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ABSTRACT

A short term memory task was used to explore the effects of color cues and of a condition that permitted rehearsal as compared to one that did not. Eighty subjects per grade at grades 3, 5, and 7 were tested. A stimulus array consisted of five cards, each of which contained pictures that could be designated as central or incidental. The stimulus cards were presented for 20 trials. Recognition for central stimuli improved when color cues differentiated them from incidental stimuli, but there was no differential effect with age. Permitting rehearsal resulted in improved recall and recognition performance. At the older age levels, in the rehearsal condition, recognition of central stimuli was hindered less by the incidental stimuli than in the condition which interfered with rehearsal. (Author/DP)

# COLOR CUES AND REHEARSAL IN SHORT-TERM MEMORY

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## ABSTRACT

A short-term memory task was used to explore the effects of color cues and of a condition that permitted rehearsal as compared to one that did not. Eighty subjects per grade at grades 3, 5, and 7 were tested. A stimulus array consisted of 5 cards each of which contained pictures that could be designated as central or incidental. The stimulus cards were presented for twenty trials. Recognition for central stimuli improved when color cues differentiated them from incidental stimuli but there was no differential effect with age. Permitting rehearsal resulted in improved recall and recognition performance. At the older age levels, in the rehearsal condition, recognition of central stimuli was hindered less by the incidental stimuli than in the condition which interfered with rehearsal.

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The present study was designed to investigate the effects of color cues and of subject-employed strategies in the development of selective attention in a short-term memory task. In previous studies it has been found that the proportion of incidental to total material recalled decreased as chronological age increased (Maccoby and Hagen, 1965; Hagen, 1967; Hagen and Sabo, 1967; Druker and Hagen, 1969). A decline in incidental learning with age has been found by others (Crane and Ross, 1967; Hale, Miller and Stevenson, 1968; Siegel and Stevenson, 1966). In both learning and recall, the decline in incidental performance was particularly evident at the twelve to fourteen year age range.

In previous studies, it was not clear whether the age differences found were due to an inability of the younger subjects to distinguish the two categories of pictures, central and incidental, or to an inability to encode only the to-be-recalled pictures while ignoring the others. Druker and Hagen (1969) found that increased spacing between the pictures decreased incidental recall, suggesting that the incidental pictures were distracting. In this study, a comparison was made between central and incidental pictures which differed in color as well as type of pictures and those which differed only in type. Color cues, redundant with the central and incidental picture categories used

in the previous studies (Hagen, 1967; Hagen and Sabo, 1967) should facilitate central performance if the difficulty lies in distinguishing between the types.

In addition to stimulus characteristics, strategies employed by the subject have been shown to affect memory. Keeney, Cannizzo, and Flavell (1967) and Kingsley and Hagen (1969) found that young children did not employ rehearsal strategies but could be induced to do so, and memory then improved. Older children who rehearsed spontaneously showed better memory in similar tasks (Hagen and Kingsley, 1968; Hagen, Meacham and Mesibov, 1970). It was predicted that in the central-incidental memory task the older children would use rehearsal to facilitate memory of the central items, thereby strengthening central memory relative to incidental memory. If rehearsal were not permitted, central memory should be reduced. Thus a condition that permitted rehearsal was compared to a condition that made rehearsal difficult if not impossible.

An improved procedure was used to measure incidental recall. In the previous experimental task (Hagen, 1967; Druker and Hagen, 1969), the amount of incidental material recalled was ascertained after the central or intentional recall measure had been made. A method was devised in which incidental recall was measured simultaneously with central. The design of the study was as follows. Series of drawings were presented in pairs for brief exposures, with the instruction to remember one of the two categories of pictures. For half the trials, the two picture categories differed only in conceptual category represented; for the other half, they also differed in color. Half of the subjects were permitted to employ rehearsal after stimulus presentation; half were required to perform a task which interfered with rehearsal. Subjects at

three age levels were used.

The predictions were: (a) central task scores should increase as a function of age level; (b) incidental stimuli should influence the performance of older children less than that of younger children; (c) memory for stimuli that differ in color as well as type of categ y should be higher, especially at the younger age levels; and (d) memory should be better when rehearsal is permitted than when task demands interfere with rehearsal, and the difference should increase with age.

## METHOD

### Subjects and Design

The 240 predominantly white, middle-class Ss were selected from the third, fifth, and seventh grades of three parochial schools in Staten Island, New York. The numbers of males and females at each grade level were as follows: Grade 3, 30 males and 50 females; Grade 5, 32 males and 48 females; and Grade 7, 31 males and 49 females. The task was administered during the first three months of the school year. In the first two schools all the children in the appropriate grades were included, and in the third school random selection was used to obtain the needed number. The mean ages of each grade level were: Grade 3, 8.4 years; Grade 5, 10.4 years; and Grade 7, 12.3 years.

Half the Ss at each grade level was assigned to the Nonrehearsal condition. Subjects were divided into groups by sex as evenly as possible. Within each experimental condition, for half the trials, the stimulus pictures were black line drawings on white paper. For the other half of the trials, the pictures designated central were drawn on a brightly colored paper; and the

pictures designated incidental were drawn on paper of a different color.

Materials

The stimulus pictures consisted of line drawings of animals and household objects. They were familiar to and easily named by all Ss. Each picture, approximately 5.2 cm square, was paired with another picture on a white 10.3 x 15.5 cm card. Each card contained one animal and one object picture placed one above the other. A presentation panel consisted of five cards placed in a horizontal row. The cards were separated from each other by a heavy black line. There were 20 rows of cards. For 10 rows, all pictures were black outline drawings on white background paper. For the other 10 rows, the drawings were made on colored paper and then cut out and pasted on the cards; otherwise they were the same black outline drawings as used in the other ten rows. Animals were drawn on yellow paper and the objects on blue. A cue card was used to test memory after the panel was presented. There were three types. The first type presented an identical pair of animal and household objects as appeared on a card in the presentation row. The second type presented an animal just previously shown but paired with a household object which had not been shown. The third type presented a household object just shown, paired with an animal which had not been shown.

Procedure

Three white, adult females tested Ss individually in a special room at each school. The child was told that he would be shown briefly a number of pictures which he was to try to remember, and he should do as well as possible, although no one was expected to remember all pictures. A practice trial was given in which a row of three picture pairs, not actual test pictures,

was shown. The row was then covered with a row of blank cards, and after a 10 second delay period a cue card was shown and the S was asked if the animal on the cue card had appeared in the presentation pictures. For the Rehearsal condition, the instruction at the beginning of the 10 second delay was to "think about the pictures;" for the Nonrehearsal condition, the S was instructed to count out loud beginning with the number "one" during the delay period. Then a cue card with a correctly paired animal and household object was shown and the S was asked if the picture designated central had appeared just previously. This was the recognition measure. If the correct "yes" answer occurred, the S was asked where in the row it had been, the position-recall measure. This response was made by pointing to the appropriate blank card to indicate the location of the presentation card that matched the cue card. One cue card per trial was used. For the practice trial only, a correction procedure was used, and if the S did not understand the task, it was explained again.

The S was then told there would be a series of picture rows and he was to try to remember locations of central pictures as he had just done for the practice trial. Each of the test rows was displayed for two seconds and removed from view. There was a 10-second pause followed by the cue card which was displayed until S replied. For half of the 20 trials, the pictures were the black line drawings and the pictures to be remembered were called "animals" by the experimenter. For the other half of the trials, the pictures were drawn on colored paper and the pictures to be remembered were designated "yellow." For half the subjects, the 10 "animal" trials were presented first; for the other half, the 10 "yellow" trials were presented first.

For each 10-trial set, the first type of cue card, animal and object both correct, was used for trials 1, 5, and 7. The second type, central correct and incidental incorrect, was used on trials 2, 4, and 9. The third type, central incorrect and incidental correct, was used on trials 3, 6, 8, and 10. After the 20 trials were completed, the S was questioned concerning strategies he may have used to remember the pictures. If there was no reply to the general question, "How did you go about trying to remember the right ones?" two specific questions were asked. The first concerned which pictures he had tried to look at during the stimulus presentation, and the second probed for use of covert verbal rehearsal. Then the S was thanked and returned to the classroom. Testing took between 15 and 20 minutes.

## RESULTS

### Central Task Scores: Recognition and Recall Measures

The mean number correct recognition and recall scores for each grade level and for Rehearsal versus Nonrehearsal conditions are presented in Table 1. Three way analyses of variance were performed on these data.

Insert Table 1 about here

Grade level was significant for both recognition, $F\ (2, 234) = 11.91$, $p < .01$, and recall, $F\ (2, 234) = 13.39$, $p < .01$, with better retention by subjects in the higher grades. Thus the improvement in memory with age found in the earlier studies was replicated.

The Rehearsal condition had higher performance scores than the Nonrehearsal condition across grade levels (for recognition scores, $F\ (1, 234) = 9.11$, $p < .01$; for recall scores, $F\ (1, 234) = 13.20$, $p < .01$). For recall scores, there was a significant interaction between grade levels and Rehearsal

versus Nonrehearsal, $F(2, 234) = 4.80$, $p < .01$. Recall was substantially lower in the Nonrehearsal condition as compared to the Rehearsal condition at the seventh grade level, moderately at the fifth grade level, and unaffected at the third grade level. The mean differences showed a similar trend for the recognition task data even though the interaction was not significant. The results are consistent with the hypothesis that the older subjects' memory should be more affected by the condition which interfered with rehearsal.

Analyses of variance performed on the stimulus background variable, color versus white, resulted in a significant difference in recognition performance, $F(1, 234) = 4.71$, $p < .05$. As predicted, the pictures on color were recognized better than the pictures on white. The direction of difference was the same for the recall measure. The prediction that the greatest differences should occur at the youngest age level was not confirmed for either measure.

Central versus Incidental Task Scores

The effect of the incidental pictures on memory was measured by examining the difference between two types of central recognition scores, as elicited by the first and second type of cue card. The first type, in which both the animal and the household object were correct (i.e., both pictures on the cue card had actually appeared on one of the cards in the preceding presentation) was used for 30% of the trials. The second type, in which the central picture was correctly represented on the cue card but paired with an incorrect incidental picture, was used for another 30% of the trials. If the subjects had ignored the incidental pictures, no differences should be

found between the scores on these two sets of trials. A two-way analysis of variance for grade level and the recognition measures, for the two types of cue conditions, resulted in a difference for grade level, $F$ (2, 237) = 10.21, $p < .01$, as well as a difference between the two cue types, $F$ (1, 237) = 30.37, $p < .01$. The grade level by cue type interaction was not significant, $F = 2.18$. For all grades, the recognition scores for the first-cue-condition trials were higher than for the second-cue-condition trials.

The two types of recognition scores were then analyzed separately for the Rehearsal and the Nonrehearsal conditions. Table 2 presents the mean

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Insert Table 2 about here

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scores. For Rehearsal, the difference between the two types of scores was significant, $F$ (1, 117) = 24.18, $p < .01$, as was grade level, $F$ (2, 117) = 11.01, $p < .01$, and the interaction between these two variables, $F$ (2, 117) = 71.52, $p < .01$. For Nonrehearsal, the difference between the types of scores was significant, $F$ (1, 117) = 22.79, $p < .01$, but neither grade level, $F = 1.41$, nor the interaction, $F < 1$, was significant. Hence, the predictions concerning the effects of cue type on recognition performance were confirmed for the Rehearsal condition only. The recall data for these two types of trials were not analyzed because there was a very low frequency of response in certain cells, especially those for the youngest age level.

The 40% of the trials that used the third type of cue card were not included in the analyses. This cue card contained an incorrect central picture and a correct incidental picture. A correct response was "no" whereas for the other trials it was "yes." These trials were included so that "yes" would

not be the correct response on all trials. Correlations among the three types of central recognition scores, which are presented in Table 3, revealed

Insert Table 3 about here

positive correlations between the first two types of trials and negative between either of these and the third type. Correlations between a score where "yes" was the correct response and a score where "no" was the correct response were negative with one exception. Thus, if a subject tended to be correct on the "yes" questions, he tended to be incorrect on the "no" questions. There is no obvious explanation for this response bias, but since the "no" correct trials were not included in the analyses the results reported are not affected. The positive correlations between the first two types of trials are understandable since they constitute two subtests of the larger test.

The results from the posttest questioning were coded and grouped into categories. Verbal reports of visually scanning both central and incidental stimuli as compared to visually scanning only central stimuli were more common among the younger subjects than the older, $\chi^2$ (4) = 9.16, $p < .02$. Subjects' reports of verbally naming the pictures to themselves during the task showed that younger children named less often than did older children $\chi^2$ (2) = 23.74, $p < .01$.

Sex and School Analyses

Analyses for both recognition and recall scores were performed to determine whether there were differences in the data due to sex or school differences in the subject population. No differences were found for either variable.

## DISCUSSION

The color background cue was expected to enhance the difference between the central and incidental pictures and hence to facilitate task performance. This result occurred, but only for the recognition measure. Previous studies have found that physical characteristics of the stimuli in this task affect memory performance. Hagen (1967) found that the mere presence of the incidental pictures lowered recall performance of the central pictures. Druker and Hagen (1969) varied the spatial placement of the pictures and found that when the central and incidental were spatially separated there was a decrease in incidental recall. However, the predicted age-related differences have not been found in any of these studies. One would expect that if young children, as compared to older, were less able to separate visually the two pictures, their performance would be more affected by stimulus manipulations and the availability of extra visual cues as provided in this study. Thus, it does not seem that the lower central memory performance of younger children has resulted from an inability to distinguish visually the two pictures. The inability seems rather to be related to encoding only the pictures to which the subject is supposed to attend.

The differences found between the scores for trials on which both central and incidental pictures were correct, the first type, and the scores for those trials on which only the central pictures were correct, the second type, provide evidence for the developmental hypothesis of incidental effects on acquisition and retention. It was found, under the Rehearsal condition, that younger children were less likely than the older to recognize an animal picture correctly

if it were not paired with its appropriate object. The findings are consistent with those of previous studies, and support the hypothesis that with increasing age the ability to ignore or not attend to the incidental information increases.

The prediction that the condition which permitted rehearsal would result in higher memory performance, as compared to the Nonrehearsal condition, for the older but not the younger subjects was supported. The difference between the two conditions was significant for both recognition and recall. The rehearsal x grade level interaction was significant for recall scores only. For the Type 1 versus Type 2 recognition trials, the interaction with grade level was significant, for the Rehearsal condition only. It appears that when rehearsal is permitted there is an increasing ability with age to use it and thereby acquire more intentional as compared to incidental information. Evidence that subjects do rehearse stimulus names in short-term memory tasks has been provided in numerous studies (e.g., Flavell, 1970; Hagen, 1971). A general finding of these studies has been that older subjects rehearsed more and remembered more than younger subjects. The findings suggest that at least a part of the higher memory performance of older children as compared to younger results from the use of rehearsal, and when rehearsal is interfered with, memory is impaired. Since there was not a no-delay condition in this experiment, we do not know whether older subjects would perform better than younger with this particular task. However, in the previous studies (Hagen, 1971) recall did improve with age, and evidence was found that older subjects did rehearse the items during the stimulus presentation when no delay period was provided.

The results of this study as well as the previous studies employing the central-incidental memory task indicate that material incidental to the task at hand affects central task performance more at younger age levels, but the reason seems to be not because younger children are faulty perceivers and "take in" too much information. Rather, they fail to encode and rehearse the central material in a way that maximizes retention. Neisser's dual stage processing model (1966) identifies a first stage, called preattentive, in which information is dealt with in an undifferentiated, global manner. In the second stage the organism actively analyzes and reconstructs the stimuli. We suggest that the second stage may not be well developed until the ages 11-12 years. The evidence available thus far indicates that with development, the child plays an increasingly active role in the acquisition and retention of task-relevant information.

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FOOTNOTE

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TABLE I

Mean Number Correct Recognition and Recall Scores at Three Grade Levels for the Rehearsal and Nonrehearsal Conditions

| | Type of Measure | | | |
|---|---|---|---|---|
| | Recognition | | Recall | |
| Grade | Rehearsal | Nonrehearsal | Rehearsal | Nonrehearsal |
| 3 | 12.90 | 12.48 | 2.58 | 2.55 |
| 5 | 14.35 | 13.72 | 4.35 | 3.30 |
| 7 | 15.05 | 13.65 | 5.00 | 3.08 |

TABLE 2

Proportion Correct Recognition Scores for Three Grade Levels, Rehearsal and Nonrehearsal Groups, and Two Types of Cue Conditions

| | Cue Condition | | | |
|---|---|---|---|---|
| | Central and Incidental Correct | | Central Correct Incidental Incorrect | |
| Grade | Rehearsal | Nonrehearsal | Rehearsal | Nonrehearsal |
| 3 | .63 | .69 | .54 | .55 |
| 5 | .80 | .75 | .69 | .62 |
| 7 | .78 | .71 | .75 | .63 |

TABLE 3

Correlations Between Three Types of Central Recognition Scores for Three Grade Levels and Rehearsal and Nonrehearsal Conditions

| | | Conditions | |
|---|---|---|---|
| Grade | N | Rehearsal | Nonrehearsal |
| 3 | 80 | | |
| | Type 1 & 2 | +.19 | +.39* |
| | Type 1 & 3 | -.48** | -.56** |
| | Type 2 & 3 | -.26 | -.48** |
| 5 | 80 | | |
| | Type 1 & 2 | +.48** | +.53** |
| | Type 1 & 3 | -.46** | -.59** |
| | Type 2 & 3 | -.37* | -.47** |
| 7 | 80 | | |
| | Type 1 & 2 | +.33* | +.18 |
| | Type 1 & 3 | -.28 | -.16 |
| | Type 2 & 3 | -.21 | +.12 |

* $p < .05$

** $p < .01$