SOME EXPERIMENTAL PARAMETERS AFFECTING MEDIATION IN CONCEPT LEARNING

Thesis for the Degree of M. A.

MICHIGAN STATE UNIVERSITY

Charles Ernest Kenoyer

1967

ABSTRACT

SOME EXPERIMENTAL PARAMETERS
AFFECTING MEDIATION IN CONCEPT LEARNING

by Charles Ernest Kenoyer

If it is assumed that organisms are simultaneously capable of mediated learning and of unmediated learning, the Kendler association model leads to some new predictions. In particular, the assumption that relative difficulty of reversal and nonreversal shifts depends upon the number of associations necessary in each mode of learning yields an experimentally verifiable hypothesis that the number of stimulus dimensions is an important parameter affecting the tendency of *S*s toward reversal or nonreversal shifts.

A transfer design was used, in which 28 three-year-old *S*s were given three concept tasks. The first task differed for the two shift groups in that the relevant dimension for the reversal group was size, and the relevant dimension for the nonreversal group was color. In the second concept task, half the stimuli were set aside so that the correct option could be selected by either of two criteria: the opposite value on the initially relevant dimension, or a value on the initially irrelevant

dimension. In the third concept task, the full set of stimuli was again used; half the Ss were required to choose on the basis of the initially irrelevant dimension (nonreversal task) and half were required to choose the opposite value on the initially relevant dimension (reversal task). Stimuli varied on four dimensions.

The prediction was confirmed that over half the Ss would complete the second task by performing a reversal shift, as indicated by each S's first response on the third task. Confirmation was also obtained for the hypotheses that Ss in the reversal task group would complete the final task in fewer trials than the nonreversal group.

The second major experimental variable was the effect on performance of telling Ss at the end of the first task that they had learned the "game" and inviting them to play another, similar game. Half the Ss were given this treatment, while the other half received no indication of a change in procedure. The significance level for interaction of the information variable with type of shift was $.05 < p < .10$. Analysis of variance on log trials to the last error yielded a significant F ratio for the shift task effect ($p < .01$) and for its interaction with information ($p < .05$). The prediction that number of errors per error trial (using the correction method) would be affected by information was not supported.

It was concluded that Ss in this sample had demon-

strated mediation, and therefore that the single-stage associative model was inadequate to describe their behavior. Implications of the results were discussed.

SOME EXPERIMENTAL PARAMETERS
AFFECTING MEDIATION IN CONCEPT LEARNING

By

Charles Ernest Kenoyer

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Psychology

1967

ACKNOWLEDGMENTS

I want to express my sincere appreciation to several persons who made substantial contributions to the process of writing this thesis. I am indebted to Dr. Frank N. Marzocco, chairman of my thesis committee, for his encouragement and support during the planning and execution of the experiment and for his help in the development of the manuscript. I wish to thank Dr. John E. Hunter, a member of the committee, for his contributions to the planning of the experiment and suggestions for analysis of the data. Thanks are also due the other members of the committee, to Dr. Terrence M. Allen for his suggestions for the analysis of data, and to Dr. James L. Phillips for his critical reading of the manuscript.

The valuable help of Lawrence H. Nitz in designing the experimental apparatus is gratefully acknowledged.

Finally, I wish to express my gratitude to my wife Janice, not only for her encouragement and moral support, but for her tangible contribution to the work of transcribing data.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	ii
LIST OF TABLES	iv
LIST OF FIGURES	v
LIST OF APPENDICES	vi
INTRODUCTION	1
DESIGN AND HYPOTHESES	16
METHOD	23
APPARATUS	23
SUBJECTS	28
MATERIALS	29
PROCEDURE	30
RESULTS	36
DISCUSSION	50
REFERENCES	55
APPENDIX A	57
APPENDIX B	60

LIST OF TABLES

Table		Page
1.	Frequencies for Groups Classified by Information and Inferred Shift	37
2.	Trials to Last Error for the Three Concept Tasks.	39
3.	Analysis of Variance on Phase 3 Trials to Last Error	40
4.	Trials to Last Error for _S_s Grouped by Information and Inferred Shift.	42
5.	Log Trials to Last Error for the Three Concept Tasks.	44
6.	Analysis of Variance on Transformed Data . .	45
7.	Number of Error Responses Per Error Trial. .	47
8.	Frequencies for Groups Classified by Shift Task and Inferred Shift.	48

LIST OF FIGURES

Figure Page

1. Block Diagram of Experimental Apparatus. . . 24

2. Apparatus-subject Interface. 25

3. Experimenter's Switching Device. 27

4. Apparatus Configuration (Plan View). 31

LIST OF APPENDICES

Appendix		Page
A.	Stimulus Sequences for All Tasks	57
B.	Response Sequences for All Subjects. . . .	60

INTRODUCTION

Several investigators in recent years have used the concept-learning experiment as a method of evaluating theories of mediation. In particular, the transfer design and modifications of it have been used extensively. A consistent conclusion has been that preschool children do not make use of mediation in learning concepts, but this conclusion is perhaps more general than is warranted by a set of experiments in which some parameters have been held constant across the whole set. The parameters in question are the number of stimulus dimensions (attributes) and the information, at the end of the initial task, that a new task is beginning.

The use of binary dimensions limits the possible kinds of concept shifts to two: reversal and nonreversal shifts. In the reversal shift, S is required in the training task to learn to classify stimuli according to their value on a single attribute, and in the test task to assign stimuli to opposite categories, using the same attribute as the classification criterion. For instance, size might be relevant, with large stimuli called correct in the training phase and small in the test phase.

In the nonreversal shift task, S is also required to learn a training task, but the second, or test, task requires an entirely different classification scheme. In this part of the transfer task S must classify stimuli according to a new criterion, an attribute that either varied irrelevantly or was constant during the training phase. For example, stimuli could be classified by size in the training phase and by shape in the test phase.

Simple concepts have typically been used in experiments on concept shifts. Although a defining characteristic of the concept learning experiment is that stimuli vary with respect to more than one attribute, a simple concept, as opposed to a conjunctive or disjunctive concept, is identified by only one of these attributes, the relevant one, and the remaining attributes are irrelevant. Size, for instance, might be the relevant attribute or dimension, while shape and color might vary, but in such a way as to provide no help to S in his task of classifying stimuli. Some of the ways in which Ss have been required to indicate classification are by sorting stimuli into groups, stating whether individually presented stimuli are or are not instances of a concept, and choosing the one of a simultaneously presented pair that is an instance of the concept.

Buss compared the two kinds of transfer in 1953. His Ss were adult humans, and the stimuli were wooden blocks, the same ones that Buss (1952) had described as similar to those of the Vygotsky test. The blocks varied with respect to height, color, top surface area, and shape;

there were two values for height and three for each of the other dimensions. Classification was accomplished by sorting blocks into two groups. Buss found that the nonreversal shift required more trials to criterion than the reversal shift. He attributed this result to partial reinforcement of the nonreversal response during early trials of the test phase. Since Ss performing a nonreversal shift performed correctly on half the trials of the test phase if they continued to classify stimuli exactly as in the training phase, Buss reasoned that the training phase response was not extinguished immediately and so interfered with acquisition of the correct test phase response. The Ss performing a reversal shift, on the other hand, performed incorrectly on all trials of the test phase if they maintained the established training phase response, and so the old response was extinguished without delay.

Kendler and D'Amato (1955) offered an alternative explanation. They agreed that partial reinforcement had occurred in the nonreversal condition of the Buss experiment, but considered it to be of secondary importance in determining the results. They hypothesized that the reason for the relative facility of the reversal shift was that this condition, but not the other, required the same mediating response for both tasks. The crucial experiment required the elimination of partial reinforcement of the training phase response, and Kendler and

D'Amato accomplished this by setting aside the stimuli that could be correctly assigned to the same category in both tasks, returning them to the stimulus set again only after S had reached criterion on the reduced set.

Since the attributes of the stimuli used in the Kendler-D'Amato study were complex, the following illustration is given in terms of simpler attributes. If all large stimuli belonged in category A for the training task, and all black stimuli belonged in category A for the test task of the nonreversal group, then Ss in both the reversal and the nonreversal groups would be shown only large white and small black stimuli during the early test trials. After learning this task to criterion, groups then received different treatments, in that they were required to classify differently the stimuli returned to the set for the final task.

Under the modified procedure Ss again learned the reversal task more easily than the nonreversal task. Kendler and D'Amato concluded that Buss's partial reinforcement argument could not be applied to their experiment and that the extant S-R model for learning in infrahuman organisms (Spence, 1936) was insufficient to explain their data. They suggested a two-stage model in which the S-R association was mediated by a covert response specific to the relevant stimulus dimension.

Buss was reluctant to abandon the simpler model; he argued that the Kendler-D'Amato procedure might still allow the occurrence of partial reinforcement. The partially reinforced response to which he referred, however, could only be construed as a covert mediating response. As H. H. Kendler stated in a note at the end of Buss's paper, Buss had apparently adopted a mediational model without being aware of doing so. The experimental results reported by Buss in the same paper confirmed those of Kendler and D'Amato; Harrow and Friedman (1958) again obtained confirming data under somewhat different conditions.

At about the same time this work was proceeding with human Ss, Kelleher (1956) found that rats learned the nonreversal shift more quickly than the reversal under the conditions of his experiment. The contrast leads naturally to the hypothesis that phylogenetic differences are responsible for the discrepancy, but it must be recognized that the rat study involved pairs of stimuli that differed on only two dimensions, while the studies with adult humans employed more dimensions and, in some instances, more values per dimension.

With the expectation that a transitional stage could be found in the human developmental process, Kendler and Kendler (1959) performed a learning experiment on kindergarten children. The stimuli in that experiment were empty water tumblers of two heights, enameled either white or black. The classification task was to select the correct tumbler, that which covered a reward. Pairs were presented simultaneously, the members of any pair differing from each other on both dimensions. The possible combinations, therefore, were tall black with short white and tall white with short black. In a simple two-group comparison, there was no significant difference in number of trials to criterion. The Ss were then separated into two categories on the basis of training task performance; the slow learners were found to perform the nonreversal shift more rapidly than the reversal shift while fast learners performed the reversal shift more quickly.

The Kendlers concluded that the group studied was in transition from unmediated to mediated learning, with the slow learners still tending to learn through a single-stage S-R process while fast learners tended to mediate. Since the transition hypothesis refers to a developmental change, the conclusion does not follow from the data of the experiment; moreover, procedural differences as well as population differences distinguish the Kendlers' experiment from the previous studies with adults. As in Kelleher's rat study, the number of distinct pairs of stimuli presented to the Kendlers' Ss was smaller than in any of the adult studies.

The next step in attempting to establish the existence of the transitional stage was to investigate shift behavior of preschool children (Kendler, Kendler, and Wells, 1960). The stimulus situation was similar to that of Kendler and Kendler (1959), but the stimuli were enameled cookie cutters and the nature of the transfer task was different. Stimuli for the training series differed with respect to one dimension only, for all _S_s. Tasks for the three experimental groups differed only in the test phase, a design (Andreas, 1960, p. 476) which happens to confound type of shift with type of test-phase task. Stimuli for the test phase varied on a new dimension as well as on the dimension that had been relevant throughout the training phase. For the training phase, 96 _S_s were evenly divided into four groups on the basis of the characteristic of the positive stimulus. For two groups, all stimuli were of medium height; black was positive for one group and white for the other. For the other two groups, all stimuli were red; tall positive for one group and short for the other. In the test phase, stimuli for the control and reversal _S_s varied both in height and in brightness. Pairs differed simultaneously on both dimensions, so that tall white and short black or tall black and short white cookie cutters were presented. For the nonreversal group, the positive training-phase cue did not appear in the test series; a nonreversal _S_ trained to white, for example, was presented with stimuli that differed in size and shape, but not color. Forms were circles, clubs, and spades; colors were white, red, and black; and heights were .5 in., 1 in., and 2 in., obtained by presenting cutters singly or in stacks. The control group reached criterion most quickly, followed by the nonreversal and reversal groups in that order.

Next in the series of studies was a comparison of several age groups. Kendler, Kendler, and Learnard (1962) collected data on groups with mean ages of 43, 54, 77, 102, and 127 mo., and a maximum within-group range of 13 mo. Stimuli were black or white squares of two sizes on a mid-gray background. The design included three phases: the training phase; the early trials of the test series, in which the reduced set of stimuli was presented; and the later trials of the test phase, in which removed stimuli were reintroduced. This design, now called the optional shift design, was identical to the transfer design with control for partial reinforcement (Kendler and D'Amato, 1956) throughout the first two phases. The third phase of the optional shift design, however, was distinguishable by the following characteristics: (a) a fixed number of trials, and (b) a change in the pattern of reinforcement. The Ss were rewarded independently of their choice response to reintroduced stimuli, while the reward contingency for the pairs that had been presented throughout Phase 2 remained the same as on Phase 2 trials. Those Ss who made the same choice for at least 8 out of 10 of the presentations of the reintroduced stimuli were classified as reversal or nonreversal, depending upon the choice response, and those whose responses were split in any other way were classified as inconsistent. The proportion of Ss in the reversal and inconsistent categories differed significantly over the age range tested, but the proportion of nonreversals did not differ significantly. The statistical test employed was not reported.

Jeffrey (1965) conducted a follow-up study consisting of two experiments. Experiment I was concerned with the effect of pre-training on shift behavior; Ss were 4-year-olds and 10-year-olds. Stimuli for the optional shift task were black or white circles of two sizes, .5 in. thick, and stimuli for the pre-training task were 20 pairs of small toys mounted on masonite squares so as to cover the reinforcement holes. The Ss in the learning-set training group were trained to a criterion of 9 correct second-trial responses in 10 sets, then Phase 1 of the optional shift problem was initiated. Ss in the control group began Phase 1 with no pre-training. Pre-training facilitated Phase 1 learning but had no significant effect on learning in Phase 2. Small sample size (eight 4-year-olds per group) made it necessary to pool inconsistent and nonreversal categories for a chi square comparison of Phase 3 performance. The differences in category frequencies were not significant for experimental groups pooled across age, but the age effect was significant. Jeffrey observed that the younger children tended to verbalize values of both dimensions of the stimuli. He considered it likely that those Ss would maintain the specific choice response learned in Phase 1 and so exhibit the nonreversal pattern.

In Experiment II, Jeffrey replicated the design of Kendler, Kendler, and Learnard except for three changes: the ages of the Ss, the kind of stimuli presented, and the changing of a stimulus characteristic between Phase 1 and Phase 2. The age groups in Experiment II included children 4, 6, and 8 years of age and a group of college students. The 4-year-old group had a mean age of 4.16 years and ranged from 46 to 54 months. The other groups' means and ranges were not reported. Stimuli like those employed in Experiment I were again presented, but included squares as well as circles. Circles were presented in the first phase and squares in Phases 2 and 3. By changing the form of the stimuli after Phase 1 was completed, Jeffrey hoped to reduce the chance that the test-stimuli would be treated by the Ss as the identical Phase 1 forms. Under the conditions of the Jeffrey study no significant differences were found among the proportions of Ss in the three shift-type categories for the various age groups. The constancy is also remarkably apparent in Jeffrey's table of proportions.

The discrepancy between Jeffrey's results and those of Kendler, Kendler, and Learnard may reasonably be attributed to the changes introduced by Jeffrey and cited above. The difference between the stimulus sets used in the two studies is not striking, particularly in view of the considerable variation in stimuli among the previous studies, all of which found age differences. The age differences between the youngest groups of the two studies cannot be discounted: the graph presented by Kendler, Kendler, and Learnard shows that the most rapid performance change occurs within the range of their two youngest groups, and Jeffrey's youngest group falls in that range.

The fact that a change in stimulus form was introduced into the procedure seems an important departure from the procedures of all of the preceding studies of classification shifts. Jeffrey intended, of course, that the change have an effect on performance and showed, by means of a chi square comparison, a significant difference between the performances of the 4-year-old groups in his two experiments. He concluded that the procedure of Experiment II had been successful in reducing the tendency to respond to all dimensions on which stimuli varied.

Beginning with the Kendler-D'Amato experiment, the studies cited above have been concerned with experimental hypotheses derived from the model presented by Kendler and Kendler (1962). The Kendler model includes two alternative processes: the single-unit process and the two-stage mediational process. The single-unit theory is the

S-R system of Spence (1956); the Kendlers argued that this theory predicts more rapid learning for the nonreversal than the reversal shift.

> The reason for this is that at the time of the shift the difference between the strength of the dominant incorrect habit and the to-be-correct habit is much greater for the reversal, as compared to the nonreversal shift. Consequently more training will be required to make the correct habit dominant in a reversal shift. According to the mediational theory the situation is entirely different. A reversal shift enables the subject to utilize the same mediated response. Only the overt response has to be changed. A nonreversal shift, on the other hand, requires the acquisition of a _new_ mediated response, the cues of which have to be attached to a _new_ overt response. Because the old mediational sequence has to be discarded and a new one formed, the nonreversal shift should be executed more slowly than a reversal shift. (Kendler and Kendler, 1962, p. 7).

A footnote pointed out that the superiority of the reversal shift may be explained either by the greater number of new associations necessary for a nonreversal shift or by the "possibility . . . that a mediating response is more difficult to extinguish than is an overt response" (p. 7).

The two important parameters of the Kendlers' model, then, are the number of associations necessary for the acquisition of correct performance and the difficulty of extinguishing overt responses as opposed to mediating responses. In an investigation of developmental changes in the mediational process, it is important to take these parameters into consideration, particularly as they affect the relative difficulty of acquisition through the two processes, single-stage and two-stage. Unless it is assumed that humans lose their ability to learn without mediating responses when they acquire the ability to learn with them, variations in these parameters may be expected to have an effect upon selection of the process (single-stage or two-stage) by which the task is learned. If the mediational sequence is more difficult for a given task than the set of single-stage associations, then acquisition of that task by the single-stage process should be completed more rapidly than by the two-stage process, and so the transfer characteristics of the learning would fit the single-unit theory.

The Kendlers' diagram of their model made it clear that they consider a single-stage association to be formed for each stimulus pair. The number of associations to be formed in a two-stage sequence, then, is just one more than the number for a single-stage process, since the mediating response has to be associated with each stimulus and the stimulus component of the mediator must be associated with the overt response. Pre-experimental associations probably reduce the difficulty of the mediated solution, however. The other, and probably more important, source of difficulty in the mediational process is the difficulty of extinguishing irrelevant mediators. If, as the Kendlers' model implies by its notation (r_{size}), a mediator corresponds to a stimulus dimension, then the difficulty of extinguishing the inappropriate mediating responses increases with the number of irrelevant dimensions.

The ratio of the number of stimuli to the number of dimensions therefore seems a particularly important variable in concept-attainment experiments. Since the number of stimulus objects or figures that can be constructed from N binary dimensions is 2^N, the ratio is $2^N/N$, a strictly increasing function for positive N, and so may be manipulated by simply varying N. A more detailed quantitative development of the relationship between difficulty of acquisition and the two parameters (number of associations and difficulty of extinction) would make it possible to predict the number of dimensions at which the advantage switches from one mode of learning to the other. The research effort required for the collection of the data necessary to do the complete job, however, should not be spent if a rough test of the assumptions of the above model can be made more efficiently. In particular, it seems appropriate at this point to replicate previous studies with a larger value of N, since there is no evidence that young children actually behave differently from adults when $N > 2$.

The model upon which this study is based, then, is a modified version of the Kendler model, which acknowledges that _S_s may be able to select, consciously or otherwise, their mode of learning, and so an individual _S_ capable of performing as a two-stage learner under some conditions may also be capable of performing as a single-stage learner under other conditions. Considering the two Kendler models as representing alternative processes both available to the same organism makes it possible to derive from the assumptions of the Kendler model the conclusion that the mode of learning selected depends upon the number of stimulus dimensions.

DESIGN AND HYPOTHESES

Presenting stimuli with a larger number of dimensions than were used in the studies cited above should, according to the argument in the preceding section, increase the probability of mediation. Four binary dimensions were used to construct the figures of this study. The dimensions, and their values, were color, red and green; size, large and small; shape, square and circular; and border, present or absent. Figures were presented in pairs. Combinations were constrained as follows: members of the pair were alike in shape and in presence or absence of a border and differed both in size and in color. These constraints eliminate two dimensions, color and shape, as possible criteria by which S could choose, and so serve to decrease the number of potential mediators. Both the increased number of dimensions and the constraints on pairs should increase the ratio of the number of stimuli to the number of potential mediators, and so increase the probability that an organism able to mediate will do so.

The transfer design of the Kendler-D'Amato study was selected for this experiment. As compared to the optional shift design (Kendler, Kendler, and Learnard, 1962), the transfer design has the advantage of giving more learning data in that Ss can be run to criterion or at least to many trials, rather than terminated at some small arbitrary number of trials. Information about the shift selected by the S during the trials with a reduced stimulus set may also be recovered, as readily as in the optional shift design. It is true that selective reinforcement may be expected to change response probabilities in Phase 3, but the effects, in the optional shift design, of unconditional reinforcement of either choice response to half of the set of stimuli are not known either. The only uncontaminated measure of Ss' state at the end of Phase 2 (the phase in which half of the stimuli are removed) is the trial 1 response in the next part, Phase 3, and this measure may be used in the transfer design without the sacrifice of information on Ss who require many trials to reach criterion. Although the transfer design is used, it is convenient to describe the experiment in the terms coined for the optional shift design. "Phase 1" refers to the training task, "Phase 2" to the early trials of the test task, in which half of the stimuli are set aside, and "Phase 3" to the latter part of the test task, in which the removed stimuli are returned to the active stimulus set.

The stimulus conditions of this study, as explained above, lead to the expectation that more Ss in the present experiment than in the Kendler-Kendler-Learnard study will perform reversal shifts. Because of procedural differences, and particularly the difference between the dependent variables, such a direct comparison does not seem appropriate. A more conservative test of the model is to compare the obtained probability estimate with P(reversal) = .5. If Ss are in the pre-mediational stage hypothesized by the Kendlers and their associates, less than half should perform reversal shifts. One prediction that follows from the assumption that P(reversal) $>$ .5 in this study is that more Ss will make trial 1 responses in Phase 3 that are consistent with a reversal shift than will make trial 1 responses consistent with a nonreversal shift. Those Ss in the reversal group who have performed a reversal shift in Phase 2 have no further learning to accomplish in Phase 3, while those in the nonreversal group who have performed a reversal shift then have to perform a nonreversal shift in Phase 3 in order to respond correctly. If P(reversal) $>$ .5, it follows that performance in Phase 3 will be facilitated for more Ss in the reversal than in the nonreversal group, and so the prediction is that the reversal group Ss require fewer trials to criterion than those in the nonreversal group.

Another mediational theory relevant to this experiment is that of Mowrer (1960). Mowrer argues that learning, even in rats, is accomplished through a mediating state which he calls expectation (p. 287). The importance of the expectation construct to learning theory is not in acquisition, according to Mowrer, but in various forms of unlearning, including counter-conditioning, of which concept shifts are a species. This framework suggests the significance of one of the parameters of the Jeffrey (1965) study. Jeffrey's alteration of the optional shift design in his Experiment II, in which he used circles as stimuli in Phase 1 and squares in Phases 2 and 3, had at least two separable effects: it added a new dimension of variation to the stimulus set for the whole experiment and it provided a procedural change at just the point where Ss were required to unlearn one task and to learn a different set of response contingencies given the same dimensional variations of the old task. If S continued, on trial 1 of Phase 2, to respond as in the original task, Mowrer's theory would lead us to expect a change in S's expectation, because of the close conjunction of S's first error in several trials with a change in the stimulus situation.

It is possible to manipulate dimension and signal, the two aspects of Jeffrey's innovation, separately if information about task change is given verbally. Half the Ss in each shift group were told at the end of Phase 1 that they had learned that "game" (the Phase 1 task) very well and were invited to play a similar game. For the other half of the Ss there was no pause or other break in the procedure at the point of transition from Phase 1 to Phase 2. If this information changed S's expectation about the appropriate choice, then the unlearning task would be avoided (whether extinction, as the Kendlers regard it to be, or counter-conditioning) and learning would be facilitated for the informed group.

Another dependent variable observed in this experiment was S's tendency to perseverate on a response after it failed to be reinforced. There is a good deal of empirical data demonstrating the tendency of infrahuman organisms to emit intensified perseverative responses in operant-transfer situations (Brown, 1961; Mowrer, 1960). Mowrer discussed the affective aspect of expectation, stating (p. 476), "If a rat is not sure whether a given trial is the one which is to result in reinforcement, he is not particularly frustrated (surprised, disappointed) if there is no reinforcement, but if, on a particular trial, reinforcement is confidently expected and does not materialize, then there will be maximum frustration and correspondingly greater counter-conditioning (extinction) of hope and habit strength." Elsewhere (p. 405 ff), Mowrer argues that the immediate result of this frustration is anger, which leads to aggression aimed toward the frustrating obstacle.

If the information provided in this experiment changed S's expectation concerning the stimulus consequences of his responses, then Mowrer's theoretical treatment of expectation implies that the usual response pattern associated with cessation of reinforcement should be altered. A specific aspect of this response pattern that is described by Mowrer (1960) and Brown (1961) is the intensification of the previously reinforced response. Although the stress in both Mowrer's and Brown's discussions was on such measures as speed or force of a response, it seems reasonable to extend Mowrer's explanation of frustration behavior during extinction to include the occurrence of perseveration on the response that is no longer reinforced. Evidence of an increased response rate at the outset of extinction appears in data on children in the second year of life from a study by Weisberg and Fink (1966). The measure used in this study was the mean number of incorrect responses averaged over trials on which at least one error occurred. Since the correction method was used, each trial consisted of a string of incorrect responses followed by a correct response, where the length of the string of errors could be zero or greater. The effect typically fades quickly during extinction, and so the mean was computed over the first several trials only. Every S who made at least one error required at least nine trials, and so it was convenient to compute the measure over the first nine trials for each S who made at least one error.

The design of the experiment included two independent variables; shift task and information, with two levels of each. All *S*s in the reversal group were required to learn to select the *small* figure in Phase 1 and the *large* figure in Phase 3. Those in the nonreversal group were required to select the green figure in Phase 1 and the large figure in Phase 3. For Phase 2 all pairs were large red-small green combinations and all *S*s in both groups were required to select the large red figure on each trial. The only difference between the two tasks, then, was the Phase 1 discrimination. Dependent variables for testing predictions were number of trials to criterion on Phase 3 and proportion of *S*s classified as having performed a reversal *versus* a nonreversal shift during Phase 2 for the shift type variable, and number of errors per error trial and number of trials to criterion in Phase 2 for the information variable.

METHOD

Apparatus

A block diagram illustrating the components of the apparatus and communication among them appears in Fig. 1. Fig. 2 shows the machine-S interface. Stimuli were displayed by rear projection of 35 mm. slides on a screen of opal glass. The screen was located 1/4 in. behind the window in the front of the cabinet shown in Fig. 2. The cabinet was constructed of Masonite and wood. The window consisted of three clear plastic panels 1/4 in. thick. A 4 x 4 in. square portion of each panel was visible through the 4 x 12 in. aperture in the front of the cabinet. The center panel, which was not used in this study, was blocked so as to be immovable. The left and right panels were suspended from hinges. The bottom of each panel was held in position against the front of the cabinet by the spring action of a Microswitch. Pressure on either panel closed an electrical circuit which delivered a single pluse to the control apparatus. Subjects were instructed to press a panel to indicate selection of the stimulus appearing on the screen directly behind the panel. Spatial separation of stimulus and response was thus minimized, a condition that has been found (Jeffrey and Cohen,

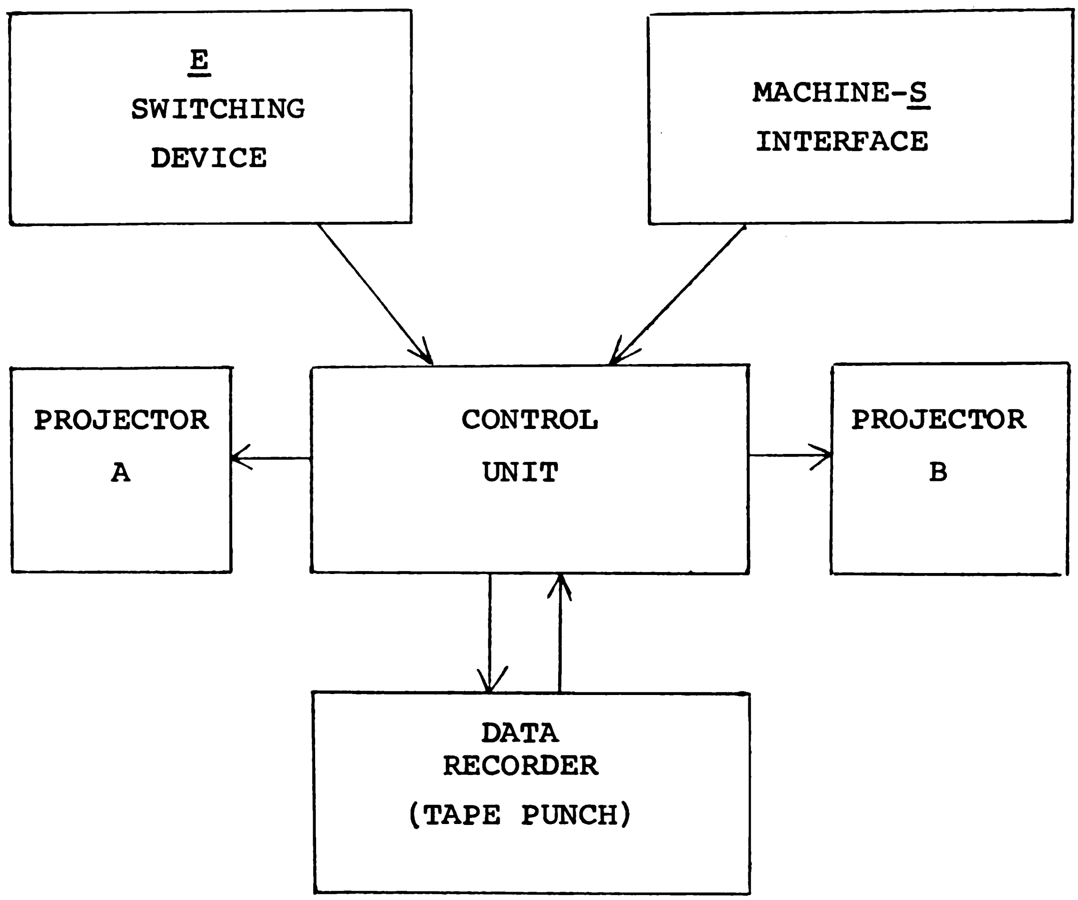

Figure 1. Block diagram of experimental apparatus.

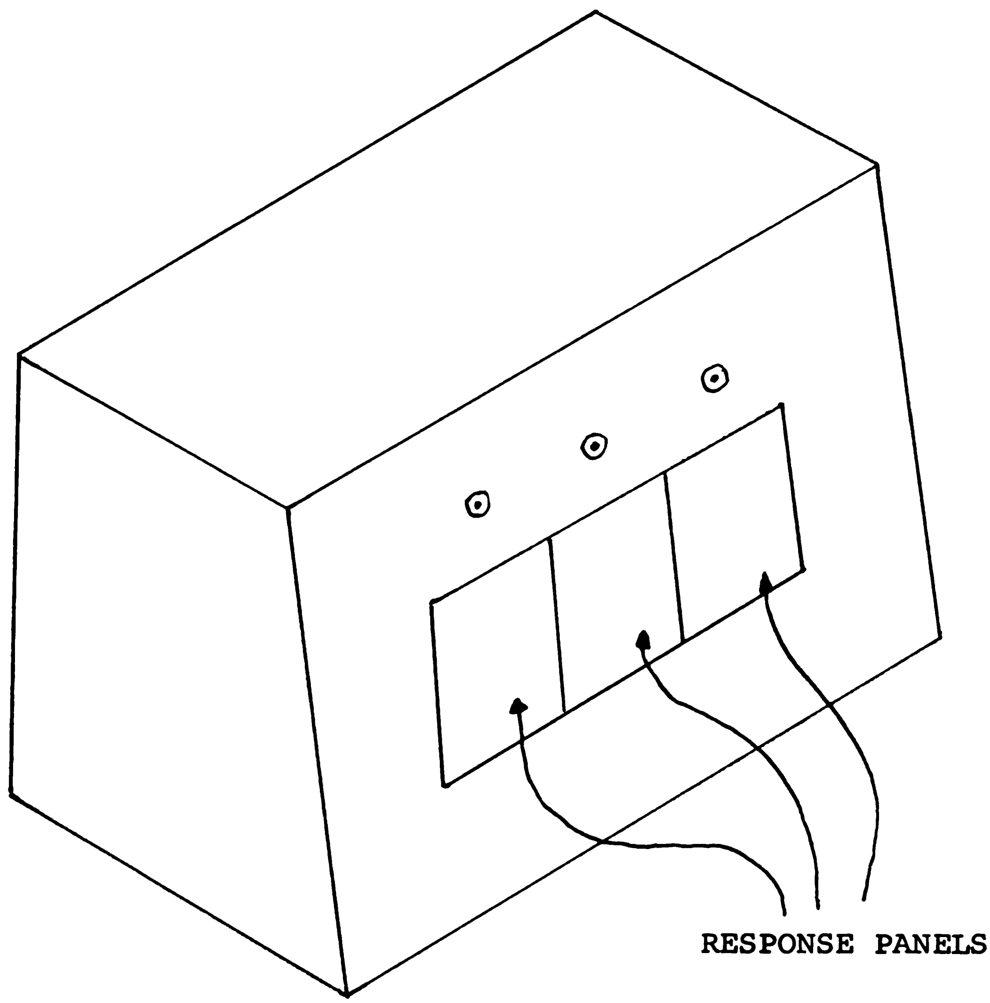

Figure 2. Apparatus-subject Interface.

1964) to facilitate learning in children.

Reinforcement contingencies were controlled by E. A switching device, consisting of four 5/8 in. doorbell pushbuttons installed in a 1 x 1 x 4 in. rectangular prism of plastic, was held in E's hand. This device, shown in Fig. 3, delivered signals to the control unit. The E selection was entered in the corresponding memory unit of the control device and consequently transmitted continuously to the recording device until that memory unit was cleared. The memory unit could be cleared either by E's selection of the complementary switch button or by S's correct response. For instance, if E pressed the button specifying reinforcement of selection of the left panel, this selection by E was cancelled if E pressed the button for the right panel or if S pressed the left panel.

A correct response by S also advanced the slide tray of the Carousel projector, bringing the next stimulus into position. The correction procedure, which has been shown in another situation to facilitate learning in children (Suppes and Ginsberg, 1962), was thus incorporated into the design of the apparatus. Presentation of the new stimulus required a new selection by E as well as by S.

Two slide projectors were used in order to provide the two sets of stimuli required for the experiment, the

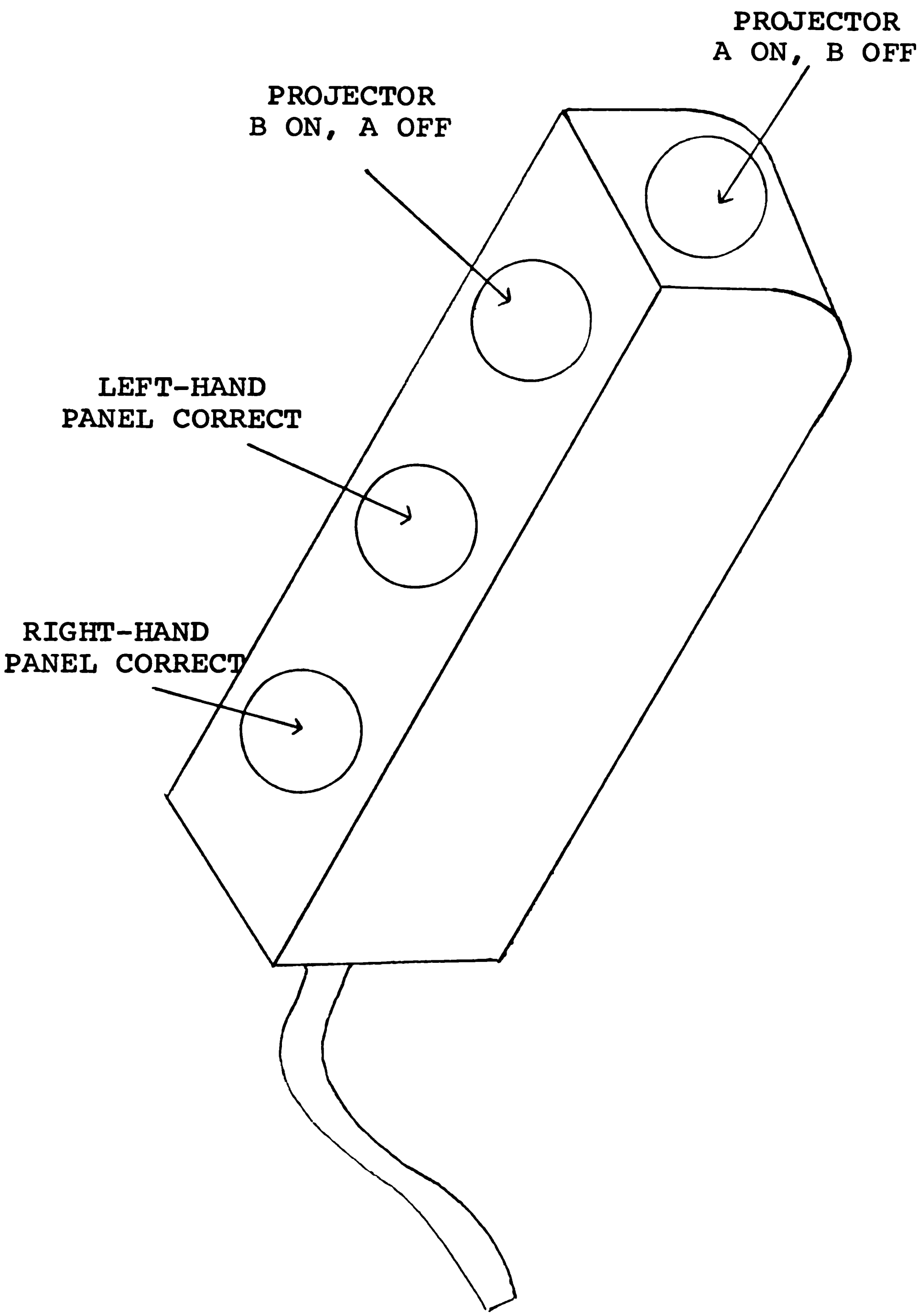

Figure 3. Experimenter's switching device.

full set and the set remaining after half of the slides were removed. A correct response advanced only the projector that was on. Two of the buttons on E's switching device enabled E to switch either projector on, but not both.

The E's switching device was connected to the control unit by a 5-wire electrical cable, allowing the plastic cabinet containing the circuitry to be placed at some distance from S. Cues provided by relay noise were thus minimized.

The data recording device was an 8-channel Teletype paper tape punch. The six data channels used were activated by the control unit described above. Two channels indicated which projector lamp was on; two channels indicated E choice; and two, S choice.

Subjects

Children between 37 and 48 months of age from University housing and from nursery schools in and near Lansing, Michigan[1] served as Ss. Twenty-three Ss failed

---

[1]Participating schools in the Lansing area were Jack and Jill Playhouse, MSU Cooperative Nursery, Wesley Cooperative Nursery, Carol Lee Nursery, Miss Cheryl's Play Center, YWCA Meridian Cooperative Nursery, and Pennway Cooperative Nursery. Eleven Ss were procured from another nursery school, but when only five of them were present on the day of the first experimental session (for the warm-up task), and only two of these passed the warm-up task, research at that location was discontinued.

the warm-up task; 11 failed the Phase 1 task; five refused to participate in Phase 1, and one in Phase 2; five Ss were lost due to apparatus malfunction; and four were lost due to experimenter errors. Twenty-eight Ss survived beyond trial 1 of Phase 3, and so were included in all analyses except that of trials to criterion on Phase 3. One S was excluded from the trials analysis due to experimenter error during Phase 3, and one due to apparatus malfunction; 26 Ss were therefore included in the trials analysis. Subjects were assigned to groups without regard to sex or age; the mean age for the 28 Ss was 43.9 months.

Materials

All stimuli were presented by projecting 35 mm. slides on the screen of the interface apparatus. Stimuli for the initial discrimination task were photographs of pairs of animal pictures, which were clipped from a child's picture-story book. The pictures were lifelike rather than stylized drawings. Each pair consisted of the correct option, which was always the same picture of a dog, and the incorrect option, which was either a rabbit, a squirrel, a parakeet, or a pony. The sequence of stimuli is listed in Appendix A.

The concept task stimuli were pairs of geometric figures differing in both size and color. Figures were squares and circles colored either green or red. A large green figure was always paired with a small red figure, and a small green figure with a large red figure. The two figures were always alike with respect to shape and presence or absence of a border; borders were white and backgrounds were black. Concept stimuli were produced by photographing geometric forms cut from red and green construction paper. Although color-matched light and film were used, a color shift toward blue was apparent in the slides, making the reds pale, the greens bluish, and the backgrounds more nearly navy blue than black. Large squares were approximately 2 x 2 in. when projected under the constraints of the apparatus configuration (Fig. 4), and small squares were approximately 1 x 1 in. Circles were approximately 2-1/8 in. and 1-1/16 in. in diameter for large and small respectively.

Procedure

The E visited nursery school classrooms and homes of Ss not enrolled in nursery school in order to establish rapport. As soon as possible after the rapport session, usually 1-5 days, the first experimental session was held. For one nursery school, the first to participate, repeated apparatus failure on scheduled experimental days extended the period between first contact and first experimental session, but the continued coming and going of E probably enhanced rapport. In the first experimental

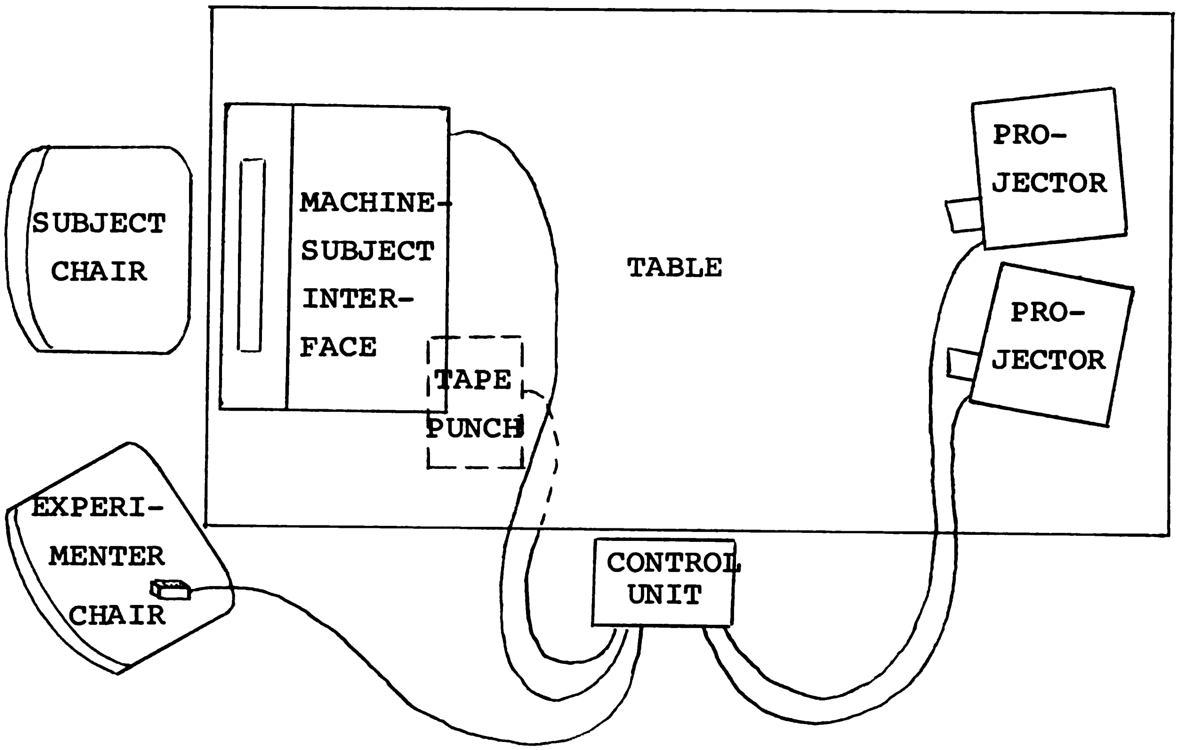

Figure 4. Apparatus configuration (plan view).

session the discrimination task with the animal pictures was administered. Before presenting instructions and a demonstration, _E_ offered each _S_ a balloon and a piece of candy. These were then placed on the table beside the response device until completion of the game.

The _E_ gave instructions and a demonstration from memory in order to facilitate communication with _S_. While there was undoubtedly some variation a typical instruction ran approximately as follows:

> This is the game I've told you about. Here's how we play the game. You see we have two pictures here. The way we play the game is to try to pick the right one. We just push like this (pressing the correct panel, which was on the left), and if we pick the right picture, it changes. (The correct panel, again on the left, was again pressed.) See, every time we pick the right picture, it changes. If we pick the wrong one, we can tell we made a mistake (in a manner implying that the mistake is not at all serious) because nothing happens; (pressing the correct panel, again on the left) it only changes when we pick the right one. Sometimes the right picture is here (pointing to right panel), so we don't pay any attention to where it is; we just look at the _picture_ (pressing the correct panel, now on the right). Now let's push it with _your_ hand (taking _S_'s hand and pressing the correct panel--on the right--with it). Okay, now _you_ may do it by yourself.

The _S_ operated the response device with no further instructions, except that _E_ answered questions as noncommittally as possible, prompted _S_s to continue responding whenever necessary, attempted to persuade _S_s to continue if they indicated a desire to stop, and provided information, when necessary, to enable _S_s to operate the device properly. Some Ss attempted to press both panels simultaneously at the outset of the first task, and so had to be instructed to press only one at a time.

The first session was terminated when S reached a criterion of 8 consecutive correct responses, completed 80 trials, including the demonstration by E, without reaching the criterion, or refused to continue. A second warm-up session was administered for Ss who terminated by reaching the 75-trial cutoff without reaching criterion. Any S who failed to reach criterion on the second attempt was excluded from the classification task. After learning the warm-up task to criterion, Ss were invited to participate again in the final session.

In the final session the warm-up task was administered again, just as in the warm-up session(s). After S reached criterion, E told S that he had learned that game very well and invited S to play the same kind of game "with this kind of picture," switching to the projector loaded with the Phase 2 (reduced) stimulus set and pointing to the screen. After S agreed, E asked S to wait a moment while E changed the tray on the other projector, loading it with the full set of stimuli used in Phases 1 and 3. As E resumed his seat beside S, he switched projectors again, so that the figures for the first trial of Phase 1 appeared on the screen.

For the reversal group the Phase 1 task was to learn to select the smaller figure; the nonreversal group was required to select the green figure. When S reached a criterion of 8 consecutive correct responses, Phase 2, the transfer task with reduced stimuli, began. Any S who failed to reach criterion within 100 trials was excluded from the remainder of the experiment. Since it was impossible under the circumstances to keep an accurate trial count, Ss were run beyond 100 trials, but a 100-trial cutoff was observed in processing the data.

When S reached criterion on Phase 1, the treatment differed for the informed and uninformed groups. For Ss in the informed group, E switched to the projector holding the reduced set of stimuli used in Phase 2, informed S that he had learned the game, and invited S to play another game with the same pictures, adding the qualification, "But this time we play it a little differently." For the uninformed group, E proceeded immediately with Phase 2 without comment. Phase 2 was terminated when S reached the criterion of 8 consecutive errorless trials, completed 80 trials without reaching criterion, or refused to continue. For Phase 2, as for the initial discrimination task, the count of 80 trials was kept accurately by leaving the 81st slot in the slide tray empty.

When S reached criterion on Phase 2, E immediately switched again to the projector that was loaded with the stimuli for Phase 1 and 3, with no break in procedure.

Phase 3 was terminated when S reached criterion (8 consecutive errorless trials), completed 100 trials without reaching criterion, or refused to continue. As in Phase 1, it was impossible to count 100 trials accurately.

RESULTS

It was predicted from the model described above that more than half of the Ss in this study would perform a reversal shift during the second phase of the experiment, in which either a reversal shift or a nonreversal shift would have led S to respond correctly. One of the experimental hypotheses derived from this prediction was that the first response in Phase 3 would be consistent with a reversal shift for more than half of the Ss. For the reversal task group, the first task was to select the small figure, and so Ss in that group who selected the large green figure were classified as having reversed during Phase 2. For the nonreversal group, the first task was to select the green figure, and so Ss who selected the small red figure were classified as having reversed during Phase 2. For purposes of this analysis, trial 1 of Phase 3 was taken to be the first trial on which the stimulus was a large green-small red combination of figures after S reached Phase 2 criterion. The apparatus used in this study provided no way of ensuring that the first figures displayed after switching to the full set of stimuli would be that combination. Some Ss were given as many as three trials between the Phase 2 criterion trial and the first

Phase 3 trial. Table 1 shows the group frequencies for Ss classified by information level and type of inferred shift.

Table 1

Frequencies for Groups Classified by Information and Inferred Shift

	Informed	Uninformed	Marginals
Inferred Reversal	9	10	19
Inferred Nonreversal	5	4	9
Marginals	14	14	28

It is apparent that the frequencies are virtually identical for the two information levels. Since the single-stage Kendler model is consistent with any reversal-shift probability less than .5, the appropriate statistical analysis is a one-tail binomial test on the marginals for type of inferred shift. The probability of a frequency of 19 or more reversals in a binomial distribution with $n = 28$ and $p = .5$ is .044. The single-stage model was rejected, therefore, in favor of an alternative that leads to the prediction $p > .5$, such as the two-stage model.

The second hypothesis from the modified Kendler model was that Ss in the group assigned the reversal task would complete Phase 3 in fewer trials than those assigned the nonreversal task. Group means and standard deviations for trials to the last error on all tasks appear in Table 2. For this analysis, trials are numbered from the trials immediately following the Phase 2 criterion trial. Although this method of counting trials exposes Ss to unequal numbers of large green-small red figure combinations, it has the advantage of equalizing the lengths of the combined criterion runs for Phases 2 and 3. Unequal criterion runs would allow the probability of criterion performance by chance to be greater for some Ss than for others. In a two-choice task, the probability of such a spurious criterion run is p^n, where p is the probability of a correct choice by chance and n is the number of trials to criterion. The 2 x 2 analysis of variance shown in Table 3 yielded a significant F ratio for type of shift. Both measures, then, confirm the hypothesis that the probability of a reversal shift in Phase 2 was greater than .5.

Even though the majority of the Ss apparently performed reversal shifts during Phase 2 (the optional shift phase), it would be desirable to be able to explain those nonreversal shifts that did occur. Under the assumptions of the Kendler model, nonreversal shifts become more probable if S fails to use mediating responses. There are

Table 2

Trials to Last Error for the
Three Concept Tasks

	Reversal		Nonreversal	
	Mean	Standard Deviation	Mean	Standard Deviation
Phase 1	7.62	10.85	13.73	16.77
Phase 2				
Informed	7.17	10.67	3.75	4.37
Uninformed	8.28	5.74	6.71	6.34
Phase 3				
Informed	8.50	8.46	40.86	35.80
Uninformed	1.14	1.95	64.17	20.03

Table 3

Analysis of Variance on
Phase 3 Trials to Last Error

Source	df	SS	MS	F
Information (I)	1	411.19	411.19	< 1
Shift Type (S)	1	14696.76	14696.76	32.08**
I x S	1	1519	1519	3.32*
Error	23	10079	438.22	

**$p < .0005$

*$.05 < p < .10$

three ways in which this failure might occur: if S satisfies the requirements of the task before he resorts to the use of the mediator, if the response is not in S's repertoire, or if the response becomes temporarily inaccessible for use as a mediator. Elimination of the first of these conditions was a major purpose of constructing a set of stimuli varying on four dimensions. The remaining two conditions lead to hypotheses easily tested with the data of this experiment. In view of the two major results already presented above, the hypothesis that P(reversal) $> .5$ was strongly supported. The results were consistent, therefore, with the assumption that the experimental task was constructed so as to be more difficult for Ss who did not mediate than for those who did. Then if any S either lacked the mediating response or if it became inaccessible, that S should learn the tasks for both Phase 1 and Phase 2 more slowly than if he could use mediation. A post hoc hypothesis, then, was that Ss who had performed nonreversal shifts in Phase 2 would require more trials to complete the earlier Phase 1 and Phase 2 tasks.

The test of this hypothesis was a comparison of mean numbers of trials to criterion in the two inferred shift groups. Those Ss who were classified as having performed a nonreversal shift in Phase 2 should, under the above hypothesis, require more trials to criterion on the Phase 1 task and the Phase 2 task than those who were classified as having performed a reversal shift. Means and standard deviations for Ss grouped by inferred shift and by information level appear in Table 4. The t test on the mean for the Phase 1 task yielded a t value less than 1, and the 2 x 2 analysis of variance (inferred shift by information) on the trial scores for Phase 2 yielded F ratios less than 1 for both main effects, information and inferred shift, and their interaction.

Other experimental hypotheses dealt with the information variable. If information served to eliminate the unlearning trials immediately following a task shift, then transfer should have been facilitated for the informed

Table 4

Trials to Last Error for Ss Grouped by Information and Inferred Shift

	Inferred Reversal		Inferred Nonreversal	
	Mean	Standard Deviation	Mean	Standard Deviation
Phase 1	17.32	65.23	20.00	36.58
Phase 2				
Informed	12.40	24.17	15.25	30.23
Uninformed	17.44	1.85	12.40	5.93
Phase 3		Reversal Task		
Informed	8.75	8.50	.87	.347
Uninformed	0	0	.70	0
		Nonreversal Task		
Informed	28.80	29.50	1.838	.184
Uninformed	60.25	16.00	1.846	.173

group in Phase 2. If the experience of a shift without warning at the beginning of Phase 2 led to expectation of a change of task immediately upon the occurrence of an error in Phase 3, then transfer should be facilitated for uninformed Ss in Phase 3. Means and standard deviations for trials to criterion in Phase 2 and 3 appear in Table 2, already referred to above. A 2 x 2 analysis of variance for Phase 2 trials to criterion yielded an F ratio less than 1 for each main effect (shift task and information) as well as for their interaction. For Phase 3, however, the significance level of the F ratio for the interaction was $.05 < p < .10$, as shown in Table 3.

The data of Table 2 also show a result that requires further analysis of the data. The group means and the corresponding standard deviations are closely related, with only one such pair of quantities, the mean and standard deviation for the uninformed nonreversal group in Phase 3, deviating appreciably from the pattern. The correlation with that pair excluded is .98, and with the pair included it is .72. The method usually suggested (e.g., Anderson and Bancroft, 1952, p. 222; Snedecor, 1956, p. 320) for correcting this particular kind of heterogeneity of variance is the log transformation. The transformed data appear in Table 5, and the analysis appears in Table 6. The main effect due to type of shift task is significant at the .01 level, and its interaction with information is significant at the .05 level.

Table 5

Log Trials to Last Error for the
Three Concept Tasks

	Reversal		Nonreversal	
	Mean	Standard Deviation	Mean	Standard Deviation
Phase 1	.632	.5413	.864	.5710
Phase 2				
Informed	.627	.5167	.554	.3410
Uninformed	.901	.2623	.759	.3603
Phase 3				
Informed	.714	.6013	1.338	.6579
Uninformed	.200	.3995	1.798	.1296

Table 6

Analysis of Variance on Transformed Data

Source	df	SS	MS	F
Shift (S)	1	7.961	7.961	33.63**
Information (I)	1	.047	.047	< 1
S x I	1	1.531	1.531	6.47*
Error	22	5.208	.226	

* $p < .05$

** $p < .01$

Another important aspect of the strong relationship between the means and the standard deviations is the kind of distribution suggested by this relationship. A well-known discrete probability distribution for which the mean and the standard deviation are closely related is the geometric distribution. The mean and variance for the distribution are $\frac{1}{p}$ and $\frac{1-p}{p^2}$, respectively (Parzen, 1960, p. 28). For fairly small values of p, the mean closely approximates the standard deviation, $\frac{\sqrt{1-p}}{p}$; for instance, for p = .05, the mean is 20 and the standard deviation is 19. This distribution of trials to the last error is consistent with a model which assumes that the conditional probability, p, of mastering the acquisition task, given that mastery has not already occurred, is constant over trials. A development of the geometric distribution from such a sequence of Bernoulli trials is given by Feller (1950, p. 156) in more general terms.

It was also predicted on the basis of a generalization from Mowrer's theory and of data cited by Mowrer (1960), and Brown (1961), and data presented by Weisberg and Fink (1966) that information would affect Ss' tendency to perseverate on incorrect responses that had been reinforced on previous trials. The indicator selected for this tendency was the mean number of incorrect responses made on each error trial before S terminated the trial with a correct response. In this experiment any S who made one or more errors required at least nine trials to reach criterion. In order that the same number of trials be used to compute the measure for each S, the number of incorrect responses in the first nine trials was divided by the number of error trials for the first nine trials only and data for Ss who made no errors was excluded from the analysis. Information group means and standard deviations appear in Table 7. Differences were not significant by t test.

The shift-task variable was confounded, in this study, with a difference between Phase 1 tasks. The relevant dimension for that task was size for one shift-task group

Table 7

Number of Error Responses
Per Error Trial

	Informed		Uninformed	
	Mean	Standard Deviation	Mean	Standard Deviation
Phase 2	1.81	5.79	1.95	5.22
Phase 3	1.13	1.23	1.33	1.23

and color for the other. A comparison of the two groups by t test showed that the difference was not significant, but p was less than .25. In view of this difference it seems necessary to consider whether the 11 Ss who failed to perform the Phase 1 task would have changed the major outcomes of this experiment if they had participated in the Phase 3 task. The comparisons of the two inferred shift groups in terms of Phase 1 trials to criterion, discussed above, provides no evidence of a difference between the two groups. The frequencies shown in Table 8 also fail to indicate any difference in inferred shift frequencies for the two shift-task groups.

Another potential source of bias not controlled experimentally was the possibility that Ss selectively failed the discrimination task in such a way that the

Table 8

Frequencies for Groups Classified by
Shift Task and Inferred Shift

	Reversal Task	Nonreversal Task	Marginals
Inferred Reversal	9	10	19
Inferred Nonreversal	4	5	9
Marginals	13	15	28

major results of the study were affected. A t comparison between the two inferred shift groups, however, did not indicate any difference in the number of trials to criterion on the discrimination task.

Some of E's informal observations during the experiment seem relevant to the problem of planning similar studies, and so are presented here. The design of the apparatus used in this study was such that E was required to specify the reinforcement contingency at each trial and to switch from one projector to the other at the end of each phase of the concept task. If E switched projectors quickly enough after the last trial of the criterion sequence, the lamp of the projector just switched off would fade out before the slide advance process was complete, but if _E_'s reaction was slow, the lamp would have a sufficiently bright afterglow to project an image, and _S_ would see a double image for a half second or so. Double image presentations could have distracted _S_ from the task, or particularly in the case of the uninformed group, could have provided a change-of-procedure cue. Whenever _E_ noted the occurrence of the double image, he therefore excluded the _S_ from the experiment, counting the loss of _S_ as due to experimenter error.

Another observation concerning the design of the apparatus was that some _S_s would press both right and left panels simultaneously. As reported in the procedure section, _E_ advised these _S_s not to press simultaneously, explaining that the machine would not work properly if they did so. The effect of such pressing behavior was intermittent occurrence of the slide advance operation, and so it seemed advisable to eliminate the behavior if possible. The _E_ did not alter the pre-task instructions in an attempt to avoid such behavior, however, because he suspected that expanding the set of instructions would result in a loss of _S_s' interest in the "game." The simultaneous pressing of the two panels was observed to occur only on the discrimination task, and _E_'s undocumented impression was that this response appeared only when _S_ had been unsuccessful and had become restless.

DISCUSSION

The two hypotheses concerning proportions of Ss performing each type of shift during Phase 2 (the optional shift phase) were supported unequivocally. Trials to the last error for the two shift tasks differed significantly ($p < .0005$), and the proportions of Ss classified as having performed reversal and nonreversal shifts, respectively, differed significantly ($p < .05$). Both the frequency of classification as inferred reversal or nonreversal shift and trials to the last error supported the hypothesis that the probability of a reversal shift was greater than .5.

Comparison of these results with those of previous studies with children shows the importance of the number of stimulus dimensions used in determining the tendency to mediate. An important implication of this finding is the necessity of taking the stimulus dimensions into account in the design and interpretation of concept-learning studies and other problems in which mediational processes are of interest. The dependency of the mediation tendency upon the number of dimensions is a relationship that can be represented as a quantitative function, $P\ (\text{reversal}) = f(N)$, and so a reasonable next step in the investigation of the problem is the collection of data for several values of N, the number of dimensions.

The expectation that the Ss classified in the reversal group would display superiority in the acquisition task of Phase 1 or in the optional transfer task of Phase 2 was not confirmed by the data. The failure of this hypothesis, however, gives rise to further questions. It seems likely that the tendency to perform a reversal shift in the optional situation is due to some cause other than failure to employ mediation, but further confirmation of this assumption is certainly desirable. Another question for further research is whether the tendency toward a reversal *versus* a nonreversal shift is a characteristic of individual Ss or simply a parameter of a stochastic process. More extensive data on individual Ss is needed to answer this question.

The effect of information, indicated by its interaction with shift task in the analysis of untransformed scores, was not statistically significant, and so could be attributed to sampling error. The analysis of the transformed data, however, showed a significant interaction between information and type of shift. The absence of any effect in Phase 2, immediately after the information was communicated, mitigates against the conclusion that information was generally facilitative or motivating. The kind of interaction found in Phase 3 provides a clue to the nature of the underlying process. The effect of information was facilitative for the nonreversal group and detrimental for the reversal group. A possible interpretation of this result is that some Ss understood the information that a new game was beginning to mean that the old choice criterion should be abandoned, and so adopted a new criterial dimension; that is, they performed a nonreversal shift. But Table 1 does not support this assumption, and if all Ss who were inferred to have performed a nonreversal shift are excluded from the analysis, the interaction pattern remains, as is apparent in Table 4.

No differences in repetition of error responses appeared in either Phase 2 or Phase 3. This negative result may be attributed to the absence of any effect of information on Ss' tendency to become frustrated. It is also possible that the measure selected was not sufficiently sensitive, since it was an average over the first 9 trials and it did not take response intensity into account.

The tests for effects due to selective attrition were all negative, but there remains the possibility that those Ss who failed the discrimination task were qualitatively different from those who passed, although the performance of the latter Ss was unrelated to their tendency toward one or the other type of shift. A developmental variable of some kind may well be involved in the selection of Ss on this task or understanding of behavior appropriate to a game. The only kind of difference that would be relevant to this test of the Kendler model, however, would be in Ss' tendency to mediate. The discrimination task, requiring only that S consistently select one picture (the picture of a dog), should be easily learned through the single-stage associative process.

Selection on the Phase 1 task is less easily dismissed. If the task was very difficult for Ss who did not use mediators and relatively easy for those who did, then the task would select for the ability to mediate. This assumption is double-edged, however, and implies that Ss who succeeded probably did so through mediation. The large proportion of Ss who succeeded (29 out of 40) then indicates that Ss in the population who survived the discrimination task use mediation with high probability.

The strong relationship between group means and their associated standard deviations was an unanticipated result, but the evidence that the probability function is geometric, provided by this relationship, is of considerable importance. One set of assumptions from which the geometric distribution can be derived is that the sequence of trials is a sequence of Bernoulli random variables, in which the probability, p, of success is constant over trials. The result is consistent with an all-or-none learning model, then, in which the probability of solution is constant for all trials. Confirmation of the assumption of independent Bernoulli trials can be obtained from other statistics of the data, but generally requires fairly large samples. Development of this argument is therefore left for further research.

The major outcomes of this study, then, indicated the effectiveness of both of the manipulated variables, since the main effect for type of shift and its interaction with information were both significant. The hypothesis that most Ss in the sample employed mediation in the solution of the problem was supported. The contrast between these results and those of the previous studies already cited has several important implications. For researchers, there is a demonstration of the danger of stereotypy of method and at least a suggestion that underestimation of Ss' abilities can be detrimental to the design of an experiment. To the extent that the experimental situation resembled 'real-life' learning situations, the implication is that even three-year-old children may use simplifying principles to enhance learning when it is to their advantage to do so, and the process, even at this low level of linguistic sophistication, may be altered by instructions.

REFERENCES

Andreas, B. G. _Experimental Psychology_. New York: Wiley, 1960.

Brown, J. S. _The Motivation of Behavior_. New York: McGraw-Hill, 1961.

Buss, A. H. Some determinants of rigidity in discrimination-reversal learning. _Journal of Experimental Psychology_, 1962, _44_, 222-227.

________. Rigidity as a function of reversal and nonreversal shifts in the learning of successive discrimination. _Journal of Experimental Psychology_, 1953, _45_, 75-81.

________. Reversal and nonreversal shifts in concept formation with partial reinforcement eliminated. _Journal of Experimental Psychology_, 1956, _52_, 162-166.

Feller, W. _An Introduction to Probability Theory and Its Applications_. New York: Wiley, 1950.

Harrow, M., & Friedman, G. B. Comparing reversal and nonreversal shifts in concept formation with partial reinforcement controlled. _Journal of Experimental Psychology_, 1958, _55_, 592-597.

Jeffrey, W. E. Variables affecting reversal-shifts in young children. _American Journal of Psychology_, 1965, _67_, 577-580.

Kelleher, R. T. Discrimination learning as a function of reversal and nonreversal shifts. _Journal of Experimental Psychology_, 1956, _51_, 379-384.

Kendler, H. H., & D'Amato, M. F. A comparison of reversal shifts and nonreversal shifts in human concept formation behavior. _Journal of Experimental Psychology_, 1955, _49_, 165-174.

Kendler, H. H., & Kendler, T. S. Vertical and horizontal processes in problem solving. _Psychological Review_, 1962, _69_, 1-16.

Kendler, T. S., & Kendler, H. H. Reversal and nonreversal shifts in kindergarten children. Journal of Experimental Psychology, 1959, 58, 56-60.

Kendler, T. S., Kendler, H. H., & Learnard, B. Mediated responses to size and brightness as a function of age. American Journal of Psychology, 1962, 75, 571-586.

Kendler, T. S., Kendler, H. H., & Wells, D. Reversal and nonreversal shifts in nursery school children. Journal of Comparative and Physiological Psychology, 1960, 53, 83-88.

Mowrer, O. Hobart. Learning Theory and Behavior. New York: Wiley, 1960.

Parzen, Emmanuel. Modern Probability Theory and its Applications. New York: Wiley, 1960.

Snedecor, G. W. Statistical Methods. Ames, Iowa: Iowa State University Press, 1956.

Spence, K. W. The nature of discrimination learning in animals. Psychological Review, 1936, 43, 427-449.

________. Behavior Theory and Conditioning. New Haven: Yale University Press, 1956.

Suppes, P., & Ginsberg, R. Application of a stimulus sampling model to children's concept formation with and without overt correction responses. Journal of Experimental Psychology, 1962, 63, 330-336.

Weisberg, P., & Fink, E. Fixed ratio and extinction performance of infants in the second year of life. Journal of the Experimental Analysis of Behavior, 1966, 9, 105-109.

APPENDIX A

STIMULUS SEQUENCES FOR ALL TASKS

Part 1: Stimulus Sequence for Discrimination Task

Left	Right	Left	Right	Left	Right	Left	Right
Bird	Dog	Dog	Rabbit	Pony	Dog	Squirrel	Dog
Pony	Dog	Dog	Pony	Bird	Dog	Dog	Rabbit
Rabbit	Dog	Dog	Squirrel	Squirrel	Dog	Dog	Squirrel
Dog	Rabbit	Bird	Dog	Dog	Squirrel	Pony	Dog
Dog	Bird	Squirrel	Dog	Dog	Pony	Rabbit	Dog
Pony	Dog	Dog	Bird	Dog	Bird	Bird	Dog
Dog	Rabbit	Squirrel	Dog	Dog	Rabbit	Rabbit	Dog
Rabbit	Dog	Pony	Dog	Dog	Bird	Dog	Rabbit
Bird	Dog	Dog	Pony	Squirrel	Dog	Dog	Bird
Pony	Dog	Squirrel	Dog	Dog	Rabbit	Squirrel	Dog
Dog	Squirrel	Dog	Pony	Rabbit	Dog	Bird	Dog
Dog	Pony	Bird	Dog	Bird	Dog	Dog	Squirrel
Squirrel	Dog	Rabbit	Dog	Pony	Dog	Dog	Pony
Rabbit	Dog	Squirrel	Dog	Dog	Rabbit	Pony	Dog
Dog	Squirrel	Dog	Bird	Dog	Pony	Dog	Rabbit
Dog	Pony	Dog	Pony	Squirrel	Dog	Bird	Dog
Squirrel	Dog	Pony	Dog	Dog	Bird	Dog	Squirrel
Dog	Bird	Rabbit	Dog	Dog	Squirrel	Dog	Pony
Pony	Dog	Dog	Squirrel	Bird	Dog	Rabbit	Dog
Rabbit	Dog	Dog	Rabbit	Dog	Rabbit	Dog	Bird

APPENDIX A (continued)

Part 2: Stimulus Sequence for Phases 1 and 3

Code:	L:	large	R:	red	Q:	square	B: border
	S:	small	G:	green	C:	circle	N: no border

Only the left member of each pair is described. The description of the right member can be reconstructed, since it is of opposite size and color and of the same shape and border type.

SRCN	LRCN	LGQB	SRCB	SGQN	SGCN	LGCB	SRQN	LGQB	LRQB	SRCB	LRQN	LRCN
SGCB	SRCB	LRQN	LRQB	LGCN	SGCN	SRCN	LGCN	SGQB	SGQN	SRQB	SRCN	LGCB
LGCN	SGQB	LRQN	SRCN	SGQN	LGCB	LRCN	LGQB	SGQB	SRQB	LRCN	SRCB	LGQN
LRCB	SGCN	LRQB	SRQB	SGCB	SRQN	LGQN	LRCB	SRCN	LGQB	SGCB	LGCB	SGCN
SRQB	SGQN	SRQN	LGQN	LRCB	LGQN	SRCB	LRCN	SGQN	SGCB	LRCB	LGQN	SRQN
SGQB	LRQN	SRCN	LGQB	LRCB	SGCN	SGQB	LGCB	SRQN	LGCN	LRQN	SGQB	LGCN
LRQB	LRCN	SRQN										

APPENDIX A (continued)

Part 3: Stimulus Sequence for Phase 2

Coding is the same as for the preceding stimulus sequence.

LRQN SGCN SGQN LRCN LRQB SGQN LRCN SGCB LRQN LRQB LGCB SGQB SGQN

SGQB LRQN LRCN SGQN SGQB LRCN LRCB SGCN LRQB SGCB LRCB SGQN SGCB

SGCN LRCB LRCN SGQN LRCB LRQN SGQB LRQN LRQB SGCN SGQB LRQN LRCN

LRQB SGQB

The forty elements comprising the second half of the sequence are a repetition of the first half listed just above.

APPENDIX B

RESPONSE SEQUENCES FOR ALL SUBJECTS

Explanation of Coding

1. Columns 1 and 2: subject identification.
2. Columns 3 and 4: task identification.
    a. Dn denotes the discrimination task, n^{th} attempt for that subject.
    b. W denotes the warmup task (column 3 only).
    c. P1 denotes the phase 1 task.
    d. P2 denotes the phase 2 task.
    e. P3 denotes the phase 3 task.
3. Column 5: card sequence number within subject and task.
4. Columns 6-80: response description.
    a. L denotes left choice before reinforcement was specified.*
    b. R denotes right choice before reinforcement was specified.*
    c. 1 denotes correct left response.
    d. 2 denotes incorrect right response.
    e. 3 denotes incorrect left response.
    f. 4 denotes correct right response.

---

*L and R codes indicate that the subject responded before the experimenter could press the button to specify the correct response.

SUBJECTS WHOSE DATA WERE USED IN THE ANALYSIS.

INFORMED NONREVERSAL GROUP

```
AGD1133141112441144331241144433144R114141114RR
AGW  L11144314111441 1
AGP112242414331114314444R1444
AGP212222222222244241141411 4
AGP311443124444112412443111224443141124144431124141424441112414431124431241144 14
AGP3211
AMD11141114411
AMW  14111441
AMP11242414111414
AMP21241312412441144441 1
AMP31241142443111242414242441124144413312424314131441442431312414142444411 14144
APD11141114411
APW  33141114411
APP112424314111414 4
APP2122441124141314244311441141 4
APP311142411124412444241143142243131314414131441242424114314144424313131412424 13
APP3214431444131424141314131312414144224141314131424113124241R2
ARD111411144 11L
ARW  14111441
ARP11244312431311243124444312422443114111244311124411411 44
ARP2122444114141
ARP3143131243124424133312414144443133331143331422413142414131441413141112443 1144
ARP324131243112433112444431131443144244311243144311124431243112431244433131 43124
ARP331424444413112414411244314114431224 31
BED113124111441 14
BEW  14111441
BEP11244141114 1
BEP21224222224114141 14
BEP31L1222241144311122441242444112412244LL111224431431L312412444333331124124124 2
BEP32444 1L311241424RR1L1422222414131441411 41L11414144
BJD11314311144 1L1L4
BJW  14111L441
BJP1142414313114144244144431314131144113144R112241333142441L414414
BJP2124431314141L3144441142411414144
```

BJP313114141424444113314142431142412224313144314431413114241314R4431241314131441 1
BJP321441L
CRD111222411144112244141 14R44
CRW 14111441
CRP11443141114144
CRP212443114141144
CRP311144311144124444

UNINFORMED REVERSAL GROUP

AND1131241 1144R1144124311 4RR443144114124111244R114411124444414331112441441431 44R
AND12311L112441L124R4RR1414414
AND2114111443114414 11
ANW 14111244411441 4
ANP11243141311414431244112444114111
ANP212443114312411444411
ANP31243312414411144
BKD113124311122441144331411444122441141411
BKW 14111441
BKP1114411141
BKP212424311414114R
BKP3111411441
CAD11122411144114
CAW 14111441
CAP11333333333333331441 11414
CAP21222222222242224311414311444441 4
CAP311411441 1
CLD1133143111 2244R31124431243311242222443312443133122414131144112244333111244444 3
CLD1214331111443144314314433111144112441412443 14
CLD211411L1441
CLW 14111441
CLP1114113114144144
CLP21224411414311 4444R31124411241 41L44411
CLP31441 11L441L4R4424114142411L14414114144411
CMD1114111422222222222222222411441433114441441
CMW 14111441
CMP1113424131L14144144
CMP21222222424112431241314444 1144

CMP3144111441444
CTD111222431313124411424141114441
CTW 14111441
CTP113144111414
CTP21242431314141 1444
CTP31141144111 44
DPD1114111441
DPW 14111441
DPP11144131124 1441441
DPP212244311433143114444114
DPP312413131441444 41141

UNINFORMED NONREVERSAL GROUP

AJD1114111441
AJW 14111441
AJP1144141114
AJP2144114141
AJP3133333331141 1444111
AWD1114111443131441 41144
AWD2114111441
AWW 14111441
AWP11242431431114 14444
AWP214411141433114444311441 1414
AWP31443111424144443114142413112441431141444111131441243131144114442414131314314
AWP32442412444311243131144311124431124313114243124142414142413131314141414244114
AWP33312414241431313141413144242424124131314142442431244242431143131144311312441
AWP341431124424312431424141424131313131414142241314314142241411314141314242424 41
AWP352413131
AYD11333333333122411L12441L12441411444
AYW 12411144114
AYP11243141114144
AYP2122222222222224241141 4114
AYP31114243111422431224444133122412244411124224312433112431242244114143144443 1111
AYP3241244114 4141
CHD1133333331224111441144
CHW 14111441
CHP1144141114

```
CHP21224433131414111444
CHP31331124131441114224124424411241224431114224312411412442413124124124244243131
CHP3214144114
DQD1114111222244111441 41
DQW   14111441
DQP11242414313131241244441244421141112441114411
DQP21224241141 4114
DQP31131443143114144413141414444
DTD11331224131124411242431411424431443311224143331114413144311L12444443314R31114
DTD124144
DTW   14111441
DTP11242431431112412442424142441314 31L1312242241131244112413124222441114241241244
DTP121111241412414411414
DTP21244114141 1
DTP31412411441411431114433114
DVD11141114241314241241144431424131R41411144
DVW   14111441
DVP1124414113141424 44R144R41122411 14411
DVP21L22441314141 1444
DVP312412424131414241322224131 41R242424L312431L41442244133313141424LR11242241413
DVP3214414131431RR
DWD111411144311244141 1444
DWW   14111441
DWP11222441411124122444431444 11411
DWP2122431141411 44
DWP31422244112412441112424314131412424413141243144244313114314413124R43141124414
DWP32112431L3114241124441243112411443113144144441
        INFORMED REVERSAL GROUP
ASD11312431131441124414112444144 1141
ASW   14111441
ASP1114411141
ASP21222441141411 44444
ASP31114114411 1141444
BCD1114111441
BCW   14111441
BCP1141411141
```

```
BCP212441141411
BCP31311241144 1114
BOD113141114411
BOW  14111441
BOP113144111414
BOP212441141411
BOP3114131441112441444431114144111
CKD1114111441
CKW  14111441
CKP113124413112414243144114424313141111443143114441312414414111
CKP2124241312414114 44R241144114
CKP31311414142444113141441144
CUD11141112411144 1L41
CUW  141112241144141
CUP113144111414
CUP212441141411
CUP31141144111
DFD111411124411 44141
DFW  14111441
DFP11L114413114314431244114424114111 14
DFP21242431L124314114244411244114143144431141141 14
DFP313124124243111443124313141424411 41414
```

* SUBJECTS CR AND DV WERE TERMINATED BY EXPERIMENTER ERROR ON PHASE 3 AND WERE THEREFORE NOT USED IN THE ANALYSIS OF PHASE 3.

SUBJECTS WHO FAILED THE DISCRIMINATION TASK.

```
ABD1131313124243141R1312244331333142433124131424243124224133141243313114224131 44
ABD12131312424242424143113142412441414L22431313133124431142414142414
AOD1131241 31R12441124431411444314431124124111441144
AGD11333331243331112224433333112443333124313124443331244333133331241411124243331
AGD123124431313144444331413131443142414142431313112424311242433143124 43124
AGD21312413131424131424141312424241424L31314141313142241314241313142424242414131
AGD2231424142433141424113131244112442124142414L1131424141313124224131424141144 41
AQD234244124143131144112443
AZD113331241331312424313124243141312424241242411414131314243131244311314442424 12
AZD1243131L314412424141424131313142 41L31424L314142414
```

```
BMD1131241313314R24R131424R141331424241443131431241 31L3122422431122424R13131244R
BMD124443124313131443 1L4224314L42431111244331124433124314224124
BMD2131411314431144143114424312 44R1143124311312441144113 1L244242443124313131443 1
BMD2242431L2431424R3113112443112443122431 2443124
BQD1131411R31L4413142431413 1L242443 1L42413143124313 1L3122244311 2244333
BQD21141L311242431314241241312224241424R31
BRD11L4L443312241311222244312443141424313333311 122224431314243124142414
BXD11312413112441144141113144312413111314431411124243112443314114441244333112224
BXD1214111443 11L24R43111222244R4R4412411144314412433144 1L1LL114R44R111224141LL44
BXD1314
BYD111444331111424112244 33141L2424124
CFD11333143111222222224433131242243141331422244314243131243 14R11331441124341131
CFD124224424444 31L243111242431422431414224313131331244311422243312431 24414
CFD2112411144112 44141144
CID1131241 31R1R422413314 4R141R314R22441424131R43312241333133144R31331R4224313131
CID124R24R2444144131422 4R144331243142413331LR131222222222222244R33331212 44314142
CID13414
CID211241313142413144124313124244124241314141313142413142413131442424241411142 41
CID22424143142222413131314241314243314142414
CJD11331243311122424131 224141312424241 24R241424L3241311424311424R1311 42424R2424
CJD1231R131314241342414142411311424131324241414414
CJD21141313 14R224131L42414131424414413124141313142413142413131424242424314131312
CJD2242414L4141R24413131314241R141314333314414
CND1131L222222224111222222222244313 1L2424124313142443 1L2443133312412411124241 14
CND1243111 1L2244444312243 11L1242431441414431111244311244314344 14
CPD11333312243311122443311242431431312444314431122243314313112424131242431112444
CPD124433122431 1124R431244312222433333122224433 31L113124433131224431 24R31242431
CPD1324
CPD2131R2411144112443124313 1L442224144311243 1L2431112244311244RRR333111244442222
CPD2243122243333133131424 1L4414142431313131443313122222222422414124243124R
CYD1114131124241314241413 1L42424314243131414131 31L4243131424133131424242 44141331
CYD12L33142414222414142413313311424331314241414222 4331R4
CYD2114133131441314224141314422414241314141331331422431331424313133142424 2242431
CYD222413313314224142431424222413131314241314241L4142414
DAD11331L2431112441331L24R431L22431L312244431242433 1L1412431311222244311 22244311
DAD1212222222424 4R443122224R333333 1L11222244142241L224124431L11L1L244313314431241
```

DAD13244314
DCD111224313131242433131443141312424431424313124143111L2443112443131124444243333
DCD1233331L22222431311443144312431443111124243333331124431243333333331224L243
DCD131224
DDD1114333133311222222224431L122424331431L12444331244114314111244112244R1L111LL2
DDD122222224RR44443331241112244122431414431111244112441241L443331224
DGD1131L41311424311242241L41312424414241312431413313124241314241313142442242431L
DGD124131314241424141424133131R14241312424141R242414
DJD1133124131124243112424312431312244433144311241243131124241122244313112444RR44
DJD121241112244314431243124431 1L3112443112443124312443124
DKD1133333314R1331L12242243112443333122243131 4244R3
DMD1133143113144331314431431R1244431443131431243311314433131443131144444331 24313
DMD121314224333122224431224314411112244114L41414224R14
DND11331222433113333122424311242222222433124313122442431242433112431241311244 11
DND12242243131 1224R24414412 41L11244314431414241131314241144143144314
DND2114113 1L42241142414114444312441124314111441124431114244443141114R31L244314314
DND21431111L2441122224R41L4312443314
DXD1133143313131224224 31R12441413142224241422241331R2414131314224131424313 1L31424
DXD12242 4R243141L131242431242414142413131144331124431414414
DYD11331243111242431124431224313124244312443 1L1243124311122443131244311124444431
DYD12431L112443124431414431111242431124431243144 31224

SUBJECTS WHO FAILED THE PHASE 1 TASK.

BPD111411144311443141144414
BPW 14111441
BPP1142414313131243144441242443131431311424311314413124131242 4224R14R1424141424R
BPP12113131431241241424313143141424141 31L3141241312244222424241411314142 4R244144
BPP132413124313311 24241
BUD113143313112424313124243124313124242431441L314122431313124 42R311L244411244442
BUD1243143111242412441 4R14243111122224R4R3131443141 4414
BUD21141114241124241411244241441124124 1L1312424311244111424424412411124431242414
BUD22144111
BUW 14111424114241411424414411241241112244311443 1L1142444431241 1144144
BUP11424141112412424244314242431312431112242431313144331124311242424312414241224
BUP123142222413111124143143124411412412441124111222224314311242424242431433 1313
BUP13312213124424243124244311222241L1

```
CBD11141111441
CBW  14111441
CBP11312242431112414224312443112244431124311311443124311242443 1L3122414243141112
CBP1244141413 1L1114241241312441331 4L14224131414241424431122441331314142412244131
CBP13424243114111124414131
CCD1131243111224R41331244R14R1144R4414RR4
CCW  14111441
CCP1124241L4R131141224242424124244131243131312441313 1L24431L1241312244241243 1242
CCP12414142413131124312241241424114312414241411 3312414131244224242433141313 12412
CCP134242441244433311241313124
CDD11R331411144RRR1
CDW  14111441
CDP1112242413131414241242413142 44131
COD1112241313142413142414112242441424131241241331314241314224113142424242 4141131
COD12424124414142413131142411441414
COW  14111441
COP11424124313131431424244314244131413114241311441141314242431414241241441331313
COP12141414142413141414241241313141413142424244141313124142224241424241314131 3142
COP1341313124222413141314242433141424141424131313141414142413143141R4241413131414
COP14131424242441241
CSD11312413333131224241314241413314224241424311241413131424133142243133 1R1422444
CSD12431222224R1L113142243312424141441111
CSW  31411144114
CVD1114111L441
CVW  1L41L114414
CWD113141114411
CWW  14111441
CWP1112441313141424142243311244224313 14L313111443124 31L333331LL2424R433331121314
CWP1241224133114222241431433311311422443 1224
DHD11141L11441
DID11312411122224431144141114441441L1
DLD11312241313122422 4R13122424124331L1222442431L22443112243124311124431122244313
DLD121142442244314331114 41L441
DLW  1411144311441 4114
DLP114222414131314122422444312444313122431112424313114241312243112244243 1L222414
DLP1222412431244333113131241414 3124
```

```
DRD1114111441
DRW   14111441
DRP11242412411141242444122424431312413131244113124431124131244224124142224143314
DRP12241313131414141424114141424141313141241L12424L4242414113141224242441424241 3
DRP1312433111222224 24L331131224431 1L43311242424
DSD11312431331314243311222222443312222433333311224242412244311243122433111 22333
DSD121124411122444414111
DSW   14111441
DSP11242414313111412444241444131243111244113124411243112444314144124314413131 3124
DSP12312431243 1L4431L14314314431411314312413144444143111412444431444131243111244
DSP133113142411241

     SUBJECTS WHO FAILED THE PHASE 2 TASK.
BLD11141111 44114
BLW   14111441
BLP111424111241424142411444 1141
BLP212422241331243314 11L4242424313121 1
DUD111L4111441
DUW   14111441
DUP11L242414313114124424243 1L4244131411L33142411314431312431312424431241242 24141
DUP12441L11
DUP2144112 41224114
     SUBJECTS WHO WERE ABSENT WHEN THE CONCEPT TASK WAS ADMINISTERED.
AXD11333333124131124431144124112424241424331124141311244112443111442444143111L2
AXD12441441414L
CXD1133312224331311222222443333331122224431243112444312224431124312222224311 12244
CXD12311LL44311L124444431LL2241LL1LLL1LLL24R243122224431LLL4314431LL11LLLLLL1222
CXD13222222222222222222244114414

     SUBJECTS WHO WERE OLDER THAN THE UPPER AGE LIMIT.
AAD1113131242412411124241131242 41R413124242412424112412411144311242411124444431 2
AAD124311124222224333331244312412424313111242431142414144314
AAD2131243111244114431241144 4144
ACD11313131242431243111242431124 4R3331241124444 3124R2224331124312411142243112 4421
ACD121124R42444312411124R4R14
ADD113131312424122433331 33112441144314114443144331143314111244114433111444441
```

```
ADW   1114431L4111L4411
ADP11242431241331331412224242424122422424313141313144313131424112413142244 1R4142
ADP12241241424311131241241222414431314312412424414131144122443112424444431431
AED11313131242431243131312224241312424312431314242431424311243143111242411 2424311
AED12124442441L431112443 1L441241424111144112443 12414414
AED2 14111441
AFD11124111 2441144141
AFW   11144141
AFP1144141114
AFP2144114141
AFP3143114244314131411424411312441 24R4242411241242411142431411241424241312414144
AFP32242413111414413144 14131
AHD11314331112443313122 4R41241124242414L433112431431L1R1L443331124411124244 44141
AHD12114
AHW   131314414111L4
AHP1131424111 41441
AHP21224222222222244111 41411
AHP3141144414
AID11333314111441124414 11444
AIW   11L144141
AIP1122224241RL1124142431441312442431141111441
AIP212424114L31241144 4411
AIP3112441114414
AKD113314111244 1144141
ALD1133124112443311244314114443124431141 41114
ALW   11144141
ALP112441411141
ALP21244311241241144 44411
ALP3131224311224431112443122444431312414431311244314313124444312444131241431 24444
ALP324311144314243112424143131244312 4R3131431313144311244431222431314313124411 31
ALP332443144 24R4413143312444313133124412413124124424112431412224244 1124312441L14
ALP344412431144312 43114
BBD11333122224331131222222224433331122244333122243112244443333122222441143312411
BBD12124243131242413131242424424241R24413131242431424141424313131312424131424141
BBD134241R24
BND111413333313124422224133142241413314224414241331414133133142 24R1RL14224R133112
```

```
BND12424244243141З1RLL14243142414l4L24131313142243114241414414
BSD11333122413311224411242431241312424243124241312241431311242 41L142431313144444
BSD121222413131422431222424 1R41424R11L1242411422414L31142
BTD1114111441
BVD1133143 1L1122222222443311222244141331422443142 4131L24141112424112244311124444
BVD12RR414113142
BWD1131413313142413331422414131424222414243131414131L3124413142 4R131314444414111
CGD113314R1114411
CGD11141114241L
CZD113141L3131441144141

    SUBJECTS WHO WERE YOUNGER THAN THE LOWER AGE LIMIT.
BZD113331413131242431312424312431144R41443114141114                 CARD COUNT
```