THE EFFECTS OF CONCEPTUAL TRAINING ON REVERSAL LEARNING IN YOUNG CHILDREN

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Introduction

Since the mechanisms involved in human learning undergo a transition from early childhood to adulthood, an analysis of the development of learning requires the isolation of these mechanisms. Howard and Tracy Kendler (1962a), working in the area of discrimination learing, have sought to determine the nature of these mechanisms by investigating age-related changes in performance on tasks termed "reversal and nonreversal shifts."

Both types of shifts initially begin with a simple discrimination involving, for example, two different squares varying both in size and brightness. During this discrimination the subject is consistently reinforced for choices based upon one of the two available stimulus dimensions. Therefore, if size is the relevant dimension, by choosing, say, the larger square regardless of its brightness, the subject will be rewarded. Once a subject reaches some predetermined criterion on this initial discrimination phase, the reward contingencies are shifted. On reversal shifts, the same dimension (i.e., size) maintains its relevance, however now the subject is consistently reinforced for choosing the smaller of the two squares again regardless of its brightness. However, in nonreversal shifts, the previously irrelevant dimension now becomes the relevant dimension. Thus, if size was previously reinforced, now brightness (either black or white) becomes the consistently rewarded alternative.

The Kendler's (1962b) have found that with increasing chronological age, more and more children are able to master reversal shifts. In another experiment, the Kendlers (1959) found that children around the age of four learned nonreversal shifts much more easily than reversal shifts. Children between the ages of five and seven divided about evenly in their response styles. However, when this group was examined more closely, it was found that those children who had learned the initial training series the fastest, fared far better on the reversal shift task than those children who were slow learners on the nonreversal shift task. Beyond the age of seven, the Kendlers found a general increase in reversal shift behavior and a general decrease in nonreversal shift behavior.

Over the past fifteen years a number of experimenters have investigated various properties of reversal and nonreversal shift behavior. Harrow and Friedman (1958), controlling for the effects of partial reinforcement, found that partial reinforcement is not a necessary factor for explaining the superiority of reversal shift over nonreversal shift behavior in college students. Working with rats, Kelleher (1956) found that transfer from the original learning task to either type of shift was negative, but the nonreversal shift was accomplished much more readily than the reversal shift. Performing a similar experiment on nursery school children, Kendler and Wells (1960) found that children of this age responded best to nonreversal tasks and showed positive transfer. These same children performed poorly on reversal tasks and showed negative transfer. Reversal-nonreversal tasks have been performed with size and form as the two dimensions available (Kendler and Kendler, 1970), size and brightness (Kendler and Kendler, 1962b) and brightness and form (Kendler and Kendler, 1970) in subjects ranging in age from five to eighteen. These tasks have also been performed using words (Kendler, Kendler and Sanders, 1967) and pictures (Kendler and D'Amato, 1955) as the dimensions available with college-aged subjects.

To fit these results into some form of conceptual framework, the Kendlers (1962a) proposed a Spencian model of discrimination learning. Important to this model are the occurrences of (1) horizontal processes (referring to the continuity of behavior over time), (2) vertical processes (independent S-R units of behavior occurring simultaneously) and (3) chaining (the linking together of S-R associations to form integrated, continuous behaviors). Relying on these three processes, the Kendlers proposed a _single-unit theory_ to explain the nonreversal preference of rats and young children and a _mediational theory_ to explain the reversal preferences of older children and adults.

The single-unit theory assumes a direct association between the external stimulus and the overt response. This model predicts a reversal shift to be more difficult than a nonreversal shift because a reversal shift requires the subject to replace a response which has previously been consistently reinforced with a response that has previously been consistently non-rewarded. In a nonreversal shift, however, initial training has incidentally, although inconsistently, reinforced responses to the newly relevant dimension. Therefore, strengthening one of these associations does not require as much extinction of its competitors as is required in a reversal shift and will consequently be more easily acquired.

Mediational theory stresses the importance of covert processes which elicit overt responses. In a reversal shift the initial dimension maintains its covert relevance and therefore so does the mediating response. Only the overt response needs to be changed. Since the experimental situation provides only one alternative overt response, the problem presents no great difficulty. However, in a nonreversal shift the previously acquired mediation is no longer appropriate to the situation. Therefore, both the mediating and the overt response must be replaced making this task more difficult than a reversal shift.

One possibility explored by the Kendlers was that verbal mediators are one of the more important factors responsible for linking external stimuli with overt responses. To test this possibility, Kendler and Wells (1960) looked for the existence of verbal mediators in nursery school children; however, they found no evidence of verbal mediation occurring within this age group. At the five and six year-old level Kendler (1964) found that by requiring the child to say a sentence labelling the positive and negative stimuli of the relevant dimension, initial learning was facilitated and the proportion of children making subsequent reversal shifts was increased.

Kendler concluded from these results that at this developmental level, overt verbalizations have the same effect as the mediational model assigns to covert verbalizations among more mature humans. This conclusion is relatively consonant with the previous findings of Kendler and Kendler (1962a) that, for college students there is no significant difference in the effects of overt verbalization on shift learning so long as the verbalizations are relevant to the task's solution. Kendler, Kendler and Sanders (1967) using reversal and partial reversal shifts with verbal material (conceptually-related words and trigrams) on college subjects found that, although with conceptually-related words reversal shifts were executed much more rapidly than partial shifts, no differences were found between reversals and partial reversals when trigrams were used. These results suggest that the accessibility of verbal representational responses (i.e. conceptually-related terms) greatly facilitate the execution of reversal shifts.

Since verbal mediation is basically a covert process, attention must be given to a person's covert ability to perceptually organize and conceptually categorize stimuli from his external environment. Kagan, Moss and Sigel (1963) have termed this covert organization and categorization -- cognitive or conceptual style. Without the ability to process and organize environmental information into meaningful concepts, covert mediation would be impossible. In an attempt to discover some of the characteristics of cognitive development Kagan designed several tests, foremost among which is the Conceptual Styles

Test. Each of these tests was formulated to isolate stable individual modes of perceptually organizing and conceptually categorizing stimulation. These tests are basically discriminatory in nature, offering the subject a number of different response choices ranging from relatively simple to very complex. Typically, the subject is asked in what way two of three stimuli are alike.

From these discrimination tasks Kagan et. al. (1963) and Kagan, Rosman, Day, Albert and Phillips (1964) have isolated three distinct modes of responding. The most primitive and least discriminatory is the relational response. Subjects using this response mode are basically unable to separate figure from background and base conclusions on functional relationships among elements in stimulus sets. No stimulus alone can serve as an independent instance of a concept. Instead each stimulus depends for its membership on its relationship to other stimuli in the group. This functional relationship can involve temporal or spatial contiguity between objects or inter-object relationships among stimulus members. A second more discriminatory mode of responding is the inferential-categorical response. Conclusions within this response mode are based on inferences about the stimuli grouped together. Any stimulus in this response style is an independent instance of a concept. The final, most discriminatory mode of responding is the analytic-descriptive response. Within this response mode, conclusions are based on similarities in objective elements, within a stimulus complex, that are part of the total stimulus. For example, if a subject is shown a picture of three men and asked in what way two of them are alike, the response, "they are brothers" would be a relational response. "They are professionals" would be an example of an inferential response while the comment "These two men are wearing hats" would represent an analytic response -- i.e., categorization based on objective stimulus elements.

Using a correlational approach, Kagan et. al. (1963 and 1964) have found that with development, analytic responses increase and nonanalytic responses decrease. The relational response, considered to be the most immature form of nonanalytic responding because of the small amount of discrimination ability involved in such a response, is hypothesized (Hess and Shipman, 1965) to occur most frequently in preschool children. With development, analytic responding becomes more prevalent until by the age of seven or eight it is a relatively stable response preference among females. Among males analytic responses often appear earlier than in females, but do not become stable response preferences until a later age.

There have been no experimental studies which pinpoint the average ages for the onset of various modes of responding or for the transitions between these response modes; however, it has been shown by Kagan and his associates (1963) that analytic children are more likely than nonanalytic children to attach overt verbal labels to parts of an abstract geometric design. Therefore, it may be hypothesized that the onset of analytic responding in some way coincides with the beginnings of verbal mediation as proposed by Kendler and Kendler (1962a).

For the purposes of this study it is hypothesized (1) that discrimination learning and cognitive development are not unrelated psychological processes, but rather conceptual style is, at least in part, responsible for performance on a discrimination task; and (2) that as a child's conceptual style becomes more developed (i.e., analytic), so does his ability to solve increasingly more complex discrimination problems. If these hypotheses are correct, then one would predict that a change in conceptual style should result in a change in performance on a discrimination task. More specifically, training in analytic responding should facilitate the learning of reversal shifts and training in nonanalytic responding should inhibit the learning of reversal shifts.

Method

Subjects. Subjects were 135 preschool, kindergarten and elementary school children of both sexes from the Blacksburg, Virginia area. Forty-five of these subjects were four years-old (26 females with a mean age of 4 years 8 months and 19 males with a mean age of 4 years 7 months), another 45 were 6 years of age (22 females with a mean age of 6 years 3 months and 23 males with a mean age of 6 years 5 months) and the remaining 45 subjects were 8 years of age (20 females with a mean age of 8 years 6 months and 25 males with a mean age of 8 years 5 months).

Apparatus. The apparatus (modified from the Kendlers, 1959) consisted of a baseboard (30.48 cm X 40.64 cm) mounted on a swivel base and divided in half by a perpendicular board 20.32 cm high and 30.48 cm wide. On each of the halves of the baseboard were two, felt-padded depressions (10.16 cm from each side of the base and 10.16 cm apart). The entire apparatus was painted a medium gray.

Procedure. Subjects were tested individually by the experimenter in a small, quiet room. Upon entering this room the subject and experimenter sat at opposite ends of the apparatus. One half of the apparatus was used for each trial (the presentation of two stimuli), so that while the subject was making a choice on one half of the apparatus, the experimenter could set up the next stimulus presentation on the other half of the apparatus. A marble placed in one of the depressions served as a token reward and was revealed only if the subject chose the correct stimulus.

Each subject participated in a three part experiment consisting of initial learning, training and testing. During the first part of the experiment an initial discrimination learning task was taught. The stimuli used in this part were two hemispheres 7.6 cm in diameter and two hemispheres 5.7 cm in diameter. one of the larger and one of the smaller hemispheres was painted black and the remaining two hemispheres were painted white. For half of the subjects in each age group tested black was the rewarded choice. For the remaining half of each age group white was the rewarded choice. Subjects were randomly assigned to these two reward contingencies. Stimulus pairs presented were : large black-small white, large white-small black, small black-large white and small white-large black. These four pairs were presented in random order. However, to avoid confusion due to position changes during initial learning, the position of stimuli remained unchanged from trial to trial until a correct response was made. The instructions given to each subject at the start of initial learning are included in Appendix A.

As subjects from each age group met a criterion of 9 out of 10 successive correct choices for initial learning, they were assigned to one of three groups of 15 subjects each by a quasi-matching process. The purpose of this matching process was to create three groups essentially equivalent on initial learning. Of these three groups one received analytic training, another received nonanalytic training on either a relational or inferential task and the third group served as a control group receiving no training task.

Instructions for both of the training groups are given in Appendix B. Criterion for training was a correct response accompanied by a correct verbal reason for the choice on each of the 15 stimulus presentations.

In place of a training task, subjects assigned to the control group were read a story of their choice for a period of 10 minutes. After the story or, for experimental subjects, after the training criterion had been met, a reversal shift procedure was instituted. For this task the response alternative opposite to that which was previously rewarded in initial learning was the correct choice. In other words, if black was rewarded during initial learning, white was now the rewarded choice; and if white was rewarded during initial learning, black was now the rewarded choice.

Instructions for this procedure along with criterion for success were the same as they were for initial learning.

Results

Initial Learning. Table 1 summarizes the mean trials-to-criterion data for initial discrimination learning. Statistical analysis of these data with a 3 x 3 x 2 x 2 (age x training x sex x brightness) analysis of variance indicated that only the age effect was significant ($F=4.213$, $df=2, 99$, $p<.025$). Inspection of the means for 4, 6 and 8 year-old subjects (26.7, 28.4 and 19.1 respectively) showed that 6 year-old subjects took slightly longer than 4 year-old subjects to master the initial learning task and both of these age groups took considerably longer than 8 year-old subjects to reach criterion on initial learning. However, when these differences were compared with a Duncan's New Multiple Range Test, only the difference between the performance of 6 and 8 year-old subjects reached significance ($p<.05$). Since no training effect was found, it was assumed that all treatments within age groups were equal going into the training phase of the experiment. The complete summary table for the analysis of variance performed on initial learning is presented in Appendix E.

Training. A summary of mean trials-to-criterion scores for only those subjects receiving nonanalytic (relational and inferential) training is shown in Table 2. When these data were submitted to an analysis of variance consisting of three age levels, two training types and two sexes, no significant differences were found

TABLE 1

Mean Trials-to-Criterion Scores for Initial Discrimination Learning With Two Sexes, Two Brightness Levels, Three Age Levels and Three Training Levels [Analytic (AT), Nonanalytic (NAT) and Control (C)]

		Four Years Old			Six Years Old			Eight Years Old		
Sex	Brightness	AT	NAT	C	AT	NAT	C	AT	NAT	C
Male	Black	32.0	20.7	34.3	26.8	24.0	34.7	29.0	17.7	16.0
	White	35.5	23.5	31.4	27.5	33.5	26.3	14.4	26.0	19.5
Female	Black	29.3	15.8	17.3	26.7	36.5	24.7	12.5	15.5	23.0
	White	17.0	42.0	22.3	34.7	23.3	28.2	15.0	15.4	16.5

TABLE 2

Mean Trials-to-Criterion Scores for Those Male and Female Subjects, Four, Six and Eight Years Old, Receiving Either Relational or Inferential Training

	Four Years Old		Six Years Old		Eight Years Old	
Sex	Rel.	Inf.	Rel.	Inf.	Rel.	Inf.
Male	16.5	15.3	17.0	16.6	15.8	16.3
Female	17.6	17.2	15.2	15.5	16.0	16.0

between relational and inferential training ($p > .05$). A second result of this analysis was a significant age x sex interaction ($F=5.804$, $df=2, 33$, $p < .01$). A Duncan's New Multiple Range Test found that only 4 year-old females learned significantly slower than 6 year-old females ($p < .05$). The mean trials-to-criterion scores for these two groups of female subjects were 17.40 and 15.22 respectively. However, it should be noted that for this particular analysis the number of subjects per cell was, in some cases, as small as 2. For this reason it was considered more meaningful to interpret the significant age effect which was found ($F=3.519$, $df=2, 33$, $p < .05$). A Duncan's Test contrasting each age level tested showed that 4 year-old children took significantly longer than either 6 or 8 year-old children to reach criterion on nonanalytic training ($p < .05$). Although no significant differences were found betwee 6 and 8 year-old children, mean trials-to-criterion scores for these two age groups indicated that 8 year-old children took slightly longer to reach criterion than did 6 year-old children. The complete analysis of variance table for this 3 x 2 x 2 factorial design is presented in Appendix F.

Table 3 presents the mean trials-to-criterion scores for subjects receiving analytic training. Although a 3 x 2 (age x sex) analysis of variance performed on these scores yielded no significant main effects or interaction, it should be noted that 6 year-old children took the most number of trials to reach criterion on analytic training. This observation complements the previous finding

TABLE 3

Mean Trials-to-Criterion Scores for Those Male and Female Subjects, Four, Six and Eight Years-Old, Receiving Analytic Training

Sex	Four Years Old	Six Years Old	Eight Years Old
Male	17.0	17.9	17.1
Female	17.5	18.3	15.4

that 6 year-old children took the least number of trials to reach criterion on nonanalytic training. The summary table for this 3 x 2 analysis of variance is given in Appendix G.

The total number of analytic and nonanalytic responses given by subjects in each age group during the first training trial is presented in Table 4. This first response was used as a measure of the subjects' preferred mode of responding before such a preference was subjected to additional training. A chi-squared test performed on this data showed that both 4 and 8 year-old children were significantly more analytic in their response preference than were 6 year-old children ($x^2=4.53$, $p<.05$ and $x^2=5.933$, $p<.02$) or in other words, 6 year-old children were significantly more nonanalytic on first-trial training responses than either of the other two age groups involved.

Reversal Shift Learning. Table 5 shows mean trials-to-criterion scores for reversal shift learning. When these scores were submitted to an analysis of variance with three age levels, three training levels, two sexes and two rewarded brightness choices, significant main effects were found for age ($F=4.824$, $df=2, 99$, $p<.025$) and training ($F=4.266$, $df=2, 99$, $p<.025$). These effects were further analyzed with a Duncan's New Multiple Range Test and two significant results were found: (1) 4 year-old subjects performed significantly poorer than 8 year-old subjects on reversal shift learning ($p<.05$) and (2) analytic training produced significantly faster reversal

TABLE 4

The First Training Response Given by Four, Six and Eight Year Old Subjects During Either Analytic or Nonanalytic Training

Training	Four Years Old	Six Years Old	Eight Years Old
Analytic	17	7	20
Nonanalytic	13	23	10

TABLE 5

Mean Trails-to-Criterion Scores for Reversal Shift Learning With Two Sexes, Two Brightness Levels, Three Age Levels and Three Training Levels [Analytic (AT), Nonanalytic (NAT) and Control (C)]

		Four Years Old			Six Years Old			Eight Years Old		
Sex	Brightness	AT	NAT	C	AT	NAT	C	AT	NAT	C
Male	Black	15.5	16.0	25.2	12.3	15.5	27.0	9.4	9.8	16.0
	White	21.0	17.0	40.7	11.6	14.4	23.3	15.6	14.0	17.2
Female	Black	11.2	36.4	22.5	13.7	10.5	26.2	9.7	12.8	15.0
	White	10.7	25.2	18.7	17.7	19.3	11.7	9.5	13.0	16.4

shift learning when compared to the control group which received no training ($p < .05$). Although no other significant findings were observed, two relationships should be mentioned. With increasing age the number of trials needed to reach reversal shift criterion decreased. Those subjects receiving analytic training required the least number of trials to reach reversal shift criterion followed first by those subjects receiving nonanalytic training and then by those subjects receiving no training. A complete summary of this 3 x 3 x 2 x 2 analysis of variance can be found in Appendix H.

In order to assess the efficiency of reversal shift learning, a reversal index was computed for each subject by dividing his trials-to-criterion reversal learning score by his combined trials-to-criterion scores for pre-reversal and reversal shift learning. Employing this scoring technique, reversal indices less than .50 indicated that reversal learning took a lesser number of trials to master than did pre-reversal learning. Indices of exactly .50 indicated that reversal learning and pre-reversal learning took the same number of trials to master and reversal indices greater than .50 indicated that reversal learning took more trials to master than did pre-reversal learning. However, one of the risks involved in converting data to this type of proportional index is that heterogeneity of variance and non-normality are increased. To compensate for this statistical distortion, an arcsin transformation was applied to each reversal index as suggested by Winer (1962). An analysis of variance was then performed on these transformed scores.

Mean reversal indices are summarized in Table 6. A 3 x 3 x 2 x 2 (age x training x sex x brightness) analysis of variance revealed a significant age effect ($F=8.180$, $df=2, 99$, $p<.01$) and training effect ($F=14.257$, $df=2, 99$, $p<.01$) along with a sex x brightness interaction ($F=4.676$, $df=1, 99$, $p<.05$). A Scheffe's Test performed on the means of each age group revealed that 6 year-old subjects showed the largest decrease in number of trials needed to reach criterion between pre-reversal and reversal shift learning, followed by 8 year-old children and then by 4 year-old children ($p<.05$).

For training group means, a Scheffe's Test indicated that all groups performed significantly different from one another ($p<.05$). The greatest decrease in the number of trials needed to reach criterion between initial and reversal shift learning were found in the analytic training group followed by the nonanalytic training group and then by the control group. A Duncan's New Multiple Range Test was used to further examine the brightness x sex interaction. Significant differences were found only between those male and female subjects who were rewarded for choosing the white hemisphere during initial learning. However, the value of this interaction is questionable since the number of subjects per cell in this analysis was in some cases as small as 2. The complete 3 x 3 x 2 x 2 analysis of variance summary table is presented in Appendix I.

TABLE 6

Mean Reversal Indices for Two Sexes, Two Brightness Levels, Three Age Levels and Three Training Levels [Analytic (AT), Nonanalytic (NAT) and Control (C)]

		Four Years Old			Six Years Old			Eight Years Old		
Sex	Brightness	AT	NAT	C	AT	NAT	C	AT	NAT	C
Male	Black	.37	.41	.59	.31	.40	.36	.39	.45	.50
	White	.31	.41	.38	.31	.32	.47	.41	.31	.45
Female	Black	.31	.53	.51	.37	.30	.31	.43	.46	.44
	White	.40	.44	.54	.34	.31	.48	.40	.45	.48

Discussion

According to Kagan et. al. (1963) and Moore, Gleser and Warm (1970), a child progresses from a point in development where he is unable to separate a figure from its background to a point where such discriminations no longer present any great difficulty. In other words, a young child initially judges similarities between objects on the basis of their global-relational characteristics since he is unable to discriminate on a more analytic basis. However, with age, the child's discriminative abilities sharpen and similarities between objects can now be more analytically judged on the basis of their component parts. Kagan has observed that this analytic preference among children becomes a relatively stable response mode at approximately 7 years of age. Present results indicate that both 4 and 8 year-old children preferred the analytic mode of responding while 6 year-old children showed a marked preference for the relational, more nonanalytic response mode. Consequently, the initial, interpolated training response modes of children in the present study lends little support to Kagan's view of conceptual development.

Subjects in the present study were judged as having given an analytic response if they determined the similarity between two objects on the basis of color. However, evidence suggests that in discrimination tasks, children show a marked dimensional preference when judging the similarity of a number of objects. Suchman and

Trabasso (1966a) have found that preschool children prefer to discriminate between objects on the basis of color while kindergarten children make their discriminations on the basis of form. Similar findings have been reported by Brian and Goodenough (1929), Corah (1964) Lee (1965), Wolff (1966) and Gaines (1970). Therefore, in interpreting the response preferences given by subjects in the present study, special attention must be given to the role of dimensional preferences in discrimination learning.

It is possible that 4 year-old children in the present study were not responding in an analytic fashion, but were merely responding along a color dimension. It is just as conceivable that 6 year-old children were not responding in a nonanalytic fashion, but were merely discriminating on the basis of form. However, if Kagan et. al. (1963) and Moore et. al. (1970) are accurate in assuming that the young child is not capable of separating a figure from its background, then color preferences alone cannot be used to explain the present findings. In this study, merely by discriminating on the basis of color, a child showed that he was more than able to isolate color from the larger stimulus complex of which it was only a part. For example, by labelling a red ball and a Tareyton cigarette package as being the same along a color dimension, a subject demonstrated his ability to isolate only that relevant red portion of the cigarette package.

An hypothesis more consistent with the present results has been stated by Piaget. Piaget (1950) and Corah (1964) theorize that a young child's perception is "centered". More specifically, this means that a child not only attends to the dominant characteristic of a stimulus configuration at the expense of all its other characteristics, but also bases his discriminative judgments on this characteristic. With age, Piaget suggests that the child's perception becomes more "decentered" and he is able to attend to all of the characteristics of the stimulus configuration before choosing the most relevant dimension in a given task. Thus, in the present study 4 year-old subjects may have labelled color on the basis of their own dimensional preferences as the dominant characteristic of the set of stimuli presented. On the other hand, relying on their own dimensional preferences, 6 year-old subjects may have perceived form as the dominant dimension and responded accordingly. Eight year-old subjects in the present experiment may have reached the point in which they are able to perceive all the stimulus dimensions of a stimulus configuration and their response may have been based on their estimate of the most relevant dimension (color, in this case). Further research is needed here to determine if indeed this explanation is accurately portraying the preferred response style of different-aged children.

The hypothesis that analytic training would facilitate reversal shift learning was confirmed. However, nonanalytic training was also found to be of some benefit on reversal shift performance. Two training factors stand out as possible causes for this effect. The most obvious of these is that when reward contingencies were established for a given dimension, the subject quickly learned to attend to that dimension. Since color was the rewarded dimension for reversal shift learning, analytic training on the color dimension served to focus the subject's attention exclusively on that dimension. While nonanalytic training did not focus the subject's attention exclusively on the relevant dimension of reversal shift learning, it did presumably supplement the subject's ability to isolate relevant dimensions in a given stimulus complex. For example, in the relational response "the cup and the spoon go together because the spoon can stir something in the cup", while the subject is not labelling any dimension relevant to the reversal shift task, he is being forced to isolate those dimensions which both the spoon and the cup have in common.

Indirect support for this hypothesis has been given by Lowenkron and Driessen (1971). These researchers found that by giving subjects overtraining on pre-reversal shift learning, reversal learning was facilitated (known as the overlearning reversal effect). They concluded that the additional pre-reversal trials allowed the subjects more time to isolate the relevant dimension consequently improving performance on the reversal shift task. In the present study, the training phase may have served a similar function by allowing the subjects additional practice at isolating relevant dimensions.

In another study, Shepp and Gray (1971) found that by showing the subject the relevant component dimension before the discrimination task began, discriminative control could be rapid and performance on the discrimination task could be greatly facilitated. Again, it was concluded that such a procedure aided the subject in focussing his attention on the relevant stimulus dimension.

A second factor (and not unrelated to the factor discussed above) which may have influenced the course of training and consequently reversal shift learning is that subjects in the present experiment were asked to verbalize their reasons for choosing the dimension which they did. Verbalization of the relevant dimension during training may also have aided the subject's ability to attend to relevant stimulus dimensions during reversal shift learning. This statement may be especially appropriate when considering the inferior performance of younger children on reversal shift tasks.

Kendler and Kendler (1962a) have proposed a three-stage, age-related hierarchy of development to explain the performance of children on reversal-nonreversal shift tasks. This hierarchy theory is integrally related to the child's ability to verbalize the relevant dimensions of the reversal-nonreversal shift task. According to the Kendlers, reversal shifts represent the highest level of discriminative performance a subject can attain. At this level subjects are assumed to be able to verbally label (at a covert level) the relevant dimension of the discrimination task. The Kendlers have noted that most 8 year-old children are able to assign verbal labels to their discriminative actions.

The most primitive level of responding on a reversal-nonreversal discrimination task is considered by the Kendlers to be a response pattern which favors neither dimension of the test pair. Such response patterns are most frequently observed in children below the age of 4 and are interpreted as meaning that the subject is unable to verbally label the relevant stimulus dimension. An intermediate response level associated with a nonreversal shift response preference has been found in children between the ages of 4 and 6. Such a response preference is interpreted as indicating that although covert verbal labelling may be occurring, it is either occurring too late in the learning process to be of any benefit or such labelling is not mediating the subject's overt behavior. In the present study the finding that with increasing age, the number of trials needed to reach reversal shift criterion decreased, would appear at least superficially to lend support to the Kendler's three-stage hierarchy of development.

Verbalization has also been linked to a person's ability to respond in an analytic fashion by both Kagan et. al. (1963) and Moore, Gleser and Warm (1970). In both studies, subjects responding with an analytic response mode were most proficient at verbally labelling stimulus dimensions. Here as in the Kendler's findings such abilities were not stable in children until around the age of 8.

In the present study, 6 year-old subjects showed the greatest decrease in the number of trials needed to reach criterion between initial and reversal shift learning. Working under the Kendler's verbal mediation theory, all the 6 year-old subject should need to increase his reversal shift performance is to have his verbal mediating abilities focused on the relevant stimulus dimension. Either type of training in the present experiment could easily have served this function. Training effects for 8 year-old subjects in the present experiment were not nor would not be expected to be as pronounced since 8 year-old children are already capable of verbal mediation. Training for such subjects could only be expected to provide them with additional practice at labelling the relevant stimulus dimension. Four year-old children were found to show only a marginal amount of improvement between initial and reversal shift learning. However, since 4 year-old children are, theoretically, only beginning to develop verbal mediating abilities, training of the rather modest duration provided in this experiment would not be expected to produce an overwhelming effect. Further research is still needed to determine whether prolonged training would be of any greater benefit to the 4 year-old's reversal shift performance. Further research is also needed to determine whether such training effects can be obtained employing either a training procedure consisting of rewarding a right choice without requiring correct explanatory verbalizations or a training procedure consisting of explanatory verbalizations without reward.

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APPENDIX A

Instructions for Pre-Reversal and Reversal Shift Learning

"We are going to play two games, but before we begin listen carefully and I will tell you how to play. In the first game (procedure to be demonstrated while the instructions are being given), there are two things here (point to the hemispheres). When we start the game, you will pick one of them and lift it up. If you have picked up the right one, you will find a marble under it. If you have picked up the wrong one, you won't find anything underneath it (demonstrate). Each time you may have all the time you need to decide, but you may pick only once. After you have picked, I will turn this (apparatus) around like this (demonstrate) and you will have another turn. Remember on each turn you can pick only once (to be repeated whenever necessary). The game is to see if you can get a marble every time you pick. If you get a marble you can put it in this plastic container. At the end of both games you can have a box of Cracker Jacks with a special prize inside (show box of Cracker Jacks). Before I tell you how to play the next game let's do this game until you can get a marble on every turn."

APPENDIX E

Instructions for Analytic and Nonanalytic Training

"This game we are going to play involves all of these things (point to all the stimuli listed in Appendix C). Before we begin the game can you tell me what each of these things is called (go through each stimulus and ask for its name) (if the subject does not know the name of a stimulus, give it to him and explain its use). In this game two things will be placed here (demonstrate by rotating apparatus and presenting the subject with two stimuli) and I will show you a third thing like this (demonstrate). You will pick the one thing here (point to the two stimuli on the apparatus) that is in some way the same as the thing I am showing you and tell me why they are the same (see Appendix D for a list of stimulus-pairings used in presentations). You can take as much time as you need to make up your mind. If you have picked the right thing, you will find a marble underneath it. If you have picked the wrong thing, You won't find anything underneath it. Each time you may chose only one thing. Each time you pick, I will turn the board around like this (demonstrate) and you will have another turn. The game is to see how soon you can get a marble everytime you pick. Remember on each turn you can pick only once. If you get a marble, you can put it in this plastic container. Now let's try to play the game."

APPENDIX C

The Stimuli Used in Training Along With Their Major Color Characteristics

Stimulus	Color
fork	red
spoon	silver
knife	silver
bottle opener	red, blue, silver
Pepsi bottle	clear
pen	blue, silver
pencil	green
assignment pad	yellow
crayon box	green, yellow
crayon	brown
matches	yellow, white, black
cigarette pack (Benson and Hedges)	green
cigarette pack (Tareyton)	red, black, white
cigarette	brown, white
pipe	brown, black
candle	green
block	red
top	yellow
ball	red
ball	blue
cup	yellow, white

APPENDIX D

Stimulus Pairings Used During Analytic And Nonanalytic Training

Test Stimulus	Analytic	Relational	Inferential
matches	top	pipe	
bottle opener	red ball	bottle	
pencil	candle	pad	
matches	cup	cigarette	
bottle opener	blue ball	bottle	
matches	pad	cigarette	
matches	cup	candle	
Tareyton pack	red ball	matches	
matches	crayon box	candle	
matches	pad	candle	
cup	top	spoon	
Tareyton pack	red ball	cigarette	
crayon box	pad	crayon	
matches	top	candle	
cup	pad	bottle	
matches	crayon box		Benson and Hedges
top	matches		red ball
blue ball	bottle opener		block
red ball	fork		top
pen	blue ball		pencil

APPENDIX D (Continued)

Test Stimulus	Analytic	Relational	Inferential
pencil	candle		crayon
block	bottle opener		top
pen	blue ball		crayon
Benson and Hedges	candle		bottle
cigarette	cup		pipe
fork	block		spoon
top	matches		block
bottle opener	block		cup
fork	red ball		knife
crayon box	candle		bottle

APPENDIX E

A 3 x 3 x 2 x 2 (Age x Training x Sex x Brightness) Analysis of Variance Performed on Trials-to-Criterion Scores for Initial Discrimination Learning

Source	df	F	P
Age (A)	2, 99	4.213	$<.025$
Training (T)	2, 99	0.002	ns
A x T	4, 99	0.002	ns
Sex (S)	1, 99	0.472	ns
S x A	2, 99	0.764	ns
S x T	2, 99	0.382	ns
S x A x T	4, 99	1.044	ns
Brightness (B)	1, 99	0.034	ns
B x A	2, 99	0.421	ns
B x T	2, 99	1.183	ns
B x A x T	4, 99	1.244	ns
B x S	1, 99	0.100	ns
B x S x A	2, 99	0.351	ns
B x S x T	2, 99	0.103	ns
B x S x A x T	4, 99	1.171	ns

APPENDIX F

A 3 x 2 x 2 (Age x Training x Sex) Analysis of Variance Performed On Trials-to-Criterion Scores for Subjects Receiving Either Relational or Inferential (Nonanalytic) Training

Source	df	F	P
Age (A)	2, 33	3.519	<.05
Training (T)	1, 33	0.289	ns
A x T	2, 33	1.924	ns
Sex (S)	1, 33	0.099	ns
S x A	2, 33	5.804	<.01
S x T	1, 33	0.344	ns
S x A x T	2, 33	1.195	ns

APPENDIX G

A 3 x 2 (Age x Sex) Analysis of Variance Performed on Trials-to-Criterion Scores for Subjects Receiving Analytic Training

Source	df	F	P
Age (A)	2, 39	1.847	ns
Sex (S)	1, 39	0.042	ns
A x S	2, 39	1.159	ns

APPENDIX H

A 3 x 3 x 2 x 2 (Age x Training x Sex x Brightness) Analysis of Variance Performed on Trials-to-Criterion Scores for Reversal Shift Learning

Source	df	F	P
Age (A)	2, 99	4.824	<.025
Training (T)	2, 99	4.266	<.025
A x T	4, 99	0.785	ns
Sex (S)	1, 99	0.048	ns
S x A	2, 99	0.101	ns
S x T	2, 99	2.072	ns
S x A x T	4, 99	0.789	ns
Brightness (B)	1, 99	0.016	ns
B x A	2, 99	0.574	ns
B x T	2, 99	0.634	ns
B x A x T	4, 99	0.576	ns
B x S	1, 99	0.810	ns
B x S x A	2, 99	0.140	ns
B x S x T	2, 99	0.207	ns
B x S x A x T	4, 99	0.484	ns

APPENDIX I

A 3 x 3 x 2 x 2 (Age x Training x Sex x Brightness)

Analysis of Variance Performed on Reversal Indices

Source	df	F	P
Age (A)	2, 99	8.180	<.01
Training (T)	2, 99	14.257	<.01
A x T	4, 99	1.242	ns
Sex (S)	1, 99	2.257	ns
S x A	2, 99	0.268	ns
S x T	2, 99	0.017	ns
S x A x T	4, 99	2.139	ns
Brightness (B)	1, 99	0.173	ns
B x A	2, 99	2.111	ns
B x T	2, 99	1.380	ns
B x A x T	4, 99	2.131	ns
B x S	1, 99	4.676	<.05
B x S x A	2, 99	0.550	ns
B x S x T	2, 99	1.771	ns
B x S x A x T	4, 99	1.160	ns

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THE EFFECTS OF CONCEPTUAL TRAINING ON

REVERSAL LEARNING IN YOUNG CHILDREN

by

Thomas Joseph Fagan

(ABSTRACT)

To determine the relationship between conceptual development and performance on reversal learning tasks in children, a three-part experiment was conducted employing 45 preschool, 45 kindergarten and 45 second grade children. During part one, all 135 subjects were taught the initial learning phase of the Kendler's (1962) reversal shift task. When initial learning criterion was met, subjects from each age group were divided into 3 subgroups of 15 subjects each. The first subgroup was given conceptual training on an analytic task described by Kagan, Moss and Sigel (1963). The second subgroup was given conceptual training on a nonanalytic task (also described by Kagan et. al., 1963) and the third subgroup served as a control group by receiving no conceptual training. Once training criterion was met, all subjects were given a reversal shift task. Three significant trends were found: (1) with increasing age, reversal performance improved, (2) kindergarten children were more nonanalytic in their response preference than either preschool or second grade children and (3) while both types of training resulted in enhanced reversal performance,

analytic training was more useful than nonanalytic training in facilitating reversal learning. Two separate phenomena are suggested by these results. First, preschool and kindergarten children appear to make discriminations on the basis of dimensional preferences while second grade children are able to discriminate on the basis of analytic reasoning. Second, for those subjects unable to verbally mediate, training appears to help them focus their attention on the relevant dimensions of the discrimination task.