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ABSTRACT

The study paired-associate (PA) learning via the anticipation (ANT) and study-test (ST) procedures across second, third, fourth and fifth grades. Specifically, age differences in the rate of learning and examining PA learning according to the stage analyses were examined. Retention was also of interest: however, a ceiling effect negated the opportunity to make meaningful comparisons. The results showed that: third grade males experienced more difficulty than their female counterparts; the ST resulted in faster learning for females, but not for males; and that the two learning procedures produced few differences across the age spectrum for males. The stage analyses showed that both response and associative learning stages contributed to the superiority of the ST procedure for females. In view of the lack of variation for males, the present study concludes that learning processes vary with sex. Females in the study possibly exhibited more efficient learning strategies or males may have been more dependent upon immediate feedback. (Author)

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Introduction

Paired-associate (PA) learning requires the subject (S) to form an association between two verbal units, typically referred to as the stimulus (St) and response (R), so that upon presenting the St the S can provide the appropriate R. Performance, in a PA task, is regulated by either the anticipation (ANT) or study-test (ST) learning procedure. The ANT procedure is characterized by alternation of anticipation and feedback intervals. During the anticipation interval, the St is presented and the S attempts to pronounce its R. Immediately following this interval, the St-R pair is presented to provide feedback and a chance for the S to study the pair. The ST procedure, on the other hand, clearly separates the study and test portions of learning which are analogous to the feedback and anticipation intervals, respectively. In this procedure, each St-R pair is exposed as a study trial, then, the St of each pair is presented in a test trial and the S attempts to pronounce the R. This latter procedure separates the retrieval and storage processes of the test and study trials, respectively, but in doing so removes the immediate feedback or knowledge of results.

A stage analysis concept proposed by Underwood and Schulz (1960) is the popular theoretical explanation of PA learning. These authors contend that response and associative learning stages are necessary for PA learning. Response learning consists of placing each R member into storage so that they are available to the S during the anticipation or test intervals. After the R members are available, efficiency of learning depends on the S "hooking-up" or forming an association between the intrapair St and R members.

The PA task has been a very popular tool with an adult population, but only recently has it been used with children. Several studies (Cole & Kanak, 1971; Cole, Sharp, Glick, & Kessen, 1968; Gladis, 1960; Kausler & Gotway, 1969; Klinger & Palermo, 1967) which have been concerned with children's PA learning have found an age difference in the rate of learning. These studies employed the ANT procedure and reported that children above the third grade level required fewer trials to learn than children in grades one, two and three. The Cole and Kanak study attempted to account for this difference by means of the stage analysis concept and they found that variability in both the response and associative learning stages contributed to the age affect. At least two studies have reported age differences when using the ST procedure (Gaith & Allen, 1966; Rohwer, Lynch, Suzuki & Lenin, 1967), but the findings are equivocal and no attempt has been made to define these results according to the stage analysis. Differences in methodology more than likely attributed to the equivocal findings.

In view of the paucity of research examining the ANT and ST procedures with children, there is a definite need to examine age differences within each procedure as well as to compare these procedures in a developmental framework. It is conceivable that age differences in rate of learning may interact with age of the learner. That is, the reported age differences with the ANT procedure may be based on the fact that younger children experience more difficulty alternating between the retrieval and storage processes than older children. Separating the two stages in the ST procedure may then facilitate learning particularly for the younger children. Furthermore, comparing the ST and ANT procedure across several age levels and examining learning according to the stage analysis concept could provide some valuable insight into the nature of PA learning at each grade level.

The Cole and Kanak study also found that the degree of associative learning was invariant across grades one, three, five and seven as indexed by an immediate retention task. Retention results also supported the associative symmetry hypotheses (Asch & Ebenholtz, 1962) which states that whenever the S learns an St-R association an equally strong R-St association is concomitantly established. However, Cole and Kanak pointed out their findings may be attributable to a ceiling affect. Upon reducing the likelihood of the ceiling affect, age differences may occur in the retention scores and may correspond to any age differences demonstrated in acquisition. Removal of the ceiling affect may also be accompanied by assymetrical associative strengths; St-R associations are more available for recall than R-St associations, as reported in many adult studies (Feldman & Underwood, 1957; Kanak & Neuner, 1971; Lowry & Wollen, 1969). Associative symmetry is not expected to interact with method of presentation, though, since both procedures require the learning of St-R associations.

In short, the present objectives are to: (1) assess age differences in PA learning when the St-R pairs are presented according to the ANT and ST learning procedures, (2) examine the stage analysis concept of PA learning within a developmental framework, (3) examine the associative symmetry hypothesis.

Procedures

Subjects. Sixteen boys and sixteen girls were randomly selected from each of the second, third, fourth and fifth grades (N=128), in an elementary school within the Russellville, Arkansas Public School System. Subjects within each grade level were assigned to the ST and ANT procedures in an ABBA order.

Materials. Eighteen simple line drawings were selected from below the fourth year level of the Peabody Picture Vocabulary Test on the basis that each line drawing be associatively unrelated to each other. A randomization procedure was then used to generate the nine St-R pairings of List 1A. List 1B was constructed by re-pairing List 1A. The two lists were employed to allow greater generality of findings and to control for possible differential ease of forming St-R or R-St associations in a given pairing. Each list was used equally often in a counterbalanced manner within each treatment condition. In addition, each list was prepared in four different serial orders to minimize position cues. For the ST procedure the four orders of the test trials were different from orders of study trials.

Procedure. Prior to the experiment proper, each S received instructions corresponding to either the ST procedure or the ANT procedure. Those Ss receiving the ST procedure were told that the St-R pairs will be presented one at a time for them to study. The Ss were also told a test trial will alternate with the study trial in which each St appears alone during which they are to pronounce its R. The Ss were informed this alternation of study and test trials will continue until achieving one perfect test trial. The Ss receiving the ANT procedure were instructed that the St will first appear alone during which time they are to pronounce its R, then the St and R will be presented together to inform them whether or not their anticipation was correct. This group of Ss was also informed about the one perfect trial learning criterion, but neither group of Ss were cued about the recall tasks. To equate performance on the first trial, the Ss receiving the ST procedure were first given a test trial followed by the study trial.

To insure comprehension of the instructions for the respective presentation procedure, practice trials were given on a two pair list composed of nonexperimental pairs prior to practice on the experimental list. A Kodak Carousel Slide Projector was used to present both the practice and experimental lists at the 2:2 second rate with a 4 second intertrial interval.

In order to assess the strength of St-R and R-St associations, a paced (4 seconds) bidirectional modified free recall (MFR) task was administered immediately after learning the PA list. In the MFR task, half of the Ss first recalled R items to presented St items followed by recall of St items to presented R items. The remainder of the Ss received the reverse sequence. The order of administering the MFR sequence was counterbalanced within each treatment condition. An associative matching (AM) task was also administered after completing the MFR task as an additional index of associative learning. The advantage of the AM task is that it equates item availability. That is, St and R items are presented in two separate columns and the S is instructed to match them. Order of presenting the St and R items in the two retention tasks differed from those employed in the PA lists.

Results

Analyses completed to assess the comparability of the list variants showed they were equal in difficulty ($ps < .25$). Lists were then not included as a factor in the remaining analyses on total number of errors, number of correct anticipations (NCA), number of intrusions (INT), no responses (NR) and stage analysis. The initial analyses for each of the above set of scores included Grades (second, third, fourth and fifth), Procedures (St and ANT) and Sex (female and male) as factors thus creating a 4X2X2 analysis of variance problems. However, the second order interaction was usually significant, and under these conditions, Sex was analyzed with a simple main affect analyses and a 4X2 analyses of variance with Grades and Procedures as factors, respectively, was completed for each sex.

<u>Acquisition</u>. For total number of errors the significant sources of variation included Grades, $\underline{F}(3,112) = 3.59$, $\underline{p} < .05$; Procedures, $\underline{F}(1,112) = 11.77$, $\underline{p} < .005$; Procedure X Sex interaction, $\underline{F}(1,112) = 3.55$, $\underline{p} < .025$; and the second order interaction, $\underline{F}(3,112) = 3.16$, $\underline{p} < .05$. Analyses completed for the significant second order interaction showed that the superiority of third-grade females over third grade males learning under the ST procedure was the only significant sex difference, $\underline{F}(1,112) = 8.60$, $\underline{p} < .005$. Further analyses revealed that the ST procedure yielded faster learnint rates than the ANT procedure for females, $\underline{F}(1,56) = 17.38$, $\underline{p} < .005$, and there was a significant difference between the Grades, $\underline{F}(3,56) = 4.74$, $\underline{p} < .025$. According to the Newman-Keuls test the slower learning rate of second graders relative to the learning rate of fifth graders, ($\underline{p} < .05$) contributed to the significant affect as other comparisons were not significant ($\underline{p}s > .05$). The analyses for males failed to show any significant variation ($\underline{p}s < .25$).

Initial analyses for the NCAs revealed only a significant second order interaction, $\underline{F}(3,112) = 4.78$, $\underline{p} < .005$. Examination of this interaction showed that males had more NCAs than females for both the ST and ANT procedures at the third grade level ($\underline{p} < .025$ and $< .05$, respectively) and with the ST procedure at the fifth grade level, ($\underline{p} < .05$). Analyzing for Grades and Procedures failed to yield significant variability for females ($\underline{p}s > .05$), and only the interaction was significant for males, $\underline{F}(3,56) = 3.91$, $\underline{p} < .05$. The interaction was apparently attributed to the fact that the ANT procedure produced more correct anticipations at the second grade level than the ST procedure, $\underline{F}(1,56) = 4.48$, $\underline{p} < .05$, but the latter had a higher number of correct anticipation at the third grade, $\underline{F}(1,56) = 7.35$, $\underline{p} < .01$. Neither procedure was superior at the other grade levels, $Fs < 1$, nor did Grades produce significant variation ($ps > .05$).

The INT data yielded three significant sources of variability, Procedures, $F(1,112) = 6.97$, $p < .025$; Procedures X Sex interaction, $F(1,112) = 6.41$, $p < .025$; and the second order interaction, $F(3,112) = 3.40$, $p < .025$. Again, a sex difference occurred at the third grade level with males having more INTs than females, $F(1,112) = 11.23$, $p < .005$. Further analyses for females revealed that Procedures main affect was the only significant variability, $F(1,56) = 11.64$, $p < .005$, with the ANT procedure yielding the most INTs. The Grade X Procedure interaction represented the only significant variability for males, $F(3,56) = 3.28$, $p < .05$. The interaction is apparently attributed to the inflated number of INTs with the ANT procedure, relative to the ST procedure, at the second grade level, $F(1,56) = 7.36$, $p < .01$ as the other sources of variation were not significant ($ps < .25$).

The Procedures main affect, $F(1,112) = 11.13$, $p < .005$, and the second order interaction, $F(3,112) = 3.29$, $p < .05$, were significant in the analyses on the NR data. Examination of the interaction again showed that third grade males experienced more difficulty than third grade females as the former had more NRs when learning under the ST procedure, $F(1,112) = 10.62$, $p < .005$. Fifth grade males also had more NRs in the ST procedure, $F(1,112) = 4.82$, $p < .05$. Additional analyses for females showed that Grades, $F(3,56) = 5.50$, $p < .01$; Procedures, $F(1,56) = 13.43$, $p < .005$, and the interaction, $F(3,56) = 3.02$, $p < .05$ as significant. The interaction revealed that the ANT procedure produced significantly more NRs at the second and third grades ($ps < .025$) than the ST procedure. There was no difference between the procedures at the other grades ($ps < .25$). Grades also differed significantly, but only within the ANT procedure, $F(3,56) = 7.73$, $p < .005$. The Newman-Keuls test showed that the fifth grade had fewer NRs than the other grades ($p < .05$) which did not differ from each other (ps $> .05$). Variability for the males was not significant.

<u>Stage Analyses</u>. Analyses for RL showed only Procedures, $F(1,112) = 8.02$, $p < .01$, and the Procedures X Sex interaction, $F(1,112) = 4.68$, $p < .05$, to be significant. Additional analyses showed that females completed the RL stages faster than males in the ST procedure, $F(1,112) = 5.70$, $p < .025$, but there was no sex difference within the ANT procedure, $F < 1$. Females receiving the ST procedure likewise completed RL before females in the ANT procedure, $F(1,112) = 12.47$, $p < .005$. Males did not differ, $F < 1$.

Both associative learning scores were analyzed. The A-1 scores, however, did not produce any significant variability, (ps $< .25$). On the other hand, the A-2 scores produced a significant Procedure main affect, $F(1,112) = 6.06$, $p < .025$, and a second order interaction, $F(3,112) = 3.11$, $p < .05$. Examination of this interaction showed that third grade males learning under the ST procedure required more trials for associative learning than their female counterparts; $F(1,112) = 4.62$, $p < .05$. Further analyses showed that with female <u>S</u>s the ANT procedure required more trials for associative learning than the ST procedure, $F(1,56) = 5.57$, $p < .025$. Analyses for males failed to show any significant variability (ps $> .05$).

<u>Recall</u>. The MFR scores showed that 96% of the St-R pairs and 92% of the R-St pairs were recalled while 99% of the pairs were correct in the AM task. In view of the apparent ceiling affect in the recall scores, further analyses on these data are omitted since the opportunity for meaningful comparisons does not exist.

Discussion

Needless to say, the predominance of significant second order interactions increased the complexity of the findings. However, there are at least three consistent findings in the acquisition analyses. First, males in the third grade experienced more difficulty than their female counterparts, whereas sex differences in other grades were not reliable. Second, the ST procedure produced faster learning rates than the ANT procedure for females. Although it was very weak, any reported age differences occurred with females. Third, the null hypothesis was typically supported when the affects of Grades and Procedures were analyzed for males.

In regard to the objectives of the experiment, mainly age differences and comparisons of the two procedures, the results were a little disappointing. Age differences were only found with females, however, this may prove to be a reliable finding because other studies apparently did not test for sex differences when examining age differences. It is not clear exactly what contributed to the present age differences, as a corresponding Grade affect was not present in the stage analysis.

For the second objective, the present findings lead to the conclusion that the learning processes of males are different from those of females. Apparently, females benefited form separating the storage and retrieval processes. The stage analysis showed that both response and associative learning contributed to the superiority of the ST procedure. Developmentally, this may mean that females took advantage of the opportunity and demonstrated their more efficient learning abilities or males were more dependent upon the immediate feedback afforded by the ANT procedure.

Finally, the ceiling affect in the recall scores prevented any meaningful comparisons. However, this finding does imply that word pairs should be used to study retention as picture pairs are apparently very easily stored in memory.

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