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By-Nunnally, Jum C.
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The research concerned the association of neutral objects, such as nonsense syllables, with rewards, such as money and candy, in children. Thirty-six subjects were obtained from grades two through six of local public elementary schools in Nashville, Tennessee. Associations between neutral objects and rewards were formed in a task concerning discrimination learning. Subsequently, measures of the effects of the associations were obtained with respect to verbal evaluation, expectancy of obtaining new rewards, choice behavior, and a variety of aspects of selective attention. In different experiments, parameters of learning, such as magnitude of reward and per cent of reward, were investigated. The hypothesized effects were obtained with respect to the dependent measures. Studies of selective attention such as eye movements, were made with respect to a wide variety of stimulus variables concerning different aspects of information, such as novelty. With all types of materials, selective attention was found to be a monotonically increasing function of amount of information in the display. (Author/JS)

FINAL REPORT

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Jum C. Nunnally

Vanderbilt University

Nashville, Tennessee

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U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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SUMMARY

The research concerned the association of neutral objects (e.g., nonsense syllables) with rewards (e.g., money and candy) in children. Subjects were obtained from grades 2 through 6 of local, public elementary schools in Nashville, Tennessee. Associations between neutral objects and rewards were formed in a task concerning discrimination learning. Subsequently, measures of the effects of the association were obtained with respect to verbal evaluation, expectancy of obtaining new rewards, choice behavior, and a variety of aspects of selective attention. In different experiments, parameters of learning were investigated such as magnitude of reward and per cent of reward. The hypothesized effects were obtained with respect to the dependent measures. Studies of selective attention (e.g., eye movements) were made with respect to a wide variety of stimulus variables concerning different types of information (e.g., complexity and novelty). In terms of all types of materials, selective attention was found to be a monotonically increasing function of amount of information in the display.

A major purpose of this line of research has been to open up and make do-able experimental methods for affectively associating neutral objects with rewards and the development of dependent measures concerning a wide variety of effects of such associations on behavior. For these reasons, the research up to the present time has had a strong methodological flavor. During the year numerous methodological improvements and extensions have been made in our techniques. Among these are the development of within-subject designs and procedures, which during this year have proven to be very effective in the conditioning of reward value. Concerning dependent measures, we have made improvements in many of our old measures, such as in measures of reward expectancy and selective attention. Also, some new measures were developed and validated, such as measures of choice behavior and perceived value. It is hoped that these methods will be adopted by others for investigating important aspects of the acquisition of evaluative meaning.

INTRODUCTION

The major objectives of the research were (a) to learn some of the principles governing the conditions under which neutral objects acquire some of the properties of positive incentives (rewards) and (b) to determine some of the effects that such incentives have on a variety of symbolic and attentional processes. In terms of psychological theories and in terms of pedagogy, issues regarding rewards and punishments play very large parts indeed. (Although the emphasis in our research was on rewards, we also performed some parallel investigations on punishment.) The importance of rewards in psychological research is evidenced by the fact that the term reward frequently is used synonymously with the term reinforcement, suggesting that the obtaining of a reward for a correct response is all important in learning. Then if rewards play such an important part in theories of learning, it is proper and important to ask how neutral objects come to function as rewards. When one speaks of rewards, it is tempting to think in terms of consummatory responses relating to food, sex, and other needs largely grounded in the biological make-up of the organism, but, of course, many of the powerful incentives in humans become incentives through learning experiences. Examples of such learned incentives are the sound of the mother's voice, the word Excellent written on a student's test paper, the smell of Christmas trees and decorations, and the fond memories associated with the "old oaken bucket." In some cases, learned incentives achieve remarkable power to influence behavior, as is evidenced in fetishes some men have for collecting particular items of women's clothing.

In spite of the obviousness of the principle that many incentives are acquired rather than wired-in, and in spite of the obvious importance of such acquired incentives for molar behavior theory, very little has been done to determine by experimentation the principles underlying the conditioning (learning) of incentive-value. This was one of the two major purposes of the proposed research.

Most frequently it is assumed that the acquisition of incentive-value occurs in accordance with simple principles of conditioning when neutral objects are associated in time and space with rewards and punishments. Admitting that associations in time and space are important considerations, many important questions still need to be raised regarding effects of such variables as (a) the degree to which the neutral object serves as a cue for the reward, (b) the degree to which the neutral object is discriminably different from other stimuli in the conditioning situation, (c) whether the reward is obtained fortuitiously or as the result of problem solving, (d) the extent

to which the conditioning procedures force sharp discriminations of the roles of neutral stimuli in relation to obtaining the reward, (e) different types of schedules on which rewards are obtained and are associated with a neutral object, (f) frustration in partially obtaining or not obtaining an expected reward, (g) the sensory characteristics (e.g., modality) of the neutral stimuli, (h) prior familiarity with the neutral stimuli, and (i) many, many others. In our research we have been investigating questions such as the above regarding the conditioning of incentive-value, and we continued to investigate such questions during the period of this grant.

The second major purpose of the research was to determine some of the diverse effects of incentive objects on behavior. Most frequently effects of incentive objects have been measured in terms of instrumental motor responses, e.g., in the speed with which rats traverse a runway for different kinds of food rewards or in the effects of magnitude of reward on the rate of lever-pressing in children. Measurement of the degree to which a neutral object acquires incentive-value has been made almost exclusively in terms of the degree to which the neutral object impedes extinction of an instrumental motor response. Such research is said to concern <u>secondary reinforcement</u> (4).

Our experimental procedures were analogous to those used in studies of secondary reinforcement, but the important difference was that we investigated effects on a variety of dependent behaviors in addition to instrumental motor responses. Our first major effort in that regard was the development of measures of verbal evaluation, e.g., an adjective checklist to determine the extent to which children differently evaluated nonsense syllables that had been associated with rewards and punishments. The use of measures of verbal evaluation is based on the common sense observation that people usually say good things about objects that they like. If this is a reasonable assumption, it is also reasonable to hypothesize that children will positively evaluate objects with acquired positive incentive-value and negatively evaluate objects with acquired negative incentive-value. These contentions have been consistently supported in numerous studies performed to date.

Our second major effort regarding dependent measures was to develop measures of reward expectancy. This effort is based on the hypothesis that a cue for a reward in one situation can be expected to serve as a cue for the same or a different reward in another situation. For example, a nonsense syllable that has been associated with the obtaining of money in one game is hypothesized to produce an expectancy of obtaining money or candy in a different game. This contention is supported in eight of

our studies (e.g., 2, 5, 8).

In addition to measures of verbal evaluation and reward expectancy, in our studies of acquired incentive-value we also have employed various measures of selective attention. The use of such measures is based on a general hypothesis that, in terms of various behavioral systems relating to attention, there is a tendency for people to enhance stimulation from rewarding objects and to reduce stimulation from negative incentives. Stimulation from a rewarding object can be enhanced in various ways, through (a) postural adjustments toward the object, (b) instrumental motor responses to bring the object into view, (c) instrumental motor responses to bring the object into clearer focus, (d) instrumental motor responses to keep the object in view, (e) and, most important, instrumental eye movements to focus on rewarding objects rather than neutral objects or negative objects. Enhancement of stimulation is also hypothesized to occur as a function of end-organ adjustments (e.g., the retina) and as a function of central mechanisms (e.g., the interplay of the cortex and the reticular system). Also, the process of perceptual enhancement of rewarding objects is thought to be evidenced in pupillary response to the object. If some, or all of these attentional effects are instigated by rewarding objects, then it is reasonable to hypothesize that to some extent they are also instigated by neutral objects that have been associated with rewards.

Our major efforts so far have been with respect to three of the foregoing aspects of attention: (a) instrumental motor responses to bring incentive objects into view, (b) eye movements toward incentive objects, and (c) pupillary response to incentive objects. We generally obtained significant effects with respect to a (e.g., 5, 8, 2), but we progressively refined our measurement procedures and continued this refinement during the period of this research grant.

We have obtained mixed results with respect to eye movements, with clear results being obtained in some studies (e.g., the three studies reported in 6) and less clear results in other studies. Efforts to improve measures of eye movements in studies of conditioned incentive-value have formed a significant part of the research.

So far, our studies of pupillary response have mainly concerned stimuli relating to "natural" positive and negative incentives (e.g., pictures of pretty girls and automobile accidents for male college students). Results from these studies are encouraging, but as yet we have no hard evidence that pupillary responses reliably relate to conditioned incentives in children,

e.g., that pupillary dilation occurs to a nonsense syllable that has been associated with the obtaining of money or candy. We have continued to explore the possibility of using pupillary response as a measure of conditioned incentive-value.

Theory Relating to Objectives

Psychological theories are important with respect to three aspects of the research: (a) the nature of the conditioning or learning that takes place in our procedures for associating neutral objects with rewards and punishments, (b) the dependent measures that we are developing for indexing the extent to which conditioning occurs, and (c) the use of the conditioning procedures and dependent measures quite generally in the testing of theories regarding human learning and motivation. Each of these will be considered in turn.

For want of a better word, the treatment conditions in this series of studies have been referred to as "conditioning," but conditioning in these studies may differ importantly from that in studies of classical conditioning. In classical conditioning supposedly what occurs is the linkage of a discrete stimulus to a discrete response (e.g., salivation to the sound of a bell), although that view has been challenged on numerous occasions. In our studies, a stimulus-stimulus association was formed, e.g., the sight of a nonsense syllable with the sight of candy. Some of the types of overt responses that are affected by the association do not occur at all in the conditioning situation. For example, in the conditioning situation children speak very little, and only rarely do they say "nice" things about the reward, such as "I like pennies." Yet later, when called on to make choices between pleasant and unpleasant adjectives to describe a nonsense syllable that had been associated with the reward, children predominately choose the former. Such effects might be understandable in the context of "mediation theory" as it has been presented by Osgood (7) and others. To account for the conditioning effects, a three-stage model was constructed in which (a) before the conditioning sessions a rewarding object typically elicits a variety of responses, (b) during conditioning an association is formed between a neutral object and a rewarding object, and (c) in the post-conditioning test phase, fractional components of some of the responses typically elicited by the rewarding object are now elicited by the neutral object, such responses being mediated by the association.

Regarding our dependent measures, theory concerns <u>which</u> fractional components of the responses typically made to the rewarding or punishing object "rub off" on the neutral object. The theorizing behind our choice of dependent measures was

discussed previously, the only theory required for the use of measures of verbal evaluation and reward expectancy being the theory of common sense; the theory underlying the use of measures of different aspects of attention springs from a general hypothesis concerning an enhancement of stimulation from rewarding objects. These general principles have helped us find those forms of behavior that actually generalize from the rewarding object to the neutral object, which prevents us from making the mistake of assuming that all of the behaviors toward the rewarding object generalize to the neutral object. We would not, for example, predict that a child would attempt to "spend" a nonsense syllable that had been associated with the obtaining of money or attempt to eat a nonsense syllable that had been associated with the obtaining of candy.

In addition to the theory which has guided the development of particular dependent measures, we were guided by a more general set of hypotheses concerning the major cognitive and affective processes that are involved in conditioning of incentive-value. First, in temporal order, it was hypothesized that an associative stage occurs in which the child learns that a neutral object has regularly been related to the obtaining of a reward in the past. Second, the child learns an expectancy of receiving future rewards in conjunction with the appearance of the neutral object. Third, the child develops pleasant associations toward the neutral object. Fourth, after continued development of the association of pleasantness, the object develops the power to motivate some types of instrumental responses. Fifth, at a further stage, the motivational properties of the formerly neutral object develop to the point where it induces emotional-autonomic responses. Our dependent measures were intended to index different stages in these processes. All of them required that the child pass through the first stage, which we determined by testing the memory of children for the roles of nonsense syllables in games played on previous days. Our measure of expectancy was intended to be a rather pure measure of the effects of the second stage, and our measure of evaluation was intended to be a rather pure measure of the effects of the third stage. Effects of the fourth stage are measured primarily by eye movements and instrumental viewing responses. Pupillary response was used to measure effects of the fifth stage.

Regarding the third way in which psychological theory is important for our research, after effective methods of conditioning are developed and after reliable dependent measures are developed, there is no end of hypotheses in the learning-motivation field that will be opened to rather direct investigation. The major hypotheses that we have investigated so far have concerned effects on conditioned incentive-value of (a) schedules of reward or

punishment and schedules of pairing those with neutral stimuli, (b) conditioning in the anticipation phase rather than in the phase of actually receiving the reward or punishment, (c) frustration of an expected reward in comparison to the actual receipt of a reward, (d) amount and distribution of practice in the condititioning sessions, (e) durability of effects as a function of different treatment parameters, and(f) variation of the conditioning task to manipulate the amount and kinds of attention forced with respect to different aspects of the conditioning manipulanda. Hypotheses regarding these classes of variables spring directly from a variety of facets of molar behavior theory, including Hull-Spence (10) theories regarding anticipatory goal responses, Tolman's (11) theories regarding the formation of valences and expectancies, Amsel's (1) theories regarding frustration, Mackintosh's (3) theories regarding selective attention in learning, Sokolov's (9) theories concerning orienting responses in conditioning, and many, many others.

METHODS

A thumbnail sketch of one of our simpler studies (8) will serve to illustrate the general nature of the procedures employed in the research. The purpose of the study was to investigate the effects of different schedules of pairing nonsense syllables with rewards. The conditioning apparatus was a spin-wheel game, in which the stopping of a pointer on one syllable resulted in the child receiving a penny and the stopping of the pointer on a second syllable resulted in no reward (frustration). Children were familiarized with a third (neutral) syllable which was not part of the spin-wheel game. Thirty-six children aged 6 to 10 were randomly divided into three groups. One group received a penny 100% of the time the pointer stopped on the "winner," a second group received a penny a random 66% of the time, and a third group received a penny 33% of the time. The children were seen individually on six different days. The first was for familiarization of the child with the experimenters and with the experimental tasks. This was followed by four days of conditioning, in which the child was allowed to spin the wheel and to keep whatever money he won. Subjects in different groups were allowed different numbers of spins to yield approximately the same amount of reward (15¢). The sixth day was used to measure the effects of conditioning sessions. The dependent measures concerned verbal evaluation, instrumental viewing responses, and reward expectancy. As hypothesized, the only significant difference between the groups was in terms of the measure of reward expectancy, there being an inverse relationship between the reward expectancy associated with the rewarded syllable and the per cent of syllable-reward pairing in the conditioning sessions. Within treatment

groups, all groups gave significantly higher scores on verbal evaluation and instrumental viewing responses to the rewarded syllable than to the frustrating syllable or the neutral syllable.

The research involved a three-pronged attack on issues concerning conditioned incentive-value, which entailed (a) the continued development of effective conditioning procedures, (b) the continued development and validation of measures of different effects of the conditioning procedures, and (c) the use of experimental treatments that provided evidence about important aspects of theories of learning and motivation.

Subject Populations

Subjects were children in grades 2 through 6 of the Metropolitan School System of Nashville, Tennessee. Most of the schools were in the middle income neighborhoods. Subjects were seen individually in an especially equipped research trailer parked beside the school. Experiments were conducted in three different schools separated by at least several miles from one another.

Conditioning Procedures

In addition to the spin-wheel game, we explored the effectiveness of a variety of other conditioning tasks. One was a slot-machine on which different nonsense syllables appeared in a window, the machine being automatically programmed to give money on any desired schedule. Another conditioning task that we were investigating required the child to push a button to expose a series of syllables on a screen. Rewards and punishments were administered on various schedules in conjunction with particular syllables. We will continue to investigate these and other conditioning tasks.

The conditioning task used in most investigations during the current grant period concerned discrimination learning, with a method similar to the Wisconsin General Test Apparatus. On each trial the child was required to choose between two lids labeled with different nonsense syllables. Three or four different lids were rotated in pairs from trial to trial. Corresponding to each lid was a particular outcome, e.g., to receive money or to return money previously received. In order to maximize rewards, the child had to successfully discriminate the reward contingencies of the syllables and to make appropriate choices on each trial. In all experiments, children were taken to a very high criterion of 100 per cent learning. The parameters varied in experiments during the previous grant year were per cent of reward and magnitude of reward. Subsequent to the learning task

(typically one day afterwards), dependent measures were employed.

Dependent Measures

A major aspect of the research was the extension of our dependent measures to new forms of behavior and the refinement and validation of all such measures.

(a) Verbal evaluation. Principally we have employed two measures of verbal evaluation, the first of which is an adjective checklist. Some time after the end of conditioning sessions (at least one day), the child was shown three stick figures with blank faces. A different nonsense syllable was placed below each stick figure, the syllables having previously served as cues for rewards, punishments, neutral events, frustration, or other outcomes. The child was told that each nonsense syllable was the name of a boy. A list of pleasant and unpleasant adjectives was read to the child one at a time, and the child was asked to attribute each adjective to one of the "boys." For example, the child was asked "Which is the friendly boy?" and "Which is the mean boy?"

The second measure of verbal evaluation also employed stick figures as the names of boys, but it was somewhat more "projective." Instead of attributing adjectives to the "boys," the child attributes positive and negative activities. For example, the child was asked "Which boy cheats in school?" and "Which boy is kind to animals?"

With both measures, a total verbal evaluation score for each syllable was obtained by subtracting the number of negative adjectives or statements from the number of positive adjectives or statements attributed to the particular syllable. Statistical comparisons were then made among the scores given to different syllables, and comparisons were made of the scores given by differently treated groups of children.

(b) Reward expectancy. So far in our research the measure of reward expectancy has consisted of some type of "treasure hunt." The typical procedure was as follows. On a table before the child were 18 pill boxes, with each of three nonsense syllables appearing on each of six boxes. The child was told that there was a quarter (25¢) in one of the 18 boxes, or, in other instances, the child was told that one of the boxes was blackened out inside. If the child found the one box with a quarter, he could keep it, or, if he picked the one box that was blackened out inside, he could have a prize of some type. The child was given six selections, but, to prevent the successive choices from influencing the child's initial expectancies, he was

not allowed to look inside the boxes. Actually all of the boxes were identical and none contained money. The experimenter inspected the boxes, and, in our typical procedure, told all children that they had won. Because this measure probably resulted in some new learning with respect to the syllables, it was always applied after all other measures had been applied.

A measure of reward expectancy employed considerably this year concerned a spin-wheel game. The child spun a pointer, which stopped on one of eighteen spaces, each of which was labeled with one of the nonsense syllables that had played a role in the conditioning task. The child was told that sometimes the stopping of the pointer would indicate that he had won a large amount of candy, other times a small amount of candy, and still other times no candy at all. The child was told that he would not be informed from trial to trial about his winnings, but would be given all the candy that he had won at the end of the game. On the completion of each spin, the child was required to guess how much candy he had won. By scoring the different responses 3, 2, 1, respectively, it was possible to obtain an over-all measure of expectancy during the playing of the game. This measure of reward expectancy proved to be far superior to any that we previously had developed. Also, since the measure requires a generalization of expectancies from money in the conditioning task to candy in the dependent measures, logically the measure has more external validity than expectancies going from money to money only or from candy to candy only.

(c) Instrumental viewing responses. It is necessary to distinguish among instrumental motor responses to obtain incentive objects, instrumental motor responses to bring them into view or to keep them in view, and instrumental attentional responses to more clearly discriminate one object from another (e.g., eye movements). The second type of response, which we refer to as instrumental viewing responses, will be discussed in this section.

There are many different ways to study instrumental viewing responses, and we are finding that apparently small differences in apparatus and procedures can have relatively large effects on the results. The method that we have employed most frequently relates to a "looking box" containing six small windows. There is a separate button for each window, which, when depressed, projects a "slide" inside the box onto the screen. Slides of anything that we choose can be placed in the box, slides of different nonsense syllables being used when investigating the effects of previous conditioning sessions. Various types of instructions have been employed, but most frequently we simply tell the child that he can push buttons and look at what he likes. A remote unit counts the number of times each button is pushed

and the total amount of time spent viewing each slide. In most of our experiments we have found statistically significant effects in the expected direction: in order, children look most at rewarded syllables, next most at neutral syllables, and least at syllables associated with punishment. Also, we have found some interesting differences between differently treated groups, e.g., in the two studies of frustration reported by Knott, Nunnally, and Duchnowski (2). This measure of instrumental viewing responses was employed in three studies during this year of grant support.

(d) Eye movements. In terms of our theoretical orientation, eye movements should provide a very important source of data in the investigation of both "natural" and conditioned incentives. Eye movements can be thought of as an important type of coping behavior, one that is highly important in the avoiding of punishments and the obtaining of rewards. For these reasons, we have devoted considerable effort to the study of eye movements, but only with mixed results.

The procedure that we have most typically employed for the study of eye movements involves a three-foot long box, with a two-foot square screen at one end. The child sits with his head in a chin-rest at one end of the box and views pairs of pictures, one picture appearing on the far right of the screen and the other picture on the far left of the screen. (Other arrangements of the stimuli are also being investigated.) Infra-red "black" light is cast on the child's left eye, and, via a small mirror, the position of the eye is photographed with a movie camera.

Employing procedures of the kind discussed in the foregoing paragraph, we have found highly significant results in four experiments (e.g., 6). These results were all in the same directions: children spent more time looking at rewarded syllables than at neutral syllables, and they spent more time looking at neutral syllables than at syllables associated with punishment. In four other experiments, however, no significant differences were found.

Obviously there are numerous subtleties regarding the apparatus, instructions, and procedures for studies of eye movements. Preparatory to additional extensive studies of eye movements in relation to conditioned incentives (e.g., nonsense syllables), we performed extensive parametric investigations with "natural" incentives, e.g., pictures of toys, foods, objects of value, and social settings relating to pleasant and unpleasant activities. We hope that the results of such studies not only will be important in their own right but will indicate the most effective methods for the measurement of eye movements

in relation to conditioned incentives. A major study of college students has been completed, and a major study of children was undertaken in the spring of 1968.

A major development during the past year was the employment of more naturalistic settings in which to measure observing responses. Rather than have the child look into a viewing box, he was placed in a realistic-appearing waiting room, where he supposedly was biding his time while the experimenter assembled materials elsewhere. The waiting room was half of a research trailer. The waiting room had been attractively furnished with rug, tables, lamps, and chairs. The child was seated opposite the wall dividing the trailer. On the wall were two viewing screens separated by approximately five feet. Carousel slide projectors behind the screens continuously presented pairs of pictures, these pictures varying in terms of informational and affective characteristics. The child was told that, while he waited for the experimenter, he could watch pictures if he liked. Head and eye movements of the child were recorded by an observer behind a small one-way vision screen. Logically this naturalistic measure of looking behavior has much more external validity than the more laboratory-like methods that had been employed by us and other investigators in nearly all research on this topic to date.

(e) Choice behavior. Whereas in previous experiments we had repeatedly demonstrated consistent effects with respect to the types of dependent measures described above, we had never been able to demonstrate that our conditioning procedures actually affected the future choices of children with respect to the desirability of objects. During the present grant period, two such methods were developed and validated. The first consisted of having the child select candy from one of three plain boxes, the only differences between them being their labels--each was labeled with different syllables that had appeared in different roles in the conditioning task. The new measure produced hypothesized results in three experiments. Children consistently picked more boxes labeled with a syllable that had been associated with obtaining rewards than with syllables associated with loss of rewards or neutral events. Also children picked more boxes labeled with syllables that had been associated with reward a higher per cent of the time than boxes associated with reward a lower per cent of the time.

The second measure of choice behavior concerned the selection of trinkets, which children were allowed to keep. Three identical trinkets were labeled with nonsense syllables that had appeared in the conditioning task. The child was allowed to select one of the trinkets. It was found that children selected trinkets

that were labeled with syllables previously associated with rewards rather than ones that had previously been associated with the loss of reward or with neutral events. Also, more trinkets were selected with syllables that had been associated with more reward rather than syllables that had been associated with less reward; and more trinkets were selected that were labeled with syllables that had been associated with larger rewards than those that had been associated with smaller rewards.

RESULTS

1. Effects of magnitude of reward on acquired reward value. This experiment employed the discrimination learning task (described earlier) with 30 children. For each child, one syllable was associated with obtaining a dime, another syllable with obtaining a penny, and the third syllable was associated with neither a gain or loss of money. Syllables with lids attached were presented in random pairs, and on each trial the child made a choice between the two lids. Each child was taken to a stringent criterion of 24 correct responses. On the following day, each child was tested with dependent measures of the kinds described previously. A linear relationship was found between magnitude of reward and effects on verbal evaluation and reward expectancy.

2. Effects of schedules of reward on acquired reward value. The second experiment employed procedures very similar to those in the first, but per cent of reward was varied rather than magnitude of reward. One syllable was associated with reward 100 per cent of the time, another syllable was associated with reward a random 50 per cent of the time, and a third syllable was associated with reward none of the time. Children were taken to a criterion of 24 correct responses. (An incidental finding was that the task was much more difficult for boys than for girls.) In comparison to a nonsense syllable associated with reward on a 100 per cent schedule, syllables associated a lesser per cent of the time were reacted to as "positive" (in terms of a number of dependent measures) but not as positive as the continuously rewarded syllable. Also, partial schedules lead to a type of curiosity motivation toward the secondary reward, as evidenced in measures of verbal meaning and measures of selective attention.

3. A semi-naturalistic investigation of the effects of different levels of novelty on looking behavior. To avoid the "laboratory atmosphere" that has dominated most studies of selective visual attention in children as a function of stimulus variables, a "waiting room" scene was used to measure looking

behavior. The room was half of a partitioned research trailer, furnished to look like a waiting room. Pictures of stimuli were projected onto pairs of screens from projectors behind the waiting room wall. The child was under the impression that he was waiting while the experimenter arranged materials for a study of preferences for Christmas presents. Responses to pairs of pictures varying in degree of novelty were observed from the other half of the trailer. A significant linear trend was found between degree of novelty (obtained previously from ratings of children) and amount of time fixating on pictures. Numerous other experiments are now planned with these naturalistic procedures.

4. Effects on acquired reward value of (a) meaningfulness of neutral stimuli and (b) expectancy vs. non-expectancy of receiving future rewards with respect to the stimuli. As predicted, successful conditioning of reward value was obtained only for the low-meaningfulness stimuli (nonsense syllables) and not for the high-meaningfulness stimuli (photographs of women that had been rated as neutral). Equal degrees of conditioning on all dependent measures were obtained for the two expectancy conditions, which answered a question that had been haunting this research from its inception.

5. Three related studies of effects on eye movements of stimulus information value. Amount of information in the experiments was parametrically manipulated in four types of displays: (a) dot patterns, (b) geometrical forms, (c) pictures of objects varying in terms of completeness, and (d) novelty figures varying in terms of the degree of incongruous juxtaposition of parts. Studies were conducted both of college students and children under instructions that encouraged remembering and under instructions that encouraged free looking. Significant trends were found in college students for all four sets of stimuli under both sets of instructions. Significant trends were found in children in three of the sets of stimuli under free-looking instructions, the exception being with respect to dot patterns. Under instructions to remember, a significant trend was found with respect to all four sets of stimuli. With all sets of stimuli, trends were clearer in children under the set to remember than under the free-looking set.

6. In addition to the major studies described above, a number of minor studies have been completed or are underway, including (a) investigation of effects of informational characteristics of stimuli on looking time in a lid-lifting, looking game, (b) investigation of acquired reward value under partial schedules in college students (to permit comparisons with studies of children),

and (c) studies of the correlates of learning rate under conditions of partial reward, e.g., very large sex differences have been found favoring females.

CONCLUSIONS

Our research on reward value and selective attention is still far too new to permit definitive conclusions. Rather, what is being done at the present time is to develop effective methods of conditioning and to validate dependent measures. From that standpoint, this has been a very fruitful year of research. In previous years we had worked mainly with between-group designs for determining the effects of various treatment parameters on our dependent measures. We encountered far too much variability among subjects to permit precise findings. A major shift in research strategy during the current year of research has been to work with within-subject designs, such as in our studies of magnitude of reward and per cent of reward. Much more precise findings were obtained from these within-subject designs than from the between-subject designs employed in previous years. In addition, clear trends were obtained with respect to magnitude of reward, per cent of reward, and other treatment parameters.

Our studies of selective attention were conducted partly for the measurement of conditioned reward value and partly for their own sake. Regarding the former, we added further evidence for the regularity of effects of conditioned reward value on eye movements and instrumental viewing responses. For the latter, we have provided considerable additional information to our findings in previous years of a monotonic relationship between amount of attention to a stimulus and the amount of information in the stimulus. This year our types of stimuli were broadened to include those varying with respect to a wide variety of informational characteristics. One of our most important findings for the year was that regular effects on selective attention could be obtained in a semi-naturalistic environment.

Whereas at the present time this basic research is not ready for direct application to classroom practices, eventually it should have considerable implications. Our studies of conditioned reward value concern the psychological processes whereby positive and negative affective meaning is developed, which eventually should have implications for the emotional responses of children to the teacher, textbooks, and everything in the school-day world. Since attention is such a crucial ingredient in classroom learning, our studies of the effects of different

stimulus variables on selective attention should eventually prove to be very important for classroom practices.

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