Effects of overt rehearsal procedures on free recall

IRA FISCHLER, DEWEY RUNDUS, and RICHARD C. ATKINSON, *Stanford University, Stanford, Calif. 94305*

Free recall of noun lists was examined using three different rehearsal procedures: silent study, vocal rehearsal of the current item, and "free" vocal rehearsal of any items on the list. Silent study produced the best overall recall. Serial position curves showed reduced primacy for "fixed" rehearsal, and reduced recency for free rehearsal, relative to the silent condition. The reduced primacy for fixed rehearsal supported the notion that the primacy phenomenon results largely from a greater number of rehearsals given earlier items.

In the theoretical work of Atkinson & Shiffrin (1968) rehearsal processes have been assigned an important role in the development of long-term memory. In their model rehearsal is one control process that can maintain information in a short-term store, thereby increasing the likelihood of transfer to long-term storage. Despite the theoretical importance of rehearsal, only a limited attempt has been made to analyze this process experimentally. This has largely been due to the covert nature of rehearsal, and the resulting inability to manipulate and record it. Some progress was made by using techniques like counting backwards (e.g., Peterson & Peterson, 1959), which effectively prevented rehearsal from occurring. Recently, Rundus & Atkinson (1970) have described a procedure for directly observing rehearsal by having Ss rehearse aloud, in any fashion they wished, and tape-recording this rehearsal. Using this procedure, it was shown that the probability of recall was a monotonically increasing function of the number of rehearsals given an item.

However, it is possible that the overt feature of this procedure produces changes in performance. The original study included no silent control condition against which overt performance could be compared. The present study, therefore, sought to directly compare overt and silent rehearsal procedures in a free recall task. Also, a condition was included in which Ss' overt rehearsal was restricted to only the item currently being presented, preventing

rehearsal of earlier items. This was done primarily to examine the hypothesis that the primacy effect in free recall is due largely to additional rehearsal given the initial items of the list while later list items are being presented. This followed from the Rundus & Atkinson (1970) finding that items at the beginning of a list were rehearsed with a higher frequency than later ones. If this is the cause of primacy, then equating the number of rehearsals should reduce the effect.

METHOD

Sixteen introductory psychology students served as Ss. The words used in this study were 220 concrete nouns with a frequency of occurrence of 20 to 40 per million (Thorndike & Lorge, 1944). These nouns were divided into 11 lists of 20 items each. Lists 1 and 2 were used as practice lists; the rest were used during testing. Each list received one trial, which consisted of presenting the items to S singly on 4 x 6 cards. Each item was shown for 5 sec. Presentation of the last card of a list was followed by a 2-min written free-recall test for that list.

Each S was tested under three different rehearsal conditions. In the silent condition, he was told to simply study the list silently, in any manner he chose. The fixed condition required that he recite aloud the item currently being shown, and repeat it at a regular rate throughout the 5-sec presentation period. It was suggested that he try to pace this rehearsal, so that each item received roughly the same number of repetitions. In the free condition, he was again required to

vocalize items, but was now free to rehearse any items of the list shown, up to and including the current one. The three conditions were described to each S at the beginning of the session.

Lists 1 and 2 were presented as silent and free trials, respectively. Then a random ordering of the three conditions (balanced over Ss) was repeated three times (e.g., 312-312-312), using the remaining nine lists. The order of the nine test lists was randomized over Ss. Also, the order of items on a given list was randomized over list presentations.

RESULTS

All Ss understood and performed the three procedures without difficulty. The rehearsal rate in the fixed condition typically ranged from four to six repetitions per item, with individual Ss achieving close to constant rates. Rehearsal in the free condition was somewhat more irregular.

Performance was measured in terms of probability of correct recall over the three conditions. The overall treatment effect was highly significant; $F(2,96) = 15.2$, $p < .01$. The probability of recall in the silent condition (.59) exceeded both the fixed (.48) and free (.50). There was also a tendency for different Ss to excel in different conditions; interaction $F(30,96) = 2.43$, $p < .01$.

Figure 1 presents the probability of recall as a function of serial position in the list. It appears that for the first quarter of the list, the fixed treatment is inferior to the other two. In the middle half, the silent condition is superior, and in the final quarter, the fixed and free curves have reversed, so that free is now below the other two. These effects are highlighted in Fig. 2, where probability of recall for the first 5, middle 10, and last 5 serial positions is graphed. An analysis of

Fig. 1. Probability of item recall in silent, fixed, and free conditions as a function of serial position.

Fig. 2. Probability of item recall in silent, fixed, and free conditions as a function of blocked serial position.

variance for this grouping revealed the conditions effect to be highly significant for all three positions; $F(2,96)$ equalled 14.72, 12.32, and 6.63 for 1-5, 6-15, and 16-20, respectively.

Generally, all three curves in Fig. 1 display the typical serial position effect, with both primacy and recency appearing. However, primacy exceeds recency for the free condition only, while the primacy of the fixed condition is quite low, and in fact is restricted to the first two serial positions.

DISCUSSION

The overall superiority of the silent condition to the two overt procedures shows that overt rehearsal has a generally negative effect on performance. This is understandable, since in the silent condition Ss could use any of a number of control processes (e.g., mnemonic and imagery methods) to facilitate learning. It would be difficult to use such strategies while constantly vocalizing present or past items.

The present results indicate that the overt rehearsal procedure used by Rundus & Atkinson (1970) produces certain changes in free recall performance. The silent and free curves are indistinguishable until about the middle of the list, when the free condition begins to lag. It could be inferred from this that in the later portions of the list, the silent rehearsal strategy no longer corresponds to the overt procedure of the free group, and that a more efficient strategy has been adopted. The emergence of the fixed curve as an equal of the silent in the last quarter may be a clue that the silent strategy now imitates the fixed, i.e., ignoring earlier items and concentrating on the current ones. Thus, the free rehearsal procedure may be more consistent with the covert process in earlier portions of a list.

The Atkinson & Shiffrin (1968) model of memory suggests that primacy effects are due to the additional rehearsal of the

initial list items. The results reported by Rundus & Atkinson (1970) lend support to this interpretation. The fixed condition of the current study equates the overt rehearsal accorded to each list item; with rehearsal thus equated, recall of items from the first quarter of the list is indeed suppressed. Still, the small primacy effect in the first two serial positions of the fixed curve in Fig. 1 suggests that rehearsal is not the complete answer to the primacy effect. Undoubtedly, the first item presented in a list has a unique role in the formation of an "associative net" and consequently is more accessible at the time of retrieval. The additional rehearsal of initial items influences the amount of information transferred to long-term store, but also the first item has a pivotal position in the organization of this stored information.

Since each S in the present study served in all three conditions, it may be that their strategy in the silent condition was influenced by the specified strategies required of them in the two overt conditions. If this reduced S's tendency to use imagery, for example, performance in the silent condition would be somewhat

poorer than a silent group with no other experience. Effects of this nature, however, should only serve to minimize the observed differences among the three conditions, which are nevertheless substantial in terms of the form of the serial position function.

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