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THE PRIMACY EFFECT IN SHORT-TERM MEMORY

JOSEFINA B. SANTOS
Ateneo de Manila University

The present study investigates the Glanzer and Cunitz thesis. Two experiments were conducted manipulating variables that supposedly had differential effects on both portions of the curve. The first experiment manipulated list length and delay; while the second experiment manipulated meaningfulness and delay. The results obtained from both experiments tended to support the Glanzer and Cunitz thesis. Manipulation of list length and meaningfulness seemed to affect recall in the primacy portion, whereas, manipulation of delay seemed to have affected only the *recency* portion of the curve, while leaving recall on the primacy portion relatively unchanged. Conclusions were made to the effect that the serial position in short-term memory represents output from two storage mechanisms: a long-term storage mechanism of limited capacity affected by variables affecting learning, responsible for the *primacy effect;* and, *primary memory* or an "echo-box-like" mechanism affected by delay, which is responsible for the *recency effect.*

In 1966, Glanzer and Cunitz sought to explain the serial position phenomenon in short-term memory in terms of an additive output from two types of storage mechanism, that is, the *primacy effect* or the initial portion of the curve represents output from a "long-term storage type" of mechanism limited in capacity, and the *recency effect* or the last portion of the curve represents output from a short-term storage mechanism whose limitation is the amount of time it can hold an item.

Acquisition, recall, and retention are usually considered the major factors involved in memory (Woodworth, 1954). Memory can be defined as a learned (i.e., acquired) capacity for responding (i.e., recalling), and its persistence over time, measured by the retention test (Adams, 1967). Forgetting, then, is a loss of memory strength over time.

STM and LTM

Researches have suggested that memory functions in two ways, on a long-term basis and on a short-term one (Broadbent, 1957). Adams (1967) cites three main lines of evidence to support the idea that short-term memory (STM) and long-term memory (LTM) are two different systems. Long-term storage, would in fact, refer to learning, the process by which information that may be needed again is stored for future recall or demand. Short-term memory, on the other hand, refers to the fact that a recently acquired bit of information can be forgotten even after a matter of seconds. STM and LTM studies are differentiated, primarily, by the length of the interval period between presentation of material and recall.

The Serial Position Effect

One of the most interesting and well-established phenomena found in both LTM and STM research is the serial position effect (SPE). This refers to the fact that if an individual is given a set or a list of items, he finds it easiest to retain those items found at the initial and at the last positions in the list; and he finds the items in the middle portion of the list the hardest to recall (McGeoch & Irion, 1952). Hence if item

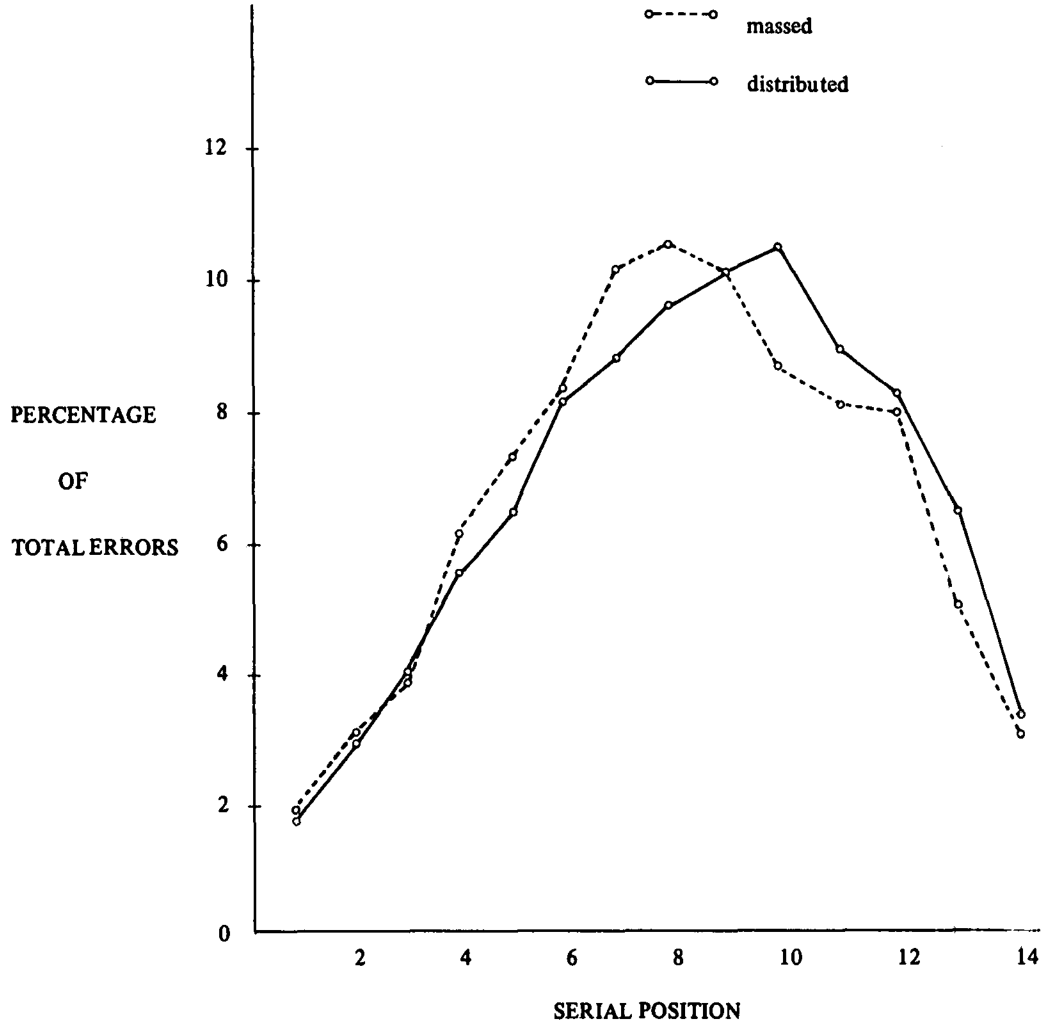

FIG. 1 – EXAMPLES OF THE BOW-SHAPED SERIAL POSITION CURVE SHOWING THE PERCENTAGE OF ERRORS AT VARIOUS SERIAL POSITIONS IN LEARNING TO MASTERY BY MASSED AND DISTRIBUTED PRACTICE (FROM HOVLAND, *J. EXP. PSYCH.*, 1938, *23*, P. 178)

positions were plotted against percentage errors, the resulting function would be like an inverted U, similar to Fig. 1.

There have been several attempts to explain this phenomenon in both STM and LTM. This paper limits its attention to the study of one particular attempt to clarify the serial position effect in short-term memory – the Glanzer and Cunitz hypothesis (1966), which seeks to explain the phenomenon in terms of a dual-function theory.

The Glanzer and Cunitz Explanation of the SPE

Glanzer and Cunitz (1966) sought to explain the serial position effect in short term memory in terms of an additive output from two types of storage mechanisms. The initial portion of the curve, or the so-called *primacy-effect*, represents output from a long-term storage mechanism limited in capacity; while the final portion of the curve, or the *recency effect* represents output from a short-term storage, whose limitation is the amount of time it can hold an item. This theory, in effect, proposes a dual-function hypothesis in short-term memory. According to these authors, the first positions in the series of items are stored in a manner of storage related to learning, while the latter positions are available only as long as they don't leave the short-term storage.

To test the dual function explanation, one would need to manipulate variables that are presumed to have differential effects on *primacy* and *recency*. Several investigators (Postman and Phillips, 1965; Jahnke, 1968; Campos, 1969) have shown results that tend to support the dual-function theory. Their findings seem to indicate that varying the delay of recall clamps down the efficiency of *recency* while leaving *primacy* unaffected. This led other researchers to hypothesize that the *recency effect* in the serial position curve of short-term memory is brought about by *primary memory*, a storage mechanism subject to decay, where information is processed by a "first come first served" basis (Campos, 1969).

Following the line of thinking of Glanzer and Cunitz, the other logical implication of the dual function theory is that, the *primacy effect* is brought about by an entirely separate storage mechanism. Furthermore, (a) this storage mechanism is limited in capacity; (b) it is related to learning in that it is affected by the same variables affecting LTM, like meaningfulness, familiarity, repetition, and the like; (c) and it is possible to localize interference in the earlier but not in the latter portion of the curve.

METHOD

Statement of the Problem

The present experimental study was an attempt to investigate the assumption that the *primacy effect* in short-term memory is brought about by a storage mechanism limited in capacity, affected by the same variables affecting learning, and different from and independent of, the mechanism producing *recency*.

The following hypotheses were tested:

(1) The *primacy effect* in short-term memory results from a limited capacity storage mechanism, affected by the amount of materials to be recalled. As the length of the list increases, there is a corresponding gradient of *primacy*, the highest, representing recall of the shortest list; and the lowest representing the longest list.

(2) The manner of storage occurring in the *primacy effect* is similar to learning, affected by the meaningfulness of the material to be recalled, so that, the more meaningful the material, the more efficient the recall in the *primacy* portion of the curve.

(3) The varying interval of delay will affect only the last portion of the curve, but not the *primacy*, even if such a variable is paired off with either list length or meaningfulness of material.

Experimental Design

Two experiments were conducted to realize the purpose of this study. Experiment 1 compared recall of six kinds of lists according to *length* (2, 3, 4, 5, 6, and 7 words). Each of these lists was paired off with each of four *intervals of delay* (0, 6, 12, and 20 seconds). Four lists of each kind were constructed, hence, there were four lists of 2-words, four of 3-words, etc. up to four lists of 7-words, making a total of 24 lists used in the experiment. Of main interest was the comparison of recall of the initial positions of the six kinds of lists. Of interest, likewise, was the possible effect of delay on the same serial positions.

Experiment 2 manipulated *meaningfulness* and *intervals of delay*. Sixteen nine-syllable lists were constructed. Each list consisted of seven low-meaningful items and two- high-meaningful ones. The 16 conditions in the experiment were determined by the positions occupied by the meaningful items in the list and the corresponding interval of delay the list was paired with (either 0 or 6 seconds). The intent here was to check the assumption that the efficiency of recall in the *primacy* is affected by the same variables affecting learning, in this case, meaningfulness of items. Again, delay was included, to see its effect on both *primacy* and *recency*.

A basic within-subject design was used for both experiments, i.e., the 58 subjects (*S*s) of Experiment 1 were made to undergo 24 experimental conditions (each *S* had to recall 24 different list at varied intervals of delay), while each of the 60 *S*s in Experiment 2 was made to go through 16 different conditions (recall of 16 different lists after either of two intervals of delay). The order of presentation of conditions was randomized for all *S*s. The composition of each list was, likewise, varied for each *S*.

Each word/syllable printed individually on index cards was presented at a more or less constant rate of one item per second. Each list was followed by either three digit numbers or by zero. If *S* saw the three-digit number, he started counting backward from that number by three, until he was stopped by *E*. He then was asked to recall the material in the list he just saw. If the list was followed by zero, *S* was instructed to recall immediately the words/syllables in the list he just saw. *S* was given the maximum period of 75 seconds to recall.

RESULTS

Frequencies of recall were tabulated and converted into percentages and graphed as a function of serial position, list length, and intervals of delay. Figure 2 illustrates differential recall for each serial position across different list lengths. A gradient can be observed, i.e., the percentage of recall for the initial positions of each list decreases as the list becomes longer.

The first five positions were studied in a more detailed manner. Efficiency of recall for each of these positions was compared across all lists; thus, the first, second, etc. up to the fifth positions of lists 1–6 were analyzed independently using Friedmann's Analysis of Variance. Table 1 shows the results of these analyses to be significant beyond the .01 level.

TABLE 1

FRIEDMANN'S ANALYSIS OF VARIANCE FOR THE FIRST FIVE SERIAL POSITIONS ACROSS SIX KINDS OF LISTS

Serial Position	χ^2_r	p
1st	15.968	.001
2nd	18.311	.001
3rd	14.350	.001
4th	9.000	.01
5th	8.000	.01

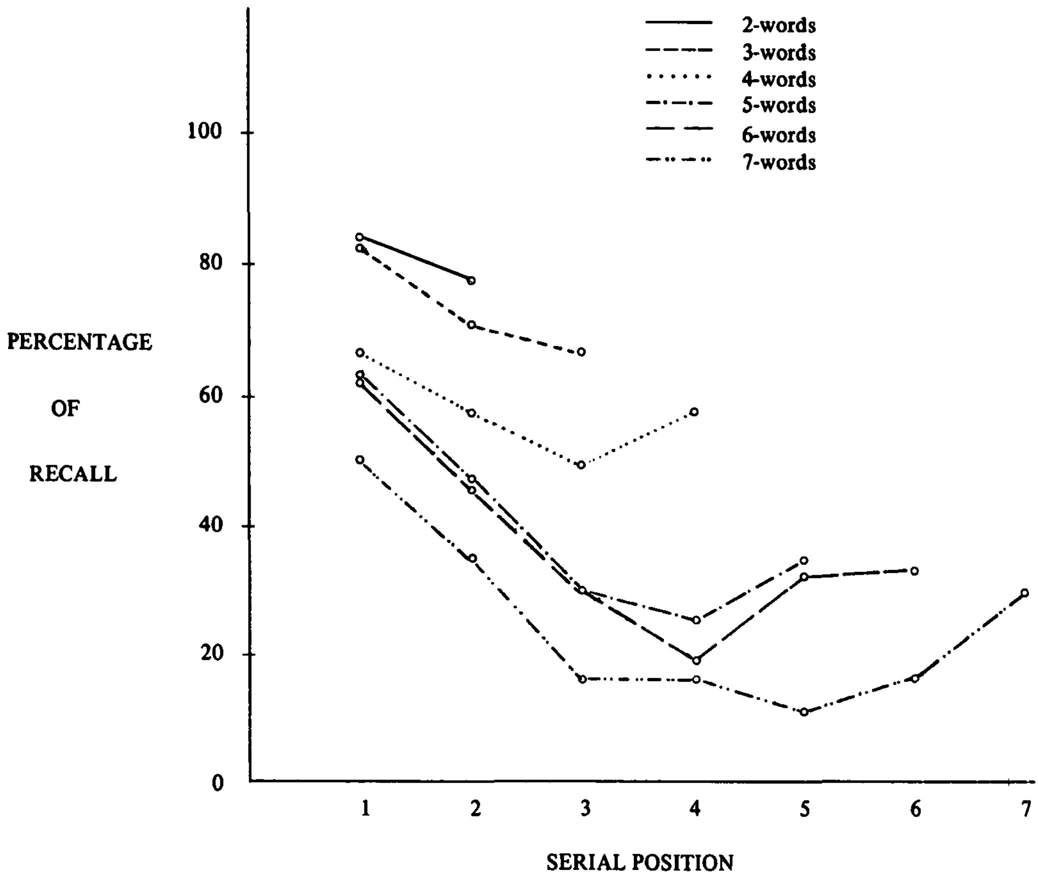

FIG. 2 – A COMPARISON OF THE PERCENTAGE OF RECALL FOR EACH SERIAL POSITION ACROSS SIX KINDS OF LIST LENGTH

Figures 3 and 4 illustrate how the efficiency of recall for each position is closely affected by the kind of material in that position, that is, either a high-meaningful item or a low-meaningful one, as was used in Experiment 2. A significant chi square value was obtained when this set of data was tested for significance ($X^2 = 43.002$, df = 56, $p < .001$).

When the data from both experiments were tested for significance, with delay as the main variable, insignificant results were obtained when the recall of the primacy portions were compared ($F = 2.59$, df = 3, 164, $p < .05$). A comparison of Figures 3 and 4, shows that even for the results of Experiment 2, the interval of delay affects the *recency* but not the *primacy* portion of the serial position curve.

DISCUSSION

The results of Experiment 1, which manipulated list length and delay were taken as evidence in support of the hypothesis that the storage mechanism responsible for *primacy* is limited in capacity. The resultant gradient of *primacy* implies that the efficiency of recall in the primacy portions of the shorter lists were better than those of the longer lists.

The results of Experiment 2 point out to significant differential serial recall for the different serial positions which contained material of varying meaningfulness. The better recall for more meaningful items was clearly apparent especially at the earlier portions rather than the latter portions of the curve. These results were thus

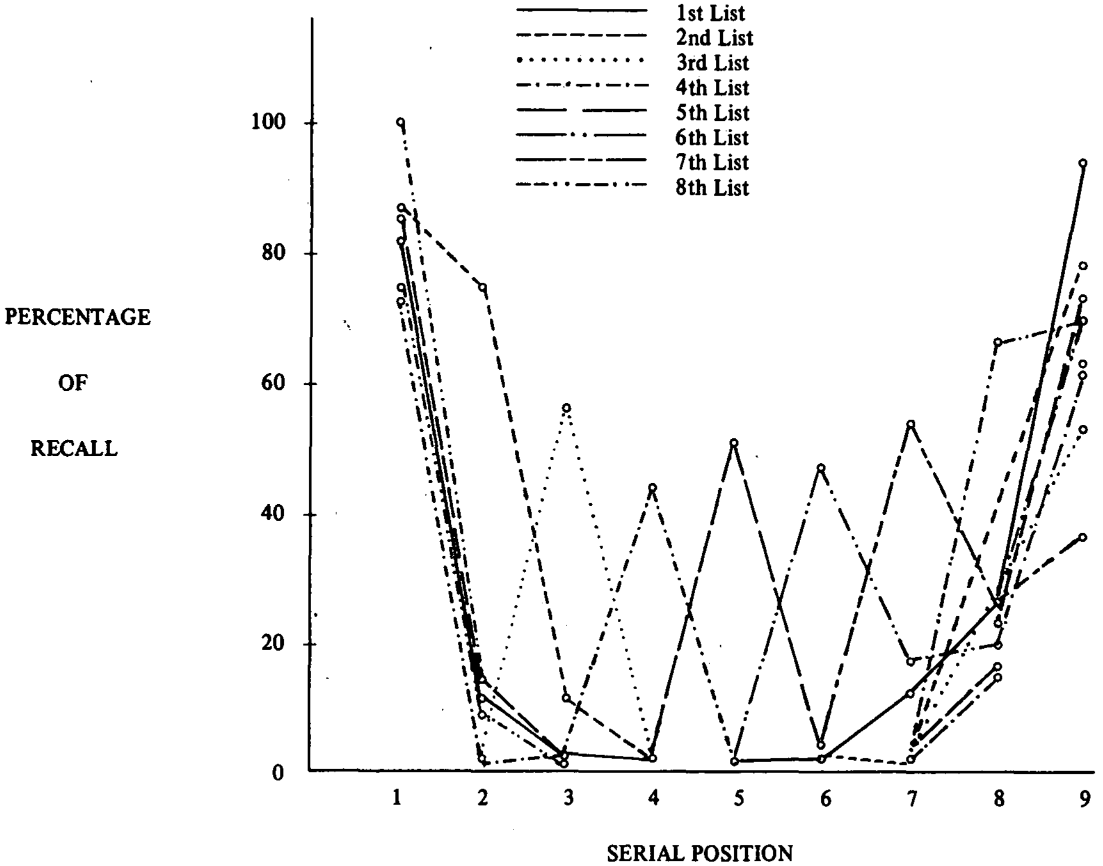

FIG. 3 – PERCENTAGE OF RECALL FOR VARIOUS SERIAL POSITIONS, SHOWING COMPARISONS ACROSS EIGHT DIFFERENT LISTS. AT 0 SECOND DELAY

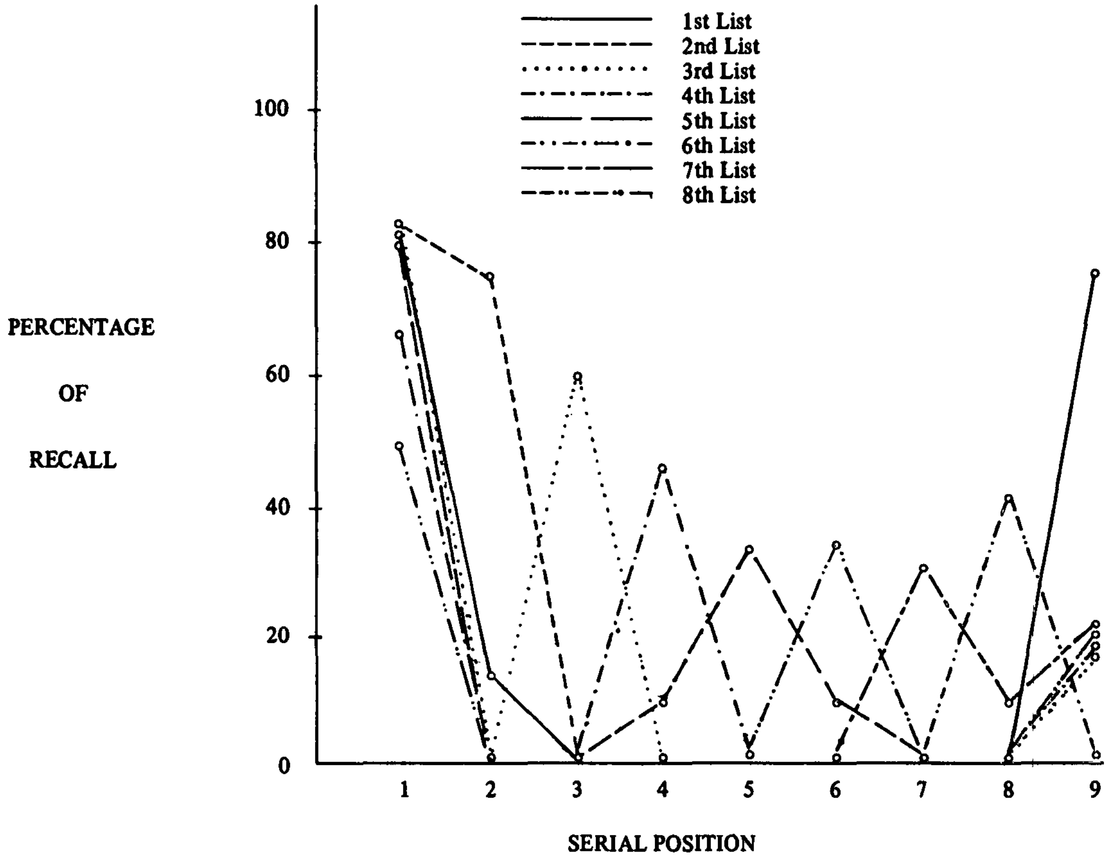

FIG. 4 – PERCENTAGE OF RECALL FOR VARIOUS SERIAL POSITIONS, SHOWING COMPARISONS ACROSS EIGHT DIFFERENT LIST, AT 6 SECONDS DELAY

taken as evidence in support of the second hypothesis of this study.

The analyses of the results on delay seem to indicate the following: (a) the independence of the time variable from the list length variable, suggesting that the time variable does not affect *primacy* significantly, since no difference in recall was obtained when a comparison was made on the different intervals of delay; (b) the favorable effect of immediate recall on *primacy* (better recall on the primacy for immediate rather than delayed recall) seems to disappear as the list became longer, which supports the assumption that the time variable is responsible for the *recency effect.*

Santos (1970) previously investigated the role of proactive inhibition in STM. Her results were interpreted as a successful attempt at localizing the proactive inhibition effects in the *primacy* portion of the serial position curve.

The trend of results in this study (the gradient of the *primacy effect,* significant differential recall for the first five positions of different list lengths, marked alterations in the serial position curve produced by the varying positions of the meaningful items in the list, and the differing effect of delay on *primacy* and *recency*), together with the results of Glanzer & Cunitz (1966), and the findings of Santos (1970), seem to firmly establish the dual-function theory of short-term memory. Specifically, they support the Glanzer-Cunitz hypothesis on the *primacy* *effect.* Indeed, the serial position phenomenon in STM seems to represent output from two storage mechanisms: a long-term mechanism of limited capacity affected by variables affecting learning, responsible for *primacy;* and, *primary* memory or an "echo-box-like" mechanism affected by delay, which is responsible for *recency.*

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