STM in retardates as a function of direction and delay of recall^{1,2}

WILLIAM R. BLOUNT, *Institute III: Exceptional Children and Adults, University of South Florida, Tampa, Fla. 33620*

Direction (forward, backward) and delay (0, 2, 4 sec) of recall was investigated using three groups of 12 retardates each matched on MA and CA. Results indicated significantly more errors occurred in forward learning than in backward learning on Trial 1 only. Analysis of total errors showed delay of recall significant with no differences in frequency or kind of error in forward or backward learning.

Interest in populations of lower-than-average mental ability has initiated a series of attempts to determine the replicability of certain learning phenomena largely researched with populations of "normal" intellect on populations of retardates. Within this framework, the present research was interested in two STM phenomena; specifically, the principle of associate symmetry (Asch & Ebenholtz, 1962) and the influence of delay of recall. Murdock (1962) found that both number and kind of errors were essentially identical whether the S was required to learn the pair "forwards" (receiving the left-hand member of the pair and being required to recall the right-hand member) or "backwards" (receiving the right-hand member). Numerous studies are available which demonstrate that delay of recall increases both number of errors and trials to criterion whether the delay interval is "filled" with silence (Murdock, 1961) or competing responses (Peterson & Peterson, 1959).

The typical procedure of paired-associate (PA) studies was modified in the present investigation in that the same PA lists were used over trials. Recall was tested after each pair (e.g., Peterson & Peterson, 1963), rather than after the entire list (e.g., Murdock, 1962). An analysis of Trial-1 data provided a measure of STM unconfounded by practice.

SUBJECTS

Three groups, corresponding to the three delay intervals (0, 2, or 4 sec), of 12 retarded Ss each were selected from the available Ss pool at Dixon State School and matched on MA and CA. It should be noted that all differences between the delay groups in Table 1 were n.s.

STIMULUS MATERIALS

From a list of pictured objects familiar to the Ss, 16 were randomly selected and paired. Two of the pairs (Tree-Car, Scissors-Wagon) were randomly selected as practice pairs. The remaining six pairs were: Book-Airplane, Radio-Necktie, House-Eyeglasses, Chair-Key, Wheel-Shoe, Dog-Football. Red and green colored cards were also constructed to serve as filler items during the delay intervals. Which color or which order of colors appeared during a given delay interval was counterbalanced. All pictures were drawn on 3½ x 6¼ in. white cards, the cues for recall being on their respective halves of the card rather than centered. Three of the six pairs were randomly selected to serve as forward pairs; the remaining three served as backward pairs. Within the forward or backward pairs, stimulus and response items were counterbalanced across Ss, thus creating two criterion "lists." In addition, five random orders of each of the two lists were constructed to control for the serial position effect noted by Murdock (1961, 1962).

PROCEDURE

Subjects were seen individually. Each S was first required to name each of the pictures to be used to a criterion of two errorless trials. For this familiarization procedure each picture was presented individually in random sequence. This procedure was executed prior to practice pairs as well as criterion pairs and only the pictures to be used in the succeeding task were included. Colored cards were inserted in the familiarization cards and practice pairs for Ss in the 2- or 4-sec delay groups. Each S was required to learn one of the two six-pair criterion lists to a criterion of five consecutive errorless trials or 10 trials. Ss were presented with a given pair, required to verbalize aloud the name of each picture in left-right order, and then

Table 1
Subject Data

Delay Group	0 sec		2 sec		4 sec	
Variable	Mean	SD	Mean	SD	Mean	SD
MA	7.37	3.0	7.33	1.1	7.45	1.2
CA	18.50	3.5	19.83	2.4	20.25	2.1
IQ	50.75	7.5	48.83	5.4	49.67	8.0
LI*	6.88	4.3	8.25	6.3	10.45	4.9

* LI = length of institutionalization; all data except IQ are in years

presented with one of the pictures as the cue for recall of the other. Either none (0-sec delay), one (2-sec delay), or two (4-sec delay) colored cards were inserted after presentation and verbalization of a given pair. Ss were also required to verbalize the color of the colored cards. Correct and incorrect responses were so indicated by E during the practice pairs, but all responses were reinforced alike during criterion pairs. All pairs and colored cards were presented at a 2-sec/2-sec rate with an intertrial interval of 15 sec. Recall was "self-paced" (Murdock, 1963) from 0 to 10 sec. If no response was forthcoming during the 10 sec, an omission error was scored. All errors were recorded verbatim.

RESULTS

The dependent variables of interest were the number of Trial-1 errors, total errors, and trials-to-criterion. All data were subjected to a square root transformation ($\sqrt{x + .5}$). For the Trial-1 data, a 3 by 2 analysis of variance was used (Delay Interval by Direction of Recall). The results of this analysis indicated that only Direction of Recall was significant [$F(1,33) = 9.40, p < .01$], such that significantly more errors were made in forward learning than in backward learning. Delay

Fig. 1. Kind of error and mean errors as a function of delay of recall (a score of .71 indicates no errors).

Fig. 2. Kind of error as a function of direction of recall (a score of .71 indicates no errors).

of recall was close to significance [$F(2,33) = 2.61, p < .101$], the means showing a tendency for more errors to be made at the 2- and 4-sec delay intervals than at the 0-sec delay interval.

The analysis of total errors included counterbalanced lists as an additional factor, creating a 2 by 2 design with direction of recall again a within-Ss factor. Delay of recall was the only significant source of variance in this analysis [$F(2,30) = 4.99, p < .025$]. t -tests revealed that, as predicted, significantly more errors were made at the 4-sec delay interval than at the 0- or 2-sec delay intervals (respectively: $t = 2.49, p < .025$; $t = 1.76, p < .05$; $df = 22$); the 0- and 2-sec delay intervals did not differ significantly (Fig. 1).

An examination of the kinds of errors made at each delay interval (Fig. 1) indicated that there were no differences in the frequency or kind of error at 0-sec delay, but significantly more intralist intrusion errors than extralist intrusion errors occurred at the 2-sec delay ($t = 2.98, p < .01$; $df = 22$) with a similar trend at the 4-sec delay interval ($t = 1.70, p < .10$; $df = 22$). There were no omission errors at either the 0- or 2-sec delay intervals with a presumed significant increase in this kind of error at the 4-sec delay interval. Intralist intrusions were the most frequent kind of error, showing a significant increase in frequency at the 2-sec delay interval over the 0-sec delay interval ($t = 2.18, p < .05$; $df = 22$), but a n.s. increase from the 2- to 4-sec delay interval. There were no significant differences in the frequency of extralist intrusion errors across delay intervals.

An error analysis concerned with the frequency of a given kind of error as a function of direction of recall revealed no significant differences (Fig. 2). In addition, similar patterns of the frequency of the three kinds of errors appeared in forward learning and in backward learning. As can be seen in Fig. 2, there were significantly more intralist intrusions than omissions or extralist intrusions in forward learning (respectively: $t = 3.56, p < .01$; $t = 4.33, p < .01$; $df = 70$, and approximately the same

pattern could be noted for backward learning, although the relationship was not as strong (respectively: $t = 2.22, p < .05$; $t = 1.98, p < .10$; $df = 70$). Differences between omission and extralist intrusion errors were n.s. in both forward and backward learning.

The trials-to-criterion analysis yielded results in agreement with the above total errors analysis.

DISCUSSION

Consistent with results obtained with normal Ss (e.g., Peterson & Peterson, 1959), the analysis of Trial-1 errors suggests a significant decrement in the retention of single PAs with delay intervals greater than 2 sec. That direction of recall was a significant variable in the Trial-1 analysis tends to support evidence of a primacy effect in the STM of PAs reported by Peterson et al (1962). While forward pairs were more difficult than backward pairs on Trial 1, this effect did not manifest itself in the total error analysis. Apparently, direction of recall is a significant variable only for the initial trials of PA learning, during the associative hook-up phase, being bidirectional thereafter. Alternately, the rate of learning in the initial phase of PA learning might be considerably different for retardates and normals.

Of considerable interest in the present study was the tremendous effect the 4-sec delay interval had on recall. The percentage of total errors made at each delay interval was 8%, 27%, and 65% for 0, 2, and 4 sec, respectively. Over half of all errors made in the present study occurred at the 4-sec delay interval and suggest a multiplicative rather than simply linear relationship between delay of recall and errors.

The particular pattern of errors found in the present study might have been a function of the familiarization procedure employed. Such an explanation would account for the large number of intralist intrusions (Figs. 1 and 2). In addition, only two of the extralist intrusion errors were other than items appearing in the practice pairs.

In spite of the procedural differences between the present study and that of Murdock (1962), the results are quite similar. Murdock also found few differences in the frequency or type of errors occurring in forward and backward learning. It would appear that retardates follow similar patterns to those reported for Ss with normal intelligence in the STM of single PAs.

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NOTES

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2. Paper presented at the meeting of the Midwest Psychological Association, St. Louis, May, 1964.