Effects of stimulus modality on reversal and nonreversal concept learning in children

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This study was concerned with the effects on reversal and nonreversal learning of presenting concept information either tactually or visually. A major finding of the investigation was the presence of a significant interaction between type of shift and mode of presentation. In the reversal situation, a tactual solution enhanced the shift solution, whereas in the nonreversal task, a tactual presentation interfered with the shift solution.

The reversal-nonreversal learning paradigm has been frequently used as a method of studying concept formation in children. Briefly, this paradigm involves the following features: (a) the S is confronted with stimuli varying along two or more dimensions—e.g., color and size; (b) he is required to abstract or identify one of these dimensions by discriminating among its cues and by associating each with an appropriate response; (c) after reaching some learning criterion on the initial concept task, a shift is introduced such that the S must learn a different cue-response association. In reversal learning, the same dimension (e.g., color) remains relevant during the original as well as the shift problem. In contrast, in the nonreversal situation, one dimension is relevant during the original learning and another becomes relevant for the transfer problem.

Investigators using this paradigm have usually presented the stimuli through the visual modality. Some recent research by Blank (1968) has suggested the importance of investigating reversal shifts not only within the visual mode but also in other modalities. In Blank's study, Ss of 3-4 years were exposed to a simple reversal task. One group of Ss learned the original and shift problems using the visual mode, while another group learned the original problem visually but mastered the transfer problem using the tactual modality. In comparison to reversal learning under visual conditions, the cross modal condition (i.e., from visual to tactual) was accomplished relatively rapidly.

It should be noted that the data of Blank were limited only to reversal learning involving a simple task. In the present study, the effects of modality of stimulus presentation were related to both reversal

and nonreversal learning under conditions in which relatively complex concept information was introduced to the S.

METHOD

The study used a basic 2 by 4 factorial design involving the following independent variables: (1) type of shift (reversal or nonreversal), and (2) type of modality used in the presentation of stimuli. In the case of this variable, four modality patterns were used in presenting the original and shift problem: visual-visual (V-V), visual-tactual (V-T), tactual-visual (T-V), and tactual-tactual (T-T). For example, Ss could learn the original problem under visual conditions but learn the transfer task under the tactual modality (i.e., the visual-tactual condition). Similarly, Ss could learn both the original and transfer problem under a visual presentation (i.e., the visual-visual condition).

Eighty children between the ages of 12 and 13, and divided equally between males and females who served as Ss, were randomly assigned to the eight experimental conditions.

The stimuli consisted of 18 wooden objects which represented the dimensions of shape, size, and texture. Three attributes each were used for the shape and size dimensions. The shapes consisted of a circle, square, or triangle which were either 3 in., 2 in., or 1 in. (e.g., a circle, 1 in. in diam). The textural dimension varied equally among the above stimuli with nine objects being smooth and nine rough, being covered with coarse sandpaper.

The stimuli were used in the following manner: (a) texture was always treated as an irrelevant dimension; (b) triangularity and medium size were always irrelevant; (c) the remaining stimulus classes, large vs small and circle vs square, served as the relevant dimensions. In the reversal conditions, half of the Ss received the size dimension and the other half the shape dimension. In the nonreversal conditions, size and shape were alternated in the initial and shift problems.

Each S was tested individually. The S was given a brief explanation as to what was meant by a concept. He was then asked to form a rule by which he could decide whether each stimulus presentation represented an instance or noninstance of the concept selected by the E. Each classification response of the S was followed by feedback indicating the correctness or incorrectness of the response.

A S was required to make 18 correct consecutive responses before the transfer problem was introduced. Once this criterion was reached, a solution and modality shift occurred as follows: (a) if there was no change in the sensory modality (as in the V-V condition) the shift problem started with the next stimulus presentation after the criterion was reached; (b) if a change in the sensory modality was required (as in the V-T condition), the E made a comment about the relative ease or difficulty of the task and suggested a change in the way the objects were to be presented. The S was then given three stimulus presentations in which the original stimulus solution was correct. This procedure was introduced in order to avoid any cues indicating that a change in the solution had been introduced. After these three trials, the problem shift was made. The criteria for the shift solution was again 18 correct consecutive responses.

Subjects in the tactual conditions were prevented from viewing the objects by being blindfolded. In addition, Ss in the visual groups were only allowed to inspect but not to handle the stimulus objects.

RESULTS

An analysis of variance, type of problem by modality of presentation by stimulus dimension, was performed on the total errors during the acquisition of Problem 1. The only source of variance that proved to be significant was due to the effect of stimulus dimension ($F = 25.9$, $df = 1/64$, $p < .01$), with shape cues being easier to discriminate than size cues.

A correlation of .60 between errors occurring in Problem 1 and Problem 2 suggests the possibility of S differences in learning ability in relation to the experimental tasks. To control for such differences, a covariance factorial design involving the independent variables of type of problem by modality of presentation by stimulus dimension was performed on total errors occurring during the mastery of Problem 2 (shift problem). This analysis revealed the following significant effects: type of shift problem ($F = 4.47$, $df = 1/63$, $p < .05$); modality of presentation by type of problem ($F = 3.73$, $df = 3/63$, $p < .025$); and stimulus dimension by type of shift problem ($F = 4.37$, $df = 1/63$, $p < .05$).

Table 1 shows that in comparison to the nonreversal shift conditions, the acquisition of a reversal shift solution occurs more rapidly regardless of modality of presentation and stimulus dimension. Furthermore, when modality of presentation is considered, Ss who were presented the reversal shift problem under the tactual modality (i.e., the V-T and T-T conditions) learned the task more rapidly than Ss in the reversal shift conditions who were presented this problem visually. In contrast, within the

nonreversal conditions, the tactual mode of presentation (i.e., the T-T and V-T conditions) interfered with the acquisition of the shift solution in comparison to Ss who were presented this problem visually.

Finally, in the reversal condition form cues were easier to discriminate than size cues, whereas in the nonreversal condition, there were no differences in ease of learning as a function of kind of stimulus cue.

DISCUSSION

The findings that the reversal shift was learned more rapidly than the nonreversal shift is in agreement with the mediation theory of discrimination (e.g., Kendler & Kendler, 1962). However, had younger Ss (i.e., preschoolers) been used in the investigation, it would be expected, according to the mediation theory, that the nonreversal shift would have been easier to master than the reversal shift.

It is of some interest to note that normally sighted Ss were able to effectively cope with the initial concept task under tactual as well as under visual conditions. Accordingly, it might be expected that both the reversal and nonreversal shift solutions would have been acquired as rapidly under tactual conditions as under visual conditions. This was not the case, for the results showed that a differential effect was produced under tactual conditions—namely, an apparently facilitating effect in a reversal shift but an interfering effect in a nonreversal shift. The question arises as to what aspects of a tactual presentation contributes to this effect. One possibility suggested by Piaget & Inhelder (1956) is that the tactual discrimination of shapes requires an active searching operation if such discrimination is to occur. In contrast, such an intensive exploration in the visual modality might occur only when relatively complex stimuli are presented. Therefore, it is suggested that the reversal shift was facilitated under tactual conditions (i.e., the T-T and the V-T groups) because of the greater perceptual demands in comparison to a visual presentation. That is, for tactual recognition and discrimination to occur, the S must be more attentive to the available cues before a choice is made. Perhaps this contributes to his learning the task requirements to a degree not possible under a visual presentation. However, there may be conditions under which a tactual presentation may enhance the difficulty level of a task to a degree which far exceeds the information processing capacity of the individual. This might be the case for a nonreversal shift where, in comparison to the reversal shift, the S must not only acquire a new instrumental response but also a new mediational or cueing response (Kendler & Kendler, 1962). Under these conditions a visual rather than a tactual

Table 1
Means and Standard Deviations of Total Errors
to Criteria on Problem 2

	Reversal Shift			Nonreversal Shift		
	N	M	SD	N	M	SD
Modality of Presentation						
Visual-Visual	10	11.13	6.86	10	12.72	8.25
Visual-Tactual	10	9.92	7.90	10	25.84	10.46
Tactual-Visual	10	13.54	7.46	10	10.71	7.81
Tactual-Tactual	10	7.61	4.36	10	14.73	8.14

presentation might provide the optimal perceptual condition to acquire the appropriate cue-response associations.

It might be argued that the findings in part reflect cues provided by a cross-modal shift (e.g., from a visual to tactual presentation). That is, a change in modality might signify to the S a new task, thereby facilitating the solution of the shift problem. Certain considerations argue against this position. First, the fact that rapid reversal learning was noted in the T-T group, where no modality shift occurred, as well as in the V-T group, argues against this possibility. Second, if learning cues were associated with a cross-modal shift, one might also expect that a nonreversal solution would be facilitated in the visual-tactual condition. Such was not the case as both the T-T and V-T groups exhibited relatively slow nonreversal learning.

In conclusion, it would be important to determine whether the findings extend beyond the particular dimension stimuli used in the present investigation. Thus, it would be useful to increase the cognitive demands involved in discriminating stimuli visually and tactually. For example, it might be that the visual presentation of more complex stimuli might enhance attention

(Cantor & Cantor, 1964) and hence facilitate reversal learning under visual conditions. Furthermore, many studies have identified such variables as overlearning (e.g., Eimas, 1966) and the verbalization of cues (e.g., Kendler & Kendler, 1961) as factors facilitating reversal and nonreversal learning. It would thus be of some interest to examine how these variables interact with modality of presentation in influencing concept learning.

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Speech rate as a measure of imitative performance

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Imitative performance was assessed by two different tasks. In the speech-rate phase, 20 males and 20 females repeated numbers after a female model speaking at either one

number per 2 sec (2.0-sec group) or one number per 0.5 sec (0.5-sec group). During the content phase, these same Ss said words intermittently with a taped female model who emitted an increasing frequency of animal words across trial blocks. Both phases yielded significant imitation, but a significant correlation between the two measures of modeling failed to emerge.