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A Developmental Study of an Extradimensional Shift in Concept Learning

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A DEVELOPMENTAL STUDY OF AN EXTRADIMENSIONAL SHIFT IN CONCEPT LEARNING

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by

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ACKNOWLEDGEMENTS

"Together enlightened men . . . will probe plain and mystic facts testifying to human potentials and the majesty of what man can become." --Gordon McCloskey

In an attempt to further probe the facts of human potential, this study was conducted. It could not have been accomplished without the aid and support of many people. To Dr. Richard Covington and his staff at Hebeler Elementary School where two-thirds of the research was conducted, I express my thanks. The study itself draws upon the accumulated experience of many individuals. For wisdom in their counsel and patience in their direction, I am indebted to my committee: Dr. Don E. Guy, chairman, Dr. Max Zwanziger, Dr. Philip Tolin, and Dr. Colin Condit.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

In concept and discrimination learning problems, an extradimensional (ED) shift entails an unannounced change in solution from one relevant dimension to another. For example, if form is the relevant dimension in the preshift phase, the subject (S) would be required to place all triangular figures into category one and nontriangular figures into category two. Upon solution of the preshift phase a different dimension becomes relevant. The postshift phase could have color as the relevant dimension and would require S to sort all blue objects into category one and all non-blue objects into category two. The purpose of the present experiment is to investigate the effect on postshift performance of adding a new dimension to the stimulus patterns after S has attained a solution in the preshift phase but before the ED shift is initiated.

Two models of concept identification make different theoretical predictions concerning the outcome of such an experiment. The hypothesis-selection model (Bower & Trabasso, 1963) implies that no differences will occur in postshift performance either as a function of the number of trials or the presentation method of the new dimension.

According to the hypothesis-selection model, *S*s select and test different hypotheses throughout the problem solving process. Thus, the *S* selects a hypothesis and categorizes the stimuli accordingly until an incorrect response is made. Such an error informs *S* that another hypothesis is needed to solve the problem. When the correct hypothesis is found, no further errors occur. According to this model, the solution of a conceptual problem occurs in an all-or-none fashion. Any change in the basic conceptual problem will require a new hypothesis for its solution.

On the other hand, a cue-conditioning model (Bourne & Restle, 1959) implies a definite sequential effect on task solution. The cue-conditioning model depends upon the association of elemental stimulus-response relationships. As these relationships are built up (i.e., learned) the *S*'s associated performance changes in an incremental fashion. This model predicts that the method of introducing a new cue to a basic conceptual task will markedly influence subsequent performance. For example, this model predicts that the introduction of new cues relevant to problem solution should facilitate subsequent performance. Conversely, the introduction of irrelevant cues should retard problem solution since it will require a number of trials for *S* to learn to ignore these cues. This model also predicts that the greater the amount of practice with these cues, the greater the conditioning (i.e., learning) of them.

Earlier research explored conditions of acquisition and utilization of cues in an ED shift. Braley (1962) hypothesized that exposure to irrelevant cues prior to an ED shift would facilitate later performance if these cues became relevant after the shift was initiated. Geometric designs were the stimuli employed in the three stage experiment. Solution in Stage I required Ss to select all patterns with two small figures of the same color. After the criterion of ten correct responses was made, Stage II was initiated. In Stage II some Ss were given ten trials in which new but irrelevant cues were introduced. The remaining Ss simply received ten additional Stage I trials. In both groups during Stage II, Ss were reinforced with knowledge of results for responding to the cue relevant in Stage I. In Stage III, the irrelevant cues introduced for some Ss in Stage II became relevant for all Ss.

The results indicated that prior exposure to irrelevant cues impaired performance in Stage III since the control group performed better than the experimental group after the shift. Interpretation of the results led to some speculation that cue novelty created a greater attention-value since Ss who did not receive prior exposure to the new cue tended to respond more rapidly to the new dimension than did those Ss who had received prior exposure.

Braley and Johnson (1963) further explored cue novelty in cue acquisition. The study was similar to that of Braley (1962) except the number of trials in Stage II were varied (4, 10, or 16) for both the experimental and control groups. Further, there was an independent group comprised of Ss who merely solved Stage III without any exposure to cues in Stage I or II.

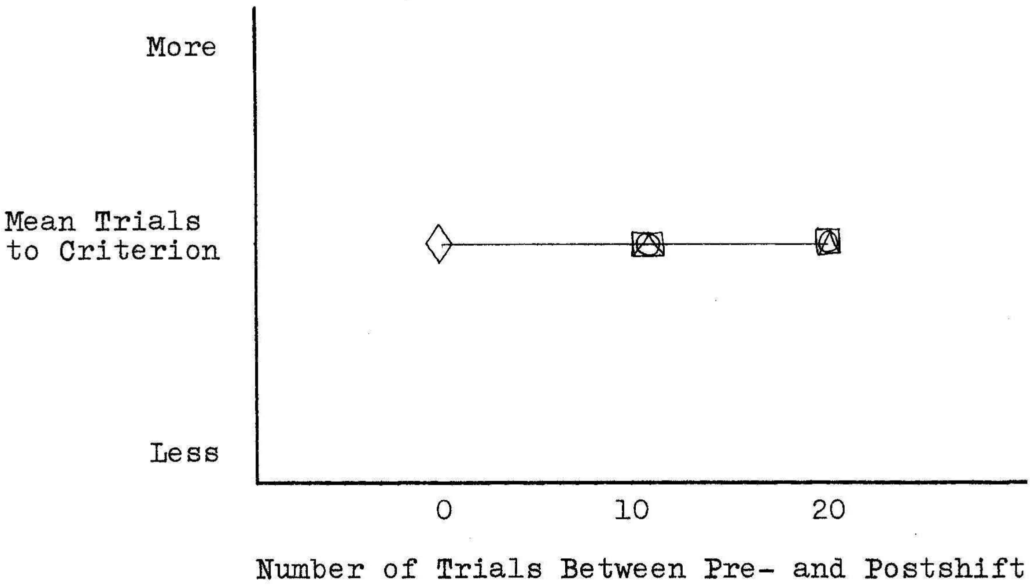
The results of this study confirmed the finding by Braley (1962), i.e., a higher level of performance was achieved for the control than for the experimental groups. The study also indicated that the number of trials in Stage II had no differential effect on performance in Stage III. Further, performance comparisons between the independent and the experimental groups were nonsignificant.

Guy, Bourne and Van Fleet (1966) also explored the effects of adding novel cues to a problem prior to an ED shift. After Ss solved a concept problem, a series of 6, 12, or 18 overlearning trials was administered during which an additional cue was introduced. This cue, which became relevant in a postshift problem, was introduced in one of three ways: (a) it was irrelevant (uncorrelated) to correct responding on the preshift problem, (b) it was redundant (correlated perfectly) with the initially relevant dimension, or (c) it was absent and presented only when it became relevant. The learning curve plotted for the postshift trials and errors to criterion indicated different levels of performance in a manner consistent with the cue conditioning theory. However, statistical analyses of the postshift performance failed to reach a significant level of reliability and so failed to support the cue-conditioning model and by implication supported the hypothesis-testing model.

The present study was similar to that of Guy et al. (1966), since it was designed to evaluate the hypothesis- and cue-conditioning models of concept learning. However, there were three major differences. First, three age groups were tested in an effort to determine whether there were age-related differences in learning strategies, as suggested by Kendler, Kendler, and Marken (1962) and Kendler and Kendler (1969). Second, the added cue was placed directly on the stimulus figure rather than in the background surrounding the figure. Third, the stimulus objects were less complex since they represented pictures of animals and articles of clothing instead of geometric designs.

Figure 1 shows the theoretical predictions that would obtain from the two learning models. If the results of the present study support the hypothesis-selection model, there should be no performance differences in the postshift regardless of either the additional number of trials preceding it or the presentation method of the new dimension.

Hypothesis-Testing Model



Cue-Conditioning Model

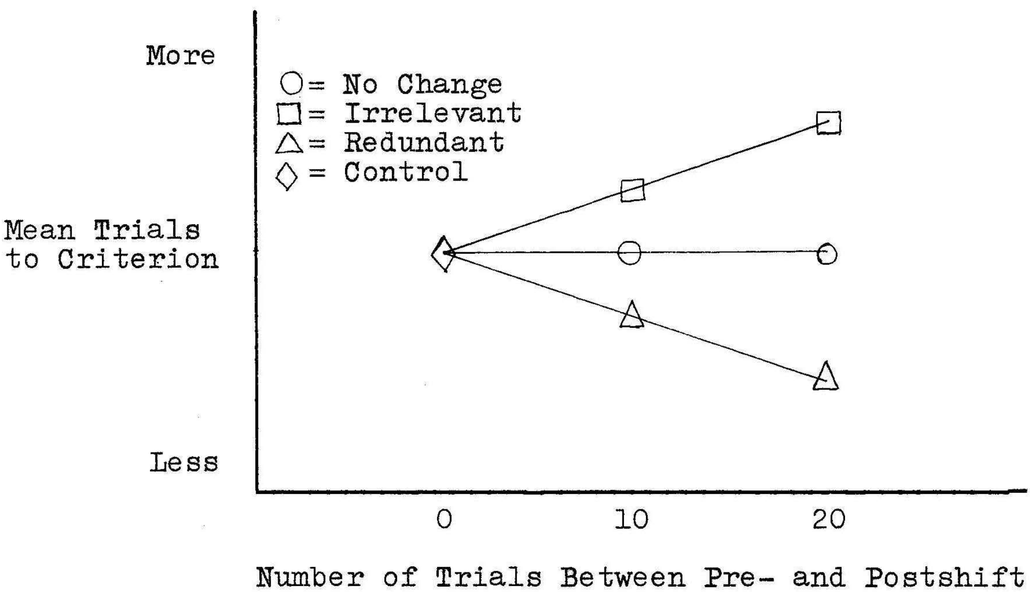


Figure 1. Theoretical Predictions for All Ages Based on Two Learning Models (Postshift Performance).

On the other hand, if the cue-conditioning model is upheld, there should be a differential ordering of performance among groups in the postshift. Specifically, the Ss who have the cue introduced redundantly (correlated 100% with the correct response) should make the fewest errors in the postshift phase. Those Ss who have the cue introduced irrelevantly (uncorrelated with the correct response) should make more errors. The magnitude of the difference in performance should be greater as the number of trials between the pre- and postshift phases increases. Neither learning model makes any allowance for cue novelty so the performance level of the control group (shifted immediately from the preshift to the postshift) and the no-change Ss who simply received 10 or 20 additional preshift trials, may be intermediate between the redundant and the irrelevant groups.

CHAPTER II

METHOD

Subjects. Forty-two Ss, representing three age groups, were used. Twenty-eight children were selected randomly from two classrooms at the Central Washington State College Laboratory School. Two age groups, fourteen Ss in each, had mean ages of 7.3 and 11.6 years. The fourteen adults were volunteers from an introductory psychology class at Central Washington State College. Within each age group Ss were randomly assigned and participated individually in an experimental session which averaged twenty minutes in length.

Apparatus. The stimuli consisted of four black animal and four black clothing forms mounted on plain, white 3 x 5 inch cards which were covered with transparent plastic. Animal forms were a dog, cow, horse, and a cat; the clothing forms were a boot, shoe, pants, and a shirt. Some of these stimuli were cross-hatched in white or stippled in white for use prior to the postshift phase while all the stimuli contained this feature in the postshift.

Other apparatus included a 10 in. high, wood partition to shield the decks of stimulus cards from S; a shoe box with two slots in the top into which S dropped the stimulus cards; and, data sheets for E to record the errors for each S.

Procedure. The S was seated across a table from the experimenter (E) and given instructions regarding the nature of the task. The 12-year-olds and adults were told the following:

> This is an experiment in concept learning. I will present some cards to you which you are to place in the box in front of you. Some cards will go in the right hand slot and some in the left, but there is a way to be right every time. After you drop the card in the slot, I will tell you whether you are "right" or "wrong." Of course, the placing of the first card will be a guess on your part. Remember, there is a way to be right every time. Any questions?

Instructions for the 7-year-olds were less formal and were preceded by a pre-training procedure which had to be utilized when it became evident, in running pilot Ss, that these 7-year-old Ss had extreme difficulty in solving the preshift phase. In this pre-training procedure, Ss were asked to identify the objects on the cards. Then they were required to sort the stimulus cards into two piles. If S did not sort the animals into one category and the clothing into the other, E assisted S by having him point out similarities and differences in the stimuli. For example, if S placed three animals and one clothing article into a pile, E pointed out to S that the clothing article did not belong in the group because it did not have a tail like the other three stimuli. The S was then required to regroup the stimulus cards into two piles. After this pre-training exercise, the directions were given and the experiment commenced.

The experiment required Ss to sort or classify a series of pictorial stimuli into two categories. The experiment consisted of three phases. In the first phase (preshift phase), S was required to classify animal stimuli into one category and clothing stimuli into the other. After a criterion of ten consecutive responses had been reached, each S was immediately transferred to one of the three conditions employed during the second phase. In this phase, form was still the relevant dimension but a texture dimension was introduced for some Ss. The added cue was irrelevant for one-third of Ss, redundant with the initially relevant dimension for one-third, and absent until the third phase (postshift phase) for the remaining Ss. Half of the Ss in each condition received 10 overlearning trials, while half received 20 overlearning trials. In the postshift phase, the texture dimension introduced during the second phase became the relevant dimension. Thus, Ss were required to sort the stimuli according to the new dimension (cross-hatching or stippling). This third and final phase continued until a criterion of ten consecutive correct responses had been made.

Design. All *S*s were treated the same in the pre- and postshift phases, but were randomly assigned to the experimental conditions employed between these two phases. The main conditions prior to the postshift phase constituted a 2 x 3 x 3 factorial design as depicted in Figure 2. There were either 10 or 20 trials between the pre- and postshift phases, three methods of introducing the new dimension (redundantly, irrelevantly, or absent), and three age groups (7, 12, and adult). A control group was also included as indicated in Figure 2. The *S*s in this group were transferred immediately from the preshift criterion to the postshift phase without any overlearning trials or any experience with the new dimension.

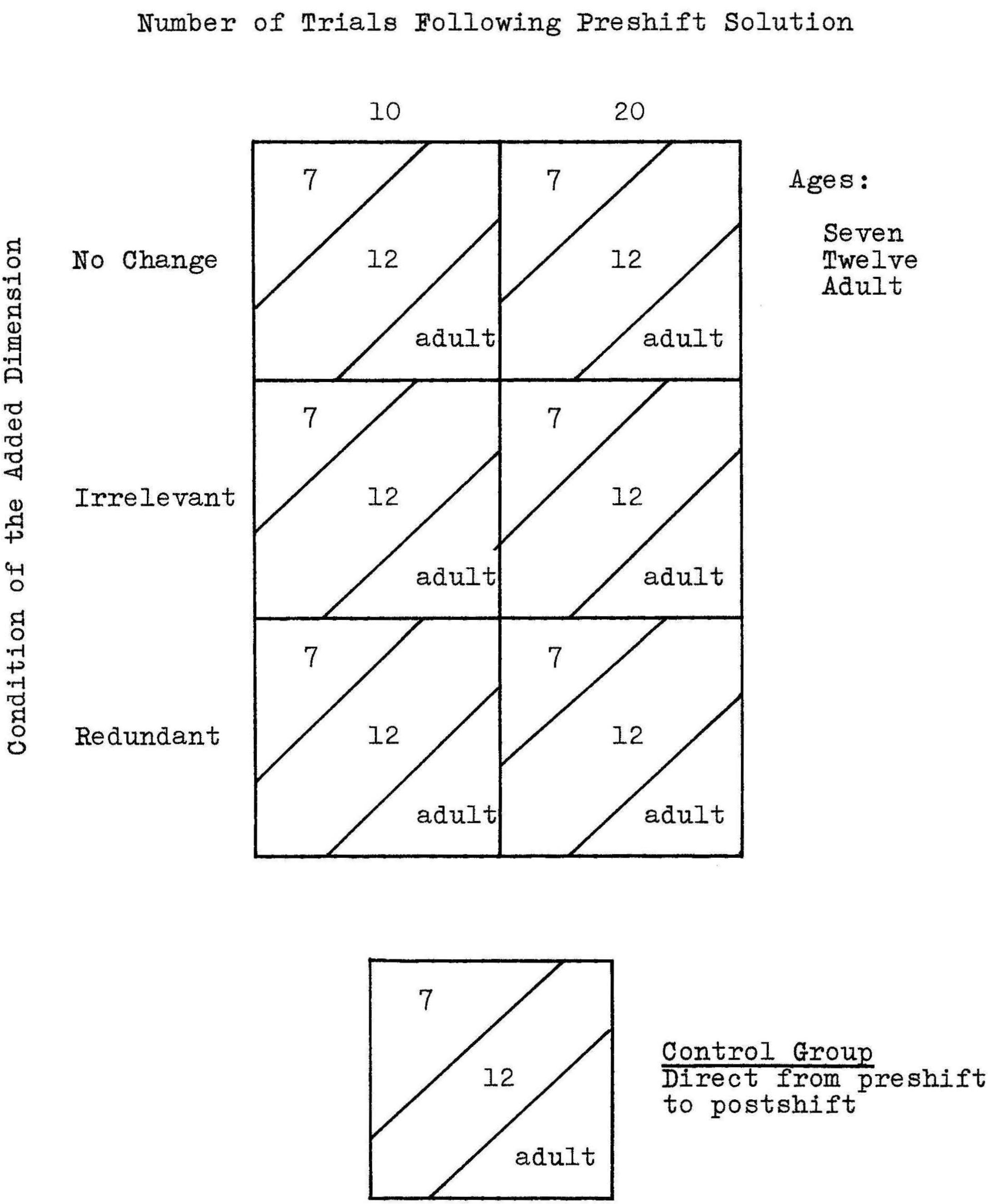


Figure 2. Experimental Conditions Between the Pre- and Postshift Phases.

CHAPTER III

RESULTS

The basic data consisted of both the number of errors made by each S prior to achieving a criterion of learning and the number of trials that it took each S to reach criterion. The criterion for solution of the problem was defined as 10 consecutive correct responses while errors were defined as incorrect categorization of stimuli prior to task solution. Appendices A and B include the raw data (trials and errors to criterion) from all Ss of the present experiment in the pre- and postshift phases, respectively.

The purpose of the experiment was to investigate the effect on postshift performance of adding a new dimension to stimulus patterns. Figure 3 depicts mean trials prior to solution for the three ages in the postshift phase as a function of the method of cue presentation between the pre- and postshift phases. Inspection of this graph indicates that the 7- and 12-year-old Ss in the irrelevant condition took the greatest number of trials to reach solution followed by the redundant, no change and control groups. For adults, the greatest number of trials were taken by those Ss in the redundant group followed by the no change, irrelevant and control groups.

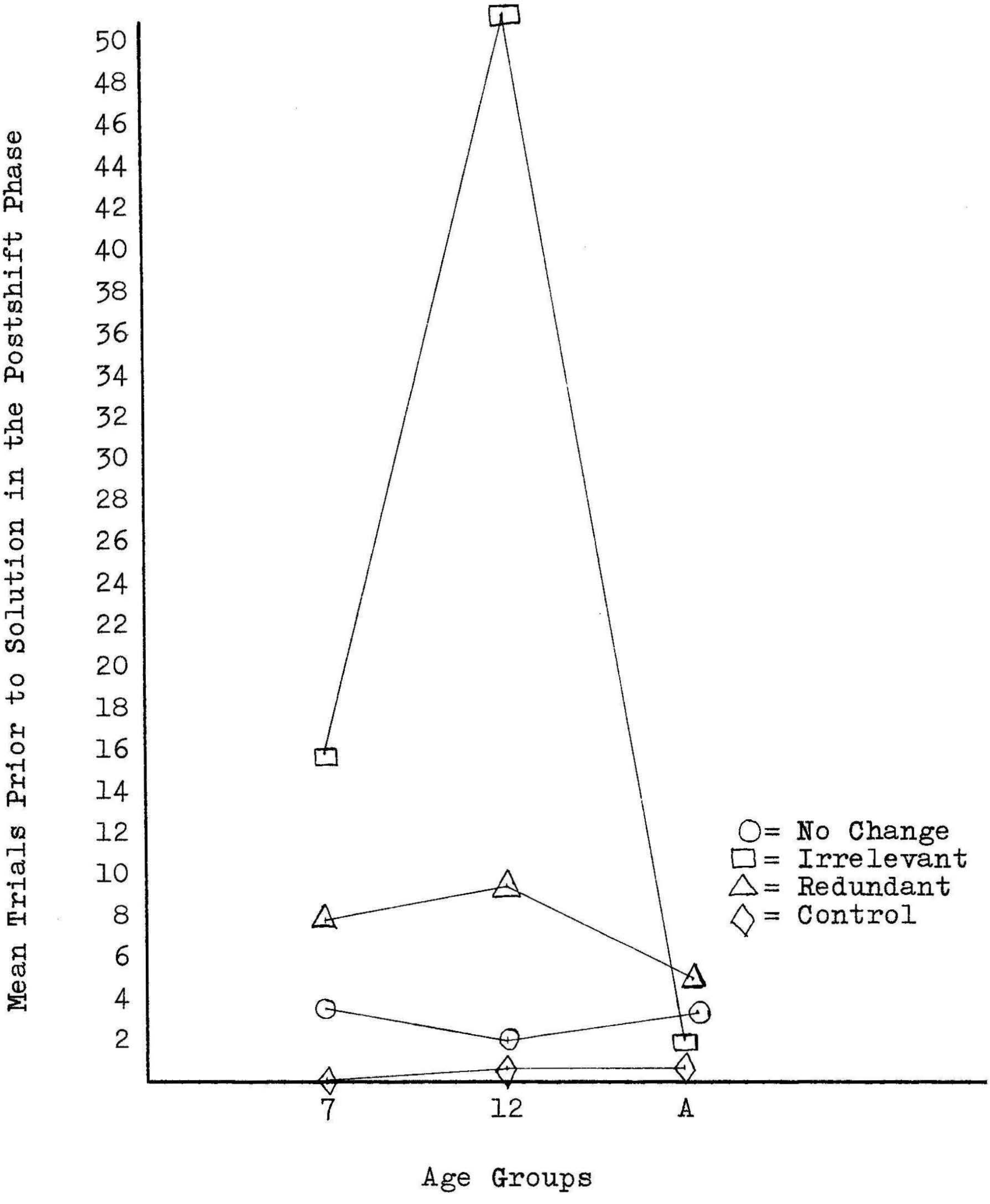


Figure 3. Mean Number of Trials Prior to Solution in the Postshift Phase for the Three Age Groups as a Function of Cue-Presentation Method Between the Pre- and Postshift Phases.

The analysis of variance of trials to criterion in the postshift phase is summarized in Table 1. The number of trials to criterion varied significantly ($p < .01$) with age of S and method of presentation of the new dimension. The table also shows that the Age X Method of Presentation interaction was significant ($p < .01$). The number of trials between the pre- and postshift phases had no reliable effect. However, there was a significant Age X Method of Presentation X Number of Trials interaction ($p < .01$).

Figure 4 depicts the mean number of errors prior to solution for the three ages in the postshift phase as a function of the method of cue presentation between the pre- and postshift phases. This graph is consistent with the data reported in Figure 3 except for the adults. Adult Ss in the redundant group made the most errors prior to solution followed by the irrelevant, no change, and control groups.

An analysis on errors prior to criterion in the postshift phase was performed. Table 2 indicates that method of presentation was the only variable which reached significance ($p < .05$).

To investigate comparability of initial performance, analyses of variance were performed on the preshift data. Table 3 presents the analyses of trials and errors prior to task solution which indicates that none of the variables had a reliable effect.

Table 1

Analysis of Variance on Trials to Criterion in the Postshift Phase

Source	df	MS	F
(A) Age (7, 12, A)	2	789.37	7.18**
(B) Condition (N, I, R)	2	1259.03	11.45**
(C) Trials (10, 20)	1	272.25	2.48
A X B	4	765.94	6.96**
A X C	2	185.08	1.68
B X C	2	127.59	1.16
A X B X C	4	660.17	6.00**
Error Term	18	109.97	---

**$p < .01$.

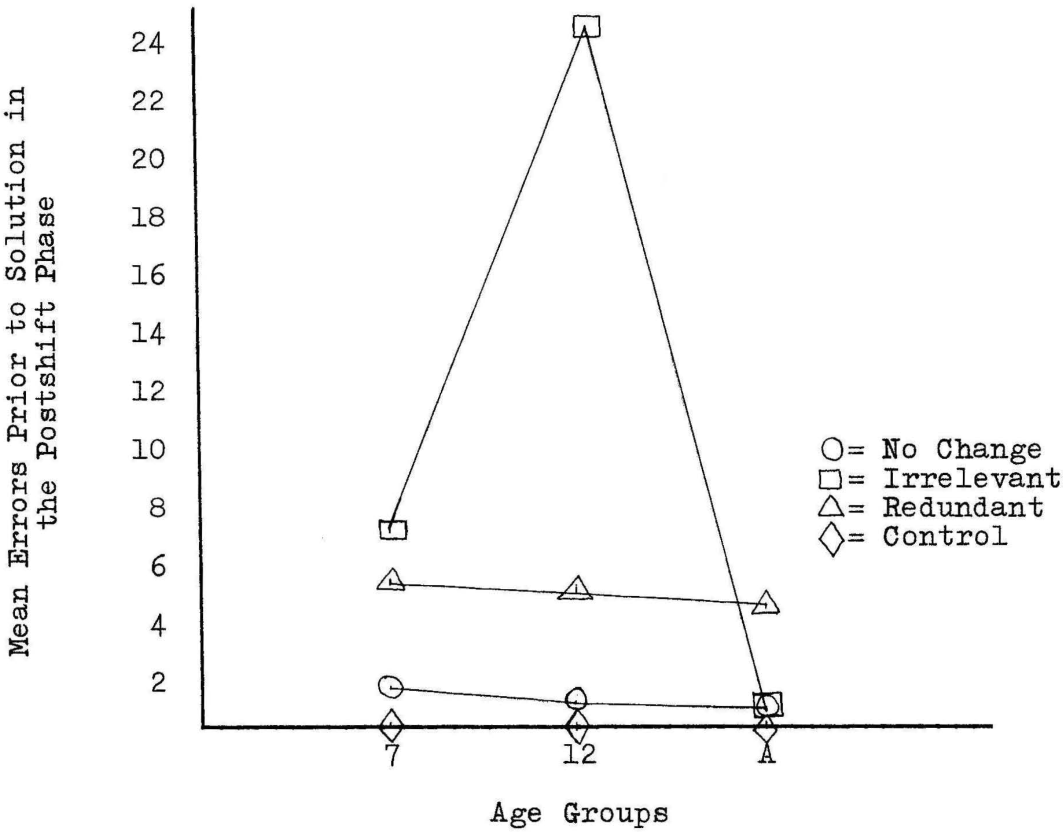


Figure 4. Mean Number of Errors Prior to Solution in the Postshift Phase for the Three Age Groups as a Function of Cue-Presentation Method Between the Pre- and Postshift Phases.

Table 2

Analysis of Variance on Errors to Criterion
in the Postshift Phase

Source	df	MS	F
(A) Age (7, 12, A)	2	179.20	2.55
(B) Condition (N, I, R)	2	269.37	3.84*
(C) Trials (10, 20)	1	169.00	2.41
A X B	4	182.74	2.60
A X C	2	85.09	1.21
B X C	2	77.54	1.11
A X B X C	4	74.93	1.07
Error Term	18	70.19	---

*$p < .05$.

Table 3

Analysis of Variance on Trials and Errors to Criterion in the Preshift Phase

Source	df	Trials MS	Errors MS	Trials F	Errors F
(A) Age (7, 12, A)	2	70.59	13.00	1.21	1.50
(B) Condition (N, I, R)	2	70.33	8.59	1.21	.99
A X B	4	74.42	15.83	1.28	1.82
Error Term	27	58.27	8.69	--	--

As indicated in Figures 3 and 4, the most divergent effect occurred in the 12-year-old group. Table 4 presents the analysis of trials prior to task solution in the postshift phase for the 12-year-old group. It indicates that number of trials was significant ($p < .05$) and that the method of presentation variable was also significant ($p < .01$). Further, the table shows that Number of Trials X Method of Presentation interaction was significant ($p < .01$).

Table 5 presents the analysis of errors prior to problem solution in the postshift phase for the 12-year-old group. It indicates a pattern of results consistent with that indicated in Table 4.

Analyses of trials and errors to criterion in the postshift phase for both the 7-year-old and adult groups indicated that neither number of trials nor method of presentation had a reliable effect. Further, the Number of Trials X Method of Presentation interaction was nonsignificant.

To further analyze this significant effect in the 12-year-old group in the postshift phase, a t test was performed between the irrelevant and redundant groups on both trials and errors to criterion. The t test difference on mean trials was significant beyond the .05 level but the mean error difference was unreliable.

In order to further illuminate any age-specific

Table 4

Analysis of Variance on Trials to Criterion in the Postshift Phase for the 12-Year-Olds

Source	df	MS	F
(A) Trials (10, 20)	1	560.33	7.62*
(B) Condition (N, I, R)	2	2612.25	35.54**
A X B	2	1283.59	17.46**
Error Term	6	73.50	---

* $p < .05$.

**$p < .01$.

Table 5

Analysis of Variance on Errors to Criterion in the Postshift Phase for the 12-Year-Olds

Source	*df*	*MS*	*F*
(A) Trials (10, 20)	1	320.34	12.01 *
(B) Condition (N, I, R)	2	595.09	22.31**
A X B	2	564.08	21.15**
Error Term	6	26.67	

* $p < .05$.

**$p < .01$.

differences in the postshift phase performance levels, a backward learning curve was plotted 10 trials prior to criterion for each age group. Figure 5 depicts the percentage of correct responses made by Ss in the three age groups across all conditions. The most striking aspect in this figure demonstrates that adult performance remained around a chance level prior to problem solution. In marked contrast to this, however, the plotted performance levels of the 7- and 12-year-old Ss illustrates an inconsistent pattern of responding prior to criterion. Specifically, the younger Ss were never consistently above or below a chance level of responding prior to criterion.

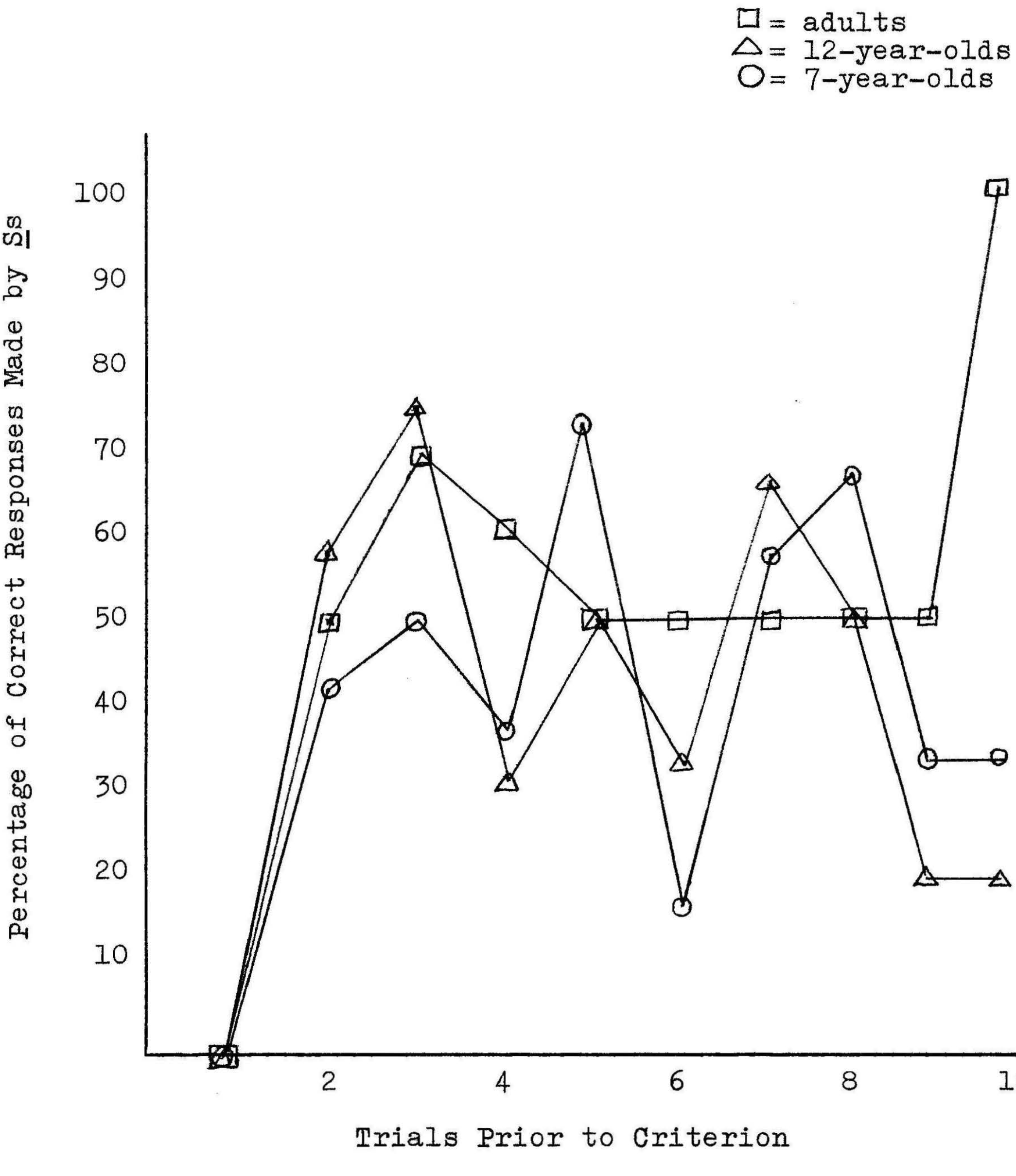


Figure 5. Learning Curve Plotted Backward Beginning with the Last Error Before Criterion. (Each Plotted Point Represents the Total Number of Correct Responses Divided by the Number of Ss Who Are Still Working Toward Solution in the Postshift Phase.)

CHAPTER IV

DISCUSSION

The results of this experiment failed to unequivocally support either the hypothesis-testing or the cue-conditioning models of concept learning. The hypothesis-testing model (Bower & Trabasso, 1963) predicts that there should be no difference in performance in the postshift phase either as a function of the number of trials or the method of presentation of the added dimension between the pre- and postshift phases. In contrast, the cue-conditioning model (Bourne & Restle, 1959) implies a definite effect on performance as a function of the method used when presenting a new dimension. Introduction of relevant cues as well as the number of trials following the preshift phase should facilitate performance in the postshift phase.

In this study, method of presentation had a reliable effect in both trials and errors prior to criterion. Analyses of the data by age group indicated that method of presentation had a significant effect only for the 12-year-old group. Figures 3 and 4 lend support to the cue-conditioning theoretical prediction (see Figure 1) since Ss in the 12-year-old irrelevant group performed at a significantly lower level than those Ss in the redundant group.

A trend in this direction was observed in the 7-year-old group but was not significant.

The cue-conditioning model also predicts that the number of overlearning trials following the preshift phase will affect performance in the postshift phase. This prediction was confirmed only for Ss in the 12-year-old group. The number of overlearning trials between the pre- and postshift phases did not have a reliable effect on performance in either the 7-year-old or adult groups. Thus, only the 12-year-old group supported this prediction of the cue-conditioning model since they alone showed an effect due to practice; i.e., those Ss in the 20 trial, irrelevant condition prior to the postshift showed a marked decrement in postshift performance, while those Ss in the 20 trial, redundant condition showed a facilitative effect.

Age level was a significant source of variability for both the number of trials and errors prior to criterion measures. Analyses of the data by age groups showed that only the 12-year-olds were significantly differentiated by the method of presentation, number of trials, and the Method of Presentation X Number of Trials interaction.

Thus, the data of this experiment are equivocal with respect to clear-cut support of either concept learning model. Certain aspects of these results clearly support the cue-conditioning model. However, one prediction necessary for the support of the cue-conditioning model was not sustained. That is, the number of overlearning trials between the pre- and postshift phases should facilitate or inhibit performance in the redundant or irrelevant conditions, respectively, but this prediction was supported only in the 12-year-old group.

On the other hand, the results of this study did not lend total support to the hypothesis-testing model which predicts no difference between groups either as a function of method of presentation or number of trials between phases. Figures 3 and 4 indicated that there were differences in mean trials and mean errors prior to solution for all ages as a function of method of cue presentation between the pre- and postshift phases. These differences were most apparent for the 12-year-old Ss in the irrelevant condition.

However, the hypothesis-testing model implies that S's performance will remain around chance level; i.e., 50% correct responding until correct solution is reached. To ascertain whether this implication was supported in the present study a backward learning curve was plotted. A chance level of responding prior to criterion is predicted by the hypothesis-testing model while a gradual reduction in errors from 50% to 0% would be more in line with the cue-conditioning model. Figure 5 suggests that the adults responded around the 50% level until correct solution was obtained. Moreover, the data reflected in the curve indicates that this chance level of responding was not evident in the 7- and 12-year-old performance levels. It is difficult to account for this inconsistency between age groups. Perhaps children are more erratic in their behavior on this type of task and operate both above and below the chance level of responding prior to criterion. Only the performance of adult Ss plotted on this curve is consistent with the notions of the hypothesis-testing model.

The results of this study are in partial agreement with those of Braley (1962) since the no-change Ss and the control Ss in the 7- and 12-year-old groups did perform better in the postshift phase compared to those Ss receiving prior exposure to the new dimension. However, this difference was statistically reliable only in the 12-year-old group.

The study by Braley and Johnson (1963) was not fully supported. Braley and Johnson (1963) found no differential effect on performance in their Stage III as a function of the number of trials presented in Stage II. In the present study, this result was supported by the performance levels of the 7-year-olds and adults but not by the performance of the 12-year-olds.

The results of this study support the findings of Guy et al. (1966) since there was a differential ordering between the groups in a manner consistent with the cue-conditioning model. However, this result was reliable only from the data of the 12-year-olds but the trend was also supported by the 7-year-old group. The backward learning curve plotted for the adult group was also similar to that reported by Guy et al. (1966). However, in the present study the children's performance levels plotted on a backward learning curve did not support either learning model. It is impossible to account for this result from the present data but one might speculate that the learning strategies used by the children may have differed widely causing such a result.

The disparity in results between this study and previous studies may be attributed to procedural differences. The stimuli used in the previous studies consisted of geometric figures while the present study utilized less complex stimuli. In the studies by Braley (1962) and Braley and Johnson (1963) two novel dimensions were involved (background and an alphabetical letter) while in the present study only one dimension was added.

Another procedural difference involved the method of stimulus presentation. Braley (1962) and Braley and Johnson (1963) used a simultaneous method of presentation in which the S simply had to choose between two instances. However, the present study used the method of successive presentation. Bruner, Goodnow, and Austin (1956) have shown the latter method of presentation to be more difficult than the former because of an increase in the S's memory load.

Minor variables that were uncontrolled in the present experiment which may have contributed to the results include a limited sample, modified instructions for the younger Ss, and the elimination and replacement of certain Ss. The Ss comprising the 7- and 12-year-old groups were selected from the campus laboratory school. This selectivity may limit the generality of the results. Similarly, the adult Ss were solicited from an introductory psychology class and were given class points for their participation in the experiment. The selectivity inherent in this procedure may also limit general applicability of the results.

Instructions for the Ss varied between age groups. The 7-year-old Ss participated in a pretraining procedure prior to receiving the instructions. Further, the instructions for this age group were less formal than those for the 12-year-old and adult Ss. While it is true that instructions are an important independent variable, there is some indication as reported by Maltzman and Morrisett (1945), that instructional set in problem solving studies may be less influential than typically thought. Further justification of altering instructional sets is offered by Kendler, Kendler, and Marken (1962):

> Although it was necessary to alter the experimental procedure at different age levels, there is no reason to believe that these modifications exerted differential effects on the CO [conceptual organization] ratio. Developmental research often requires

> modifying experimental procedures to cope with special problems of different age groups. The influence of these procedural variations can probably be minimized, if not eliminated, if developmental processes are measured not in terms of changes in a single response event but instead as changes in a relationship between independently measured responses (e.g. R[reversal] and HR [half-reversal] shifts) each of which is equally influenced by age-specific procedures (p. 234).

Data from forty-two Ss were used in this study. Nine Ss were eliminated and replaced to complete the sample of 42. One criterion for rejection was failure to solve the preshift phase after 80 trials or failure to solve the postshift phase after 120 trials. The greater number of trials before rejection was established for the postshift phase because of the apparent greater difficulty in problem solution. Two Ss were rejected because they were nonsolvers in the preshift phase and two because they were nonsolvers in the postshift phase. Prior knowledge of the experiment caused rejection of one S and E error in rejection of another S. Three Ss were eliminated because their performance level varied widely from that of the other Ss within their cells.

Although there were some minor variables that were not controlled, the present study indicated that the 12-year-old group employed a strategy suggested by the cue-conditioning model but the model did not receive unqualified support in either of the other two age groups. While this study indicated that the 12-year-olds performed in a manner consistent with the cue-conditioning model, there was not enough evidence to refute the hypothesis-selection model of learning. A larger sample may tend to make any developmental differences more apparent.

CHAPTER V

SUMMARY

The purpose of the present experiment was to investigate the effect on postshift performance of adding a new dimension to stimulus patterns after S had attained a solution in the preshift phase but before an extradimensional (ED) shift was initiated. Two models of concept identification make different theoretical predictions concerning the outcome of such an experiment. The hypothesis-testing model (Bower & Trabasso, 1963) implies that no difference will occur in postshift performance either as a function of the number of trials or the presentation method of the new dimension. On the other hand, the cue-conditioning model (Bourne & Restle, 1959) implies a definite effect on performance both as a function of the method and the number of trials used between the pre- and postshift phases.

The present study was designed to discriminate between these two models; i.e., hypothesis-testing and cue-conditioning, and to ascertain whether different learning strategies were related to developmental levels. In order to make apparent any developmental differences, Ss in the sample represented 7- and 12-year-olds and adults.

Results of the study indicated that method of

presentation had a significant effect only for the 12-year-old group. A trend in this direction was observed in the 7-year-old group but was not significant. The number of overlearning trials between the pre- and post-shift phases was reliable for the 12-year-old Ss but not for those Ss in the 7-year-old and adult groups.

Age level was a significant source of variability for both the number of trials and errors prior to criterion measures. Analyses of the data by age groups showed that only the 12-year-olds were significantly differentiated by the method of presentation, number of trials, and the Method of Presentation X Number of Trials interaction.

A backward learning curve plotted 10 trials prior to criterion indicated that adult Ss responded around the 50% level until correct solution was obtained. This chance level of responding was not evident in the 7- and 12-year-old groups. Thus, only the performance of the adult Ss plotted on a backward learning curve was consistent with the notions of the hypothesis-testing model.

This study failed to lend unqualified support for either learning model. The results indicated that the 12-year-old group employed a strategy suggested by the cue-conditioning model but the model did not receive unqualified support in either of the other two age groups. Further investigation of the two learning models is needed.

Specifically, chronological age may be an important variable to consider in evaluating the two theories of learning.

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APPENDICES

APPENDIX A

PRESHIFT DATA--TRIALS AND ERRORS TO CRITERION

Cue Presentation Method Between
Pre- and Postshift Phases

Ages and Number of Trials Between Pre- and Postshift Phases		No Change		Irrelevant		Redundant	
		Trials	Errors	Trials	Errors	Trials	Errors
7	10 Trials	0 1	0 1	0 2	0 2	0 0	0 0
	20 Trials	0 10	0 1	0 0	0 0	0 0	0 0
12	10 Trials	1 40	1 17	0 0	0 0	0 0	0 0
	20 Trials	11 0	5 0	0 1	0 1	15 0	4 0
Adult	10 Trials	0 0	0 0	0 0	0 0	0 2	0 1
	20 Trials	0 0	0 0	1 1	1 1	20 0	7 0

Control

	Trials	Errors
7	0 0	0 0
12	0 0	0 0
Adult	0 0	0 0

APPENDIX B

POSTSHIFT DATA--TRIALS AND ERRORS TO CRITERION

Cue Presentation Method Between
Pre- and Postshift Phases

Ages and Number of Trials Between Pre- and Postshift Phases		No Change		Irrelevant		Redundant	
		Trials	Errors	Trials	Errors	Trials	Errors
7	10 Trials	7 0	2 0	0 45	0 19	7 0	4 0
	20 Trials	0 5	0 4	2 16	2 6	7 7	9 5
12	10 Trials	2 2	1 0	27 16	8 1	10 19	6 9
	20 Trials	0 2	0 1	63 89	34 50	2 2	0 2
Adult	10 Trials	0 1	0 0	3 3	2 1	0 0	0 0
	20 Trials	0 12	0 3	2 0	0 0	22 0	15 0

Control

	Trials	Errors
7	0 0	0 0
12	0 1	0 0
Adult	1 0	0 0