Response latencies for intradimensional and extradimensional transfer of the oddity solution*

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Twenty institutionalized retardates were assigned randomly to four conditions comparing intradimensional (ID) and extradimensional (ED) oddity shifts in either a within- or between-Ss embedded problems design. Following extended training, high accuracy of responding was found for all shift conditions. However, ED shifts of the vehicle dimension for oddity resulted in significantly longer latencies than either ID or control shifts. The disruptive effects of ED shifts were found only when the transfer problems contained variable irrelevant dimensions and when comparison was made between groups which received either ID or ED shifts but not both conditions. The results are discussed in terms of "multiple-look" theories of attention.

House (1964) suggested that two covert attentional responses were required for solution of the oddity problem. The S must first learn to observe a vehicle dimension, such as color or form, and then notice the oddity relationship defined on that dimension. Subsequent transfer to new stimulus sets should be facilitated in the equivalent of an ID shift which maintained the same vehicle dimension, compared with an ED shift which introduced a different vehicle dimension for the transfer problems. Brown (1970) reported superior transfer of ID oddity shifts, but Levin & Maurer (1969) found that once oddity responding had been established, equally efficient transfer to new stimuli occurred, irrespective of the vehicle dimension.

Two procedural differences between the Levin and Maurer and the Brown studies may account for the inconsistencies in their findings. The Levin and Maurer study used a within-Ss design which introduced a series of ID and ED shifts to all Ss. Brown used a between-Ss design which presented only one shift type to each of two distinct groups. Previous research on retardates' learning of a simple discriminative response also suggested that ID and ED shift differentiation is reduced, or does not occur at all, when a within-Ss

embedded problem design is used (House, 1968; Scott, 1966).

The two studies also differed in the type of oddity problems selected. Brown used complex problems which contained variable irrelevant dimensions from which the relevant vehicle dimension had to be extracted. Levin and Maurer used simple oddity problems containing constant irrelevant dimensions, with variability only on the vehicle dimension for oddity. Again, previous research on simple discrimination problems suggested that ID and ED shift differences are found only when there is a variable irrelevant dimension present on the transfer shifts (Dickerson, Wagner, & Campione, 1970). Generalizing from simple discrimination problems to the oddity problem, ID and ED shift differences would be predicted for the Brown study but not for the Levin and Maurer study. The present experiment compared oddity transfer shifts in both a between- and within-Ss design, using both simple and complex problems, in order to test whether these procedural differences could account for the discrepant results of the previous studies.

SUBJECTS

Twenty retardates were selected, without regard to sex or diagnostic category, from the institutionalized population of the Lincoln State School, Ill. The mean MA was 7 years, the mean CA was 16 years, and the mean IQ was 60.

STIMULI

Color-form stimuli were used for both pretraining and the experimental sessions. There were 81 different color-form stimuli, consisting of all combinations of nine forms and nine colors, used in the experimental sessions. One form in two colors was used in pretraining and as the standard

overlearned problem of the experimental sessions.

APPARATUS

The stimuli were presented in an automated apparatus, described in detail elsewhere (Scott, 1970). A digital printout automatically recorded accuracy, position, and latency of response. The stimuli were projected onto a three-window display panel. Two of the three projection windows (4 x 4 in.) were hinged from behind on their top edges. Pressure on either of these windows activated the reward device, released an M & M candy, and switched off the display. The center window was fixed, and Ss were instructed never to choose the center stimulus.

DESIGN

Four groups of Ss were employed, following a basic design first used by Grice & Hunter (1964). The design permitted comparison to be made both within and between Ss. Two groups of Ss received the two main conditions of the experiment (ID and ED shifts) in an identical unpredictable order. The data for only one of the shift conditions from each of these groups were used. The comparison data were provided by two further groups, each of which received either ID or ED, but not both, transfer shifts. Thus, Group 1 received only ID shifts, Group 2 received only ED shifts, and Groups 3 and 4 received both ID and ED shift problems, but only the ID data from Group 3 and the ED data from Group 4 were analyzed.

PROCEDURE

Pretraining

Only Ss who had already learned an oddity solution were permitted to enter pretraining. For pretraining, all Ss were assigned to a color-relevant simple oddity problem, with two colors on the vehicle dimension for oddity and one constant form. The four possible position-counterbalanced versions of this standard problem were presented randomly for 50 trials a day for 2 days. A success criterion was set at 80% correct on at least one of the 2 days of pretraining.

Experimental Sessions

Twenty-four two-trial problems were presented each day for 10 days. Trial 1 of each problem consisted of one version of the standard overlearned pretraining problem. Trial 2 of each problem presented one of six transfer problems. There were three types of shifts away from the standard problem (control, ID, and ED) in each of two levels of difficulty (simple and complex). A simple problem contained one variable dimension which served as the vehicle dimension for oddity [e.g. red square (+), yellow square (-), yellow square

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Fig. 1. Response latencies as a function of shift type and complexity. Only the ID data of Group 3 and the ED data of Group 4 are shown.

(-)]. A complex problem contained the vehicle dimension and one three-valued variable irrelevant dimension [e.g., red triangle (+), blue square (-), blue circle (-), with color as the vehicle dimension for oddity and with form, three-valued and irrelevant]. A control shift was included as a baseline shift condition, in comparison with which the effects of the ID and ED shifts could be assessed. A simple control shift referred to the representation of the standard Trial 1 problem on Trial 2. A complex control shift consisted of the same color problem as the standard Trial 1 problem but contained variable irrelevant values on the form dimension. Both ID and ED shifts introduced different forms and colors not contained in the standard problem. The ID shift maintained color as the vehicle dimension for oddity, while the ED shift introduced form as the relevant dimension. In simple ID and ED shifts the irrelevant dimension was constant, and in complex ID and ED shifts the irrelevant dimension was variable.

The Ss were randomly divided into four groups. Group 1 (the ID-between group) received 24 two-trial problems consisting of six each of four shift types: simple control, complex control, simple ID, and complex ID shifts. Group 2 (the ED-between group) received six simple and six complex ED shifts in place of the ID shifts of Group 1. The Ss of Group 3

(ID-within) and Group 4 (ED-within) were treated identically. They received 24 problems consisting of four each of the six possible shift types. However, only the ID data for Group 3 and the ED data for Group 4 were analyzed. The remaining data from each group were rejected. To facilitate the within- and between-groups comparison of shift types, only 4/6 available data points for each shift type were analyzed for Groups 1 and 2. This resulted in four measures per day on each of the analyzed shift types for any group. Five Ss per group were run for 10 days, resulting in 200 analyzed measures of each shift type.

RESULTS

As the general level of accuracy was high, with a mean of 97% correct, only response latencies were analyzed. The 2 by 2 by 4 by 10 by 4 by 20 mixed analysis of variance consisted of: 2 levels of complexity (simple and complex problems), 2 shift types [control and experimental (ID or ED)], 4 groups (ID-between, ED-between, ID-within, ED-within), 10 days, 4 repetitions within a day, and 20 Ss. Complex problems produced longer latencies than simple problems [$F(1,16) = 65.78, p < .001$]. The mean response time for complex problems was 1.85 sec compared with 1.41 sec for simple problems. Experimental shifts resulted in a mean response latency of 1.81 sec compared with a faster mean of 1.45 sec for the

control shifts [$F(1,16) = 54.15, p < .001$].

The experimental design permitted comparison between ID and ED shifts, not as a main effect, but as a Groups by Shift Type interaction. Figure 1 presents the mean response times for each group as a function of shift type and complexity. Latencies for the control shifts in each group were approximately equal. Response times for the experimental shifts varied with conditions. When the simple problems are considered, there appears to be little difference in the latencies for each group. However, when complex problems are considered, the longest latencies are found for ED shifts when this is a between-Ss comparison but not when this is a within-Ss comparison. Both the Groups by Shift Type interaction and the triple interaction of Groups by Shift Type by Complexity reached acceptable levels of significance [$F(3,16) = 5.12$ and 4.15 , respectively; $p < .05$].

These results were replicated in a second identical analysis of variance which substituted the rejected data for the analyzed data of Groups 3 and 4. Thus, the second analysis compared the same data from Groups 1 and 2 with the ED data of Group 3 and the ID data of Group 4. No difference between the two analyses emerged.

As additional support for the finding of no difference between ID and ED shifts when this is a within-Ss analysis, the mean response times were computed for both the ID and ED shifts of the within-Ss groups. No difference between the two shifts was apparent, with ID shifts requiring a mean response time of 1.79 sec as compared with 1.71 sec for ED shifts.

DISCUSSION

Once stable oddity responding had been established, efficient transfer to new problems occurred. Changes in the vehicle dimension, or the cue values on that dimension, did not disrupt the high accuracy of responding to the salient odd cue. The impaired accuracy under ED shifts reported in a previous study (Brown, 1970) may have been the result of insufficient training prior to transfer or may be a feature of traditional designs with original learning followed by transfer.

Asymptotic accuracy scores are not sensitive to differential ease in searching for the vehicle dimension for oddity. However, they do allow the more sensitive dependent measure of response latencies to be analyzed. Both the greater ease of simple over complex problems and control over experimental shifts were reflected in the latency, but not the accuracy, of responding. Again, latency scores illustrated the interaction of problem

complexity and experimental design, which was the focus of this study.

Differences attributable to ID or ED shifts of the vehicle dimension were not found in simple oddity problems like those used by Levin & Maurer (1969) but were found in complex problems of the type used by Brown (1970). A shift in the vehicle dimension resulted in longer response times only when the vehicle dimension relevant for original learning became variable and irrelevant in the transfer problems. A parallel finding has been reported by Dickerson et al (1970) with simple discrimination problems.

Further clarification of the divergent findings of the Levin and Maurer and the Brown studies came from the comparison of ID and ED shifts when this comparison was made within or between Ss. Each group received just one of the shifts of interest in the Brown study. A similar between-Ss comparison in the present study resulted in longer latencies for the ED shift problems. The detrimental effects of ED shifts disappeared in a completely within-Ss design, as in the Levin and Maurer study, where all Ss received all shift types. A similar evaporation of ID and ED shift differences was reported in within-Ss embedded problems designs using simple discriminative responses (House, 1968; Scott, 1966). Theories of attention that permit both "single" and "multiple-looking" (Fisher, 1970) can readily account for these findings. Presented with repeated shifts of the

vehicle dimension, the S learns to process both color and form in parallel, thus facilitating rapid abstraction of the vehicle dimension and efficient responding to oddity carried on either dimension.

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other color was rewarded with a sweet, but no comment was made. When criterion was reached on this task, E, without comment, moved on to presenting a series of cards of the noninstructed color (green) and a new color (yellow). Correct placement of these cards—green to the previously "greens" box and yellow to the previously "reds" box—was rewarded with a sweet, but no comment was made. Bryant claims that on the transfer task, normals made more errors than did SSNs on both colors, the difference being more marked on the established (green) response than on the novel (yellow) one. This difference is explained in terms of the different learning strategies adopted by the two groups. Since the normals were relatively handicapped in carrying over to a new task the responses about which no instruction had been given, Bryant suggested that the normals paid little attention to the noninstructed color in the initial task and learned this task on an "a/not a" basis—i.e., the noninstructed color was not processed as "green," but as "not red." SSNs, on the other hand, were thought to learn the two responses independently. It was further suggested that these differences in learning strategies exist prior to any verbalization in the solution of specific problems.

Such a hypothesis has wide implications. It suggests that SSNs may be treated as a functionally homogeneous category with respect to their preverbal learning strategies. Such a finding would be of prime importance in view of the widely held belief that SSNs should not be so regarded. It suggests also that SSNs in a learning situation typically attempt to process more information than do normals. In view of the alleged lesser information processing capacity of SSNs than normals (e.g., Annett, 1957), this is again a surprising suggestion. These implications can be tested by the following modification of Bryant's experiment: The initial task is the sorting of black and white cards (B/W), black being the "instructed" color. This is followed immediately after criterion is reached by sorting either black and red cards (B/R) or white and red cards (W/R). If normals do learn on an "a/not a" basis, while SSNs learn the two responses independently, and given that "a" is black, the following predictions may be made: (1) Normals will find Transfer Task 1 (B/R) easier than Transfer Task 2 (W/R), since, on the black/not-black strategy, white and red are not differentiated. (2) Since SSNs learn the black and white responses independently, they will find the transfer tasks equally

A learning strategy in normal children and severely subnormal adults

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It has been suggested (Bryant, 1967) that in a simple color sorting discrimination, normal and severely subnormal Ss use different learning strategies. Normals employ an "a/not a" strategy, while severely subnormals learn the two responses relatively independently. This hypothesis is tested, using a modification of Bryant's experiment. An initial training task in which groups of normal children and severely subnormal adults, matched on mental age, learn to sort black and white cards is followed by one of two transfer tasks. One is sorting black and red cards and the other, white and red cards. No support is found for Bryant's view.

Bryant (1967) has argued that severely subnormal (SSN) Ss learn the two responses in a sorting discrimination relatively independently, whereas normals do not. He investigated the effect of single instruction of groups of normal and SSN children matched for mental age on a color sorting task. In the

initial task, red and green cards were presented one at a time for sorting into two identical boxes. During this sorting, one color, say red, was "instructed"—i.e., whenever S sorted a red into the appropriate box, he was rewarded with a sweet and instructed verbally that this was a correct placement. Correct placement of the