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ABSTRACT

This study examines the effects of initial response training and criterion training on the discrimination shift performance of preschool children; results are discussed in terms of differing theoretical orientation. After an initial task involving either criterion training or response training, 109 subjects were presented with either intradimensional shift (ID) or extradimensional shift (ED) problems. Subjects who failed to learn the criterion training task (nonlearners) were found to learn the ED shift more quickly than the ID shift. These results are best explained in terms of mediation theory, since an explanation based on the single stage process would require that preferences or dimensional dominance increased the initial habit strength for the irrelevant cue or dimension. Attention theory could also explain these results, because attention to relevant and irrelevant dimensions determines the ease of shift learning. The response-trained group, after 10 trials of reinforced motor training, learned a reversal (ID) shift more rapidly than the ED shift. This finding can be explained in terms of attention theory, because alteration of orienting probabilities would result in shift performance demonstrated by children who went through all the work of attaining criterion. Since such results are not well explained by mediation theory, the attentional model of children's learning is supported. (GO)

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THE EFFECT OF TWO TYPES OF INITIAL TRAINING ON DISCRIMINATION SHIFTS BY PRESCHOOL CHILDREN[1]

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Theory and method interact in the area of human problem-solving. Theoretical assumptions originally stimulated the use of a discrimination shift paradigm, while research using that paradigm has, in turn, guided the reformulation and development of theory. The focus of the discrimination shift paradigm is the transfer of learning from an initial discrimination task to a second discrimination or shift task. The stimuli used in both learning tasks usually incorporate two or more binary-valued dimensions. Children initially learn that one cue is rewarded or correct, after which the reinforcement contingency is altered so that a previously irrelevant cue is now correct on every trial. If the relevant cues in the two learning tasks are from different dimensions (e.g., green, a color, is correct in initial learning while large, a size, is correct in the shift task), the shift is labelled extra-dimensional, ED, or nonreversal. In an intradimensional, ID, or reversal shift, the same dimension is relevant throughout both tasks, but the initial reward contingency is reversed. (That is, "small" is correct initially and then "large" is made correct in the shift task, while color continues to be irrelevant). Typically, subjects must attain a specified criterion of N correct responses in each task in order to assume that that task has been learned. Subjects who do not reach the criterion are considered to be nonlearners.

Typically, children who do not reach criterion on the original learning task of a shift paradigm are dropped from the experiment (e.g., Caron, 1969). Sometime, however, investigators have used a "special training" procedure such as telling the child the solution in order toavoid bias through selective sampling of subjects by eliminating nonlearners (e.g., Dickerson, 1966).Children who learn an initial discrimination might be responding to their preferred dimension, thus attaining criterion. Nonlearners, on the other hand, might have been assigned (presumably by

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chance) to their nonpreferred dimension and were unable to attain criterion. Thus children who are administered the second task will be overrepresented by those who responded to the preferred dimension in initial learning. Such children should continue to respond to that dimension, facilitating reversal learning. Several studies have shown that learning is faster when the preferred dimension is relevant (c.f., Smiley & Weir, 1966; Seitz & Weir, 1971; Wolff, 1966). The special training procedures used by other investigators tries to overcome bias by promoting criterion performance by children responding to non-preferred dimensions. Blank (1966) found that such specially trained children typically learned an ID shift more slowly, supporting the assumption that the absence of original task nonlearners in the shift task can bias the results in favor of reversal shifts being easier.

Precisely how such special training facilitates performance has yet to be defined, but the two theoretical positions most relevant to discrimination shift learning--the mediation theory proposed by the Kendlers (1962, 1970) and the attention theories proposed by Zeaman and House (1963), Sutherland (1959) and others--are both concerned with the relative difficulty of the reversal and nonreversal shifts. Attention theories seem to incorporate the behavior of nonlearners more easily. Assume that the child learns a chain of at least two responses when solving a multidimensional discrimination. First, the child learns to attend to the relevant dimension. The correct instrumental response for the positive stimulus of the relevant dimension then is learned. The relative difficulty of the reversal and nonreversal shifts is related to the probability of attending to both the relevant dimension in the shift task and using the correct instrumental response in that task. Since the relevant dimension for a reversal is the same in both tasks, the probability of attending is high and only the instrumental response must be changed. An ED or nonreversal shift required that both attending and instrumental responses be relearned. The original task nonlearner has probably not learned to attend to the relevant dimension. Preferences, or perseveration responses, may both be examples of attending

to an inappropriate simulus or dimension. Special training should be successful to the extent that it increases the probability of attending to the relevant dimension.

Mediation theory is less clear about nonlearning. The Kendlers (1962, 1970) postulate two levels in the ontogeny of learning. First comes direct stimulus control of behavior through learned S-R associations. Since fewer simple approach and avoidance associations need to be relearned in the ED shift, it is learned more rapidly by young children. The second level incorporates a two-stage mediation model which accounts for the behavior of subjects six years and older, who learn a reversal more quickly. The external stimulus evokes an internal, usually covert, mediating response that produces its own internal (covert) stimulus or cue for an external response. The reversal shift is learned more quickly by older children because the same mediating response is appropriate for both initial and shift learning tasks. In the 1970 paper, the Kendlers incorporated the findings of dimensional preference shift experiments into mediation theory. Dimensional preferences were interpreted as increased behavioral potentials applicable to simple S-R associations. If nonlearners are assumed to be single-unit S-R responders or non-mediators, they could eventually learn a discrimination after overcoming initial differences in excitatory strength (i.e., preferences). Special training would be effective only to the extent that excitatory potentials were manipulated or changed. On this basis, it could be concluded that nonlearners could not be mediators if preference or perseveration behavior was in evidence.

The purpose of the present paper was to examine the effect of a minimal type of special training on children's discrimination shift performance. Additionally, we were concerned with the effect of including nonlearners in shift experiments. Finally, in order to provide some test of mediation theory hypotheses and attention theory hypotheses, preschool children served as subjects. Children at this age should demonstrate single unit performance (nonreversal easier than reversal) according to the Kendlers. Since attention theorists generally do not postulate

age differences, they would predict that the reversal would be easier. From our own point of view, a minimal training procedure--if designed to increase the probability of attending to the relevant dimension without altering response strengths--should produce learning and performance similar to that of other children who reach criterion. Children who fail to reach criterion, on the other hand, when administered a shift task should be quite different from learners. Presumably these children never learned to attend to the correct dimension, and probably continued to attend to the incorrect dimension. Thus, they should reverse the pattern of results seen with children who learn. Mediation theory seems to call for no difference in learning reversal or nonreversal shifts by original task nonlearners. Again, after fifty or more trials, the strengths of the S-R units associated with both dimensions and all cues should be about equal from equal reinforcement.

Specifically, we took an attentional point of view, and expected that children who learned the initial task would learn a reversal more quickly. For children whose probability of attending to the relevant dimension was increased by special training, a reversal should also be easier. Nonlearners, however, should learn the nonreversal shift more quickly.

METHOD

Subjects. 109 preschool children (61 male, 48 female) ranging in age from 40-66 months (mean CA, 55.9 mos.) participated. The children were from a day care center and an university nursery school. Ss in both groups were predominantly white, middle class and from a small Midwest city.

Procedure. The children were assigned randomly to the type of initial training condition with approximately one-third (n=37) in the response-trained condition and the balance (n=72) in the criterion-trained condition. For the criterion-trained Ss, a standard two-choice discrimination procedure was used in the initial task. The criterion was 10 consecutive correct responses within a maximum of 48 trials. For the

response-trained condition, the initial task was ten trials of reinforced motor training. This presumably directed the attention of the child to the relevant cue. The E pointed to the correct stimulus telling the child to "put your finger on this one." The E did not label the stimulus in any way. When the S pointed to the cue as directed, positive reinforcement was given.

Within the initial training task conditions, approximately half the Ss were assigned randomly to each shift type, ID or ED. For all groups, the shift task criterion was 10 consecutive correct responses within a maximum of 48 trials. The conditions were counter-balanced for cues reinforced in both tasks. The stimuli varied along two dimensions, each with two cue values: size (large, small) and color (green, orange). The stimuli objects were made of construction paper cutouts which were mounted in pairs on solid white 5" x 8" index cards. Throughout, all children were given noncorrective positive reinforcement (the verbal statement "right" and a marble) for each correct response. A summary of the experimental design is presented in Figure 1.

INITIAL LEARNING TASK		SHIFT TASK
TYPE OF TRAINING	PERFORMANCE LEVEL	
Criterion-Training (CT) n=72	Learners (CT-Ls) n=31	ID n=17
		ED n=14
	NonLearners (CT-NLs) n=41	ID n=20
		ED n=21
Response-Training (RT) n=37		ID n=19
		ED n=18

RESULTS

The dependent variables for both the initial learning and shift tasks were the mean Trial-of-Last-Error (TLE) and mean Total Error (TE) scores. Separate analyses indicated a similar pattern of results, so only the TLE analyses will be given here.

Two initial training level groups were formed artificially from the Criterion-Training condition. Subjects within the CT condition were assigned to either the Learners (Ls) or Nonlearners group. One-way ANOVs on the chronological age data indicated no significant difference between either CT condition, or between these and the Response-Trained group. (Table 1)

Table 1. CA data for each initial training group.

	Mean	S.D.	range
CT-Ls	55.90 mos.	8.27 mos.	41-66
CT-NLs	56.07	6.51	44-66
RT	55.87	7.64	40-66

Initial Learning Task. Forty-one (57%) of the children in the CT condition failed to learn the initial discrimination. This figure was consistent with the percentages of nonlearners reported by other investigators (e.g., Eimas, 1966; Trabasso, Deutsch & Gelman, 1966: Brown & Scott, 1972). The means of the groups on the initial learning task reflected the post-experimental division of the subjects.

Table 2. Initial Learning Task Data: TLE and TE scores.

		TLE			TE		
GROUP	n	mean	S.D.	range	mean	S.D.	range
CT-Ls	31	12.48	12.67	0-38	6.03	5.89	0-19
CT-NLs	41	47.37	1.04	43-48	24.58	6.15	15-48

The mean error scores over blocks (4 blocks of 12 trials each) are presented in Figure 2. Inspection of the figure discloses a decrease over trials for the CT-Ls. The error scores for the CT-NLs decreased slightly only over the first two trials blocks.

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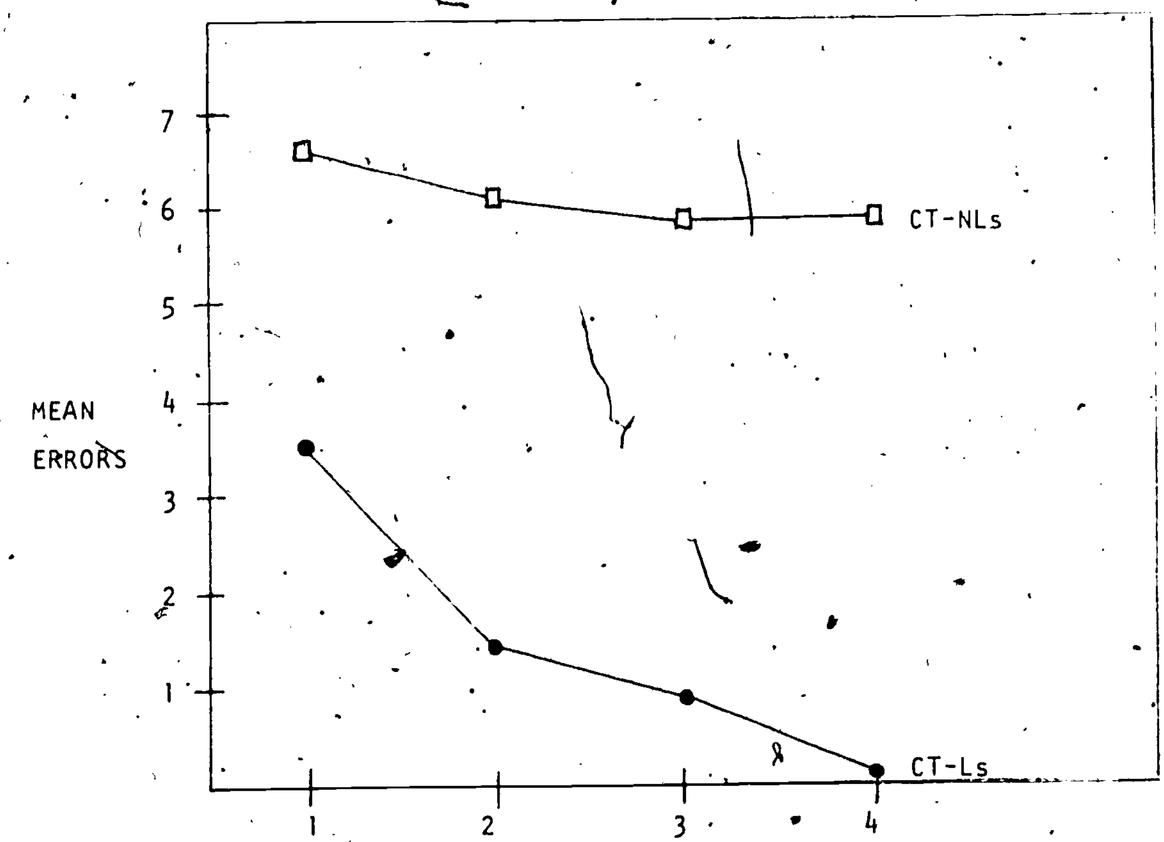


Figure 2. Mean errors over blocks for the initial learning task.

The choice responses of the children who did not attain criterion on the initial learning task were examined to determine if learning strategies had been used. Nineteen of the 41 CT-NLs utilized a consistent strategy (perseveration). Eleven children chose one of the irrelevant stimulus cues, and the other 8 responded to a position cue. The response protocols of the other CT-NLs were not categorizable.

Shift Task Learning. The mean Trial-of-Last-Error scores (Table 3) on the ID shift were lower for the CT-Ls and RT conditions. The pattern was reversed for the CT-NLs, who did better on the ED shift.

Table 3. Shift task: TLE data for all shift groups.

	ID			ED		
	mean	S.D.	range	mean	S.D.	range
CT-Ls	17.82	18.34	0-48	41.86	11.58	13-48
CT-NLs	41.30	14.65	0-48	26.52	20.48	0-48
RT	24.95	19.78	0-48	37.50	17.34	0-48

A least squares 3 x 2 Analysis of Variance for unequal cell frequencies (Winer, 1962) was performed with the mean TLE scores as dependent variable. The independent variables were Initial Training Level (Criterion Learning, Noncriterion Performance, Response-Training) and Shift Type (ID, ED). The interaction between the type of shift task and initial training performance level was significant (Table 4).

Table 4. Shift Task: ANOV for Initial Training Level and Shift Type

Source	SS	df	MS	F	p
A (Shift Type)	819.24	1	819.24	2.66	
B (Initial Training Level)	398.82	2	199.41	0.65	
AB	7308.41	2	3654.20	11.85	.001
Error	31755.07	103	308.30		

The intergroup differences were examined using Duncan's Multiple-Range Test (Bruning & Kintz, 1968). Within the CT-Ls and RT groups, performance was significantly better on the ID shift. The CT-NLs did significantly better on the ED shift.

The error data were analyzed in a least squares 3 x 2 x 4 ANOV with repeated measures (Winer, 1962). The variables Initial Training Level and Shift Type, plus Blocks over Trials (4 blocks of 12 trials each) were involved. Only Trials yielded a significant main effect. The interaction between the shift type and initial training level (confirming the results of the 3 x 2 analysis of TLE scores reported above), and the triple interaction among shift type, ~~levels of~~ initial training, and trials were also significant. The data representing the triple interaction are presented in Figure 3. Two groups of curves are distinguishable. One group of curves (CT-Ls-ED, CT-NLs-ID, RT-ED) maintained a high error level fairly consistently throughout the shift task. The other group of curves decreased over all 4 blocks. The performance of the two NLs groups contributed most to the significant interaction.

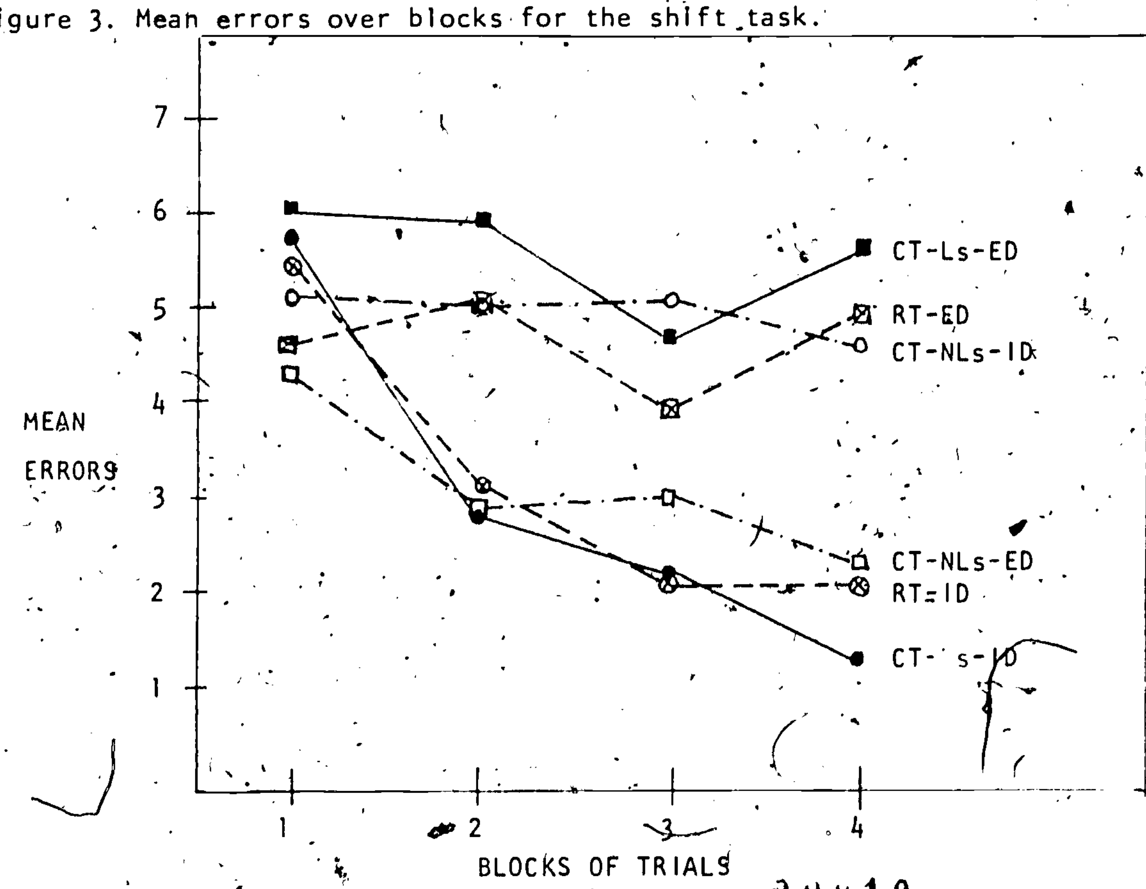
The response patterns were analyzed for all nonlearners on the shift task. Again, as in the initial learning task, many of the children evidenced perseveration patterns to either an irrelevant cue or position. Six NLs attained criterion on the

shift task because, by chance, they were switched to the cue perseverated on the initial task and thus learned the shift task immediately. Four of these Ss were in the ED group and could account for that group's better performance.

Table 5. ANOV on Shift Type, Initial Training Level, and Blocks of Trials for the shift task.

Source	SS	df	MS	F	p
Between Subjects	6396.50	108			
A (Initial Training Level)	3.47	2	1.74	0.07	
B (Shift Type)	4.99	1	4.99	0.20	
AB	3903.27	2	1951.63	79.28	.001
Subjects within groups	2535.51	103	24.61		
Within Subjects	1456.75	327			
C (Trials)	106.25	3	35.42	9.26	.001
AC	18.77	6	3.13	0.82	
BC	26.55	3	8.85	2.31	
ABC	123.96	6	20.66	5.40	.001
C x Subjects within groups	1181.22	309	3.82		

Figure 3. Mean errors over blocks for the shift task.



DISCUSSION

Only those children who failed to learn the initial task learned the ED shift more quickly. Both the learners and response-trained children learned the reversal more quickly. Other investigators (e.g., Caron, 1969; Dickerson, 1966) also have found that young children do learn an ID shift more rapidly, so these findings are not unique.

Mediation theory explains the behavior of the nonlearners. The single-stage process would incorporate such behavior into its scope as a function of excitatory tendency only if preferences or dimensional dominance increased the initial habit strength for the irrelevant cue or dimension. Since the Kendlers assumed that children exhibiting preference behavior are responding according to a single-stage process, and single-stage learners learn ED shifts easier, the findings are consistent so far. Attention theories also predict our results thus far. Attention to relevant and irrelevant dimensions determine the ease of shift learning in the manner our results have shown.

The crucial group is the response-trained group. The attention theories can account for the performance of the response-trained children more easily than can mediation theory. Response training led to shift learning identical to that by children who reached criterion. Responding to the "initial learning task" for these children was passive. They were told only to point to a specific colored square on a stimulus card. We did not say the name of the color or the size of the square--only "point to this one." Then we said "right" and gave a marble. The experimenter's behavior could easily be interpreted as reward for following instructions. For the child, it is unlikely that she made any covert mediational response. Yet the shift performance by these children seems to demand that covert response--they did learn a reversal shift more rapidly. For an attention theorist, those children's behavior is to be expected. Zeaman and House (1963) and others argue that learning is a function of the probability of attending to the relevant dimension. The passive responding we elicited could also elicit,

at most, a simple orienting to the stimulus. Such an alteration of orienting probabilities, then, resulted in shift performance identical to that of children who went through all of the "work" of attaining criterion.

On balance then, our results favor an attentional model of children's learning. The fact that young children who attained criterion learned the reversal more quickly is unusual (according to mediation theory) but not rare. As Cole and Medin (1973) have pointed out, young children can mediate. (The questions are when and why). Also, why some children this young should mediate and others not mediate (nonlearners) is not clear from a mediational model. For an attention model, these two groups simply represent children with different orienting responses. Finally, the response-trained children are a problem for mediation theory, but not for the attention models. In future research, we hope to look further at such pre-learning manipulations of attention.

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FOOTNOTES

[1]Presented at Society for Research in Child Development Bi-ennial Meeting, April 10, 1975.

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