"Primary memory": The effects of redundancy upon digit repetition

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Abstract

Ss tried to repeat series of 8 digits immediately after hearing them. Each series of digits had a predictable digit (a zero) in a known location, and Ss were told to omit this digit. Performance in this task is similar to the performance obtained in repetition of 8 non-redundant digits, although if the redundant element is near the center of the series, Ss can improve their recall of the other digits. Digit recall seems to be largely, but not entirely, a matter of "primary memory," which involves a more or less faithful unrecoded replica of stimulus input.

Problem

Although it is tempting to think of a S's memory capacity as a numerical constant, experiments comparing different types of materials suggest that Ss do not always remember a fixed number of items, nor do they seem to remember a fixed quantity of information in any obvious sense (Crossman, 1961; Miller, 1956). A theoretical assumption which helps to rationalize such findings is that Ss recode to-be-remembered input in such form that its number of items or informational content changes. However, there are certain situations in which relatively little recoding seems to be required. An example might be provided by the phenomenon of "after-hearing" (Eriksen & Johnson, 1964) in which one can recover the needed content of information previously not attended to. In the familiar instances of this one is asked a question, and does not realize the fact until later, when it is possible to "remember" the question. Waugh & Norman (1965), following William James, referred to this as "primary memory," and mention a S who called it an "echo-box" effect. Clearly the implication is that primary memory involves a more or less faithful reproduction of the input signal.

A phenomenon reported by Dallett (1964) might provide another example of primary memory. When Ss were asked to repeat only 7 of 8 digits they did as poorly as they did when asked to repeat all 8 digits even though, in the former condition, the "unwanted" extra digit was always a clearly identifiable and redundant initial zero, as in the series "03275819." It was apparently impossible for Ss to avoid remembering the redundant prefix. The present experiments enlarge upon this finding by placing redundant zeros in all positions of an 8-digit series. While the results agree in general with those just described, they indicate that when the zero is near the center of the series Ss do have a limited ability to capitalize upon its presence.

Method

Ss in the main experiment served for two sessions at least two days apart. In the first session they were given 20 7-digit and 20 8-digit series in alternating blocks of 10 (i.e., 7878 or 8787), and these were followed by four of the experimental tapes. Each of the experimental tapes consisted of 20 8-digit series with a zero in the n^{th} position, the position being the same for all 20 series on a single tape. The digit series were taken from tables of random permutations, were edited to remove ordered runs, and contained no zero other than the redundant added element. Two sets of tapes were prepared, with the digits presented at a rate of 2.2 digits/sec. The second experimental session began with a warm-up series of 10 7-digit and 10 8-digit series from the pre-test, followed by the other four experimental tapes, and a post-test consisting of 20 7-digit and 20 8-digit series as in the pre-test. Thus, for each S, there were data on 8-digit recall, 7-digit recall, and recall involving zeros in each of the 8 positions of 8-digit series. The Ss were students from introductory psychology classes, and after elimination of two Ss for whom 8-digit recall was too easy, and one who did not seem able to abide by the procedures of the experiment, 16 Ss remained. For these 16 Ss the position of the redundant zero was varied in a balanced order, 4 Ss having an ascending order, 4 a descending order, and the other 8 Ss having the same orders but with sessions reversed, getting positions 5-8 in their first session and 1-4 in their second, etc. Each digit series was preceded by the word "Ready," and the S tried to repeat it immediately after presentation, with instructions to repeat something for all 7 or 8 positions. The word "blank" was used to indicate a missing or forgotten digit. The word "zero," of course, was never repeated by the S. For each condition, he was given a card as a visual reminder of the zero's position; for the condition in which the zero was in the third position, the card read "---0-----."

Results and Discussion

The data are presented in Fig. 1 in the form of serial position curves. For each position in an 8-digit series, the total percent digits correct for all 16 Ss was obtained—hence each point is based upon 320 opportunities for recall. The dotted curve serving as a reference level in all plots is the average of the 8-digit pre-test and post-tests. Ss showed an increase from pre-test to post-test of about 10%, and were not adequately tested for 8-digit recall at other points in the experiment. Therefore, the level of the 8-digit

Fig. 1. Percent recalled as a function of position in the series for digit series with a predictable zero in position 1, 2, 3, ..., 8. The dotted curve represents in each instance the same data for non-redundant 8-digit recall.

reference curve in Fig. 1 may be off by as much as 5%, an error which would not materially change the results. It will be seen in Fig. 1 that, in general, Ss are performing more nearly as they would with 8-digit series than as they would with 7-digit series, even though they are repeating only 7 digits. However (a) with the zero in initial position, performance is slightly enhanced, and (b) with the zero in various internal locations there is a tendency for performance to improve near the position of the redundant element. When the zero is in terminal position, Ss are apparently unable to improve their performance on the penultimate digit. This is especially interesting, since it coincides with reports of Ss that they repeat the initial digits and then happen to remember (or even "hear") the last digit. The results of this experiment suggest that it is the last *acoustic* digit which is so favored, and not the last digit the S is trying to remember. The fact that the redundant zero is most beneficial in the fifth position was explained by some Ss in terms of their attempts to "group" the digits: a redundant element which can be made to fall between groups is less troublesome than one which falls within a group. Ss have always reported grouping digits; perhaps this may be a new technique for investigation of such behavior.

Some additional experiments were carried out. In a single session, Ss heard tapes with zeros in first,

Fig. 2. Percent recalled as a function of position in the series for digit series with a redundant zero in first, third or fifth position. The small differences which appear are (with one exception) not reliable.

third, and fifth positions, with 12 of the Ss asked not to repeat the zero (as in the main experiment), and 12 asked to repeat the entire series including the zero. The results (Fig. 2) showed a small advantage for non-repeaters in positions near the zero, and small disadvantages at other series positions; these differences were all less than 10%, and only in position 2 of the initial-zero series was the difference significant using an ad hoc t-test. Hence the findings in Fig. 1 should remain about the same for Ss asked to repeat the zero. Another experiment, using 20 Ss, attempted to determine whether any benefit resulted from leaving out the fifth digit in a non-redundant 8-digit series. The results appear in Fig. 3. Omitting a digit made overall performance slightly worse, although the distortion of the serial position curve is similar to that seen for 5th-digit omission in Fig. 1. The general import of these two experiments is that most of the effects in Fig. 1 are due to the redundancy of the zero, and not to the fact that an element is omitted in recall. Finally, two groups of 12 Ss were given 40 strings with initial zero, and one group was given elaborate instructions about using the initial zero as a ready signal, not listening until after the zero, etc.. These instructions did not help.

Fig. 3. Percent recalled as a function of position in the series for 8 non-redundant digits: subjects either repeated all digits or omitted the fifth one.

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