neither theory nor research was entirely compatible with such an hypothesis.

In a number of exploratory investigations, we tested the notion that the point at which learning starts might be a function of differential incentive values. In experimenting with a two-situation, two-choice discrimination task, we assumed that Ss would solve the situation cued with the high incentive earlier than the second situation with the low incentive cue; both two-choice situations (form discriminations) were randomly interspersed over a common trial sequence with subjects as their own controls. The hypothesis failed confirmation, but in a terminal preference test, Ss strongly favored the stimulus conditioned to the high reinforcement over the low one. Within the single stimulus dimension (form) employed, it appeared that once reinforcement threshold was crossed, children solved problems for the information value of the reward even though differential incentive preference obviously obtained. Under these circumstances (a reinforcement is a reinforcement is a reinforcement) faster learning could not occur however large the added incentive increment. These considerations led us to invoke a formal attention theory and to arrange the necessary conditions of an experiment for the appropriate test. The test of a differential incentive hypothesis may be facilitated by experimental arrangements clearly indicated from previous research and theory. First, pretraining with incentives of high and low magnitude demands careful control of the number of trials (Spence, 1956) during which S is reinforced. A second desideratum is that Ss experience the range of rewards studied (Meyer, 1951). Related to this is a third consideration in selecting rewards easily discriminable in incentive value by S. Finally, multidimensionality in training and test tasks seem most relevant since the correct cue in a simple dimension is easily identifiable to a human S with almost any reinforcement.

Our hypothesis that a high incentive, as compared to a low one, will facilitate the attention value of a relevant dimension in discrimination learning was tested in a series of investigations to be reported in two parts: (a) Preliminary Investigations and (b) Main Experiment. The former included Ss from Grades 4, 5, and 6 where various boundary conditions such as reinforcement type, definition of sample by learning requirements, training task instructions, and method of stimulus presentation were explored. These investigations will be briefly summarized, but our hypothesis was more centrally tested by the main experiment in Grade 2 which will be reported in detail.

B. Method in Main Experiment

The experimental design included a: (a) 40-trial training session on a two-choice discrimination learning task, during which form and color stimulus dimensions were differentially reinforced (high and low), and (b) two-choice simultaneous discrimination test in which either the form or color dimensions in compounds was relevant to task solution, while the other was variable and irrelevant. The basic experimental comparisons were defined in the test conditions where prior incentive training was evaluated by a discrimination task with a neutral reinforcement. For example, if S during training received a high incentive for form choices and low, for color, and if the correct stimulus lies within form on test, there should be a higher initial probability for observing form which should more easily lead to the identification of the correct stimulus within this dimension. On the other hand, if his opposite number with the same training experience is subsequently tested on a color stimulus, his observing probability for form should also be higher, but now this dimension is variable and irrelevant. He must overcome his initial tendency to observe form in order to facilitate learning in the low reinforced color dimension.

Subjects

Ss were 24 boys and 24 girls at each of Grades 2, 4, and 6; and 16 children from each sex in Grade 5. The 128 Ss in the preliminary investigations and the 48 Ss in the main experiment were drawn from a university community population biased toward upper middle social status reflected in the IQ (Otis Quick-Scoring Mental Ability, 1954) distributions in Table 1. Condition assignment to high and low incentive in the

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Insert Table 1

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table is based on test trials, since training was identical for each S within age-sex groups.

Apparatus

A portable modification of the Wisconsin General Test Apparatus was employed for the (a) training task and the (b) two-choice discrimination learning test. E, separated from S by a one-way screen, activated

Table 1

A Comparison of IQ Characteristics by Grade, Sex, and Experimental Condition (Test Condition)

		Condition					
		High Incentive			Low Incentive		
Grade	Sex	M	SD	N	M	SD	N
	Male	114.5	8.8	12	113.8	6.8	12
2[a,b,c]	Female	115.9	5.6	12	116.1	6.0	12
	All	114.8	7.2	24	114.9	6.4	24
	Male	118.8	6.6	12	114.1	10.0	12
4	Female	118.4	13.0	12	119.0	11.6	12
	All	118.6	10.1	24	116.5	10.8	24
	Male	118.1	12.3	8	118.1	15.3	8
5[a,d]	Female	117.2	16.2	8	116.1	11.7	8
	All	117.7	13.9	16	117.1	13.2	16
	Male	110.8	13.5	12	106.1	12.0	12
6	Female[b,c]	111.8	9.0	12	115.2	8.9	12
	All	111.0	11.2	24	110.7	11.4	24

[a]Learners only

[b]Orienting instructions

[c]Penny and bean rewards in training

[d]Successive stimulus presentation in training

an electronic control unit for displaying stimuli and dispensing rewards. Each of two 6" x 5" response panels, on a horizontal plane and tilted 60° away from S at the base of the one-way screen facing him, contained a digital display device which presented a circular stimulus figure, 15/16" in diameter, from a library of 8 color, form, and color-form stimuli.[2] When S pushed one of the two response panels containing a "correct" stimulus, a reward was automatically dispensed at the base of the panel; thus, the loci of stimulus, response, and reward were in close temporal and physical proximity during training. During test trials a light, centered just above and between the response panels, signalled the reinforcement.

Procedure

Training

Instructions for training were:

> "We are going to try something with this machine (E indicates apparatus). I will show you two pictures like this (E illuminates apertures with two forms), or like this (E illuminates two colors, and then demonstrates all color and form pairs to appear on task). I want you to look at each picture and then push either one of them, like this (E pushes one panel and stimuli lights go off). No matter which pictures you push, you will get something. One of the things you get you'll like very much, the other thing you may not care for. You may keep whatever you get and put it into this bag by your chair. Be sure that you look at both pictures before you push one. Do you have any questions? Fine! I am going behind the machine, now, where you won't be able to see me. We'll start as soon as I turn the pictures on."

Half of the training trials (20) consisted of two color stimulus choices, while the other half (20) consisted of two form choices. Color choices on a given trial might consist of two identical colors or two different ones from red and blue; form choices were similarly arranged from circle and diamond (white figures against a black background). Color and form choices were presented in random order over the 40 training trials with the restriction that each color or form arrangement appeared an equal number of times (e.g., red-red, red-blue, blue-red, blue-blue) for the following paired possibilities:

1.	C_1	C_1	5.	F_1	F_1
2.	C_2	C_2	6.	F_2	F_2
3.	C_1	C_2	7.	F_1	F_2
4.	C_2	C_1	8.	F_2	F_1

For example, for Ss in the color-high incentive condition, whenever he pushed a color panel, regardless of position or hue, a high reward (penny) was dispensed; whenever he responded to a form panel, a low reward (bean or paper clip; see Table 1) was dispensed. It should be reiterated that his choice on a given trial was always made within a given dimension, color or form, and always rewarded, high or low, but without the opportunity to explore the nonselected stimulus of a choice pair. Half of the Ss in each age-sex group were trained with high reward to color and low reward to form; the remaining half obtained high reward for form and low reward for color.

Test

Instructions for the test condition were:

"Now we are going to try something else. I will show you two pictures like this (E illuminates both apertures, each with a color-form compound, e.g., orange square on the right, green triangle on the left). I want you to look at both pictures and then push one of them. If you push the correct picture this light will go on (E flashes centered light reinforcement); if you push the wrong picture the light will not go on. The object is to make the light go on every time. Remember to look carefully at the pictures because there is something about the pictures themselves which will tell you what makes the light go on. Any questions? Fine! We'll start as soon as I turn the pictures on."

On test trials each stimulus pair consisted of a color-form compound with cues different from those available in training. Color cues were orange and green, while form cues were triangle and square. A green triangle was always paired with orange square, while green square and orange triangle always appeared together. This yielded two possible pairs of stimulus compounds to be used on a given trial:

Green triangle	Orange square
Green square	Orange triangle

Each pair of compounds appeared randomly over trials with the restriction that both pairs were presented an equal number of times over each successive block of 20 trials. Position of each compound was also varied randomly with the same restriction. S was required to make a response which would lead to a light signal for reinforcement of the correct cue. Since the stimulus pairs now differed both in form and color (as contrasted to form or color in training), this condition served to test stimulus dimension attention value as a function of prior incentive association.

The correct cue within a dimension was reinforced in such a manner that half the Ss received a light signal for the dimension previously associated with high reward, while the other half were reinforced for the trained dimension of low reinforcement. An intradimensional shift was required of the former group; an extradimensional shift, for the latter, assuming differential incentive efficacy in training. Positive cues were counterbalanced within and across dimensions to minimize stimulus preference value. Half the Ss were tested on color relevant, form variable and irrelevant; the other half, form relevant, color variable and irrelevant in each age-sex group. This two-choice discrimination test condition required a learning criterion of 9 correct trials within a block of 10, up to a limit of 80 trials. Test was immediately consequent to training, and the total experimental time averaged 35 minutes. Ss were randomly assigned to each condition with the restriction of equal representation; two male Es were similarly assigned to conditions and Ss.

C. Summary of Preliminary Investigations

In exploring various boundary conditions to determine the optimal experimental approach, several modified treatments were tried, as described below. In general, these alterations proceeded from higher to lower grade levels, and they are summarized in Table 1. These modifications suggested the final research strategy employed in Grade 2. For example, adding orienting instructions with the sixth grade female sample in the test condition seemed to minimize position tendencies from training, "Remember to look carefully at the pictures because there is something about the pictures themselves which will tell you what makes the light go on." Successive stimulus presentation on training, to minimize position strategies was also tried in the fifth grade, but without any apparent facilitation. Furthermore, earlier research (Witryol, Tyrrell, & Lowden, 1965) indicated that pennies and paper clips yielded relatively polar high and low incentive values, and these were used in Grades 4 and 5, and for sixth grade females. Prior to training, paired comparison preference rankings were obtained on sixth grade males for penny, bubble gum, charm, paper clip, and nothing, and on sixth grade females and all second grade Ss, for penny, bubble gum, charm, paper clip, and bean. Since bean yielded smaller incentive values, it was employed as a low incentive for girls in the sixth grade and for all second grade Ss (see Table 1). Finally, sample requirements included nonlearners and learners in Grades 4 and 6, and learners only in Grades 2 and 5.

The preliminary investigations[3] served to suggest:

(a) An incentive effect in Grade 4.
(b) The desirability of detecting early dimension preferences in a population of learners only.
(c) Sensitivity of the test condition to oriented instructions.

(d) Maximization of incentive differentiation by using a bean as the low reward in training.
(e) Efficacy of two-choice simultaneous, as contrasted with successive presentation in training.
(f) Stronger male than female response to incentive training.

These trends determined the final parameters to be investigated in the Main Experiment.

D. Results from Main Experiment

Means, standard deviations, and probability values are shown in Table 2 for Grade 2 incentive test total error, total trial, and trial

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Insert Table 2

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2 to 10 measures. Exact probability estimates were calculated from Mann-Whitney one-tail $\underline{U}$ tests, since distributions were characteristically positively skewed in most samples explored. Also presented in the bottom rows of the table are chi square probability values based upon the number of subjects in each incentive condition who passed or failed the critical fourth trial where a clear dimensional choice (color or form) first appeared in the test series. The random arrangement of the stimulus compounds in the test task led to a critical choice situation for the subject on the fourth trial where he first clearly committed himself to form or color; this choice, together with errors on trials 2 to 10 presumably reflected early dimension dispositions. The rationale for the fourth trial analyses can be inferred from the sequence of the first four trials on test:

1. Orange triangle - green square

2. Orange triangle - green square

3. Green square - orange triangle

4. Orange square - green triangle

There were no "correct" choices in training, and latency measures did not turn out to be discriminating.

The high incentive dimension was superior to the low incentive dimension in test trials for males on all measures at probability levels ranging from .025 to .035. Although identical comparisons for females failed statistical significance, similar trends obtained on all but the fourth trial analyses so that when sexes combined, probability values ranged from .042 to .068, excluding the nonsignificant chi square, of course. Interestingly, when second grade results were combined with all the other samples, a significant chi square value (6.72; $\underline{N}$ = 88) at the .01 level favoring the high condition on the critical fourth trial was obtained for boys, despite the alterations in procedure for age-sex samples; the same analysis for females failed significance.

Table 2

Analysis of Discrimination Test Measures, Grade 2

Test Measures	Incentive Conditions					
	High	Low	High	Low	High	Low
	Males		Females		Combined sexes	
N	12	12	12	12	24	24
Errors						
M	1.4	4.0	3.5	5.1	2.5	4.6
SD	1.0	4.2	5.0	6.5	3.7	5.4
U	39		64		214	
p	.035		N.S.		.068	
Trials						
M	10.8	15.1	14.2	17.6	12.5	16.3
SD	1.1	7.4	8.9	10.8	6.4	9.2
U	37		61		204	
p	.025		N.S.		.042	
Trial 2-10 errors						
M	0.9	2.8	1.8	2.5	1.3	2.6
SD	0.9	2.8	1.4	2.4	1.3	2.5
U	39		61		206	
p	.035		N.S.		.046	
N, 4th trial						
Pass	10	4	5	6	15	10
Fail	2	8	7	6	9	14
χ^2	4.29		.00		1.34	
p	.025		N.S.		N.S.	

Note. - One-tail probability values were estimated from Mann Whitney *U* tests for errors, trials to criterion, and trials 2-10; χ^2 values for 4th trial analyses were also one-tail tests.

Figures 1, 2, and 3 graphically demonstrate the incentive effect

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Insert Figures 1, 2, and 3

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for boys on test measures of trials to criterion, total errors, and errors, trials 2 to 10. Overall, the distributions are markedly skewed with modal performance reflecting fast learning in all samples. The male populations in all comparisons, however, show truncated distributions in the high incentive condition relative to the others, i.e., they lack extremely poor scores, but the other samples are characterized by long tails, reflecting more slow learners. Close inspection of the tails also shows fewer female cases in the high, than in the low, condition.

Backward learning curves in Figure 4 most clearly represent the

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Insert Figure 4

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attention phenomenon hypothesized as a function of differential incentive values. Zeaman and House (1963) have contended that forward learning curves typically mask individual differences in slope and asymptote, so that averaging frequently may lead to spurious generalizations. In adapting Hayes' (1953) backward learning curve to reflect the shape of the learning function more typical of the individuals comprising an experimental group, they have repeatedly demonstrated the utility of this technique in connection with their two-link learning theory. Figure 4 shows early learning in the present experiment for both experimental treatments, but the low incentive groups are displaced in the direction of poorer performance with respect to when learning started. The congruence of slope and asymptote are in accord with the Zeaman-House attention theory.

Backward learning curves serve to reflect the shape of the learning function typical of individuals comprising a group by putting each S, in effect, at the same terminal point on the abscissa for his group, namely, the median for the last five trials in this study. The scores for all such individuals are then averaged to determine per cent correct responses for location of terminal group points on the ordinate. Moving these average scores back in blocks of five trials yielded the curves in Figure 4. A minor artifact introduced by the definition of learning criterion as a running criterion of 9 out of 10 correct trials, just antecedent to a 9 of 10 block criterion, resulted in a chance level of 40% when backward curves were plotted in blocks of five trials.

E. Discussion

Our hypothesis that the probability of observing a relevant dimension in discrimination learning could be relatively more enhanced by a high incentive than a low incentive was confirmed in the main experiment,

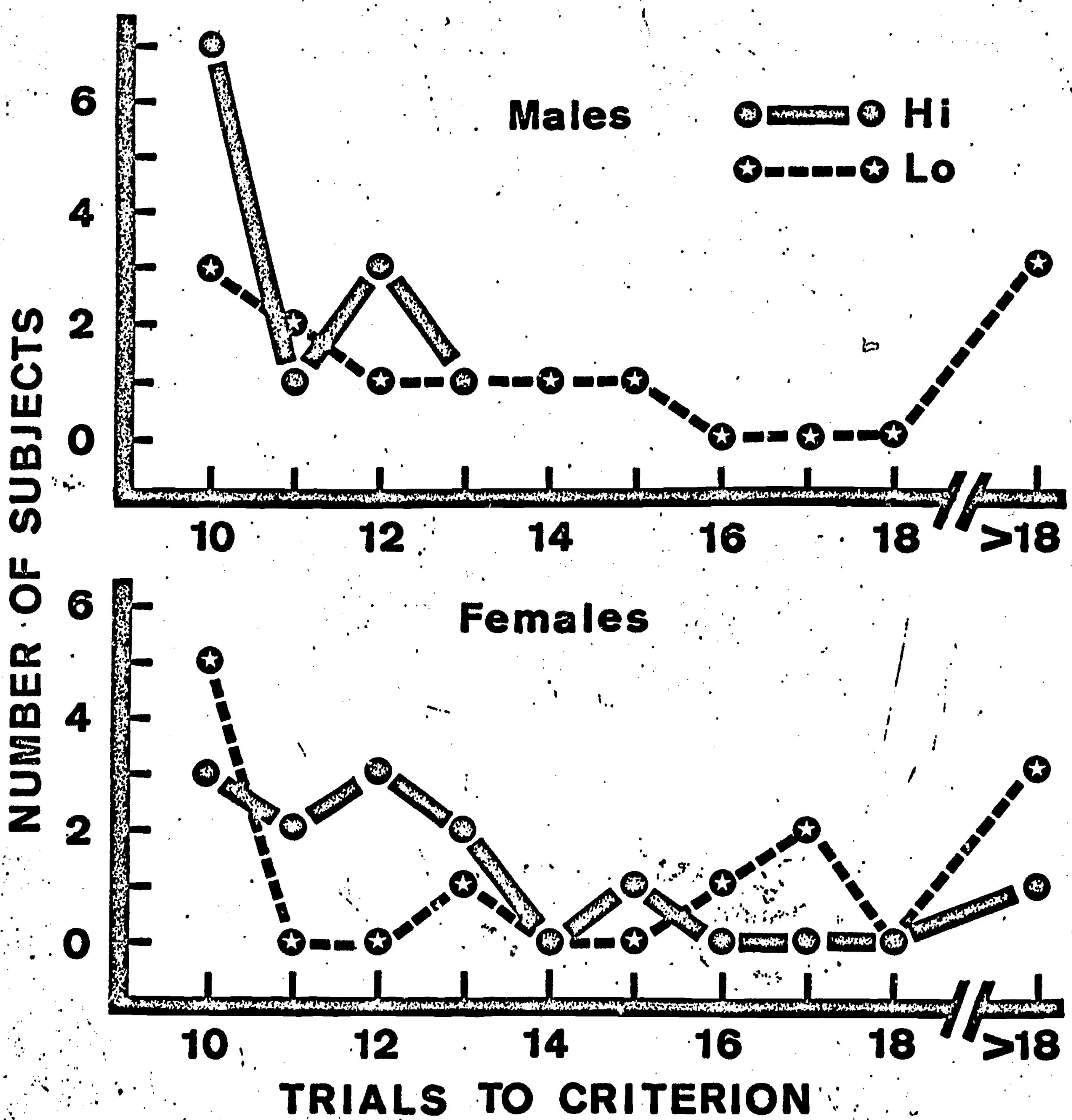

Fig. 1. Distributions of total trials to criterion by incentive conditions and sex, Grade 2.

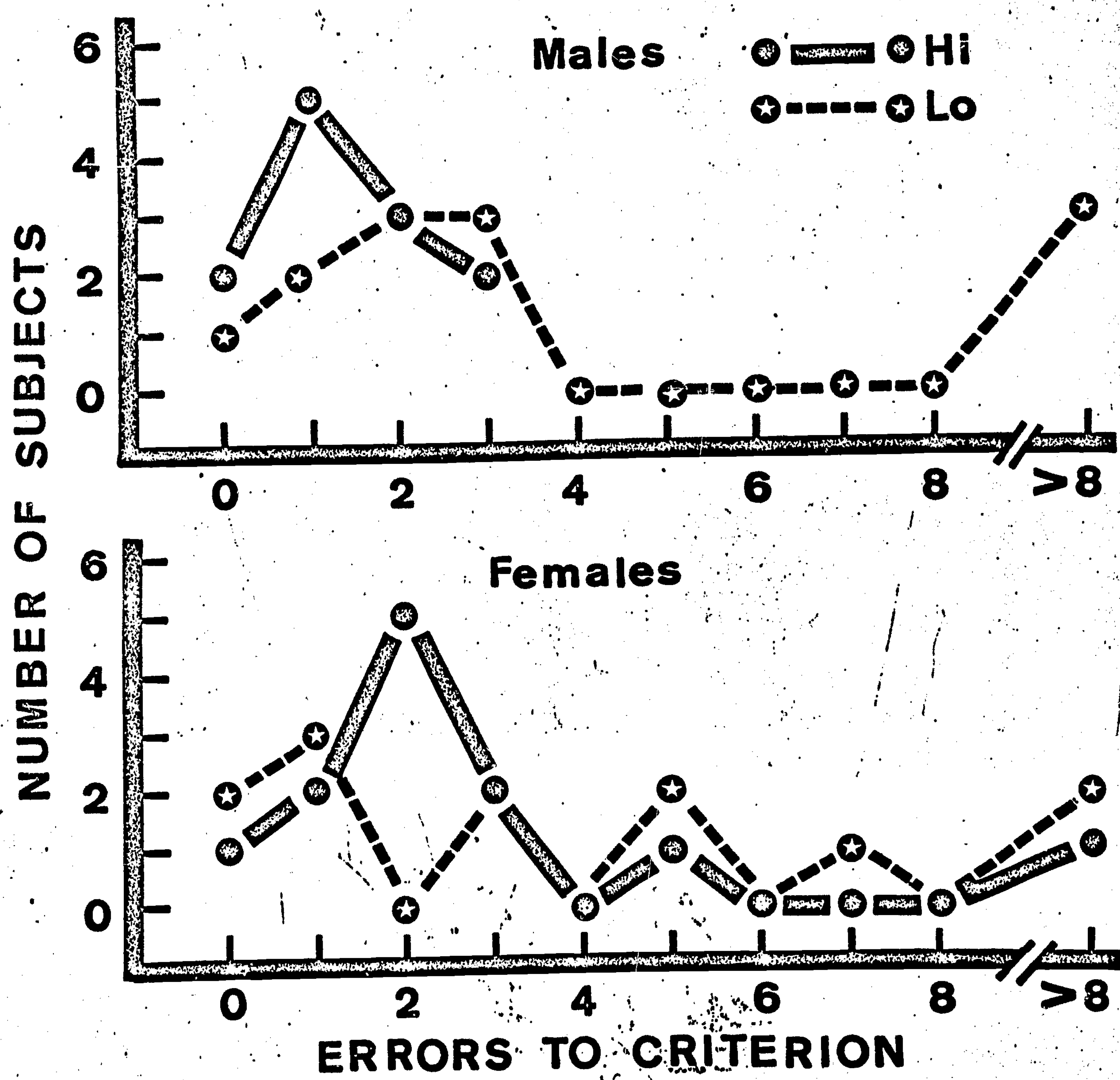

Fig. 2. Distributions of total errors by incentive conditions and sex, Grade 2.

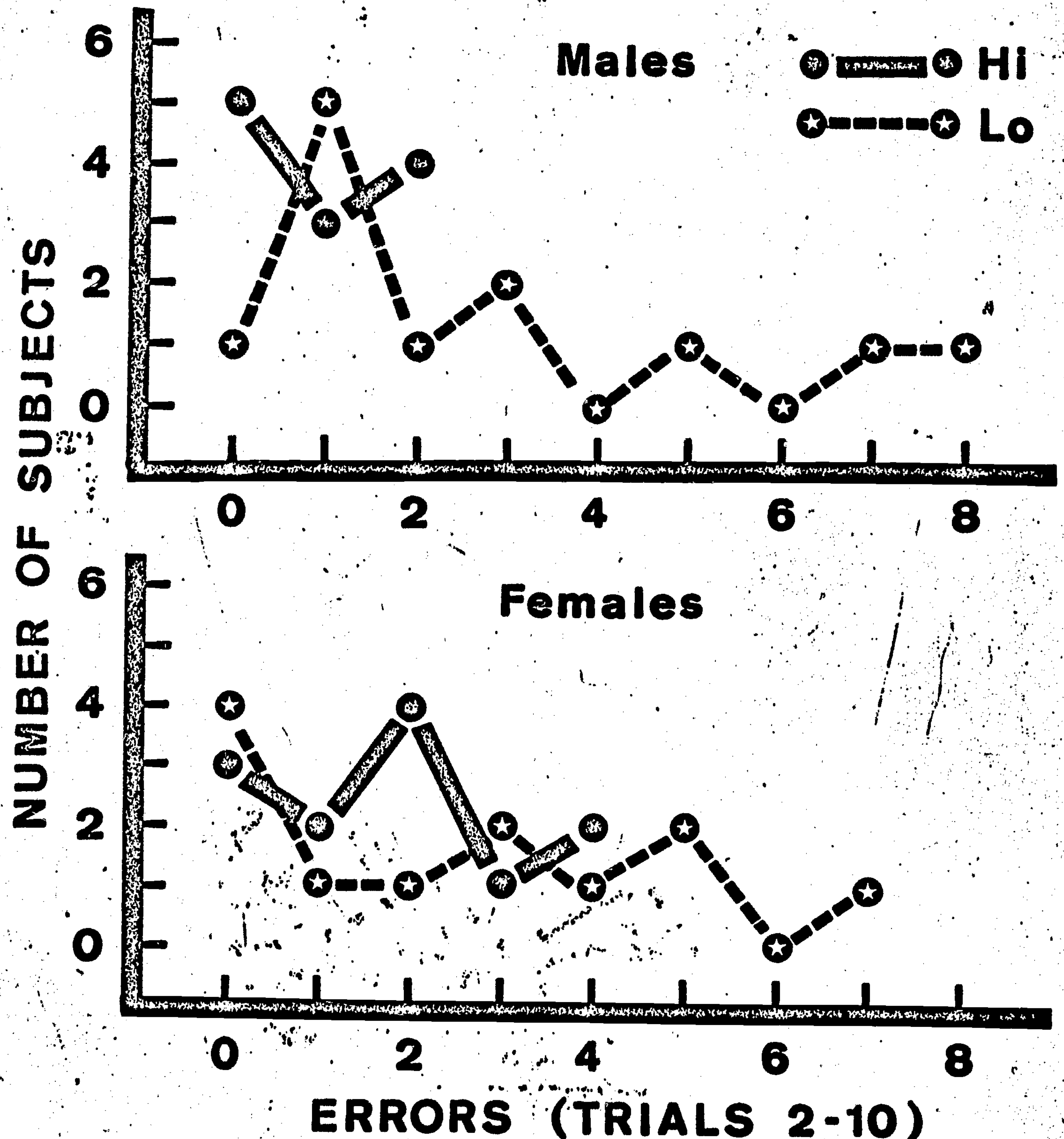

Fig. 3. Distributions of errors, trials 2 to 10, by incentive conditions and sex, Grade 2.

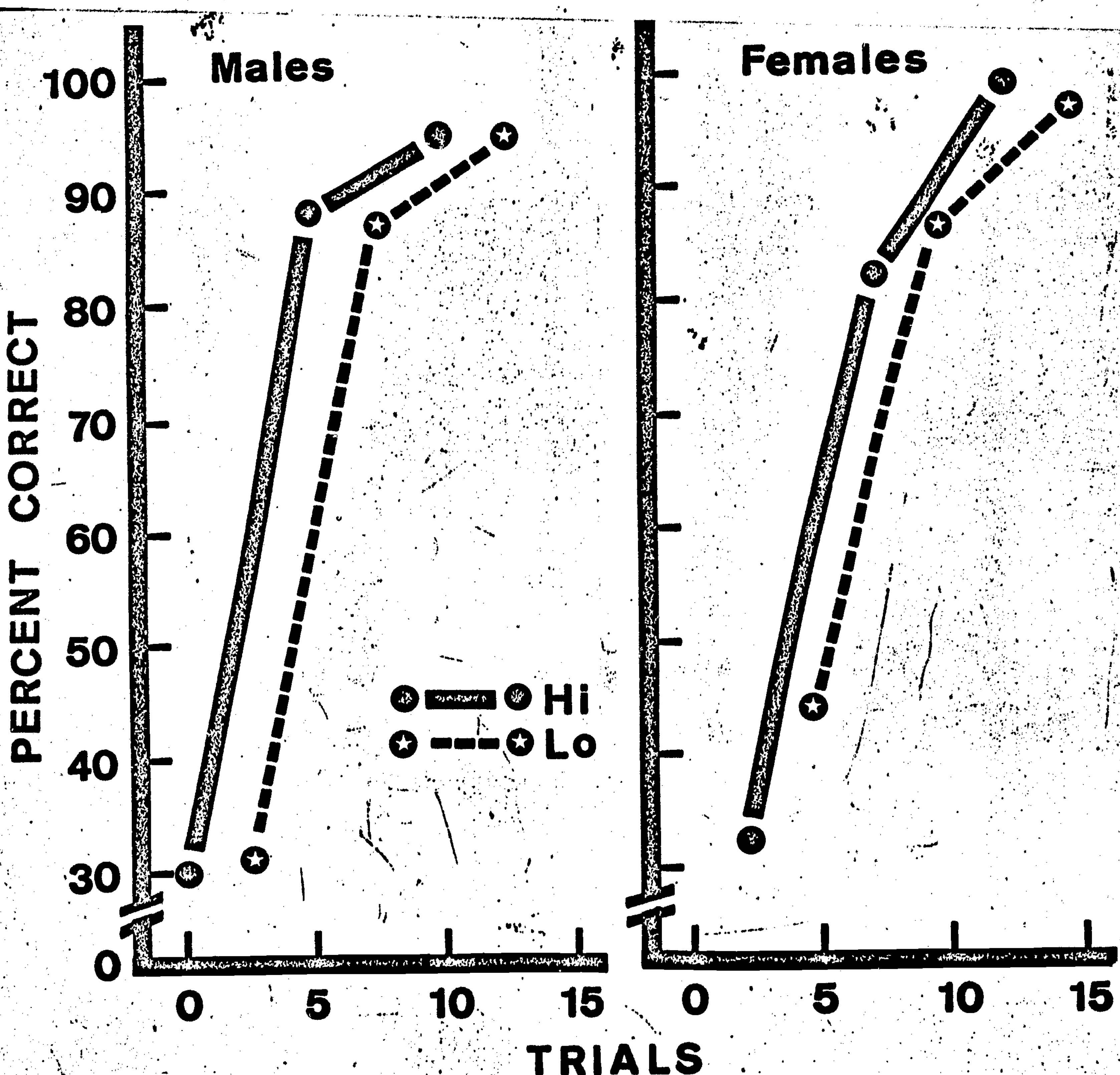

Fig. 4. Backward learning curves by incentive conditions and sex, Grade 2.

particularly for the male sample. The magnitude of the effect was small within the present experimental context because the test task was relatively easy for most of the learners when instructions were altered; this modification was necessary to minimize position tendencies from the training experience. Since S was rewarded for any response in training, it was possible for him to invoke many implicit strategies, among which might be diminished attention to cues and dimensions. This troublesome feature, apparent from poor learning on test in the preliminary experiments, was solved by test orienting instructions toward color-form dimensions, with the subsequent loss of test variance as the task became easier. Similar considerations and consequences were involved in the decision to exclude nonlearners in the definition of our final experimental samples. Nonlearners employing unusual strategies seem to confound the analysis of form-color dimension salience associated with differential incentive values. The sum of these experimental adjustments provided a cogent design to test a theoretical framework which might explain some past, previously puzzling, reinforcement associated, "acquisition" differences in the research literature.

Persistent sex differences favoring males under comparable conditions in all samples, while not always reliable, were striking. The significant chi square value obtained for all samples combined, reflecting male superiority on the critical fourth trial where a clear commitment to dimensional salience was first required, was also noteworthy. The sex differences are difficult to explain, but past research (Witryol, Tyrrell, & Lowden, 1965) suggested boys like pennies (the high incentive) somewhat better than girls. One might further speculate that the male Es generated task irrelevant drive in female Ss through cross-sex E-S interactions thus diminishing the relevance of physical incentives. When training conditions were approximately comparable, learning seemed better with age for both sexes and the differential incentive effect diminished or disappeared. This developmental trend should be interpreted with caution because of modifications in experimental procedures, which, at the same time, did not change the direction of sex differences.

Of paramount significance is the demonstration that differential incentive values can be associated with stimulus dimensions in discrimination training so as to result in positive and negative dimension transfer in the test phase. The backward learning curves in the main experiment show that a high incentive can direct attention to a relevant dimension; the point at which acquisition starts follows the identification of the proper dimension, as in the Zeaman-House (1963) two-link learning model. The curves are remarkably parallel and asymptotically congruent in the second link where instrumental conditioning takes place.

Some provocative extrapolations emerge. From animal research, Cross and Boyer (1964) reported that acquisition differences as a function of differential reward values were rarely but persistently discovered on complex learning tasks. If complexity in these instances stemmed from the inclusion of more than one dimension, our findings may be replicable in the past animal learning experiments by the simple expedient of drawing backward learning curves. Forward learning curves mask the first link of the attention model with the second link in instrumental conditioning. Acquisition differences from the animal domain, showing different slopes in forward curves might follow from the point at which $\underline{H}$ starts in the parallel backward curves of attention theory. Close inspection of pretraining procedures in the animal literature suggests this possibility. Suchman and Trabasso (1966) found that preferred dimensions, color or form, by young children facilitated or impaired learning in a card sorting task. Dimension preferences were manipulated in our own experiment via incentive associations with the same result. Under these and comparable circumstances, investigators might do well to examine their data by means of backward learning curves when incentive conditions seem to yield different acquisition rates.

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Footnotes

[1]Witryol, S. L., Lowden, L. M., & Fagan, J. F. Incentive effects upon attention in children's discrimination learning. J. exper. child Psychol., 1967, 5, 94-108. (This part of our report has been published as above, and was also the basis for a paper delivered at the Eastern Psychological Association Meetings, New York City, April 14, 1966.)

[2]Training and test stimuli pictures can be obtained from the authors upon request.

[3]A summary of statistical findings is available upon request to the authors.

III. The Effects of Instructional Set and Delay of Reward on Children's Learning in a simultaneous Discrimination Task[1]

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A. Abstract

Fifty-six third grade children were divided into four groups of 14 each and given a simultaneous discrimination task. There were two levels of reward, immediate and six second delay, and two sets of instructions, orienting and nonorienting. The notion that goal orientation, produced by orienting instructions, serves to substantially decrease the potentially detrimental effects of delaying reward was supported.

III. The Effects of Instructional Set and Delay of Reward on Children's Learning in a Simultaneous Discrimination Task[1]

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From general knowledge of immediate vs. delayed reward conditions, one would normally expect more efficient performance on the part of immediately rewarded Ss. Thus Lipsitt, Castaneda, and Kemble (1959), Terrell and Ware (1961), and Ware and Terrell (1961) have demonstrated the superiority of immediate reinforcement in the discrimination learning of children. Other investigators (Perkins, Banks, & Calvin, 1954; Erickson & Lipsitt, 1960; Brackbill & Kappy, 1962), however, have failed to detect such differences. Hockman and Lipsitt (1961) showed that delaying reward interfered with a complex discrimination but not with a simple one, and Lipsitt and Castaneda (1958) found a preference for an immediately rewarded stimulus, but no differential effect of delayed reward on response speeds.

In the light of such inconsistent findings, perhaps the important variable to consider is the behavior of Ss during discrimination trials. Speculative comments by Terrell and Ware (1961) and Ware and Terrell (1961) indicate that immediately rewarded Ss paid more attention to the meaningful components of the task situation, while delayed reward Ss became bored, fidgeted, and exhibited a general lack of attention. Lipsitt, Castaneda, and Kemble (1959) also pointed out that their differentially pretrained Ss developed orienting habits, evidenced by distinctive head and eye movements, which may have aided subsequent discrimination learning.

The importance of attention or orientation in learning has been noted by many experimenters. Hunter (1917) and Emerson (1931), for example, indicated that children can solve delayed reaction problems by the maintenance of a bodily orientation during the delay interval. Similarly, Norcross and Spiker (1957) and Spiker (1959) suggested the importance of observing responses and White and Plum (1962), the facilitating effect of attention processes in children's discrimination learning. Also relevant is the observation of Spence (1956) that the detrimental effects of delayed reward are influenced by whether or not the subject maintains an orientation toward the stimulus complex during the delay period.

The present study was based on the suggestion by Erickson and Lipsitt (1960) that an orientation toward the locus of reinforcement on the part of their Ss, presumably due to instructions, may have nullified the potentially detrimental delay effects. Hence, the purpose of this study was to investigate the effects of orienting and nonorienting instructions, interacting with immediate and delayed reinforcement, on the performance of children in a simultaneous discrimination task.

More specifically, it was hypothesized that children who were immediately rewarded compared to those who were oriented to the situation by means of instructions under delay conditions would not differ on task performance. Those Ss, however, who were both nonoriented and given a delayed reward should exhibit the poorest performance.

B. Method

Subjects

The Ss were 28 male and 28 female third graders from an urban parochial school. Mean IQ on the Otis Alpha was 107.6 with a standard deviation of 11.56. The age range was 7.8 to 9.5 years with a mean at 8.8. Modal social status was lower middle class.

Procedure

A two-choice visual display apparatus was used. Mounted on a table between E and S was a 3' by 4' gray plywood panel. Centered on the base, 12" apart, were two response doors 3" by 5", hinged on the bottom so that they remained open after S responded by pushing one or the other. Mounted on each door was a digital display cell which projected a pattern to the S. A 7 1/2 watt, 120 volt, white bulb, which was the source of the light flash used as the reinforcer, was centered at the top of the 3' by 4' panel. The bulb was activated by a silent switch controlled by E. A control panel was available to E, which enabled him to preselect the specific stimulus patterns, a square and a T inscribed within 15/16" circular apertures on the response doors.

The basic design involved two types of instructions and two levels of reward. Subjects were randomly assigned to each of four groups: Nonoriented-Immediate, Nonoriented-Delay, Oriented-Immediate, and Oriented-Delay. Of the 14 Ss in each group, half were male and half, female. The positive stimulus was randomly assigned to each S and its position was randomized over trials.

A trial was initiated when E pushed a single button in the back of the apparatus which illuminated the patterns. At the instant of the S's response, defined as pushing a 1/2" opening of either door on the front of the apparatus, the stimulus patterns were extinguished. A noncorrection procedure was used. If S made a correct response, he was reinforced according to his condition assignment with either an immediate or a 6 second delayed light flash. Thus, if S were in an immediately reinforced group, and he made a correct response, E manually administered a 2 second light flash at the instant of response. For delayed Ss, a stopwatch was activated by E at the instant of response for 6 seconds; at the end of this period a 2 second light flash was delivered.

Each S in the Nonoriented groups was given the following instructions:

"This is a game where we play with these things." The stimuli were then shown to S who was allowed to push the response doors. "If you push the right picture, the light will go on." E demonstrated light. "If you push the wrong picture, the light will not go on."

The same instructions were given to the Oriented Ss with the addendum, "Now remember the game is to make the light go on. I want you to watch that light." E pointed to the light. Questions were answered by repeating the appropriate section of the instructions.

Ss were run individually but in group order. Thus all Nonoriented-Immediate Ss were tested first, Nonoriented-Delay Ss second, Oriented-Immediate third, and all Oriented-Delay last. Since instructions were a crucial variable, it was felt that this order was necessary to control for a "grapevine" effect, i.e., this order insured that Nonoriented Ss would have no knowledge of the orienting instructions: "Now remember the game is to make the light go on. I want you to watch that light." Each S was run to a criterion of 10 successive correct responses. If S had not solved after 60 presentations, the session was terminated. The average session lasted 15 minutes.

C. Results and Discussion

Since some Ss were run to criterion and some were stopped at 60 trials, error scores were computed for each S under the assumption that those who reached criterion would have exhibited errorless or near errorless performance had they continued to the sixtieth trial. Mean error scores and failing subject frequencies for each condition are presented in Table 1.

Insert Table 1

The most striking feature of Table 1 is the high proportion, 57%, of Ss in the Nonoriented-Delay group who failed to master the discrimination within 60 trials. In contrast, only 12% of the Ss in the Nonoriented-Immediate, Oriented-Immediate, and Oriented-Delay groups combined failed to reach criterion. It appears that the 42 Ss who were either oriented or immediately rewarded found the task much less difficult than the 14 Nonoriented-Delay Ss. Closer inspection of Table 1 also reveals that the Oriented-Immediate, Nonoriented-Immediate, and Oriented-Delay groups seem to rank themselves in order of increasing mean error scores. Whether the difference among these three groups is significant is also an important consideration, since the purpose of this study is to test the hypothesis that Ss who are either oriented or given immediate reward will not differ among themselves but will be significantly different from Nonoriented-Delay Ss. To verify these observations, a one-way analysis of variance with orthogonal comparisons between treatments (Winer, 1962) was employed. This analysis was performed on log transformations of the

Table 1

Mean Error Scores and Criterion Failure Frequences

Group	N	Errors Mean	Errors SD	Ss Failing Criterion
Nonoriented-Immediate	14	8.43	8.01	1
Nonoriented-Delay	14	20.36	11.12	8
Oriented-Immediate	14	6.86	7.75	2
Oriented-Delay	14	12.50	10.70	2

original error scores because of the skewness of the distribution of error scores and differences in variability among groups. The transformation served to normalize the error distribution and to satisfy Bartlett's test of homogeneity.

As may be seen from Table 2, the overall difference among groups

Insert Table 2

is significant ($p < .025$). Breaking the treatment variance down into components contributed by comparisons between treatment means confirms the hypothesis of this study. The variance contributed by a comparison between the Nonoriented-Delay condition with the Nonoriented-Immediate, Oriented-Immediate, and Oriented-Delay groups combined constitutes approximately 70% of the total treatment variance, and it is also highly significant ($p < .01$). Correspondingly, only about 20% of the treatment variance is due to the difference between the group with the second highest mean error score, Oriented-Delay, compared to the groups with the lowest mean error scores, the Oriented-Immediate and Nonoriented-Immediate ($p < .15$). The only other possible orthogonal comparison in this series, between the Nonoriented-Immediate and the Oriented-Immediate groups, is not crucial to the main hypothesis and not significant ($p < .25$). It appears then that Ss who were either oriented or given immediate reward did not differ significantly, but they did perform significantly better than Nonoriented-Delay Ss. Not statistically confirmed consistently in all adjacent comparisons, but highly intriguing, is the logical order as a function of temporal reward and orienting conditions. The hierarchy in efficiency was Oriented-Immediate, Nonoriented-Immediate, Oriented-Delay, and Nonoriented-Delay. It should be obvious from our hypotheses that this exact order was not predicted.

In a sense, the present study is analogous to the studies (Carlton, 1954; Harker, 1950; Shilling, 1951) reported in Spence (1956) which showed that degree of goal box confinement is relevant to the effects of delaying reward. It was inferred from these studies that the physical constraint imposed by a narrow goal box forced the maintenance of a goal orientation which prevented the occurrence of conflicting responses during the delay period, thus modifying the poor performance usually found when reinforcement is delayed. Renner (1964), in a recent review of the delay of reinforcement literature, also noted that "the implication...is that the delay interval has no effect when the subject can mediate the temporal interval by some cue,...a motor response,...or a goal orientation..." (p. 356). Presumably, then, the orienting instructions given to the children in this study provided them with a temporal mediator, a goal orientation, which restricted the possibility of random, interfering responses during the delay period. In any case, these results support the notion that the effects of delaying reward are substantially altered when the S is instructed to orient to the goal during the delay period.

Table 2

Analysis of Variance on Error Scores (log transform)

Source	SS	df	MS	F	p
Treatments	13.36	3	4.45	3.66	<.025
(NI + OI + OD) vs. ND	9.34	1	9.34	7.66	<.01
(NI + OI) vs. OD	2.71	1	2.71	2.22	<.15
NI vs. OI	1.31	1	1.31	1.07	<.25
Error	63.27	52	1.22		

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Footnotes

[1]Fagan, J. F., & Witryol, S. L. The effects of instructional set and delay of reward on children's learning in a simultaneous discrimination task. Child Developm., 1966, 37, 433-438. (This part of our report was published as above.)

IV. Verbal versus Material Rewards as a Function of Schedule and Set in Children's Discrimination Preference Choice Behavior

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A. Abstract

A total of 240 first, third, and fifth grade children were divided equally into a 2 X 2 factorial design, varying two levels of instruction-induced motivation (Skill vs. Chance) and two reinforcement type schedules (100% Verbal vs. 100% Material; 100% Verbal vs. 50% Material) to test effects on children's relative preferences for verbal or material incentives. Each child was given 80 two-choice discrimination preference trials in which one stimulus yielded verbal praise, the other, a material reward. Our central hypothesis, derived from previous research and the child's natural ecology, that instructions and schedule, as well as age, enhance the value of verbal approval, was confirmed. The 100-50 schedule effect was more powerful than the Skill instruction condition. Group differences in verbal choices were interpreted to show that boys and high socioeconomic status (SES) Ss were motivated by internal locus of control (schedule), while girls and medium SES children were more responsive to conformity and social approval needs (instruction) in their achievement behavior. Low IQ, low SES, and young children were not significantly responsive to experimental manipulations, although exhibiting tendencies in hypothesized directions, and they favored verbal incentives somewhat. Over combined conditions the total sample favored verbal choices, but the disposition to distribute choices fairly evenly when two reward options are available merits further investigation.

IV. Verbal versus Material Rewards as a Function of Schedule and Set in Children's Discrimination Preference Choice Behavior[1]

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The major purpose of this investigation was to study reinforcement and task-relevant motivation conditions under which verbal and material rewards could be compared in a two-choice, discrimination learning, problem solving situation over a developmental span in the elementary school years. Since verbal reinforcements are much more commonly dispensed to children than are material rewards in this age range, and since the former are often administered within a pertinent motivational framework, the major independent variables in our design were (a) reinforcement-class-schedule and (b) motivation-inducing instructions, along with (c) age and (d) sex; we were also able to explore (e) socio-economic and (f) IQ individual differences although they were not originally planned as the prime parameters. In a recent monograph (Witryol, Tyrrell, & Lowden, 1965) we reviewed studies bearing on most of these independent variables. The algebraic sum of these investigations added up to superiority of material over verbal rewards in incentive value and influence upon learning efficiency, but generalization of findings were equivocal with respect to the other parameters and their interactions with each other and with the major variables. Thus, verbal vs. material reward preference affecting learning efficacy may shift in value from study to study as a function of (a) nature of the experimental task, (b) definition of reward, (c) reward schedule, (d) task relevance, (e) age, (f) socio-economic status, (g) instructions, and (h) experimental design, investigated in different combinations. Only very close scrutiny by a knowledgeable researcher can suggest resolution of apparent inconsistencies to yield testable hypotheses. Perhaps the most common error in surveying incentive research is the comparison of experimental designs employing the "absolute" method, where independent groups are used, with the "differential" method where each subject serves as his own control (Pubols, 1960). The latter is mandated for incentive comparison studies because each subject is then exposed to the range of rewards (Meyer, 1951), thus testing the motivating, rather than the simple cue, properties of reinforcement (Witryol, Lowden, & Fagan, 1967). Unfortunately, the differential method has rarely been used with children, except in our own program.

From these considerations we hypothesized that a larger reinforcement schedule of verbal incentives would interact with instruction-inducing motivation to enhance the superiority of verbal over material reward in discrimination learning. We reasoned from the natural ecology of childhood that children are increasingly exposed with age to verbal rewards accompanied by instructions, both implicit and explicit, to "be good, do your best, try hard." As a consequence a total of 240 first, third, and fifth grade children were given 80 two-choice discrimination preference learning trials in which one stimulus yielded verbal praise; the other, a material reward. A 2 X 2 factorial design varying reinforcement schedule (100% verbal vs. 100% material; 100% verbal vs. 50% material) and instructions ("skill" or "chance") was used. The 100-100 group of course was a control, and the 100-50 group represented a very conservative verbal to material reward ratio, even in our abundant economy. The "skill" instructions oriented the children toward the value of accumulating verbal rewards, while the "chance" instructions suggested that task performance was a matter of luck.

Edwards (1961), using monetary rewards with adults, has argued that "costs and payoffs are instructions." Following his thesis, children, particularly older children, are more apt to respond to the payoff system as a more operational definition of instructions. The skill-chance conditions were developed by Rotter (1966; Lefcourt, 1966) within his social learning theory where probability of expectancy for reinforcement represents a central construct. Skill and chance have been translated by Rotter to <u>internal</u> and <u>external</u> locus of control, respectively; the child, guided by the former, is more apt to perceive situational events as a function of his own behavior, and, guided by the latter, he is more likely to see himself as a helpless pawn of luck, fate, or powerful others. Internal and external controls have been studied as systematic, social-personality, response styles, but they have also been experimentally induced.

The dependent variable has been called <u>discrimination preference choice behavior</u> (Witryol, Tyrrell, & Lowden, 1964; 1965) in a five-choice discrimination learning experiment testing relative incentive values of one verbal and three "material" incentives via the differential method. Siegel, Forman, and Williams (1967) independently conducted a similar experiment with mental retardates and used five "material" incentives to test consequences, via an operant conditioning task, upon subsequent two-choice discrimination learning behavior from which a "work index" was derived. Versions of the method of paired comparisons were employed in both laboratories, in each case demonstrating remarkable congruence with learning criteria. Findings in the two programs were strikingly similar for individual and group reliabilities on incentive values, most of which had small scale separations. In our program when a child selects one of two stimuli, both of which are baited with reinforcements, no simple direct measure of learning is available; the response reflects preference value as well as learning. Where a child clearly prefers one incentive associated stimulus to another, learning curves reflect habit strength plus preference values, but where he chooses to distribute choices, incentive choice strategies may be confounded with learning inadequacies; hence the term, "discrimination preference choice behavior" with the special statistical analyses we devised. Despite problems of confounding learning and preference in two-choice problem solving, we preferred this approach. First, as indicated in Chapter I, this dependent variable represents a cogent paradigm of problem solving with well thought out theoretical properties whose practical implications for attending to dimensions and cues have been soundly validated. Next, choice selection between incentive associated stimulus dimensions reflects a common conflict in the child's daily routine. Third, two-choice discrimination preference choice behavior is a very obvious and direct way to compare verbal and material rewards by the differential method.

B. Method

Subjects

A sample of 80 children, 40 boys and 40 girls, was drawn randomly within sex from each of Grades 1, 3, and 5. Each sample consisted of an approximately equal number of children from three schools in eastern Connecticut. Each school serves an area somewhat distinct from the others in regard to the inhabitants' socio-economic level. Thus, from each grade sample of 80 children, about one third were rated by the Warner, Meeker, Eels scale (1949) as relatively low in socio-economic status (School A), another third, high (School C), and the remaining third, intermediate (School B). School by grade measures of IQ and socio-economic status (SES) are presented in Table 1 which demonstrates a substantial range

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Insert Table 1

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of representation with some bias toward high average scores resulting from Schools B and C. Ratings in the Warner *et al.* scale are assigned in terms of parental occupational status so that a score of 1 would be attributable, for example, to doctors, lawyers, engineers, and ministers; 2, high school teachers, trained nurses, undertakers; 3, social workers, small businessmen, auto salesmen, bank clerks; 4, stenographers, factory foremen, butchers; 5, barbers, carpenters, firemen; 6, gas station attendants, waitresses; 7, heavy laborers, janitors, migrant farm laborers. Mean ratings between 1 and 3 suggest a relative concentration at professional levels for schools B and C, while A mean ratings between 3 and 5 range from clerical through manual and service workers. The CA means and standard deviations for Grades 1, 3, and 5, respectively, were 6 yr. - 9 mo., 3.3 mo.; 8 yr. - 10 mo., 4.9 mo; 10 yr. - 5 mo., 5.0 mo.

Apparatus

Two portable versions of the Wisconsin General Apparatus test were employed by two male *Es* in the schools. *E*, separated from *S* by a one-way screen, presented each child on every trial with two stimuli covering two receptacles baited with the rewards. The two stimuli were nonsense planometric figures, randomly selected for each *S* from an available pool of 30 patterns, different in color, painted on white cards, and mounted on four-inch square wedges (Witryol, Tyrrell, & Lowden, 1964; 1965). The rewards were a small, natural colored, plastic cow (material incentive) and a verbalism, such as, "very good," "fine," or "you're doing very well" (verbal incentive). A choice of the stimulus associated with one of the verbal incentives yielded one of the *E*'s oral reinforcements, and the reward receptacle contained a small card with the word "good" printed on it.

Design

The 80 children composing each grade sample were divided equally into four experimental conditions: (a) Skill-100%-Verbal vs. Skill-100%-Material, (b) Skill-100%-Verbal vs. Skill-50%-Material, (c) Chance-100%-Verbal vs. Chance-100%-Material, and (d) Chance-100%-Verbal vs. Chance-50%-Material. *Ss* in the 100-100 conditions were rewarded 100% of the

Table 1

Measures of IQ and Socio-economic Status

	Grade 1		Grade 3		Grade 5	
	Status Measure		Status Measure		Status Measure	
School	IQ	SES	IQ	SES	IQ	SES
A						
M	107	3.7	102	4.4	99	4.4
SD	14	1.7	10	1.4	11	1.6
N	27		27		27	
B						
M	109	2.5	106	2.8	108	2.6
SD	12	1.7	7	1.6	13	1.8
N	26		27		27	
C						
M	118	1.7	107	2.6	113	1.9
SD	7	1.5	11	2.0	12	1.3
N	27		26		26	
Total						
M	111	2.7	105	3.3	107	3.0
SD	12	1.8	10	1.8	13	1.9
N	80		80		80	

time with a verbalism when choosing the verbal incentive associated stimulus, and 100% similarly when selecting the material incentive associated stimulus. Ss in the 100-50 conditions were also rewarded each time the verbal stimulus was chosen, but received the material reward 50% of the time on a random basis when the material stimulus was selected. Children in the two Skill conditions were given instructions designed to enhance the value of verbal reward by emphasizing the importance of "doing well" and "playing the game right;" the chance conditions yielded instructions suggesting the game was "a matter of luck." The number of Ss for each of the four experimental conditions within a grade was 20, 10 boys and 10 girls; IQ and socio-economic status (SES) were approximately equally represented in each age-condition group. Thus, verbal versus material reward was tested by the differential method, where each S served as his own control within each age-condition group, but motivation-instruction and reward-type schedules were represented by independent groups, consonant with the absolute method. After 80 two-choice, discrimination learning preference trials, 54, 77, and 47 children in Grades 1, 3, and 5, respectively, were tested on a ten-trial identification series.

Procedure

Reinforcements. For each S, response to one of the two stimuli over 80 trials was always rewarded with a verbalism, while the alternative choice resulted in the acquisition of a plastic cow, either 100% or 50% of the time depending on the reinforcement condition to which S was assigned. The two reinforcements were randomly assigned over Ss to the two stimulus patterns which were also randomized for position over 80 trials. S was required to choose one of the two stimuli on each trial, and he was allowed to deposit the associated reinforcement (plastic cow or "good" printed on card), cumulating rewards over trials. Scores for each S were recorded for choice frequencies of the stimulus associated with the verbal incentive; scores for the stimulus associated with material incentives were complementary to the verbal competitors.

Skill. Children in the two Skill conditions were instructed:

"Now we are going to play this game. When the game begins, I will be behind this screen where you can't see me. When I am behind it, I am going to push this tray forward so that you will be able to see these pictures. (E demonstrated by pushing the tray forward and pointing to the stimulus patterns.) Each time I push the tray forward, you may pick one of these pictures and look under it. If there is something under the picture you pick, you may put it in your bag. I will tell you when you are playing the game well, and I will give you your mark or grade at the end of the game. Remember to try hard and play the game right."

Chance. Instructions in the Chance conditions were:

"This is an experiment to see how our equipment works. I will be behind this screen where you can't see me. When I am behind it, I am going to push this tray forward so that you will be able to see these pictures. (E demonstrated by pushing the tray forward and pointing to the stimulus patterns.)

Each time I push the tray forward, you may pick one of the pictures and look under it. If there is something under the picture you pick, you may put it in your bag. Sometimes I will tell you things. It doesn't really matter what you pick. It's just a matter of luck. You can do anything you want. Remember, there is nothing special to do, but pick one picture every time. It's all a matter of luck."

Terminal Test. After 80 choice trials, S was again presented with the two stimuli for 10 trials on a terminal learning test with instructions, "This time when I push the pictures out, don't lift either of them--just point to the picture that I ask you about." On each of the ten trials S was asked to identify the stimulus which he thought had the plastic cow or "good" sign under it. The particular reward requested on each trial was randomly determined, and stimuli were randomized for position. The terminal test sequence was an additional learning check for S's association of each reward with the relevant stimulus; learning criterion was defined minimally as 9 of 10 correct identifications. This test was inserted after the experiment was under way, and not all Ss were included. In our earlier program using five-choice discrimination learning, terminal tests were so decisive (Witryol, Tyrrell, & Lowden, 1964; 1965) that we had assumed this two-choice experiment to be an easy task; partial results with Grade 1 children in the present study indicated resumption of the terminal test.

C. Results

Major Independent Variables

Means and standard deviations for verbal choices over 80 trials are presented in Table 2, where, within each grade, N = 20 for the cell size

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Insert Table 2

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of the basic 2 X 2 factorial design, two incentive-class schedule conditions (100-100 and 100-50) interacting with two instruction conditions (Skill and Chance). For example, the mean verbal value in Grade 1 for 10 boys and 10 girls in the Skill-100-100 condition is 42.1; the value under the last column, first row, headed "Both," is 41.8, the mean for 40 children across the Skill conditions obtained by adding scores under 100-100 and the 100-50 schedules. Similarly the value, 39.5, opposite "Both," in the first column of mean scores, third row, is based on 40 children by summing the Skill and Chance scores under the 100-100 schedule. Finally the total mean score for verbal choices in Grade 1 is 40.5, appearing in the third column, third row, where "Both-Both" intersect to represent 80 Ss; Grades 3 and 5 can be read in the same way. The bottom section of the table for All Grades contains 60 Ss in each basic cell, 120 in the "Both" subtotals, and all 240 Ss in the lowest right hand corner. Since mean verbal choices are arithmetical complements of material choices, it should be recalled that the latter can be obtained by subtracting the former from the total 80 trials to determine the average tendencies for Ss to approach the material incentive associated stimulus.

The tendency to distribute choices to the two incentives is apparent from mean verbal values, ranging from 37.0 in Grade 1 for Chance-100-100 to 55.2 in Grade 5 for Skill-100-50. Intermediate mean choices in other age-conditions suggest the distribution strategies we discovered in a recent pilot study (see Chapter V) where children were permitted to take one of two incentives over long and short trial sequences, when rewards were either of different or comparable values. The polar range of mean verbal choices attached to the age-condition groups cited above are congruent with hypothesized age-schedule-instruction effects. The mean number of verbal choices increases with age, independent of experimental conditions, from 40.5 in Grade 1 to 45.8 in Grade 3 to 48.3 in Grade 5. Only in Grade 1 under Chance-100-100 did the children select verbal incentives below 50%, mean choices being 37 for verbal and 43 for material over 80 trials.

These observations are more explicitly defined in the analysis of variance in Table 3 derived from the basic data on age, instructions,

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Insert Table 3

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and schedule in Table 2, with sex and trial blocks added. Conditions approaching conventional significance levels are summarized here from the original split plot design. Of the two major experimental variables, schedule was the more powerful effect, yielding a p value of .025, while instructions reflected marginal significance, $p < .10$. However, when trial blocks were taken into account, the Instructions X Trials effect was significant at the .025 level, and Schedule X Trials, at the .001 level. A graphic illustration of these main effects interacting with trial blocks appears in Figure 1 where the superiority of Skill

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Insert Figure 1

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over Chance and 100-50 over 100-100 is demonstrated. The main effect of trial blocks significant at the .001 level is illustrated by the curve "All" designating the combination of all experimental manipulations. In a preliminary analysis of variance, we had employed total scores on the last 40 trials as the dependent variable on the assumption that choice preferences had stabilized after the first 40 trials. Excluding trial blocks from this analysis, we obtained significance values similar to those in Table 3. While only marginal significance was obtained for the instruction variable using either all 80 or the last 40 trials, the Instructions X Trial block interaction showed a significantly more rapid increase of verbal choices over trials for Skill Ss as compared to Chance.

Table 3

Analysis of Variance Summary of Significant

Trends for Total Trials

Source	*df*	*MS*	*F*	*p*
Grade (A)	2	159.15	5.30	<.01
Instructions (B)	1	92.75	3.09	<.10
Schedule (C)	1	182.53	6.07	<.025
Sex (D)	1	4.41		
B X C X D	1	193.80	6.45	<.025
Subjects within cells	216	30.05		
Trial blocks (E)	7	22.81	8.12	<.001
B X E	7	7.24	2.58	<.025
C X E	7	10.86	3.86	<.001
Subplot error	1512	2.81		

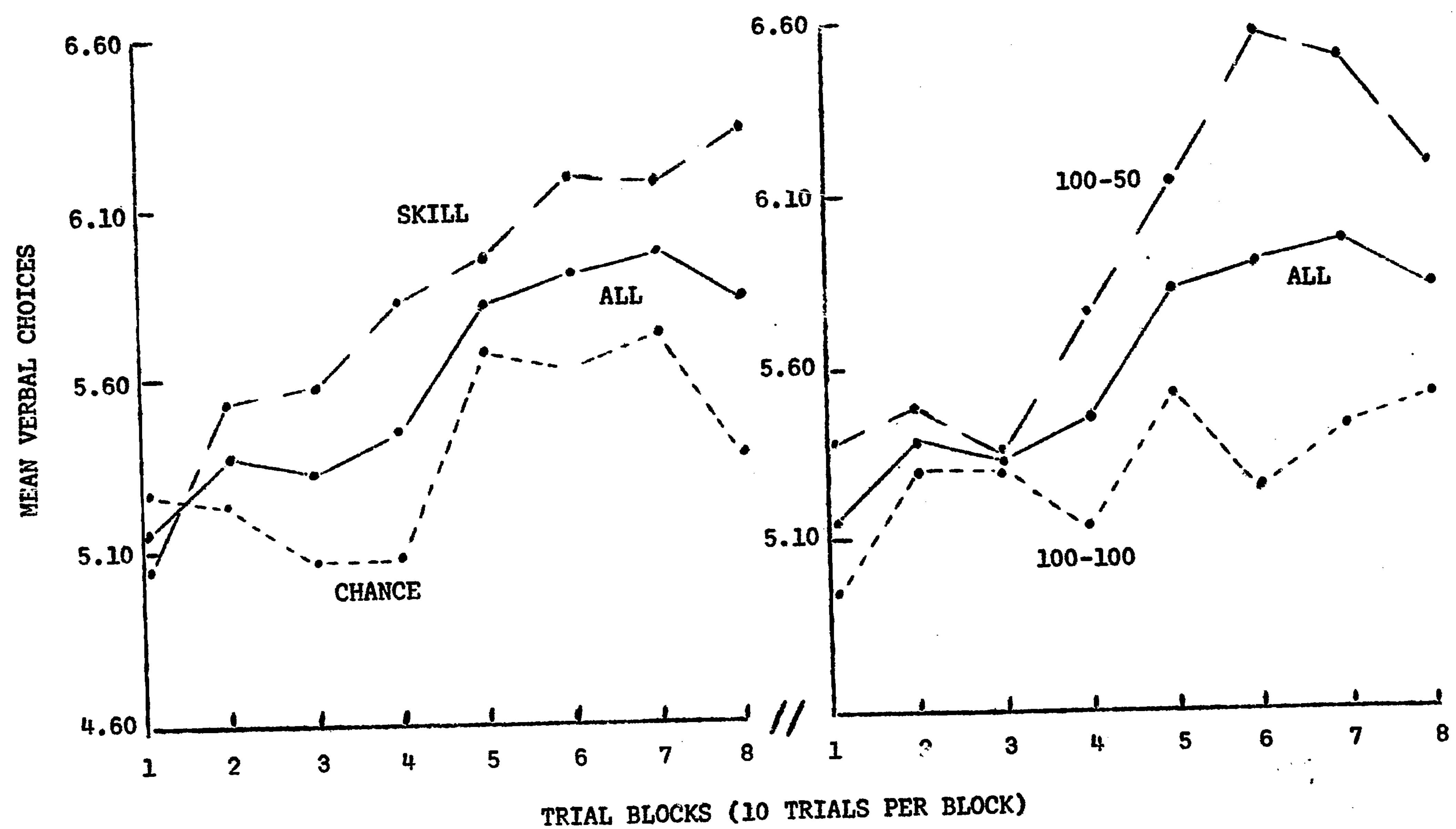

Fig. 1. Mean verbal choices over trial blocks for all grades on instructions, schedules, and all conditions combined.

The developmental effect of age in increasing verbal choices, reflected in the .01 significance for Grade in Table 3, constitutes further confirmation of our main hypothesis. There was no sex main effect, but the triple interaction ($p < .025$) of Instructions X Schedule X Sex merits special attention in Figure 2, where it can be seen that boys

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Insert Figure 2

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in the Skill condition increased their verbal choices from the 100-100 to the 100-50 schedule; under Chance, they selected the verbal incentive at about the same low level for both schedule conditions. On the other hand, girls showed little schedule changes under Skill in verbal selections at a relatively high level, but under Chance they increased their verbal choices markedly as a function of schedule from a low level at 100-100 to a high level at 100-50. Thus, boys were relatively unresponsive to schedule in the Chance condition, but very responsive to the 100-50 condition interacting with Skill instructions. Girls responded to the Skill conditions under both schedules, but only to the 100-50 condition under Chance.

Verbal vs. Material Choices

The results so far have demonstrated the nature of the influence of the major independent variables upon the number of verbal choices selected in competition with material incentives. How many verbal selections were made as compared to material choices under various experimental conditions? We have already pointed out a general tendency to distribute choices between the two rewards fairly evenly in this experiment and in a pilot (see Chapter V) where Ss made choices between two incentives directly with no instrumental learning required over large and small trial sequences. The obtained mean number of verbal choices over 80 trials for each condition-group was compared against an equal 40-40 split by t tests, employing the data from Table 2. The mean values converted to percentages, and the t values appear in Table 4.

Insert Table 4

The mean percent of verbal choices over all grades and conditions was 56.6, significant beyond the .001 level. The smallest percent of verbal choices was 46.2 in Grade 1 under Chance-100-100, the only sample to show a tendency toward material choices, significant at the .04 level; choices under the other conditions for this age group were not significantly different from a mean 40-40 split. We prefer to designate this distribution operationally, rather than the more common reference to a "chance" division, because it is conceivable that children were purposely balancing their incentive selections; this does not preclude alternative interpretations of chance determination. The largest percent of verbal choices was 69 under Skill-100-50 for the older children in Grade 5, significant well beyond the .001 level. For all grades combined the Chance-100-100 group yielded an even split at 51.1% verbal choices, with

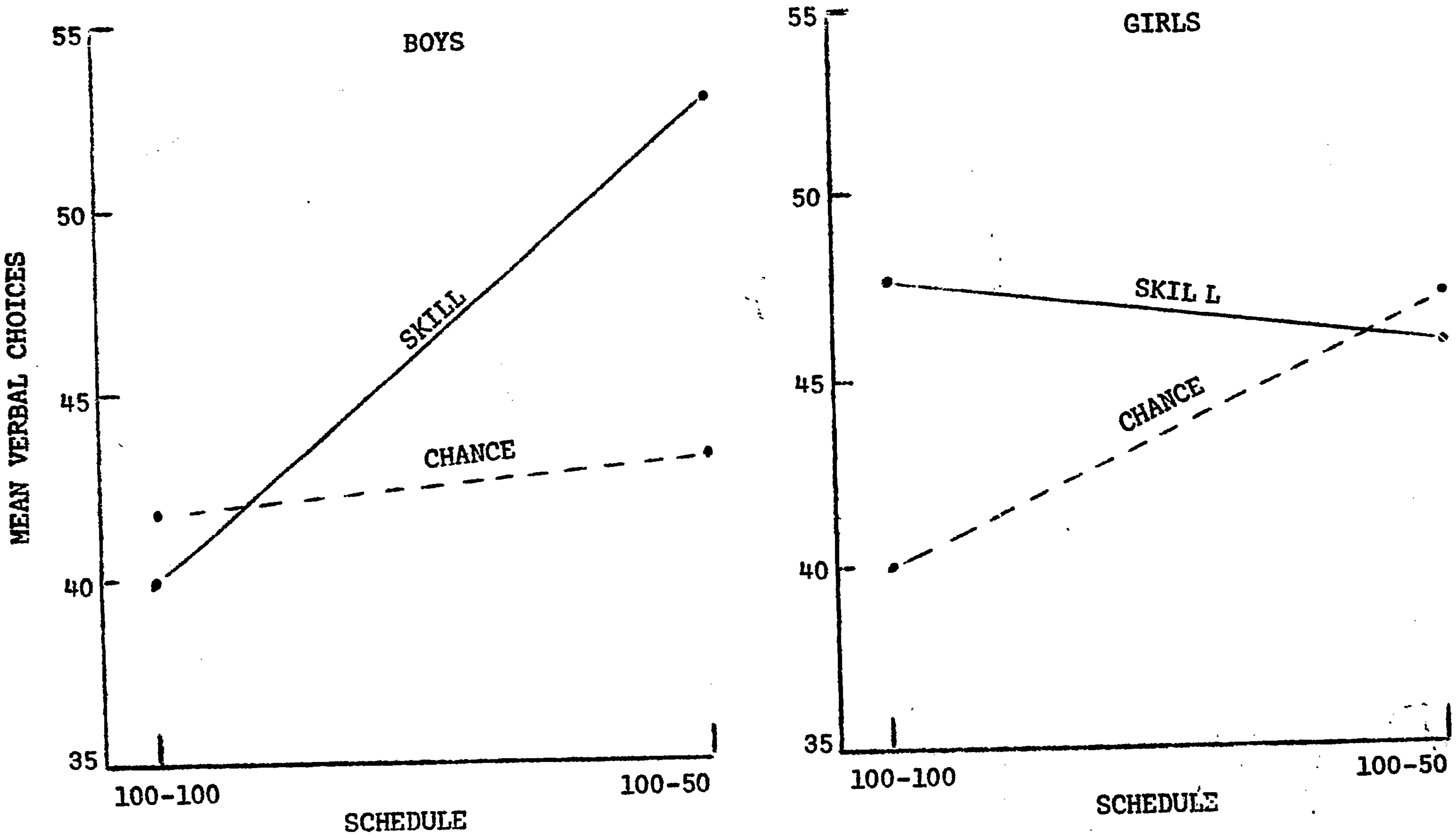

Fig. 2. Representation of sex, schedule, instruction triple interaction.

Table 4

Verbal Choice Comparisons to Expected 40-40 Split over 80 Trials

Grade	Instruction	% Verbal choice and t	Schedule 100-100	100-50	Both
1	Skill	Percent	52.6(20)	52.0(20)	52.2(40)
		t	.66	.66	.94
	Chance	Percent	46.2(20)	51.9(20)	49.0(40)
		t	-2.23###	.58	.52
	Both	Percent	49.4(40)	51.9(40)	50.6(80)
		t	.27	.88	.43
3	Skill	Percent	53.0(20)	64.2(20)	58.6(40)
		t	.87	3.45**	3.14**
	Chance	Percent	53.5(20)	58.1(20)	55.8(40)
		t	.76	2.67*	2.12###
	Both	Percent	53.2(40)	61.2(40)	57.2(80)
		t	1.14	4.32***	3.76***
5	Skill	Percent	59.0(20)	69.0(20)	64.0(40)
		t	1.62	4.12***	3.78***
	Chance	Percent	53.8(20)	59.8(20)	56.8(40)
		t	.56	2.12##	1.66
	Both	Percent	56.4(40)	64.4(40)	60.4(80)
		t	1.50	4.37***	3.76***
All Grades	Skill	Percent	54.9(60)	61.8(60)	58.2(120)
		t	1.93#	4.85***	4.71***
	Chance	Percent	51.1(60)	56.6(60)	53.9(120)
		t	.41	3.05**	2.18###
	Both	Percent	53.0(120)	59.1(120)	56.1(240)
		t	1.62	5.63***	4.86***

Note. - Sample N's are given in parentheses after verbal choice percentages.

#p < .06
##p < .05
###p < .04

*p < .02
**p < .01
***p < .001

percentage of choices and t values increasing from the marginal .06 level for Skill-100-100 to .01 probability for Chance-100-50, and finally to .001 for Skill-100-50. This same ordinal trend was apparent in Grades 3 and 5, thus confirming our analysis of variance demonstrating some instruction effects, strong schedule effects, and largest effects under Skill-100-50 at the older two age levels.

Incentive selections tended to stabilize over the last 40 trials, as can be seen in the trials curve for all conditions and samples in Figure 1. Exemplary of percentage verbal choice stabilization for the last 40 trials are the sex differences in the triple interaction reported earlier; these are shown in Table 5. It should be noted that Figure 1

Insert Table 5

was based on all 80 trials. The percent of verbal choices across conditions for both sexes combined was 59 on the last 40 trials, compared to 56.1 for all 80 trials. The combined sexes also yielded 51.1% verbal choices in the Chance-100-100 condition for the last 40 trials, identical to the percentage on all 80 trials. The ordinal rank of conditions for the combined sexes on the 40 terminal trials was the same as on the total trials: Chance-100-100 (51.1%), Skill-100-100 (57.5%), Chance-100-50 (60.8%), and Skill-100-50 (66.5%); the last three percentages are higher than on total trials. Observed variations from this order by each of the sexes in Table 5 is congruent with the triple interaction shown in Figure 2. The highest percent of verbal choices in Table 5 is 71.4 in the Skill-100-50 condition for boys; the lowest, 49.3, in the Chance-100-100 condition for girls. While the percentage magnitudes in Table 5 are higher for the last 40 trials, they are in agreement with those for all 80 trials and consonant with effects of independent variables demonstrated by analyses of variance. Thus, in general it turned out that the Chance-100-100 condition provided a baseline, even split between verbal and material choices, so that the three remaining experimental conditions could be evaluated for verbal preferences near or greater than this equal choice distribution.

Terminal Test, Socioeconomic (SES), and IQ Analyses

We have already presented the basic data, fundamental to the explicit design of the experiment for estimating the effects of instruction, schedule, age, and sex on verbal vs. material choices in discrimination learning, and we have also analyzed the extent of verbal preferences over material choices. In addition, we employed a terminal learning test after the experiment was well under way, and we explored individual differences in socioeconomic status (SES) and IQ implicit in our data.

On each of ten trials at the end of the main experiment, 54, 77, and 47 Ss in Grades 1, 3, and 5, respectively, were required to identify, wothout correction, the stimulus associated with one of the incentives, thus yielding a maximum score of 10. "Learners" were defined as those Ss who made 9 correct identifications; the chance probability of such a

Table 5

Percentage of Verbal Choices by Sex and Condition for All Grades on Last 40 Trials

Sex	Instruction	Schedule		
		100-100	100-50	Both
Boys	Skill	51.2%	71.4%	61.3%
	N	30	30	60
	Chance	52.9%	57.2%	55.0%
	N	30	30	60
	Both	52.0%	64.3%	58.2%
	N	60	60	120
Girls	Skill	63.9%	61.6%	62.8%
	N	30	30	60
	Chance	49.3%	64.3%	56.8%
	N	30	30	60
	Both	56.6%	63.0%	59.8%
	N	60	60	120
Both Sexes	Skill	57.5%	66.5%	62.0%
	N	60	60	120
	Chance	51.1%	60.8%	55.9%
	N	60	60	120
	Both	54.3%	63.6%	59.0%
	N	120	120	240

a score was .01. The sample of 26 Ss in Grade 1 not tested on this terminal task was from School "C," superior in IQ and SES to the other two schools as shown in Table 1. This bias did not obtain for the limited sample in Grade 5. The terminal learning task was added when preliminary results showed that many Ss approximately equally divided their incentive choices between verbal and material rewards. Under these circumstances it would be difficult to interpret such choices as failure to learn the discrimination task versus systematic tendencies toward equal incentive distributions.

Percent correct identifications by those Ss tested in Grades 1, 3, and 5 were 43, 66, and 77 respectively, suggesting the discrimination task to be more difficult than anticipated. This was not consonant with results we had obtained with comparable Ss, employing the same stimuli on five-choice discrimination learning (Witryol, Tyrrell, & Lowden, 1965), where terminal task learning levels seemed higher. One explanation might obtain from differences in reliability of a 10-item measure in the present instance, compared to the previous measure which yielded a maximum score of 25. Furthermore, any "learning" measure is arbitrary. Our terminal task required relatively explicit retention for identification determination without reinforcement, different from the trial by trial sequential feedback in the main experiment. For example, of the 31 "nonlearners" in Grade 1, five chose either material or verbal rewards consistently over 80 trials at probability levels high enough to suggest "learning." Three more such cases in Grade 3, and one in Grade 5 were detected. The bias toward lower IQ and SES for those taking the terminal task in Grade 1, compared to the parent population in the main experiment, should be considered. Finally, the tendency for the Chance-100-100 group in Grade 1, cited in Table 4, to select material rewards, the only evidence in all of our analyses deviating from equal incentive divisions or verbal preferences, reflects learning. This is striking because the condition presents a weak motivation instruction under an equal schedule condition.

These considerations have been analyzed in detail on the limited data from our terminal learning task as a consequence of the significant Grade effect, demonstrated in the analysis of variance in Table 3 to show increasing verbal preferences with age. The developmental effect can be attributed to superior discrimination learning with age as older children more easily located and obtained their preferred incentives, verbal reward; or it can be interpreted as age-determined preference for verbal incentives; or both possibilities might obtain. While we think that both possibilities obtain, the weight of the evidence from this study and previous research (Witryol, Tyrrell, & Lowden, 1965) leads us to attribute greater variance to a developmental verbal preference interpretation.

Analyses of variance were calculated employing the major independent variables with SES and IQ as dependent variables to test randomization of assignment of each of the latter two. Probability values did not attain statistical significance for SES, but age and sex p values at .01 were obtained with IQ. The age variance was attributable to the superiority of Grade 1 where the mean IQ of 111 was significantly larger than the means of 105 and 107 reported in Table 1. Sex differences favored girls whose mean of 109.7 was larger than the boys, 105.7, at the .05 level.

As one exploration of individual differences interacting with the experimental manipulations, subjects were divided into three SES levels from the status ranks described in Table 1: (a) high (rank 1), (b) medium (ranks 2 and 3), and (c) low (ranks 4 to 7). Since such an analysis was not a primary objective in our design, the *N*'s in each cell are not equal. The logic of the divisions was dictated by sensible, if arbitrary, SES groupings and comparable cell sizes, but further subdivisions by age and/or sex was precluded because cells would have been impractically fractional. Results for the total sample are presented in Table 6 to show

Insert Table 6

SES levels interacting with the main effects of instructions and schedules. Main effects became more pronounced as SES increased. Probability values from *t* tests of equal verbal-material splits increase from low to high SES levels in Table 6. Although tendencies to chose verbal rewards are apparent at all levels, *t* tests between condition effects were not significant for low SES children, but high status children yielded the expected significant one-tail comparisons: Skill 100-50 vs. Skill 100-100 (t = 2.66, p <.01); Chance 100-50 vs. Chance 100-100 (t = 1.85, p <.05); Skill vs. Chance (t = 1.44, p <.10); 100-50 vs. 100-100 (t = 3.27, p <.005); the first condition in each comparison yielded larger mean verbal choices. The medium status group yielded marginal significance for Skill 100-100 vs. Chance 100-50 (t = 1.43, p <.10), and higher significance for Skill vs. Chance (t = 1.91, p <.05) with one-tail tests; surprisingly, no overall schedule effect obtained, possibly because instructions in the Skill 100-100 cell had exhausted the variance.

The relationship to SES is perhaps most strikingly illustrated by the regular progression, with higher status, of mean verbal choices in the cells containing the combined main effects of instruction and schedule: Skill 100-50; mean choices were 43.2, 49.8, and 55.8. Significant also is the powerful schedule effect (p <.005) in the high SES group where the instruction effect was marginal (p <.10), contrasted to the schedule failure in the medium SES group where some instruction effect seemed to obtain (p <.05). Reasoning from general, known correlations between SES and IQ to explain these findings in terms of intelligence does not quite hold from the following section.

Further analyses were explored by dividing population individual differences in IQ into three groups: high (115+), medium (101-114), and low (100 and below); these logical groupings were dictated by the same basic considerations as in the SES analyses. Results for IQ levels interacting with instructions and schedules appear in Table 7 where mean

Insert Table 7

verbal values were evaluated by *t* tests for even, 40-40 splits between the two incentives. Significance values for verbal choices in condition cells

Table 6

Mean Verbal Choices by Conditions for High, Medium, and Low Socioeconomic Status (SES) over 80 Trials

SES	Instruction	Score	Schedule 100-100	100-50	Both
High	Skill	M	41.5(19)	55.8(19)***	48.1(38)**
		SD	15.5	17.6	17.7
	Chance	M	37.6(20)	48.8(16)##	42.6(36)
		SD	19.1	16.5	18.3
	Both	M	39.5(39)	52.6(35)***	45.7(74)**
		SD	17.1	17.0	18.3
Medium	Skill	M	48.8(18)###	49.8(20)**	49.3(38)***
		SD	16.1	15.0	15.2
	Chance	M	40.1(18)	44.2(18)	42.2(36)
		SD	20.3	12.4	16.5
	Both	M	44.5(36)	47.1(38)**	45.8(74)**
		SD	18.3	13.8	16.2
Low	Skill	M	42.0(23)	43.2(21)	42.6(44)
		SD	17.6	10.9	14.5
	Chance	M	44.6(22)#	43.9(26)#	44.2(48)*
		SD	12.2	12.0	11.8
	Both	M	43.3(45)	43.6(47)###	43.4(92)*
		SD	14.9	11.2	13.2

Note. - Sample N's are given in parentheses after mean verbal choices.

Probabilities from t tests of departure from expected 40-40 choice distribution:

#p <.11
##p <.06
###p <.04

*p <.02
**p <.01
***p <.001

Table 7

Mean Verbal Choices by Conditions for High, Medium, and Low IQ's over 80 Trials

IQ	Instruction	Score	Schedule 100-100	100-50	Both
High	Skill	M	45.0(17)	51.4(21)**	48.6(38)*
		SD	23.6	16.0	19.5
	Chance	M	42.3(21)	46.5(18)##	44.2(39)
		SD	20.3	12.4	16.9
	Both	M	43.5(38)	49.2(39)***	46.4(77)**
		SD	21.3	14.3	18.3
Medium	Skill	M	43.5(29)#	50.9(25)**	46.9(54)***
		SD	11.6	14.3	13.4
	Chance	M	37.2(21)	43.4(20)	40.2(41)
		SD	18.2	12.7	16.0
	Both	M	40.9(50)	47.5(45)***	44.8(95)*
		SD	15.0	14.1	15.0
Low	Skill	M	43.3(14)	45.3(15)	44.3(29)
		SD	15.7	15.7	15.5
	Chance	M	44.2(17)	44.6(22)	44.4(39)##
		SD	10.6	14.2	12.4
	Both	M	43.8(31)#	44.9(37)##	44.4(68)*
		SD	13.0	14.4	13.8

Note. - Sample N's are given in parentheses after mean verbal choices.

Probabilities from t tests of departure from expected 40-40 choice distribution:

#p >.10 <.15
##p <.05

*p <.02
**p <.01
***p <.001

increase from low to high IQ groups, but the medium group seems comparable to the high sample. The generally powerful Skill-100-50 condition yielded progression from low to medium, but not from medium to high, IQ samples. Total verbal choices for each of the groups across all conditions were statistically significant, but relatively homogeneous, ranging from 44.4 to 46.4. There were no condition differences among Ss in the low IQ sample, and the high sample yielded a marginal one-tail .10 probability value ($t = 1.36$)for schedule. The medium group yielded identical one-tail confidence values for instruction and schedule condition differences favoring Skill over Chance and 100-50 over 100-100 on mean verbal choices ($t = 2.19$, $p < .025$). While it appears from these results that the medium IQ group contributed the major variance to the main effects, the general ordering of conditions, derived from the analysis of variance in Table 3, approximately obtains in the other IQ groups: i.e., Chance 100-100, Skill 100-100, Chance 100-50, Skill 100-50, from low to high mean verbal choices. This order is somewhat obscured in the low IQ group, but it is quite regular in the high group. Hence, additional variance was contributed to main effects from marginal differences, and also from the fact that N was largest for the medium sample at 95, compared to 77 in the high group and 68 in the low sample.

Summary of Results

1. The major hypothesis was confirmed from analyses of variance showing mean verbal choice increases as a function of instructions, schedule, and age; schedule effects were generally more powerful than instructions.

2. A significant trials effect demonstrating increasing verbal choices obtained. The marginal instructions effect became very reliable in the trials interaction.

3. A triple interaction between instructions, schedules, and sex showed that girls were responsive to the Skill instruction at a high level for both schedules in selecting verbal incentives, but under Chance, they were responsive to the 100-50 schedule. Boys did not respond differentially to schedule in the Chance instruction, performing at a relatively low level, but under Skill, verbal choices increased markedly from a low level in the 100-100 to a high level in the 100-50 schedule.

4. With one exception all samples under all conditions in the major analyses either distributed choices evenly between verbal and material rewards or preferred verbal incentives. The exception occurred in the youngest group, Grade 1, under the Chance 100-100 condition where there was a slight preference for material rewards;choice distributions between incentives were evenly divided in the other conditions for this age sample. At older age levels, and for the total sample combined equal incentive distributions obtained for the Chance 100-100 condition, which provided baseline performance.

5. At older ages and for the total sample, the majority of choices were verbal as a function of instructions, schedules, or both. The largest mean percents of verbal choices were 69 and 71, respectively, in the Skill-100-50 condition for the oldest sample, Grade 5, on all 80 trials, and for all boys in the same condition on the last 40 trials where choices stabilized. The mean order of verbal choices from low to high by condition was generally Chance-100-100, Skill-100-100, Chance-100-50, Skill-100-50.

6. Children categorized low in socioeconomic status (SES) selected more verbal than material rewards, but at levels lower than medium and high SES subjects. High SES children were greatly influenced by schedule conditions, while medium SES children were more responsive to instructions. Condition effects were nonexistent in the low group where simple verbal preference seemed to carry the small variance.

7. Verbal choices for all conditions combined were preferred and comparable for groups classified low, medium, and high in IQ. No condition differences were obtained in the low sample, and the high sample yielded a marginal schedule tendency favoring 100-50. Predicted instruction and schedule differences were significant in the medium group which constituted the largest single sample; furthermore, directional tendencies in the other samples were approximately congruent, though failing clear significance. High and medium IQ children chose more verbal incentives under Skill-100-50 than did children classified low in IQ.

8. Equivocal evidence favors verbal preference rather than discrimination learning ability, as an explanation for the developmental increase in verbal choices.

D. Discussion

Our central hypothesis was that verbal approval would be enhanced as a function of motive-inducing instructions, reward-type schedule differences, and age, when children are given the opportunity in discrimination learning to solve on the basis of two incentives concurrently, verbal and material. By employing the differential method (Pubols, 1960) to evaluate verbal vs. material preferences in two-choice discrimination learning, we permitted each $\underline{S}$ to experience the range of rewards as a cogent test of incentive value; the absolute method involving independent groups provided assessment of experimental manipulations and individual differences. Our experimental manipulations were classically simple in design, yielding a basic 2 X 2 factorial with two levels of instructions and two levels of schedule. To these two variables, however, were added a third, the verbal vs. material incentive preference, independent of manipulations, and a fourth and fifth, age and sex, implicit in most developmental researches; a sixth variable, trials effects, is also implicit in our discrimination learning task. We attempted, furthermore, to assign socioeconomic status (SES) and IQ to major conditions at random, failing in minor respects, and these provided supplementary seventh and eighth variables to explore with profit. All of these variables are relevant to the problem of verbal incentives, and, although the multivariate analyses were complex, the central hypothesis was confirmed for our 2 X 2 factorial design, while the other independent variables provided refined specifications for the conditions under which the hypothesis would obtain.

Given the general tendency to distribute choices evenly in the baseline Chance-100-100 group, children showed verbal preferences over most conditions of our experiment. The baseline even split was fortuitous and not expected, while not surprising at the same time. Children might have, for example, preferred the material incentive strongly, and our independent variables still could have influenced increased verbal choices within a range under 50%. As it was, only one small material incentive tendency occured in Grade 1, so that when verbal choices were significantly above 50%, they obtained as a function of major variables in our main analysis, although level differences in SES and IQ modified this pattern somewhat.

The use of small plastic cows as material rewards was arbitrary, but based upon past research with five-choice discrimination learning, where their incentive value was higher than verbal reinforcements (Witryol, Tyrrell, & Lowden, 1965), except for Grade 5 girls. In the present study, oral presentation of verbal reward was accompanied by delivery of the word "good" on a card in the reward tray. We profited from our earlier experience where children noted the contrast between trays delivering material rewards, while verbal reinforcement yielded an empty receptacle, contrary to conditioned incentive expectations. It might be argued that other material rewards would have yielded higher incentive values and larger material choices. While this is true, it should be recalled that the major purpose of this investigation was to study verbal enhancing variables. The experimental designation of an incentive previously shown superior in value to verbal rewards, and at best equivalent, seemed most relevant. Significant also are our findings in pilot studies that children, asked to select directly from two incentives of disparate value (bubble gum vs. bean) over a large and a small number of massed trials, chose beans 30% of the time, at the least. Given two reward options over trials, most children distribute them.

Our major experimental manipulations were directed from observations of "real life" where verbal rewards in child training are administered in exceedly greater proportion to material reinforcements, and where instructions or admonitions to get social approval and feedback for excellence in performance are central to child rearing. These considerations seem crucial to verbal-material reward comparisons if the practical economy of the former is to be demonstrated. Our schedule difference favoring verbal reward on a 2 to 1 basis, the 100-50 conditions, was a conservative ecological approximation, and our Skill instructions were designed to exploit overt and latent achievement or approval motives. The fact that schedule differences were generally more powerful is evidence that many children perceived Skill and Chance as achievement orientation. In short, the task itself invoked relevant motivation, and then Edwards (1961) seems confirmed in proposing that "costs and payoffs are instructions." Some variance, nevertheless, was attributable to instructions, especially interacting with trials, to generate more verbal choices. Perhaps more interesting are instructions and schedule in the triple interaction with sex and again in their effects at various SES levels.

Girls under both schedule conditions preferred verbal incentives under the Skill instruction; under Chance verbal choices increased markedly from the 100-100 to 100-50 schedule. This is consonant with research (Crandall, 1963, pp. 431-432) suggesting that the achievement motive in girls is guided by a need for social approval, while boys more autonomously internalize standards. The girls' conformity orientation was reflected in uniformly high levels of verbal choices under both schedules in response to Skill instructions; under Chance, without directive instructions, the expected schedule difference maintains as a function of higher verbal payoffs. The achievement motive in boys was reflected in the strong schedule effect under Skill which seemed to invoke a payoff orientation. In the Skill-100-100 schedule, the boys could get a reward on every trial, and they preferred to divide choices evenly between verbal and material reinforcements. In the Skill-100-50 condition, however, a strong achievement orientation would inhibit material selections since a payoff would fail to occur on 50% of the trials; hence, the marked increase of verbal choices which provided a 100% payoff. Under Chance, without an achievement orientation, boys displayed no marked incentive preferences and were unresponsive to schedule. These sex differences demonstrate that payoffs and instruction-inducing motivation are both vital in problem solving performance and goal orientation.

Another example to confirm these interpretations derives from our SES analyses. The high SES group yielded a strong schedule and a marginal instruction effect. This is interpreted as a payoff orientation deriving from strong achievement needs of high SES children generated from child rearing practices of those characteristically "pushy" college professors and their wives who dominated this sample. The more conforming medium SES children showed a significant instruction, but no schedule, effect, and no experimental effects were found for the low SES children. All groups showed verbal preferences, nonetheless; the overall level for the low group was slightly smaller than for the higher two. IQ did not appear to account for the SES interactions because, while a marginal schedule effect obtained for the high IQ group, both instruction and schedule attained significance in the medium group. The low IQ, like the low SES, group preferred verbal choices, but were not significantly responsive to experimental conditions.

The significant age effect is more difficult to interpret unequivocally as either a developmental progression in learning or in internalization of verbal approval. The major variance resides in the smaller verbal mean of the first grade compared to the two higher grades. Similar differences between verbal values for low IQ and SES samples, compared to higher levels, taken together with relatively poor first grade terminal task learning performance, suggest a learning interpretation. Terminal task subjects, on the other hand, represented a biased sample of lower IQ and SES status for Grade 1 in contrast to the parent population. Since past research (Witryol, Tyrrell, & Lowden, 1965) suggested that the discrimination learning task in the present study should have been easy, we are inclined to favor increasing internalization of verbal approval, along with depreciation of the specific material incentive employed, at the higher age levels. Such an explanation is consonant with a paired comparison study of incentive values (Witryol & Ormsby, 1961), in which two verbal incentives were ranked last in Kindergarten, and first in Grades 3 and 6; the material rewards in that investigation were generally higher in value than the plastic cow employed in the present one.

In conclusion, it appears that verbal rewards, evaluated in direct competition with material incentives, can be efficiently used in a problem solving situation when they are applied relevantly by taking into account group and individual differences. Appropriate instructions and consistent application are crucial, as is sensitivity to competitive rewards available in the child's psychological climate. A rational payoff system seems to tap latent and overt achievement motives, and instructions can maximize these effects. The experimental variables yielding high verbal choices indicate that boys and high SES subjects were motivated by internal locus of control, while girls and medium SES subjects were more responsive to conformity and social approval needs in their achievement behavior. Under the conditions of this experiment, low IQ, low SES, and young children were not significantly responsive to experimental manipulations, although there were tendencies in the hypothesized direction, and they favored verbal incentives somewhat. The disposition for these and other children to distribute choices when reward options are available merits further investigation.

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V. Children's Choice Strategies in Incentive Accumulation

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A. A Novel Pilot Study

We did find time during the present contract period to explore incentive sequence choice strategies by children. In the animal laboratory, when investigators are studying differential reinforcement influences on learning processes, they typically run one trial a day. Since reinforcement value is a function of drive, then drive must be held constant to assess incentive effects. Thus, if an animal is deprived of food for four hours and then tested with two food pellets, his drive is somewhat reduced, so that on an immediately consequent trial, the value of the two pellets would be reduced. The experimenter typically waits a day, returns the animal to four hours complete deprivation and runs his second trial. It would be hard to find a school which could "deliver" children for so many sessions. Besides, children are typically run under social or intellectual motivation, and it remains to be demonstrated that these drives have the simple point to point relationship to reinforcement as in the animal domain. The Stevenson and Zigler (Stevenson, 1965) programs have been based on this relationship in more complex social form, and have variously hypothesized social and sensory deprivation, and also anxiety. In the classroom, as in the laboratory, teachers are unlikely to return to a deprivation schedule after reinforcement administration to children, and the consequences, with the exception of the programs noted above, have been largely unexplored. The effects of massing reinforcements over trials have not merited comment in Terrell's work (Terrell, 1959; Terrell, Durkin, & Wiesley, 1959; Terrell & Kennedy, 1957), and have been reported from incidental observation as relatively insignificant by Siegel, Forman, & Williams (1967) and by us. No direct test, however, has previously been available.

B. Brief Report of Progress

The simplest basic approach for initiating inquiry into this problem, it seemed to us, was to present two reward objects in pairs to 40 first grade children, who could select one from two relatively high incentive objects, or, from one high and one low, object. For this inquiry incentive objects rather than verbal reinforcements were more feasible as a starting point. Our subjects were divided into four groups: (a) 10 children selected from high (bubble gum) vs. low (bean) incentive pairs over 100 trials; (b) 10 selected from high (bubble gum) vs. high (charm) over 100 trials; (c) 10, from high-low over 20 trials with instructions that their number of opportunities would be limited; and (d) 10, from high-high as in c. Initial incentive value was determined by the method of paired comparisons. No learning was involved since the children could see the two incentives on each trial, and they could keep the one they selected on each trial. The independent variable was incentive value; the dependent variable was choice selection over trials. Choice strategies over trials were analyzed in terms of (a) incentive preference, (b) incentive alternation, (c) incentive runs (a sequence for picking the same incentive), (d) position preferences, (e) position alternations, and (f) position runs. Preliminary analyses showed:

1. When preferences were analyzed for experimental groups:
   a. Bubble gum was most preferred on total trials for the high-low conditions on both the long and short trial sequences; percent choices were about the same, 62 and 65, for both trial sequences.
   b. Although there was no overall difference between incentives in the high-high, 100 trial group, there was a significant trials effect, so that bubble gum, as compared to charms, reached the same asymptote (about 65%) in the last trial block, as it had averaged overall in the high-low condition.

2. When preferences were analyzed by individual choice strategies:
   a. The modal subjects showed significant single alternation strategies on incentives. This approach was more pronounced in the 20-trial groups than in the 100-trial groups, as well as in the first block of 20 trials in the 100-trial group.
   b. The next most prominent strategy was determined by preference for bubble gum, which tended to mask any runs strategy independent of this approach. In other words, a consistent preference is a kind of runs strategy. In statistical calculation if one uses preference as a basis for superimposing further runs, the statistical test becomes most severe, and, hence, only one such independent run occurred.
   c. Eight of the 40 children showed some kind of systematic position strategy, and only two responded at random.

What does this mean? So far as we know this is the first attempt to examine strategies for incentive cumulation in choice behavior. Even in the high-low conditions a small dry bean was selected about 35-40%. This was a persistent tendency over 100 trials where the group curve was essentially flat. In the high-high condition, on the other hand, choices were evenly distributed between bubble gum and charms for the first 60 trials after which choices shifted rather rapidly upward for bubble gum to asymptote at 65% in the last 40 trials, the same asymptote as for the high-low conditions. Children's strategies for incentive preference tend to reflect an alternation, exploratory, or trade-off approach at first, after which they stabilize in terminal trial blocks. Stabilization occurs early when the incentive conflict is small, but a low valued incentive maintains continued interest as reflected in the 35-40% choices. Position strategies confound incentive approaches even in this simple task. Finally, relative incentive preferences and trends were similar to those suggested from our five-choice discrimination learning experiment (Witryol, Tyrrell, & Lowden, 1964; 1965). Most striking from close inspection of the earlier data is the shift in bubble gum choices upward for first grade children after the 60th trial. In the present research the shift at this point suggests a satiation effect for charms, an incentive which has relative permanency, along with increasing choices of bubble gum, which has consummatory value. Using techniques from information analysis, we are now exploring additional factors inherent in the conditions of our experiment.

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VI. Reduction of Uncertainty as Incentive in Children's Learning

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A. Information as Incentive

The purpose of this study was to demonstrate the reinforcing properties of various levels of uncertainty reduction in children. Uncertainty may be defined as potential information, and the amount of uncertainty, or potential information, is a function of the possible number of outcomes of an event. The less predictable the occurrence of a stimulus event, the more potential information is available. If only a single event is occurring, as in an uncontested election, no information is provided, and no uncertainty is reduced. On the other hand, a very large number of events occuring randomly provides new information with the occurrence of each event which is not predictable, as in drawing one from a deck of 52 cards. Novel and complex stimuli have in common the potentiality of reducing uncertainty by providing information. A novel stimulus provides information about events not previously encountered or about familiar events in new combinations. Children seem to prefer novel and complex stimulation. The present experiment was designed to show that the opportunity to reduce uncertainty can make less relatively valuable incentive objects preferable to what is ordinarily a higher reward, when the two sets are placed in competition. It was further hypothesized that preference for the uncertain reward would decrease if uncertainty was not immediately reduced, but would return to its former level after uncertainty reduction. This was assumed from the limited information processing capacity of the child.

B. Preliminary Findings

The design included four experimental groups to each of which 10 from 40 Grade 4 children, equally represented by sex, were assigned. Each child was given 40 two-choice discrimination preference trials in which one stimulus always yielded bubble gum, the high reward (H), the other, an "unknown" incentive (U), a paper bag concealing one of four rewards: bubble gum, plastic cow, bean, and paper clip. The paper bag always contained a single U reward, each occurring on 25% of the trials. Thus, choice of the H associated stimulus always yielded the high reward, bubble gum, but selection of the U stimulus yielded a high reward, bubble gum or plastic cow, on 50% of the trials, and a low reward, bean or paper clip, on the remaining 50%. The first experimental group, Immediate (I), was instructed to open the package as soon as chosen. Group 10 opened U choices after 10 trials, Group 20, after 20 trials, and Group 40, at the end of all trials.

The U-Immediate and U-10 groups chose more package rewards at reliable statistical levels, confirming the main hypothesis for uncertainty reduction preference in competition with the uniformly available H reward. Groups 20 and 40 choice selections were equally divided between H and U rewards. Both the I and 10 groups were significantly different from the 20 and 40 groups, confirming the second hypothesis that delay in uncertainty reduction decreases U reward value because of the child's limited information processing capacity. This seems further confirmed by the orderly rises and falls over trials for groups 10 and 20, corresponding to opening of packages and subsequent delays. The I group choices were constant over trials, but the 10 and 20 groups showed wide fluctuations. On trial blocks immediately following the opportunity to open packages, U choices for Group 10 were at the same level as I; on trial blocks immediately preceding, fewer U than I choices were made.

The results obtained in this study point to the reinforcing powers of uncertainty reduction. Preference for U over H by the two most immediately rewarded groups, the peculiar choice patterns of groups 10 and 20, and the consistently low level of U choices by Group 40 all indicate that the opportunity for S to reduce his uncertainty about the identity of U serves as a reinforcer. These results could not be explained in terms of a higher preference value of the items included in U since the highest valued items areequal to H, and the two other items, the bean and paper clip, have been found to be of low preference value. In addition, preference for U was contingent upon the opportunity to see what was contained within the packages. If the packages themselves were preferred, they should have been picked equally by all groups. One other possible explanation of these data would be in terms of the manipulation motive demonstrated in monkeys. This possibility could be tested by running control groups under the immediate and 10-trial conditions, and using only bubble gum as both the H and U incentives. If the response patterns obtained are the same as the ones obtained in the present study, the manipulation hypothesis would be supported.

The next question to arise concerns the decrease in U choices when uncertainty reduction is delayed. These results are most parsimoniously explained in terms of the extinction of unrewarded responses. While the hypothesis of a limited information processing capacity is certainly a compelling one, the present study does not provide a real test. There also remains the possibility of an interaction between extinction and information processing capacity.

The mechanisms through which uncertainty reduction acts as a reinforcer are unknown, and the area is wide open to speculation. Fowler has advanced an S-R theory in which boredom (stimulus satiation) motivates exploration behavior, which is reinforced by novel stimulation (information). The goal response consists of all possible exploratory behaviors, and may be classified as information processing or uncertainty reduction. It is the expectation of information which functions as the $r_g - s_g$ mechanisms to motivate further exploratory behavior. Glickman and Schiff have suggested that responses to novel stimuli are species specific, and are mediated by the neural structures involved in reinforcement. They hypothesize that approach and withdrawal responses to novel stimulation are related to the reinforcing effects of electrical brain stimulation.

VII. Reinforcement Timing in Massed and Spaced Trials during Discrimination Learning

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A. Pre- and Post-Reinforcement Temporal Intervals

In the typical delay of reward study (see Chapter III) over massed trials in two-choice discrimination learning, one group of children is reinforced for the correct stimulus simultaneously with response, while another group under a delay condition is reinforced 6 to 10 seconds after appropriate response. Immediate reward generally yields superior learning to delayed reinforcement, and this is generally interpreted as a consequence of relevant cuing. Under delay the temporal reward distance is regarded as providing opportunity for the subject to associate the reward cue with stimuli irrelevant to the problem at hand. The conclusion of a trial is defined by reward administration for correct responses or a temporal interval comparable to the reward delay condition when responses are incorrect. Next follows a standard 5 to 10 second intertrial interval before the stimuli are presented again. _Note that the total temporal length of a trial is determined by the interval between response and reinforcement._ Since the stimuli generally are extinguished after responses, subjects in the delay, as compared to immediate, reward conditions experience a longer trial and a longer retention interval for stimuli over successive trials. In other words, the typical reward delay effects are confounded with retention intervals which may be impairing.

The purpose of this pilot study was to test the effects of two reward delays interacting with two intertrial intervals in children's two-choice discrimination learning. The portion of the time consumed in the conventional delay study will be referred to as _pre-reward_ delay; temporal duration after response and between trials will be designated _post-reward_. Our central hypothesis was that a longer post-reward delay interacts with a longer pre-reward delay to impair learning by compounding interference effects of task-irrelevant stimuli, implicit and explicit, in the temporal intervals before and after reinforcement.

B. Pilot Study Summary

A 2 X 2 factorial design was employed to test 40 Grade 3 children who were randomly assigned to four experimental groups based on combinations of pre- and post-reward intervals: (a) zero sec., pre and 10 sec., post; (b) zero sec., pre and 20 sec., post; (c) 10 sec., pre and 10 sec., post; (d) 10 sec., pre and 20 sec., post. Each group contained five boys and five girls tested on 80 two-choice discrimination learning trials or a criterion of 10 consecutive correct trials, whichever came first. Stimuli were two form cues, a circle and a diamond; a four-second light flash signalled the correct response. This relatively neutral reinforcement was employed to assess temporal conditions relatively independent of verbal or material incentive values. Instructions were non-orienting, as described in Chapter III, and the apparatus was the same.

Analysis of variance for the total population showed a significant interaction at the .05 confidence level between pre- and post-reward delays. The longer (20 seconds) post-reinforcement interval facilitated learning under immediate reward, but impaired learning under the 10-second reward delay. Under the 10-second intertrial interval the female sample yielded the conventional zero versus 10-second difference favoring the former at the .05 confidence level. No other effects were significant, and the interaction trends for each sex independently confirmed the combined sample finding. The findings for each sex are highly tentative because the sample cell sizes reduce statistical power. The number of subjects who failed criterion over 80 trials added to error in our small sample. Finally, many of the non-learners demonstrated strong position tendencies. Replication seems warranted with a larger sample and a more difficult task to minimize position habits. The significant interaction is interpreted as boredom, fatigue, and lack of attention by subjects enduring the combination of 10-second reward delay plus 20 seconds between trials. On the other hand the 20-second intertrial interval appeared to provide more time for consolidation and rehearsal for the immediately rewarded children, than did the 10-second intertrial interval.

VIII. Differential Delay-Of-Reward Training and Subsequent Discrimination Learning in Children

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Dissertation Summary

Four groups of 16 first grade children were given 40 single stimulus training trials and then 100 trials on a subsequent two-choice visual discrimination test which employed the previous stimuli as discriminanda. Two groups (D-0; D-10) experienced differential delays (either zero or ten seconds) of reward following a response to each stimulus during the training trials. One group (N-0) of non-differentially trained subjects experienced a zero second delay of reward, while subjects in the other non-differential group (N-10) experienced a ten second delay, following a response to both stimuli. During the discrimination test the stimulus associated with zero delay in the differential conditions became positive for one group of subjects (D-0) and negative for the other (D-10). The positive discriminative stimuli in the non-differential conditions were assigned randomly. Response speeds to the stimuli during training were inversely related to the delay of reward associated with that stimulus under all conditions. The differential subjects (D-10), experiencing the previously delayed stimulus as positive during the discrimination test, began at a significantly lower level of correct responses than the other differentially trained subjects (D-0); the performance over trials, however, became so enhanced that overall level of number of correct responses following differential (D-0 and D-10), was superior to that following non-differential (N-0 and N-10) training. The generally superiority of differential training confirmed the major hypothesis of increments in probability of observing the relevant dimension under this condition, as contrasted with non-differential training. Findings suggest that an attention theory of discrimination learning supplements an instrumental response strength theory in predicting these outcomes.

IX. Program Summary and Implications

The effect of incentive values upon children's learning has been the major focus of this program. In examining these effects it was also crucial to evaluate the conditions for maximizing incentive values with respect to timing and motivation. Efficacy of verbal rewards along with the complex individual differences controlling them merited special attention. Finally, novelty as incentive and the consequences of reward competition and accumulation were explored. Generalizations derived, applications suggested, and provocative implications for further research will be summarized here.

In Chapter II we discovered that a high incentive, as compared to a low one, could better focus attention upon a relevant dimension or generalization in children's learning. Prior to this discovery, high reinforcement values had generally been interpreted to maintain energy output or performance in the learning process,but not to influence problem solution directly. We obtained positive results for problem solving. Our findings were most pronounced for young children in the early school years, and the effect was strongest with orienting instructions. Older children were not influenced, presumably because problem solving, need achievement values were already strongly internalized. This seems especially true for our subjects who came from a college community. Further research with lower class children, different incentives, more complex problems, and experimentally induced motivation is planned. Meanwhile, educators should be sensitive to the probability that high incentives, properly administered, can be manipulated to center attention upon inductive generalizations in young children.

The significance of reward timing in children's learning was investigated in Chapters III, VII, and VIII, where it was demonstrated that, while delay of reward impairs learning, other conditions can systematically modify children's behavior under these circumstances. Thus, orienting instructions, which were also critical in Chapter II, can operate to minimize deleterious effects of reward delay. The often noted reward delay impairment is confounded in most studies by a lengthened retention interval. Our pilot study in Chapter VII, which systematically accounted for the confounding of reward delay with retention, suggested that immediately rewarded children profit from an extended inter-trial interval, while children under delayed reward suffer problem solving deficits over the same interval. Finally, Tyrrell in Chapter VIII discovered that immediate versus delayed rewards under proper conditions in problem solving can serve to make <u>salient dimensions distinctive</u>, a demonstration of the potency of reward timing in learning. Further research with children might include the study of interactions between reward values and reward delay. A high reward, for example, might maintain attention to relevant dimensions under delay, as did orienting instructions in Chapter III. Studies investigating the confounding of reward delays with retention intervals also require more research. Teachers and others should be interested in motivating mechanisms for maintaining a problem set in children before the adults are able to instrument reward immediacy. Timing features are crucial in drill exercises and with teaching machines designed to maximize learning.

In Chapter IV we demonstrated how relevant motivating instructions and a reward schedule favoring verbal approval could operate so that children would prefer verbal to material rewards in a learning situation. The form of the experiment was reasoned from the natural ecology of childhood. In this study, young children, low IQ, and low socioeconomic status (SES) subjects were least sensitive to our experimental manipulations, suggesting the need for more powerful motivating techniques with these groups. All children, however, tended to favor verbal rewards under the conditions of the investigation, and both motive-inducing instructions and schedules significantly influenced the behavior of children in Grades 3 and 5. One may reasonably conclude that verbal rewards are effective and economical under proper circumstances suggested by our major variables of instruction and schedule. The individual differences which modify these generalizations are interesting. Girls preferred verbal choices in response to motivating instructions independent of reward schedules, and this same tendency was reflected in the behavior of medium SES children; these were interpreted as conformity factors in seeking verbal approval. Boys and high SES children, on the other hand, were much more disposed to schedule payoffs than to instructions in chosing verbal rewards, a reflection of strongly internalized and relatively autonomous, need achievement behavior. The study makes quite explicit, then, the conditions under which verbal rewards are preferred incentives to learning for various age, IQ, sex, and SES groups in critical combinations. Further research should be executed to explore stronger motivating circumstances to enhance verbal values of young, low IQ, and low SES children. This has been planned as the next step in our long range program.

In research already described, children were tested in two-choice and in five-choice problems where rewards were available for almost every response, and selections were determined by reward values, as well as by learning to solve problems. We have called such problems, common in "everyday life," <u>discrimination preference choice behavior</u>. Under these circumstances the child is motivated by incentive preferences <u>and</u> the challenge of problem solution. What happens to incentive preferences as rewards are accumulated? The attempt to answer this question appears in Chapter V where rewards were directly available in competitive pairs without necessity for problem solving. The major consequence suggested, but not easily apparent from our earlier learning studies, was that children prefer to distribute these incentive selections regardless of relative reward value. No simple satiation effects were apparent, as one might be led to believe from animal drive reduction theory or from common sense, when trials were massed. Most interesting were individual and group choice strategies in (a) alternation behavior, (b) chosing favored incentives, and (c) other sequence effects. This domain, largely unexplored, warrants more intensive study. It should be reassuring to educators that simple drive reduction when massing incentives does not obtain nearly so rapidly in children as in animals, especially when rewards are rather simply varied.

In Chapter VI we explored uncertainty of incentive expectation as motivating children's performance. The attraction of unexpected rewards, compared to a constant reward similar in value to the unexpected reinforcements, seemed to lead to enhanced performance by children in the former condition. The preference for novelty is congruent with tendencies already noted, in other parts of our program, for children to distribute reward selections when options are available in problem solving. This approach might be helpful to stimulate motivation to learn among samples not so easily generated by conventional incentives, as, for example, the young children and low IQ and SES populations in Chapter IV.

Incentive value and task relevant instructions were recurring variables which seemed to influence children's learning and attention in our research program. We have rather persistently noted that the differential method, which permits the child to experience the range of rewards compared, is fundamental to incentive value comparisons. With this method we have demonstrated: (a) reward values influence major dimensions of problem solving, (b) the conditions for verbal reward enhancement, (c) children's choice strategies in accumulating rewards, and (d) uncertainty reduction as incentive motivation. These findings,along with those related to reward timing, will be further investigated by continuing to employ the differential method with careful arrangements for motive-relevant instructions.