Attribute learning in preschool children: Mediation and selection mechanisms*

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Preschool children learned to respond to a black vertical line and were tested for orientation, form, and color generalization under two test procedures. The results indicated that (1) a procedure which approximated successive generalization testing (N) provided little evidence that any of the tested-for attributes were learned, whereas a procedure which contained dimensional "orienting" properties (O) indicated that each tested-for S+ attribute was learned; (2) group analyses of the O procedure suggested a hierarchical arrangement of learned attributes; however, additional analyses failed to reveal hierarchies for individual Ss. The results suggested that during training the S+ complex activates for different individuals either one, two, or three attribute mediators and that during Phase II, properties of the test operate to select activated mediators to control test behavior.

Flat line-orientation and size-generalization patterns have been found under successive test conditions for preschool children and adults (Landau, 1968a, b, 1969). One implication of these patterns is that S has failed to "attend to" or "learn about" the attribute of the training stimulus (S+) tested for in generalization (Kalish, 1969, pp. 224-226). Thus, if S has been trained in Phase I to respond to a black vertical line and in Phase II is tested successively on black lines varying in orientation, equivalent responding to all of the orientation test stimuli implies that S had not associated the vertical attribute of S+ to the training response during Phase I. A different implication would be obtained, however, if a second group of Ss who received the same training in Phase I but a different testing procedure in Phase II generated line-orientation gradients. In the latter case it would be reasonable to conclude that the flat patterns obtained with the first group did not indicate a failure to learn and that test conditions operate to determine performance, possibly by differentially orienting Ss to the E-defined relevant dimension (Lashley & Wade, 1946; Prokasy & Hall, 1963).

The primary purpose of the present study was to compare an orienting ("attention-directing") test condition with a nonorienting (i.e., successive) test condition in order to determine if the flat line-orientation patterns obtained with children were the result of the failure of the Ss to learn the orientation of S+ (90 deg) during Phase I or the result of a testing procedure (Phase II) which did not detect that orientation learning had occurred.

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A second implication of flat generalization patterns is that an untested stimulus attribute(s) (e.g., form or color) controlled responding during successive testing. For example, if the form of the S+ (a line) was the controlling (untested) stimulus attribute, then flat line-orientation patterns would be expected since all the test stimuli were lines.

The second purpose of this investigation was to determine whether the form (a line) and/or the color (black) attribute of the S+ complex controls responding under conditions approximating successive testing.

SUBJECTS

Thirty children in attendance at nursery schools[1] in Queens, New York, ranging in age from 3½ to 4½, served as Ss.

APPARATUS

The stimuli were presented to S on a display board which measured 30¼ x 12 in. and was placed at a 30-deg angle with the table. A blind was used to prevent viewing the display board during intertrial intervals.

The 17 3¾ x 5 in. stimulus cards were constructed of 1/16-in.-thick white illustration board (H. P. Finish). The S+ was a 1/8 x 3 in. black straight line placed vertically (90 deg) in the center of the card. The S− was a "blank" white card. The testing stimuli consisted of 15 cards divided into three dimensions of five cards each. Each card of the orientation dimension consisted of a black straight line (1/8 x 3 in.) located in the center at a different orientation: 180, 150, 90 (S+), 60, 30 deg. Each card of the color dimension consisted of a vertical line (1/8 x 3 in.) of a different color located in the center [red (Color-Aid ROR hue), green (Color-Aid GYG hue), yellow (Color-Aid Y hue), blue (Color-Aid BVB hue), black (Color-Aid Black) (S+)]. Each card of the form dimension contained one of the following shapes located in the center: a black straight vertical line (S+); a black 1-in. square; a black circle (1 in. diam); a black equilateral triangle (each side 1 in.); a black diamond (1½ in. high, ½ in. wide).

PROCEDURE

Discrimination Training

Upon entering the experimental room, each of 30 Ss was permitted to select a toy which could be taken home after the "game." Each S was then given a test for color blindness (Pseudoisochromatic Color Blindness Test, Plates I-VI) and seated at a table directly facing E. No S was eliminated because of color blindness. E then read the following instructions to each of the Ss, "We are going to play a game. I am going to show you two pictures. One of these pictures is called 'special.' Your job is to point to the picture that you think is 'special.' I will tell you if you are right or wrong."

All Ss were given discrimination training for 10 trials. The S+ and S− were presented simultaneously, and position was randomized over the 10 trials. The S was informed if his response was correct or incorrect immediately after responding.

Generalization Testing

Upon completion of discrimination training, Ss received instructions appropriate to their testing procedure. The two sets of instructions had the following common properties: Ss were informed that there were going to be five pictures (stimuli) instead of two, that they were to look at all of the pictures, and that they were not going to be told if their responses were correct or incorrect.

The Ss in Group N (the nonorienting group) were informed that E was going to point to each of the five pictures displayed and ask, "Is this picture special?" The S was instructed to say "yes" if he thought the picture was special and say "no" if he did not. This procedure of pointing to each stimulus of an array and requiring S to respond to each stimulus was assumed to approximate successive presentations.

The Ss in Group O (the orienting group) were instructed to "point to the picture [one out of five] that you think is special."

The position of the five stimuli within each array was randomized for each presentation (trial). The order of presentation of the arrays (dimensions) was randomized within each of four blocks of three trials each. Each S therefore received a total of 12 trials. The Ss in Group N responded 60 times (12 trials, five stimuli per trial). The Ss in Group O responded 12 times, once to each array.

RESULTS

Discrimination

A t test between the orienting and

Table 1
Number of Responses for Individual Ss to Each of the Stimuli for Each of the Test Dimensions

S No.	Circle	Triangle	Line S+	Diamond	Square	180 Deg	150 Deg	90 Deg S+	60 Deg	30 Deg	Red	Green	Black S+	Yellow	Blue
1			4					4					4		
2			4					4					4		
3			4					4					4		
4			4					4			1	1		2	
5			4					4			3*		1		
6			4					4			1	1		1	1
7			4					4			4*				
8			4				1	3				1		1	2
9			4			1	2	1			1		1	1	1
10		1	3			1		1	1	1			2		2
11			3		1	2		2			2	1		1	
12		1	3			1	1	1	1			2	1	1	
13			3		1	1		1	2		3*		1		
14		1	3				1	1	2		1		2	1	
15			2	2		1		1	1	1			3		1
Total	0	3	53	2	2	7	5	39	7	2	16	6	23	8	7

**Three Ss (numbers 5, 7, and 13) consistently responded to the red stimulus during testing. This would seem to indicate the existence of preexperimental preference to red.*

nonorienting groups was performed on the number of errors made during discrimination training. The analysis revealed a nonsignficant difference between the two groups ($t = 1.43$, $df = 28$, $p > .05$). Mean number of errors made by Group O was .4 and by Group N was .73.

Generalization

For Group N, three separate one-way analyses of variance were performed on the total number of "yes" responses made to each of the five stimuli for each of the three dimensions. The analysis revealed no significant differences between stimuli for the orientation dimension [$F(4,56) = 2.35$, $p > .05$] as predicted. There were also no significant differences obtained for stimuli of the color dimension [$F(4,56) = 1.21$, $p > .05$]. The differences between the stimuli for the form dimension, however, were significant [$F(4,56) = 2.73$, $p < .05$]. As can be seen from Fig. 1, there are significantly more "yes" responses made to the line than to any other form stimulus, with the other form stimuli receiving approximately the same number of "yes" responses.

Although the analyses would seem to indicate that the form attribute of the S+ complex controlled responding under successive test conditions, whereas orientation and color attributes did not, inspection of individual protocols suggests that no clear conclusions may be reached regarding which S+ attribute controlled responding in the N condition. Of the 15 Ss in the N condition who responded to the form dimension, six Ss responded maximally or almost maximally to all the test stimuli, six Ss responded irradically [e.g., zero responses to the circle, three responses to the triangle, one response to the line (S+), two responses to the diamond, one response to the square], and only three Ss responded clearly to the form attribute (five responses to the line, zero responses to the other test stimuli). Similar protocols were found for the orientation and color dimensions. Thus, analysis of individual S's protocols in the N condition fails to indicate which S+ attribute controlled responding.

Since for Group O, only "yes" responses could be made by S, three separate Friedman two-way analyses of variance (Siegel, 1956) were performed on the number of responses made to each of the five stimuli for each of the three dimensions. Each analysis revealed a significant difference between the stimuli: color, $\chi r^2 = 37.35$, $df = 4$, $p < .001$; orientation, $\chi r^2 = 51.26$, $df = 4$, $p < .001$; form, $\chi r^2 = 66.96$, $df = 4$, $p < .001$. As can be seen in Fig. 1, S+ was the preferred stimulus for each dimension. A t test was performed between the number of "yes" responses made to the red stimulus and black stimulus (S+) of the color dimension (this difference being the smallest). The analysis revealed a significant difference ($t = 5.59$, $df = 14$, $p < .01$).

For each dimension and for each procedure (N and O) a chi square was computed on the frequency of responses to each stimulus. Responses from only the first presentation of each dimension for each S was utilized. All the chi squares for Group N were nonsignificant (color, $\chi^2 = 1.62$, $df = 4$, $p > .80$; form, $\chi^2 = 2.26$, $df = 4$, $p > .50$; orientation, $\chi^2 = 1.65$, $df = 4$, $p > .80$), whereas all the chi squares for Group O were significant at at least the .02 level (color, $\chi^2 = 12$, $df = 4$,

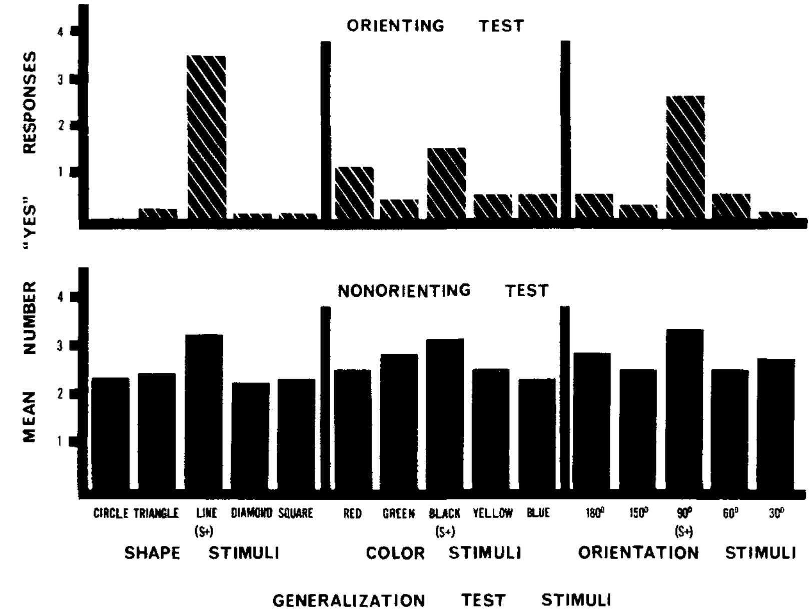

Fig. 1. Mean number of "yes" responses made to each stimulus of each dimension for the orienting and nonorienting test procedures.

$p < .02$; form $\chi^2 = 50.66$, $df = 4$, $p < .001$; orientation, $\chi^2 = 21$, $df = 4$, $p < .001$). Except for the nonsignificant chi square for Group N for form, the first presentation analyses yield the same findings as the analyses on overall data.

Since direct comparisons between Groups N and O cannot be made on absolute number of responses due to the procedures employed, each S's total number of responses made to S+ for each dimension was converted into percentages. On these percentage scores, three Mann-Whitney U tests were performed, comparing Groups N and O for each dimension. These analyses revealed significant differences between the two groups for form ($U = 22.5$, $n_1 = 15$, $n_2 = 15$, $p < .001$) and orientation ($U = 39.8$, $n_1 = 15$, $n_2 = 15$, $p < .001$), but not for color ($U = 1.00$, $n_1 = 15$, $n_2 = 15$, $p > .05$).

Calculations of the percentage of S+ responses to each dimension for Group O on overall data indicated that 88% of the responses to the form dimension were to S+, while only 65% of the responses to the orientation dimension and 38% of the color responses were to S+. Thus, Group O's group data appears to indicate that in addition to learning the three attributes, S hierarchically orders the attributes with form as dominant. In order to determine if this group distribution characterized individual behavior, the correspondence between the group and individual functions was analyzed. Table 1 presents the distribution of test responses to each dimension for each S in Group O. An attribute will be considered learned by S if S made at least three responses to the S+ stimulus within each dimensional array. Applying this criterion, inspection of Table 1 indicates the following: (1) Three Ss learned three attributes, five Ss learned two attributes, and seven Ss learned only one attribute; and (2) for those Ss (Nos. 1 through 8) who learned two or three attributes, there is little indication (however, see S 8) of differences in response strength between learned attributes.

In order to determine how the individual data contributed to group functions, the number of Ss learning a particular attribute was calculated. As may be seen in Table 1, 14 Ss learned the form of S+, 8 Ss learned the orientation of S+, and 4 Ss learned the color of S+. In summary, inspection of individual data revealed that (1) individual Ss learn one, two, or three attributes of S+ (in contrast to group data analyses, which suggested that all Ss learned three attributes) and (2) the group functions, which indicated that 88% of the test responses to the form dimension were to S+, 65% of the orientation responses were to S+, and 38% of the color responses were to S+, may be accounted for by the fact that 93% of the Ss learned the form of S+, whereas 53% of the Ss learned the orientation, and only 27% of the Ss learned the color.

DISCUSSION

The primary purpose of this experiment was to investigate the hypothesis that flat generalization patterns for line orientation indicate that the orientation attribute of the S+ training complex does not control test behavior but *need not* indicate that the orientation attribute was not learned. Thus, the hypothesis distinguished between "what is learned" and what is indicated under limited test conditions. Results from the approximated successive testing procedure (Group N) indicated that the orientation attribute of S+ did not control test behavior. However, the results from Group O indicated that the orientation attribute was learned by at least 53% of the Ss. Thus, flat line-orientation patterns obtained under successive test conditions does not indicate S's failure to learn the orientation attribute.

The second purpose of this investigation was to determine whether or not an untested-for S+ attribute [its form (a line) or its color (black)] controls responding under conditions which approximate successive testing (Group N). The results from Group N provided little evidence that the form and color attributes were learned. These results allow no conclusions as to the controlling stimulus attribute (or attributes) in this test condition. The only reasonable conclusion is that some still untested-for attribute controls responding. The results from Group O indicated that 93% of Ss learned the form of S+, whereas 27% of Ss learned the color. This result indicated that the form attribute and color attribute of the S+, although learned by the Ss, did not exert response control under approximated successive testing.

With the assumption that the O procedure had been maximally sensitive in detecting that learning had occurred on the dimensions tested, the results of the present experiment suggest the operation of activation and selection (utilization) mechanisms. More specifically, the results suggest that (1) during training the S+ complex activates, within individuals, one, two, or three attribute mediators; and that (2) test procedures which "force" S (Group O) to select one stimulus from a dimensional array permits S to select the appropriate mediator from those activated ("learned") during training, to control test behavior.

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NOTE

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The effect of anchoring upon pain threshold

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An experiment designed to measure the effect of anchoring upon the heat-pain threshold is reported. The anchor stimulus, which took the form of repeated application of a low-intensity stimulus prior to the assessment of pain threshold, was found to have a significant effect. The conclusion was drawn that the low threshold values found when a small stimulus interval is used in the assessment of heat-pain threshold by the limiting method can probably be attributed to this effect.

In two previous experiments (Haslam, 1965; Haslam & Thomas, 1967), it was found that when heat-pain threshold was assessed by the limiting method the size of the increment in successive values of the variable stimulus had a considerable effect upon the results. When the increment was as small as 8 $mc/sec/cm^2$, pain threshold was significantly lower than when the variable stimulus was increased in steps twice or four times as large as this. In an attempt to explain this finding, two