Differential reward positioning and children's performance on dimension-abstracted oddity problems[1]

ANN L. BROWN, University of Illinois, Urbana, Ill. 61801

This experiment tests the effects of rewarding all three positions, or only the left and right positions, in three-stimuli oddity problems. After pretraining, Ss were assigned either to a simple oddity problem or to a dimension-abstracted oddity problem, with their nonpreferred dimension being variable and irrelevant. Rewarding all three positions in an array significantly improved performance on problems containing variable irrelevant dimensions. On simple problems, no differences due to reward positioning were found.

In random three-position oddity problems, all positions in an array carry the odd stimulus on an equal number of trials (Gollin & Shirk, 1966). Other studies of three-stimuli oddity problems (House, 1964; Scott, 1964) reward the left or right position in an array; the center position never contains the odd stimulus and is never rewarded. There is evidence to suggest that, at least for young children, acquisition of the oddity concept is facilitated by rewarding all three positions. Gollin & Shirk (1966) reported that 42% of 4-year-old Ss reached criterion, while Hill (1965a, b) found that only 10% and 5% of 4-year-old Ss reached criterion. Gollin used the three-position reward technique. Hill rewarded only the left and right positions.

Scott,[2] using the successive-reversal method, suggests that two-position rewarding leads to bad scanning habits in retardates. It is possible that the S's attention would be directed away from the nonrewarded center stimulus, thus training S to attend to only those stimuli that appear in the rewarded positions. This should increase the probability of the S attending to a specific stimulus or to a stimulus compound, rather than to the relational concept conveyed by all three stimuli.

House (1964) suggests that the solution of an oddity problem requires the acquisition of a chain of three responses: two observing responses and a terminal, instrumental response. The S must first attend to the dimension carrying the oddity relationship, the vehicle dimension. Then he must observe the cues within the vehicle dimension before making the correct instrumental response to the odd cue. The initial observing response to the vehicle dimension is quickly learned in oddity problems, where the two nonrewarded stimuli are identical in all respects, that is, where there are no irrelevant dimensions other than position. However, in dimension-abstracted oddity problems (Lubker & Small, 1969), the nonrewarded stimuli are alike only in respect to some cue of the relevant vehicle dimension but differ on one or more irrelevant dimensions. Thus, no two stimuli in an array are identical, and the oddity relationship is less perceptually salient. Directing attention away from the center position should be particularly distracting in these problems, where several other dimensions compete for attention with the correct vehicle dimension for oddity.

The present study investigates two- and three-position rewarding in a simple oddity problem, with no nonspatial irrelevant dimensions, and in a dimension-abstracted problem, with one nonspatial variable irrelevant dimension. Previous studies[2] have suggested that first-grade Ss are capable of solving dimension-abstracted problems, if the vehicle dimension for oddity is their preferred dimension, while still requiring several trials to master a simple oddity problem.

SUBJECTS

A total of 42 Ss were tested (6:4-7:9 years, mean = 7:1). No S had previous experience with the apparatus or had previously been an S in discrimination problems.

APPARATUS

A modified version of the Wisconsin General Test Apparatus (Zeaman & House, 1963) was used. There were two interchangeable 18 x 15 in. stimulus trays. One contained two reward apertures, 2 in. in diam and 10 in. apart. The other contained three 1-in.-diam apertures, 5 in. apart.

Two types of stimulus materials were used, consisting of 3 x 3 in. cards. For the simple problems, there were two sets of stimuli, form and color. Set 1 contained white cards with black geometric forms (circle, cross, and star). Set 2 contained colored cards (red, yellow, and blue). For the dimension-abstracted problems, there was a pool of 36 stimulus items, consisting of all combinations of six forms (circle, star, triangle, square, cross, and T) and six colors (red, green, black, yellow, blue, and brown). From this pool, a set of nine stimuli, three forms in three colors, was selected for each S.

Stimuli used in the dimensional-preference test consisted of two forms (heart and Z) in two colors (orange and purple), none of which appeared later in the oddity sessions.

PROCEDURE

Each S was pretrained on a 20-trial junk problem consisting of two pictures taken from children's cartoon books. The pictures were presented following a Gellermann (1933) series. A noncorrection procedure was used. Ss who did not reach a 9/10 criterion on one of two junk problems were dropped from the study.

Following pretraining, the dimensional preference of Ss was assessed, using a "modified method of triads," described by Trabasso (Trabasso & Bower, 1968; Trabasso et al, in press). Pretraining and dimensional-preference assessment took place not more than 3 weeks or less than 1 week before the oddity sessions.

The Ss were then assigned to the four conditions of the experiment; age, sex, and dimensional preference were counterbalanced across conditions. Ss were trained on either a simple or dimension-abstracted problem, with their preferred dimension as the relevant vehicle dimension for oddity. The variable irrelevant dimension in the dimension-abstracted problems was Ss' nonpreferred dimension. All three cues of the nonpreferred dimension were present on every trial. (An example of such a problem would be blue circle (+), green square (–), yellow square (–), where form is the relevant vehicle dimension for oddity and color is variable and irrelevant.) For half the Ss in each condition, all three positions in the array contained the odd stimulus in turn. For the remaining Ss, only two positions contained the odd stimulus. Ss in the two-position condition were instructed that the center position would never be rewarded as there was "no place to hide a button," but that the button would always be in "one of these two holes" (E demonstrating the reward apertures). Any approach to the center aperture was met with, "No, no button in that one." Ss in all groups were repeatedly cautioned to "look at all the pictures before you choose the winner." The position of the odd stimulus was determined by a Gellermann series for the two-position groups. For the three-position groups, the 18 possible position-counterbalanced combinations of two like and one odd cue of the vehicle dimension were arranged to occur three times in 56 trials. The positions and cues of the irrelevant dimension varied randomly over trials. On Trial 1, the odd stimulus appeared in the right-hand position for all conditions. A correction procedure was used throughout. The reward tokens were red buttons that could later be traded for small toys. Testing continued until S reached a 6/6 criterion or until 56 trials had been completed.

RESULTS

Of the 42 Ss, 1 failed to meet criterion on pretraining, and 1 displayed inconsistent dimensional preference. Of the remaining 40 Ss, 32 were classified as form dominant and 8 as color dominant on the dimensional-preference test. All 40 Ss reached criterion on oddity learning within 56 trials. Mean trials to criterion for each group are presented in Table 1.

Two significant main effects emerged from the 2 by 2 analysis of variance. A significant effect for stimulus type was found ($F = 31.22$, $df = 1/36$, $p < .001$), with dimension-abstracted problems more difficult than simple problems. The main effect of number of positions rewarded was significant ($F = 7.21$, $df = 1/36$, $p < .025$), with three-position rewarding facilitating learning. However, there was also a significant Stimulus Type by Position Rewarded interaction ($F = 5.68$, $df = 1/36$, $p < .025$). This interaction is due to the fact that, on simple problems, Ss perform equally well under both conditions, but in dimension-abstracted problems, Ss' performance is superior when all three positions are rewarded.

Although Table 1 reveals that, on simple problems, Ss perform equally well under both reward conditions, the probability of reaching a 6/6 correct criterion by chance is much higher for the two-position condition than it is for the three-position condition (1/64 vs 1/729). It could be that the three-position condition would reveal even faster learning if a less stringent criterion for these groups was employed. A sequence of 4/4 correct would be expected 1/81 times by chance for the three-position groups, a value more comparable to the 1/64 chance expectancy for the two-position groups. Therefore, a further 2 by 2 analysis of variance was performed on the trial that preceded the criterion run for each S, using a 4/4 criterion for the three-position condition and a 6/6 criterion for the two-position condition. The results of this second analysis were essentially similar to the first, because only three Ss in the three-position condition produced a run of 4/4 correct responses prior to the previously scored 6/6 criterion run. Typically, Ss were seen to be performing at, or near, chance level (of 2/6 correct in blocks of 6) until the criterion run commenced.

Table 1
Mean Trials to Criterion (TC) on Oddity Learning

Problem	Reward	Mean TC	SD
Simple	2 Position	13.0	4.71
	3 Position	12.3	4.56
Dimension-Abstracted	2 Position	31.4	8.59
	3 Position	19.7	8.66

The number of Ss responding to the odd stimulus on Trial 1 (in the right-hand position for all groups) is presented in Table 2. Chi-square analysis, with Yates correction, revealed a significant difference between the two problem types ($\chi^2 = 5.10$, $p < .025$).

Table 2
Per Cent Ss Responding to Oddity on Trial 1

	Problem	
Reward	Simple	Dimension-Abstracted
2 Position	70	10
3 Position	50	30
Mean	60	20

DISCUSSION

The results of the present study replicate and extend the finding that dimension-abstracted oddity problems are more difficult for children to learn than are simple oddity problems (Lubker & Small, 1969). Not only is there a significant difference in trials to criterion between the two problems, but also in the number of Ss responding to oddity on the first trial. This latter finding is explained in terms of the greater perceptual saliency of the odd stimulus in simple problems, where the two nonrewarded stimuli are identical.

Direct comparison between the two techniques of rewarding only two or all three positions in an array supports the hypothesis that failing to reward the central position retards learning, at least for problems where the vehicle dimension for oddity must compete for attention with other irrelevant dimensions. Under such conditions, it is likely that attention is directed away from the nonrewarded position and perseverative errors to specific stimuli are more likely to occur. This distracting effect is minimal for simple problems, where the only nonspatial dimension is the vehicle dimension. Ss quickly attend to the relevant dimension, and the second observing response to oddity is relatively rapid. However, if variable cues of another dimension are present, the initial observing response to the vehicle dimension is impeded by rewarding only two positions. This is so, even when the vehicle dimension is the preferred dimension, with the nonpreferred dimension variable and irrelevant.

These findings suggest that future studies using multidimensional stimuli should reward all three positions in the array, thus directing attention to all stimuli equally. This should increase the probability of an S attending to the relational concept that is only attained by use of all three cues of the vehicle dimension.

REFERENCES

GELLERMANN, L. W. Chance orders of alternating stimuli in visual discrimination experiments. Journal of Genetic Psychology, 1933, 77, 7-13.

GOLLIN, E. S., & SHIRK, E. J. A developmental study of oddity problem learning in young children. Child Development, 1966, 37, 214-217.

HILL, S. D. The performance of young children on three discrimination learning tasks. Child Development, 1965a, 36, 425-435.

HILL, S. D. Transfer in discrimination learning. Child Development, 1965b, 36, 749-760.

HOUSE, B. J. Oddity performance in retardates: I. Acquisition and transfer. Child Development, 1964, 35, 635-643.

LUBKER, B. J., & SMALL, M. Y. Children's performance on dimension-abstracted oddity problems. Developmental Psychology, 1969, 1, 35-39.

SCOTT, K. G. A comparison of similarity and oddity. Journal of Experimental Child Psychology, 1964, 1, 123-134.

TRABASSO, T., & BOWER, G. H. *Attention in learning.* New York: Wiley, 1968.

TRABASSO, T., STAVE, M., & EICHBERG, R. Attribute preference and discrimination shifts in young children. Journal of Experimental Child Psychology, in press.

ZEAMAN, D., & HOUSE, B. J. An attention theory of retardate discrimination learning. In N. R. Ellis (Ed.), *Handbook of mental deficiency.* New York: McGraw-Hill, 1963. Pp. 159-223.

NOTES

1. This research was supported in part by USPHS Grant No. MH 07346 to the Children's Research Center, University of Illinois. The author wishes to thank the staff and children of Gibson City Elementary School, Illinois, for their cooperation.

2. Unpublished manuscripts, University of Illinois, 1969.