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ABSTRACT

One hundred and eight kindergarten and elementary school children, 36 at each of three age levels (5, 7, and 9 years) participated in the experiment. All children were presented a three-part successive discrimination task; original learning, presentation of incidental stimuli, and a test of recognition and recall of the incidental material. One-third of the subjects at each age level learned the original task (intentional learning) under one of three reinforcement conditions; Right-blank, Right-Wrong, or Wrong-blank. Contrary to prediction, there were no age differences in incidental recognition or recall (previous studies had found a curvilinear relation between age and incidental learning.) Although the main effect of reinforcement condition was not significant for trials to criterion on intentional learning, children of all ages who learned the original discrimination under the Wrong-blank condition showed significantly higher incidental recognition and recall than subjects tested under the Right-Wrong and Wrong-blank conditions. Results were discussed in terms of the effects of a Wrong-blank reinforcement procedure on the child's attention to the task. (Author)

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ON YOUNG CHILDREN'S INCIDENTAL LEARNING

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**THE EFFECTS OF DIFFERENT TYPES OF REINFORCEMENT
ON YOUNG CHILDREN'S INCIDENTAL LEARNING¹**

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Several recent studies have obtained a curvilinear relation between age (seven to 14 years) and incidental learning, with higher levels of performance at the intermediate ages (Maccoby & Hagen, 1965; Siegel & Stevenson, 1966; Siegel, 1968). In a follow-up study, Siegel and Corsini (1969) found that the similar performance levels of 8- and 14-year-old children were determined by different processes. Eight- and 14-year-olds were presented a three-part successive-discrimination task: Original learning, presentation of incidental material, and a test of incidental recognition and recall. The results supported a two-stage process underlying incidental learning--attention and information-processing. Little incidental learning was shown by 8-year-olds primarily because they failed to attend to the peripheral material unless specifically instructed to do so. On the other hand, 14-year-olds attended to the peripheral material whether specifically instructed to learn it or not, but processed the information efficiently only when an organizational strategy (in this case, a conceptual relation among the peripheral stimuli) was readily available.

One of the main purposes of the present experiment was to assess incidental learning in children younger than those tested in previous studies, using the same paradigm as used by Siegel and

Corsini (1969), but making the problem easier (and thus, better suited to the cognitive abilities of younger children) by using a two-choice, rather than a three-choice, discrimination problem. It was predicted that if similar processes are operating, a similar curvilinear relation between age and incidental learning would be found. We expected the incidental learning (recall) of our oldest and youngest groups to be approximately the same, but to be lower than that of our intermediate-age group. We also expected that trials to criterion on the intentional task would decrease with age.

A second goal of the present experiment was to investigate the effects of different reinforcement combinations (i. e., Right-blank, Right-Wrong, and Wrong-blank) on both the intentional (original) learning and the incidental recognition and recall of these children. The experimental literature bearing directly on the effects of differential reinforcement of intentional learning on subsequent incidental learning of children is extraordinarily sparse. Only one such study was found: Kausler, Laughlin, and Trapp (1963) found that seventh and eighth graders showed more incidental learning under a high-incentive (an offer of an amount of money contingent on good performance) than under a low-incentive ("we'd appreciate your help") condition.

Considerable evidence, however, has been amassed concerning reinforcement effects on intentional learning: Typically, on conceptual and two-choice discrimination tasks, the Right-blank, (Rb) combination produces significantly poorer performance than Wrong-blank (Wb) and Right-Wrong (RW) combinations (Brackbill & O'Hara, 1958; Buss & Buss, 1956; Curry, 1960; Meyer & Offenbach, 1962; Meyer & Seidman, 1961; Spence & Dunton, 1967; Spence & Segner, 1967). Thus, it was predicted that RW and Wb reinforcement con-

ditions would produce relatively faster learning of the initial intentional discrimination than would a Rb condition. No specific predictions were made concerning the effects of different reinforcement conditions on incidental recognition and recall.

Method

Subjects

108 elementary school children served as Ss; there were 36 children at each of three age levels: 5 years (mean age = 5 years-8 months, SD = 2 months), 7 years (mean age = 7 years-5 months, SD = 3 months), and 9 years (mean age = 9 years-5 months, SD = 4 months). All children came from essentially lower-middle to middle-class backgrounds. There were 13 Negro and 23 white children at the five-year age level; at the seven- and nine-year age levels, half the Ss were white, and half were black.

The children were average or above in intellectual ability as measured by the Detroit Intelligence Test, a group test administered to all children in the school system in kindergarten or first-grade. The mean I. Q. scores for the 5-, 7- and 9-year-olds, were 121, 114, and 110, respectively. Differences among the mean scores for the three age groups were not statistically significant.

Twelve Ss at each age level were randomly assigned to one of three reinforcement conditions (Rb, RW, and Wb). Within each group of 12, there were six boys and six girls.

Apparatus

The apparatus consisted of a 20 x 20-inch stimulus and response console, painted black. The slides were rear-projected onto

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a 5 x 6-inch flash-white glass screen which was centered in the upper portion of the console. Two 3-inch levers, centered and spaced 10 inches apart, extended from the sloping response panel. Marbles were automatically dispensed into a small tray attached to the bottom front of the apparatus. A marble board (with holes for 100 marbles) was placed beside the apparatus for S to put his marbles in, and where E could easily reach from behind the apparatus to remove them.

Stimuli

The stimuli were colored slides of pictures of common objects. Stimuli for Task 1 (intentional learning) were a truck and a plane. During Task 2 (presentation of incidental stimuli) these stimuli were each shown on a slide with three other objects (the incidental stimuli). The two stimulus complexes were: Truck--tomato, man, sheep; plane--corn, boy, cow. In Task 3 (test of incidental learning), the six incidental stimuli and six new stimuli (carrots, girl, pig, grapes, nurse, horse) were shown individually.

Reinforcement conditions

All Ss began Task 1 with 15 marbles (1 large one and 14 small ones) in the marble board. In the Right-blank (Rb) condition, S received a marble immediately following a correct response, and was told to add that marble to his reserve on the marble board; nothing happened when S made an incorrect response. In the Right-Wrong condition (RW), S got a marble for a correct response, and E removed one marble from S's reserve following each incorrect response. In the Wrong-blank (Wb) condition, nothing happened following a correct response, and E removed one of S's marbles after each incorrect response.

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Reinforcement was given only during Tasks 1 and 2. If S lost all 15 of his marbles, he was told that he could exchange the last one (the big one) for 15 more, since the big one was "really worth 15 small ones," and allowed to continue. Only three Ss had to be given extra marbles.

Procedure

The E seated S in front of the apparatus, told him that he would play a "T. V. game," pointed to the screen, and projected the two stimuli used in Task 1. S was asked to pull the levers to see how they worked. He was then told to "pull the correct handle when a picture comes on," and that "by watching the pictures very carefully, you can always tell which handle to pull." The S was then given instructions appropriate to his reinforcement condition:

Rb: "Try to get as many marbles as you can. Every time you pull the correct handle, you will get a marble from here that you can add to the ones you already have. If nothing happens, you know you pulled the wrong handle."

RW: "Try to get as many marbles as you can. Every time you pull the correct handle, you will get a marble from here that you can add to the ones you already have. If you pull the wrong handle, then I will take away one of your marbles."

Wb: "Try to save as many marbles as you can. Every time you pull the wrong handle, I will take away one of your marbles. If nothing happens, you know you pulled the right handle."

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The child was then told to try to pull the correct handle every time, and that if he had enough marbles in his board at the end of the experiment, he could win any prize among several displayed.

All Ss were presented three successive-discrimination tasks. Approximately half of the Ss were tested under one of two random orders of stimuli in Task 1, with the restriction that neither stimulus appeared more than twice in a row. The two "stimulus-correct lever" combinations were randomly assigned to approximately equal number of Ss. If an S failed to reach a criterion of eight consecutive correct responses within 52 trials he was eliminated from the study and replaced by a new S; 34 5-year-olds, eight 7-year-olds, and two 9-year-olds failed to reach this criterion.

When S reached criterion for Task 1, Task 2 was begun immediately without any additional instructions. Each of the two stimulus complexes was presented 12 times, once in each block of two trials. The response that had been correct for one of the central stimuli in Task 1 remained correct for that stimulus complex in Task 2. Two random orders of slides were generated and half of the Ss were tested under each order. If S responded correctly on fewer than 16 of the 24 trials he was eliminated from the study and replaced by a new S; seven 5-year-olds, and four 7-year-olds failed to reach this criterion.

Following Task 2, E gave the following instructions to each S:

"Now we are through with the marbles for a while. I'm going to show you some more pictures. When a picture comes on the screen, you try to remember if you saw it before in this game. If you did see it before, you

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tell me whether you saw it with the truck or with the plane. If you did not see the picture before, you tell me that, too."

S was then shown a picture of a hammer to test his understanding of the instructions. "Now, tell me if you saw this picture before in this game." If S said he had not, E said "Correct!" If S said that he had seen the hammer before, he was corrected: "No! You've probably seen one like that, but you didn't see it as a picture in this game, did you?" E was quite careful to ascertain that each S understood the instructions, and if in doubt, required S to repeat the relevant aspects of his task.

In Task 3, the series of 12 slides (six incidental and six new stimuli) were shown twice, each time in a different random order. No reinforcement was given during Task 3; E simply recorded whether S had or had not seen the stimulus before, and if he had seen it before, with which central stimulus he associated it. At the end of this task, S was given his chosen prize and returned to the classroom.

The measure of incidental learning (recall) was the number of the 12 incidental stimuli (six presented twice each) that were both correctly identified as having been seen before, and were also correctly associated with the central stimulus from Task 1. For example, if the left lever was correct for the truck in Task 1, it remained correct for the truck--tomato, man, sheep complexes in Task 2; in Task 3, the correct response for tomato, man, and sheep was to tell E that he had seen each of them with the truck.

There were, therefore, three experimental conditions (Rb, RW, and Wb): Six boys and girls at each age level were tested under each condition.

Results

Task 1: Original learning

A 3 (Age) X 3 (Reinforcement condition) X 2 (Sex) analysis of variance was performed on the number of trials required to learn the initial discrimination, excluding the eight criterion trials. Although the main effect of Age was significant ($F = 3.17$, $df = 2/90$, $p < .05$), a decreasing linear function was not found. Scheffe (.05) confidence intervals (Critical value = 3.53) indicated that the 9-year-olds took significantly fewer trials to learn the original discrimination (4.53) than did either the 7-year-olds (8.97) or the 5-year-olds (8.11); the difference between the 5- and 7-year-olds mean scores was not significant. Contrary to prediction, the main effect of reinforcement was not significant ($F < 1.00$), and the means for the three experimental groups were very similar ($R_b = 7.42$, $R_W = 7.03$, $W_b = 7.25$). No other main effects or interactions were significant at the .05 level.

Task 2: Presentation of incidental stimuli

The mean number of errors during Task 2 for all Ss was 1.33, indicating a high degree of positive transfer from Task 1. A similar analysis of variance of these data indicated that only the main effect of age was significant ($F = 12.42$, $df = 2/90$, $p < .001$). Scheffe (.05) confidence intervals (Critical value = 2.05) indicated that the 5-year-olds made significantly more errors (2.58) than did the 9-year-olds (0.47); the 7-year-olds (0.94) made an intermediate number of errors, but did not differ significantly from either the 5- or the 9-year-olds.

Task 3: Test of incidental learning

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Two measures were derived for Task 3: A recognition score and a recall score. The recognition score represents the number of incidental stimuli presented during Task 3 that were correctly identified as having been seen before minus the number of new objects that were incorrectly identified as being familiar. This score, which takes into consideration S's propensity for "guessing," seems to be a more accurate measure of recognition ability than is simply the number of correct-positive identifications. Siegel and Corsini (1969) neglected to consider this point, primarily because the frequency of false-positives was considerably lower in their sample than in this one. The recall score represents the number of incidental stimuli that were both correctly identified as having been seen before, and also correctly associated with the central stimuli with which they had been seen in Task 2. Since the recognition scores for the two series of stimulus presentations in Task 3 were highly correlated ($\underline{r} = +.84$, $\underline{df} = 106$, $\underline{p} < .001$), and since the recall scores for the two series were also highly correlated ($\underline{r} = +.74$, $\underline{p} < .001$), the two separate recognition and two separate recall scores were combined. An Age X Reinforcement X Sex analysis of variance was performed on each of these measures. Since the main effect of Sex and the two interactions with Sex were not significant, Age X Reinforcement cells means are presented in Table 1.

Insert Table 1 about here

The analysis of the recognition scores yielded only a significant main effect of reinforcement conditions ($\underline{F} = 6.89$, $\underline{df} = 2/90$, $\underline{p} < .01$). Scheffe (.05) confidence intervals (Critical value = 1.40) indicated that the mean recognition score for Ss tested under Wb

reinforcement (8.44) was significantly greater than that for Ss tested under either RW (6.42) or Rb (7.00); the mean scores for Ss in RW and Rb were not significantly different. Thus, Ss given Wb reinforcement during Task 1, attended more carefully to the incidental stimuli during Task 2. No other main effects or any interactions were significant at the .05 level. To assure that this measure of recognition was an appropriate one, separate proportions for correct recognitions and false positives were computed for each S; these were converted to d' (Elliot, 1964), and an analysis of variance was performed on the d' score for each S. The analysis yielded identical results: Only the main effect of reinforcement condition was significant ($F = 6.79$, $df = 2/90$, $p < .01$). The mean d' for group Wb was significantly greater than that for both groups RW and Rb (which did not differ significantly from each other).

The analysis of the recall scores also yielded only a significant main effect of reinforcement condition ($F = 4.55$, $df = 2/90$, $p < .05$). Scheffe (.05) confidence intervals (Critical value = 1.37) indicated that, just as in the recognition data, the mean recall score for Ss tested under Wb reinforcement (6.50) was significantly greater than that for Ss tested under RW (4.94) or Rb (5.22) reinforcement; the mean scores for Ss in RW and Rb were not significantly different.

Contrary to prediction, the main effect of age was not significant ($F < 1.00$), although the trend of the data was in the predicted curvilinear direction in all three reinforcement conditions: 7-year-olds had slightly higher recall scores than did either the 5-year-olds or the 9-year-olds. No other main effect or interaction was significant at the .05 level. Thus, recall during Task 3 was most facilitated when S received Wb reinforcement during Task 1.

Correlations

Pearson product-moment correlations were computed among all learning measures: Trials to criterion on Task 1, errors on Task 2, recognition scores, and recall scores for the entire sample, each age group, and each reinforcement condition. With the exception of the significant correlations between recognition and recall scores for all Ss, for each age group, and for each reinforcement condition ($\underline{r} \geq +.52$, $\underline{df} \geq 34$, $\underline{p} < .001$), all other correlations were insignificant ($\underline{r} \leq .18$, $\underline{p} > .05$).

Discussion

As has been found in previous studies, incidental recognition and recall scores were similar for boys and girls. In addition, although the sample was composed of both black and white children, there were no significant race differences on any measure, either for the sample considered as a whole, or for any age or reinforcement group considered separately. As expected from previous studies, measures of intentional and incidental learning were essentially independent (Siegel & Stevenson, 1966; Siegel, 1968; Siegel & Corsini, 1969). Thus, the procedure of considering only the data of the children who "learned" both Tasks 1 and 2 is justified not only because the inclusion of their performance on Tasks 2 and 3 (if they had been tested) would be meaningless, but also because incidental recognition and recall are independent of intentional learning.

As expected, there were age differences in learning both the original discrimination and in Task 2 errors: 9-year-olds learned the original problem faster than either the 5- or 7-year-olds, and made fewer errors in Task 2. Since only 36 of the 70 5-year-olds

tested learned Task 1, it is apparent that this discrimination was too difficult for an average group of 5-year-old children; regardless of age, however, once S learned Task 1 to criterion, Task 2 presented no major problems.

Previous studies (Meyer & Seidman, 1961; Spence & Dunton, 1967) have found that either RW or Wb or both are more effective reinforcement conditions for learning than is Rb. Contrary to prediction, the number of trials to learn the original discrimination was unaffected by reinforcement conditions in the present study. There are several possible explanations for this. First, in a majority of the studies in which RW or Wb have been found most effective, the problem was a simultaneous discrimination, whereas the discrimination in the present study was successive. As has been found by Reiber (1966), different types of feedback conditions have differential effects on the two types of problems. Second, there were no irrelevant stimulus dimensions in our original learning task. Meyer & Seidman (1961) found that whereas RW and Wb reinforcement facilitated learning of a problem in which two or three irrelevant stimulus dimensions were used, there were no differences in learning when only one dimension was irrelevant. Thus, in terms of number of irrelevant dimensions, our discrimination was the simplest type--possibly too simple for different reinforcement conditions to exert differential effects. This latter reasoning is supported by the fact that the mean number of trials to criterion (for those actually reaching criterion) was very low. Studies using two or three irrelevant dimensions (e.g., Lubker, 1969), have found that the mean number of trials to criterion is much higher (even though the problem is successive).

Although the trend of the recall data indicated the predicted curvilinear relation between age and incidental learning, the hypothesis was not supported since the main effect of age did not even approach statistical significance. Since the age range of five to eight years is a particularly sensitive one, in that many cognitive and perceptual changes are taking place (White, 1965), it is possible that the age range over which a curvilinear relation is found might be fairly narrow. Perhaps the predicted effect would have been obtained if we had tested six- and eight-year-olds.

The most striking finding of the study was that both incidental recognition and recall were greatest when children learned the original task under the Wb reinforcement condition. Although we had predicted that reinforcement condition would produce some differences, we were surprised by the fact that the greatest facilitation was found in the Wb condition. If anything, one would have expected that the effects of RW and Wb would have been similar. That RW and Rb produced similar effects suggests that there is something about actually receiving a marble (an immediate tangible reward) that sets conditions RW and Rb apart from Wb: Under these latter two conditions, somehow the S was assured that he would end up with a fair number of marbles and win a prize. There was no such assurance under the Wb condition--S could only see his marble supply dwindling. This may be an important, yet unexplored factor in children's discrimination learning. (In studies where reinforcement is verbal "wrong," or buzzer "wrong," S cannot see his reinforcer supply dwindling). Ss in condition Wb might have perceived the situation something like: "If you want a prize, you'd better pay real close attention; if you don't, all your marbles will be lost, and the lady said that if you saved enough marbles you could win a prize. You

better start saving, and make sure you lose as few marbles as possible (i. e., deplete your supply as little as you can)". In effect, the child's concern about losing all of his marbles (no pun intended) might have produced a high-incentive condition (relative to RW and Rb). If this were the case, then the results are in line with Kausler et al.'s (1963) data indicating that children showed more incidental learning under a high-, than under a low-, incentive set. In the present study, children paid more attention to both the central and peripheral stimuli in Task 2 (after their marbles had run very low from Task 1), and showed higher incidental recognition and recall in condition Wb. That is, the Wb condition produced more attentional involvement in Task 2. If the Wb condition only increased attention to the central stimuli in Task 2, then Ss should have shown relatively less, not relatively more, incidental learning. Clearly, this reasoning is post hoc, and further research is necessary to determine the effect of motivation-incentive conditions on incidental recognition and recall.

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Table 1
 Mean Recognition and Recall Scores for Each Age X Reinforcement Subgroup

Age Group	Recognition Scores of <u>Ss</u> in Reinforcement Condition:				Recall Scores of <u>Ss</u> in Reinforcement Condition:			
	<u>Rb</u>	<u>RW</u>	<u>Wb</u>	<u>All</u>	<u>Rb</u>	<u>RW</u>	<u>Wb</u>	<u>All</u>
5	\bar{X} 6.17 S.D. 2.26	\bar{X} 6.41 S.D. 3.47	\bar{X} 9.00 S.D. 2.08	\bar{X} 7.20	\bar{X} 5.00 S.D. 1.73	\bar{X} 5.08 S.D. 1.75	\bar{X} 5.75 S.D. 1.69	\bar{X} 5.28
7	\bar{X} 7.66 S.D. 1.24	\bar{X} 6.58 S.D. 2.32	\bar{X} 7.84 S.D. 2.73	\bar{X} 7.37	\bar{X} 6.08 S.D. 2.21	\bar{X} 5.17 S.D. 2.11	\bar{X} 7.00 S.D. 2.12	\bar{X} 6.08
9	\bar{X} 7.17 S.D. 2.82	\bar{X} 6.25 S.D. 2.58	\bar{X} 8.50 S.D. 2.52	\bar{X} 7.30	\bar{X} 4.58 S.D. 3.35	\bar{X} 4.58 S.D. 2.13	\bar{X} 6.75 S.D. 2.41	\bar{X} 5.31
All <u>Ss</u>	\bar{X} 7.00	\bar{X} 6.42	\bar{X} 8.44	\bar{X} 7.29	\bar{X} 5.22	\bar{X} 4.94	\bar{X} 6.50	\bar{X} 5.56