SERIAL POSITION EFFECT AS A FUNCTION OF INTER-TRIAL INTERVAL

Thesis for the Degree of M. A.

MICHIGAN STATE UNIVERSITY

Louis G. Lippman

1963

ABSTRACT

SERIAL POSITION EFFECT AS A FUNCTION
OF INTER-TRIAL INTERVAL

by Louis G. Lippman

A discrimination theory for serial position effect was developed. Basically, this theory stated that primacy-recency is primarily dependent upon the inter-trial interval (ITI) for providing a discriminable order cue. Experimental conditions, (1) where the ITI was set equal to the inter-stimulus interval, with and without (2) dummy items at the onset of learning, and (3) where the ITI was systematically varied through all positions in the list were compared to a control condition where the ITI was presented in a constant location as in traditional serial learning.

All experimental conditions significantly reduced primacy-recency effects and addition of dummy items further curtailed primacy effects. When the ITI was systematically relocated, learning was significantly slower than when the ITI maintained a constant position, thus indicating that rate of learning is more dependent upon consistent order cues than on massing or spacing. Finally, measures of "actual first" and "objective first"

indicated that Ss utilize and, when necessary, establish discriminable cues for primacy. Reducing the applicability, availability, or saliency of these cues slows learning and reduces primacy-recency effects. Consequently, the discrimination theory was supported.

Approved M. Ray Denny

Date Aug 12, '63

SERIAL POSITION EFFECT AS A FUNCTION OF INTER-TRIAL INTERVAL

By

Louis G. Lippman

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Psychology

1963

ACKNOWLEDGMENT

The author wishes to express his gratitude and appreciation to Dr. M. Ray Denny, chairman of his committee, for his guidance in this research and for his assistance in the development of this manuscript.

He also wishes to thank Drs. Charles Hanley and Stanley C. Ratner for their assistance, and Mr. Joseph R. Levine for his advice during the formulation of this research.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Glanzer and Peters (1962), investigating influences of temporal variables upon the shape of the serial position curve, found a marked flattening of the serial position curve when the inter-trial interval (ITI) was eliminated. This suggests that the serial position effect is primarily dependent upon the ITI's serving as a highly discriminable cue for primacy (onset of the list). Eysenck (1959) performed a similar but less extensive experiment and concluded that all theories of serial position effect, except von Restorff type (or discriminability) explanations, were endangered by his findings.

A discriminability theory for serial position effect can be formulated and stated as follows: The ITI makes the beginning, or the first item of the list, discriminable by temporally spacing the last from the first, by visual spacing or asterisks, and through constant location (order cue). Through repetition and constant location of the ITI the order cue builds up and extends beyond the first item into the list (Ebenholtz, 1963). Not only is the initial item perceptually segregated from the remainder of the list because of the ITI (primacy), but doubtless the second

and third items are similarly made more discriminable, though to a lesser extent. Further along in the list, however, there is no clear or definite differentiation. Thus with a long list the serial position curve tends to flatten near the center, with the extent of the flattening varying directly with the length of the list (Murdock, 1962). In other words, order cue qua primacy functions only for the first few items; the items in the middle are indiscriminable with respect to order. With an ITI present the end of the list is also somewhat distinctive. There are temporal cues present as one nears the end of the list that indicate to S that he is well along in the list. Therefore an order cue qua recency is also operative. Consequently, primacy-recency effects are the main order effects in the list, with the ITI serving as the main means for the establishment of this compound temporal cue. Serial position effect is thus viewed as a von Restorff effect (Osgood, 1953, p. 504) with ITI providing the distinctive stimulus (order).

The following are some predictions from this theory: (a) Increasing the differential between rate of presentation of the verbal items and the ITI (increasing the difference between the ITI and the inter-stimulus interval, ISI) increases the discriminability of the

ITI and enhances the bowing of the serial position curve. Bowing was increased by Hovland (1938b) when the ISI was reduced, relative to ITI; and by Glanzer and Peters (1962) when the ITI was increased relative to the ISI. (b) Setting the ISI equal to the ITI (essentially, eliminating the ITI) or constantly relocating the ITI markedly reduces serial position effects because the order cue is severely attenuated. (c) Increasing the discriminability of the first verbal item in any way accelerates learning, as Jensen (1963) has found. Conversely, elimination of factors which make the first item discriminable retards learning; thus if the first item is not at all distinctive and ITI equals ISI, then serial position effects will be entirely eliminated.

The purpose of the present study was to test (b) above and the second part of (c), as predictions from the discrimination theory.

PROCEDURE

Subjects

Ss were 80 students, secured on a volunteer basis, who were enrolled in introductory psychology at Michigan State University. Ss who failed to understand or follow instructions or who had previously participated in verbal learning experiments were eliminated from the sample. Those who had participated formerly in an auditory paired-associate learning experiment, however, were retained.

Apparatus

Apparatus for this experiment consisted of an MTA 100 Scholar (teaching machine), rollers for adaption to repeated-loop material[1], and a Lafayette Repeat Cycle Timer, model number one, for an external pacer. The window on the teaching machine was reduced to 17/16 by 9/16 inches and was adjusted so that the verbal items appeared approximately at the center of the window. This type of apparatus was used in preference to a standard memory drum because it allows trial-to-trial change in presentation and eliminated influences from

[1] Repeated-loop material was used in conditions C and E_1 only; conditions E_2 and E_3 were presented by continuous tape.

consistent extraneous cues, such as imperfections in the tape.

Material

Verbal material employed in this experiment was a specimen list of twelve CVC trigrams, following typical rules for construction of nonsense syllable lists, and having an average association value of 22.7 percent, according to Glaze: MEP, GAW, KOJ, CIB, ZUR, TEY, WOQ, XIG, NAH, JEC, QUT, YOF (Hilgard, 1958, p. 540). The syllables were presented at a two-second rate (ISI); the ten-second ITI consisted of four two-second blank spaces followed by a two-second presentation of asterisks.

Instructions

Hovland's (1938a) instructions, with minor modifications, were used (Appendix). Ss were given a copy of the instructions which they followed while the experimenter read the instructions aloud. Comments clarifying S's understanding of his task were made when required.

Design and Measurement

There were one control group and three experimental groups:

(1) Group C where the syllables were presented in traditional fashion with an ITI following each

complete trial.

(2) Group E_1 where the trigrams were presented without any ITI.

(3) Group E_2 which was identical to E_1 except that four trigrams (dummy items which were presented before the actual list began and never reappeared) were added. These dummy items (VAF, SIJ, FEH, ZIW) were of zero association value according to Glaze (Hilgard, 1958, p. 544).

(4) Group E_3 where the ITI was systematically varied through all positions in the list. Specifically: Trial one: 1,2,...11,12, (ITI),1; Trial two: 2,3,... 12,1, (ITI),2; Trial three: 3,4,...1,2, (ITI),3; etc.. Although all responses were recorded, Ss' anticipations to the repeated item following the ITI were eliminated from consideration in order for comparability between groups.

Responses were recorded for 24 trials, trial one being Ss' first exposure to the material. All Ss were started in the task by the experimenter's removing a slip of paper from the window simultaneously with the appearance of the first item.

At the conclusion of the 24 trials, the experimenter asked Ss in the E conditions whether any item in the list seemed to be first in any way, i.e., whether S

perceived any item as "first"; the experimenter noted Ss' choices of "subjective first".

RESULTS

The results are graphically presented in terms of learning curves (Figure 1) and serial position curves (Figures 2,3,4, and 5). Two techniques for plotting serial position curves from the E groups' data were applied: (a) From the item actually presented first (having first position on the list) and (b) from Ss "objective first", defined as the item correctly anticipated most frequently by an S/. In case of ties the tied item correctly anticipated earliest in learning was employed. The measure of "subjective first", described in the procedure, was discarded since Ss evaded the question, failed to understand what was being asked, or tried to recall which item had, in fact, been presented first.

A visual examination of the serial position curves indicates that group C produced a typical serial position curve with primacy and recency effects. E_1, when plotted from "actual first", showed slight, if any, primacy effects and marked reduction in recency; however, the plot from "objective first" retained both primacy and recency. E_2, plotted from "actual first" showed no primacy-recency; the plot from "objective first" displayed very slight primacy-recency. Finally, E_3, plotted from

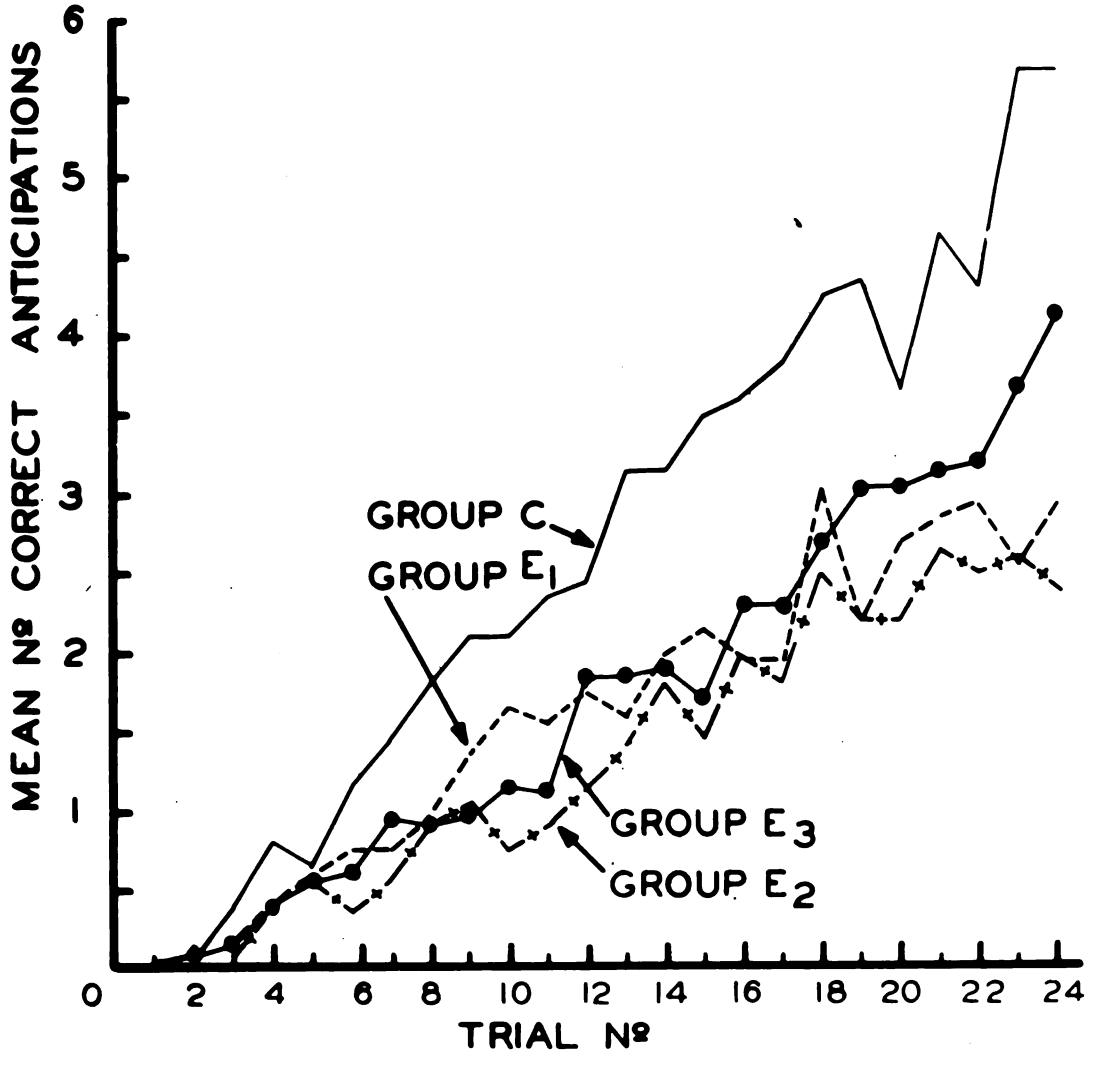

Figure 1. Learning curves for Groups C, E_1, E_2, and E_3.

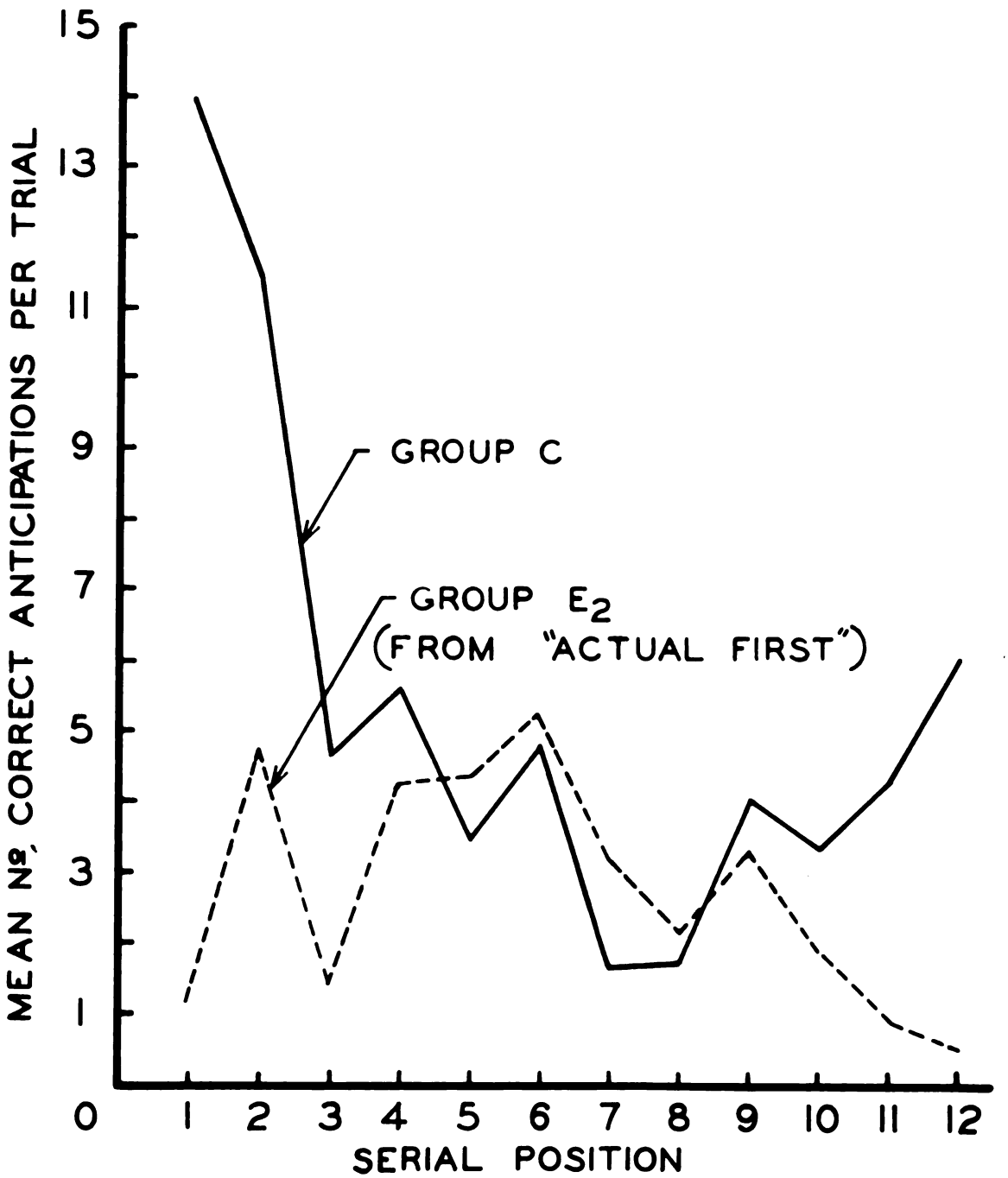

Figure 2. Serial-position curves for Group C and Group E_2, plotted from "actual first".

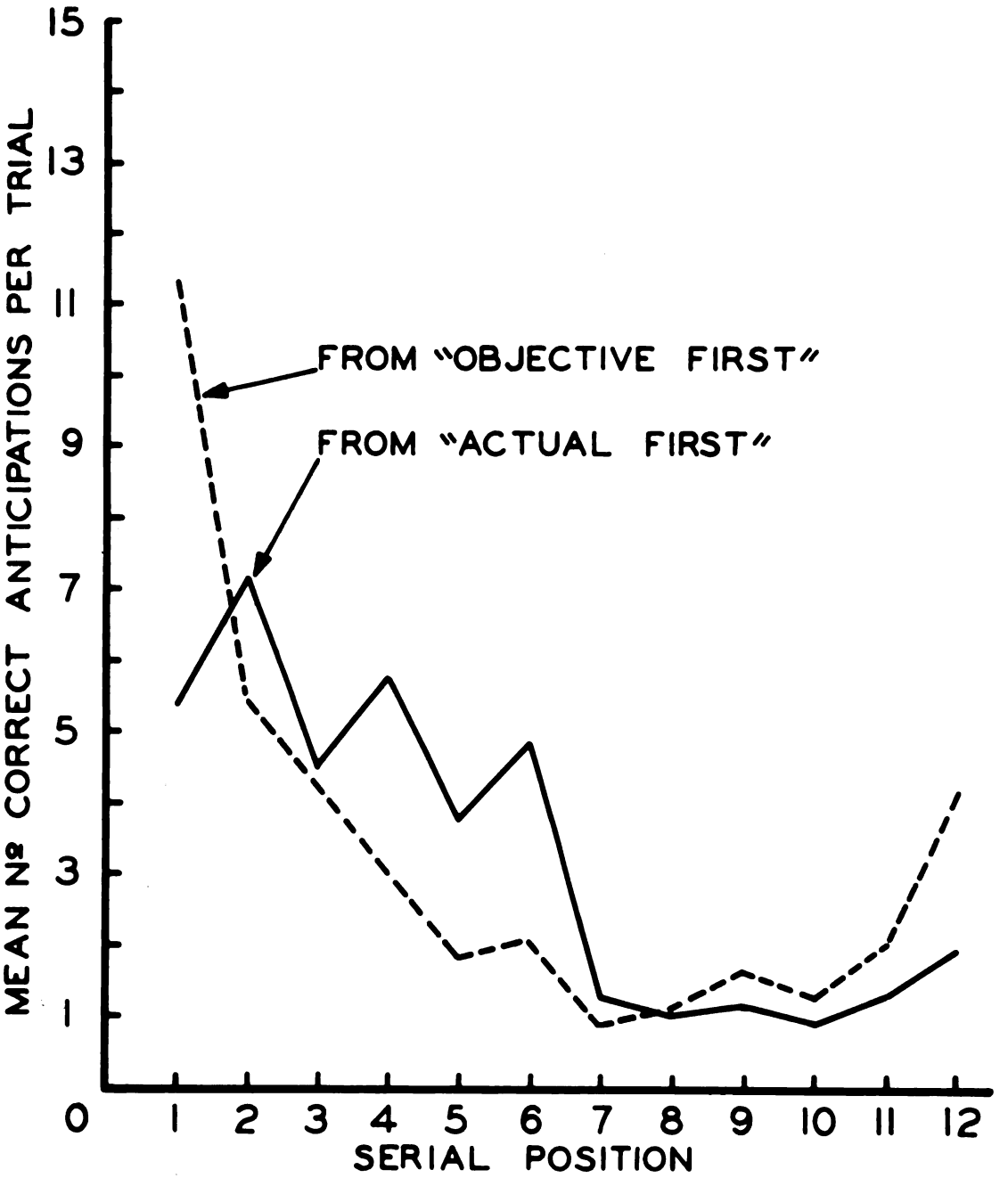

Figure 3. Serial-position curves for Group E_1, plotted from "actual first" and "objective first".

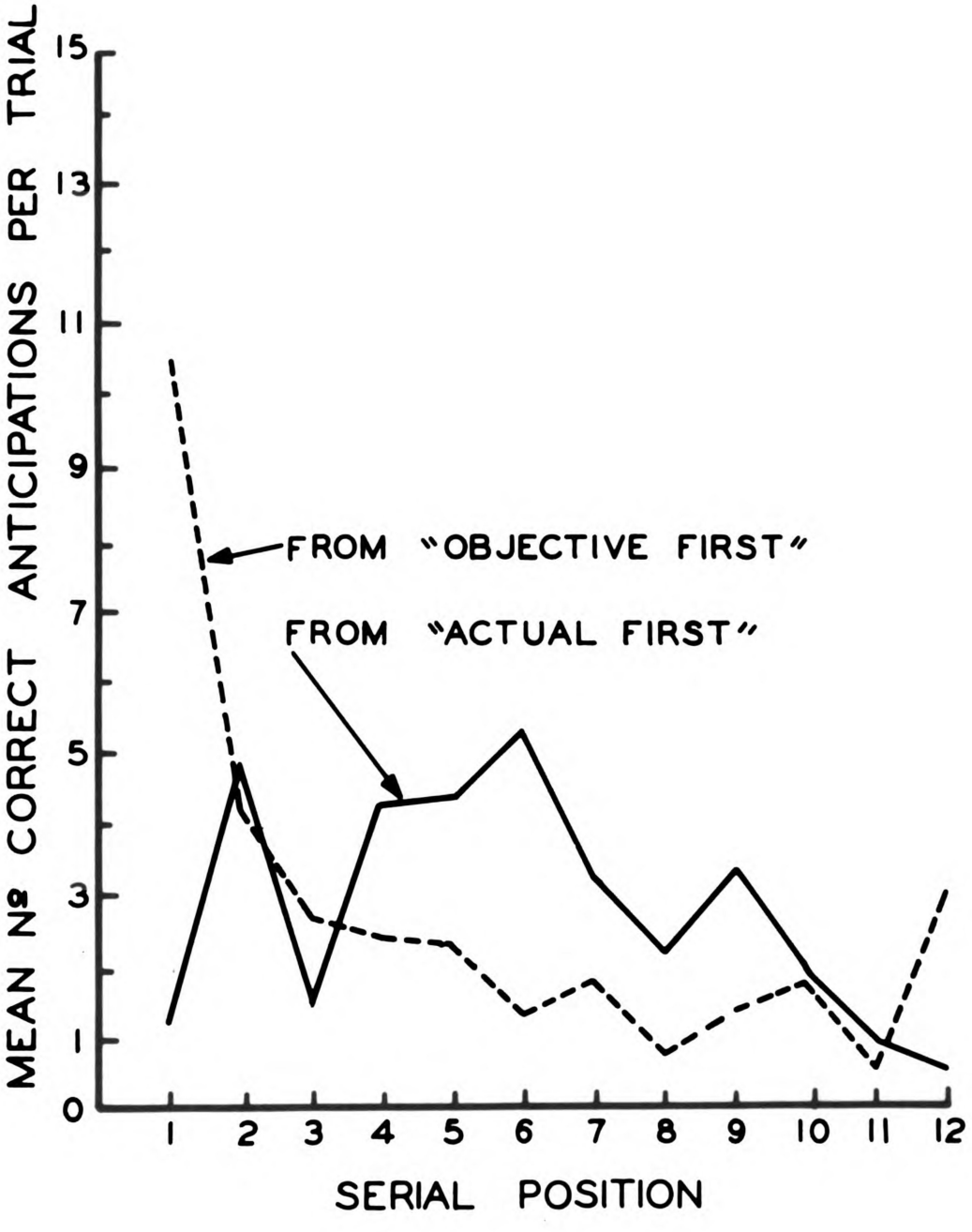

Figure 4. Serial-position curves for Group E_2, plotted from "actual first" and "objective first".

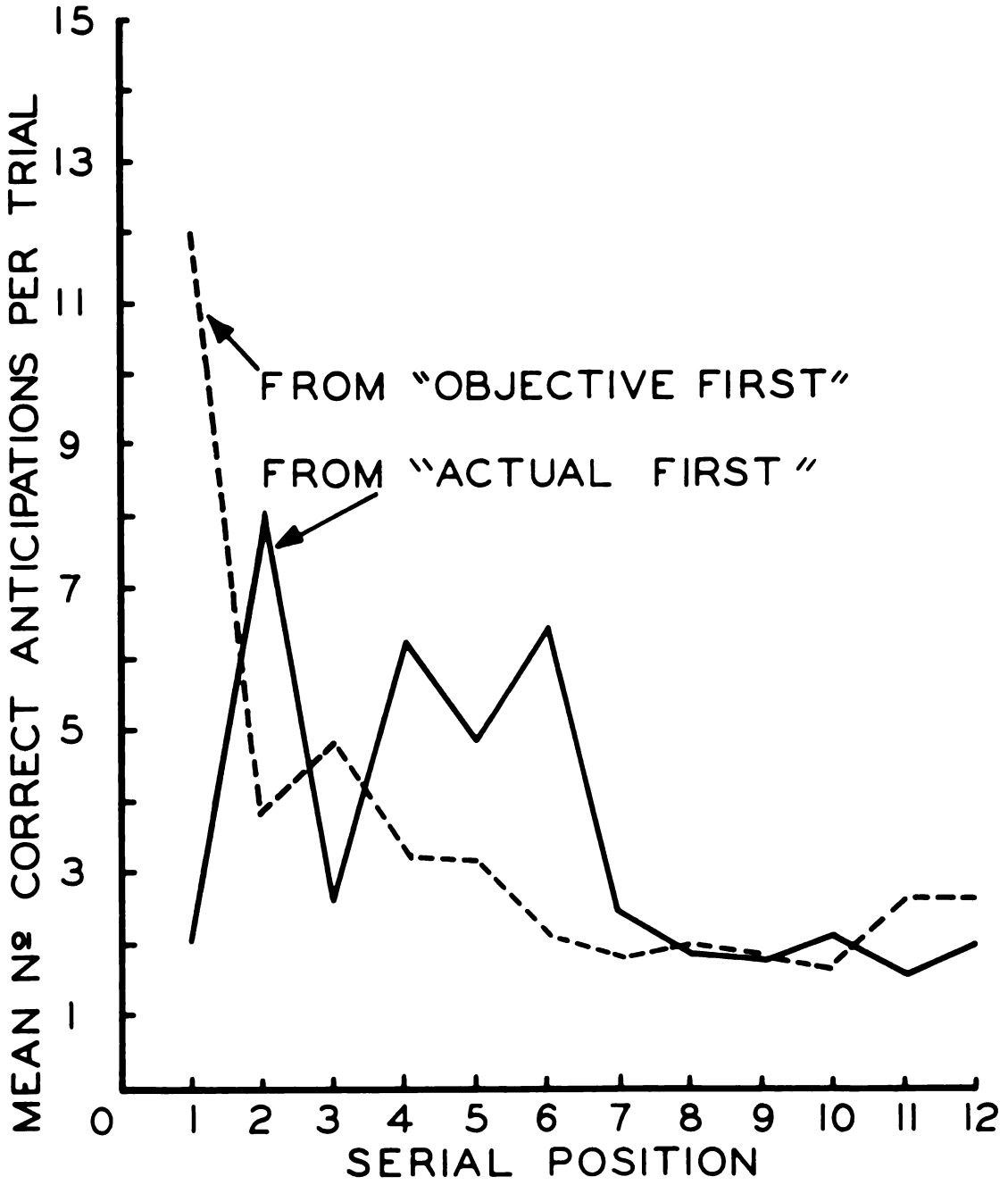

Figure 5. Serial-position curves for Group E_3, plotted from "actual first" and "objective first".

"actual first", showed a spread of primacy and absence of recency; the plot from "objective first" showed a slight primacy and virtually no recency.

An analysis of variance was performed on the data plotted in Figure 1 (Table I), and all possible comparisons between treatment means were made (Table V,a). The *F* is significant at the .005 level, and the multiple comparisons indicate that group C learned significantly faster than each of the E groups. There are no significant differences between E groups but certain trends appear. The learning curves show that groups E_2 and E_1, in that order, tended to learn faster than E_3. Group E_3 appeared to learn slowly at the start but later in learning surpassed groups E_1 and E_2.

Table I. Summary of Analysis of Variance for Learning Curves

Source	d.f.	Mean Square	*F*
Between groups	3	3424.19	5.57*
Within groups	92	614.45	

*$p < .005$

The serial position curves were arbitrarily partitioned into three sections and the groups were compared for each of these measures in order to determine the effects of the experimental manipulations (E groups) upon primacy-recency effects. It was assumed that the first four items would adequately represent any primacy effects, the last two items would describe recency effects, and items 5 through 10 would be relatively independent of primacy-recency (Murdock, 1962). The results of each analysis of variance using these measures are summarized in Tables II, III, and IV; the results of multiple comparisons between treatment means for these analyses are summarized in Table V, b and c.

The $\underline{F}$ for primacy effects is significant at the .0005 level; the multiple comparisons indicate that all E conditions clearly reduced primacy effects. Of great interest is the fact that the comparison between E_1 and E_2 on primacy showed that addition of dummy items significantly curtailed primacy effects ($p < .05$). The $\underline{F}$ for recency effects is significant at the .0005 level; the multiple comparisons show that all experimental manipulations significantly reduced recency effects. Finally, the $\underline{F}$ for the "middle" items is not significant, in agreement with Murdock's (1962) findings.

Table II. Summary of Analysis of Variance Comparing Groups' Performance on Items 1 through 4 of Serial Learning

Source	d.f.	Mean Square	F
Between groups	3	2185.48	8.90*
Within groups	76	245.67	

*p <.0005

Table III. Summary of Analysis of Variance Comparing Groups' Performance on Items 5 through 10 of Serial Learning

Source	d.f.	Mean Square	F*
Between groups	3	221.28	
Within groups	76	232.30	

*n.s.

Table IV. Summary of Analysis of Variance Comparing Groups' Performance on Items 11 and 12 of Serial Learning

Source	d.f.	Mean Square	F
Between groups	3	308.88	13.04*
Within groups	76	23.69	

*p <.005

Table V. Summary of Multiple Comparisons between Treatment Means of the Analyses Summarized in Tables I, II, and IV, applying Duncan's Multiple Range Test (Edwards, 1960, Pp. 136-140)

	A		B		C	
Groups Compared	(Table I) Learning Curves		(Table II) Serial Items 1-4		(Table IV) Serial Items 11 and 12	
	Mean Difference	p	Mean Difference	p	Mean Difference	p
C vs. E_1	21.83	.005	12.95	.05	7.10	.001
C vs. E_2	27.46	.001	25.10	.001	8.95	.001
C vs. E_3	19.54	.05	16.80	.005	6.85	.001
E_1 vs. E_2	5.63	n.s.	12.15	.05	1.85	n.s.
E_1 vs. E_3	2.29	n.s.	3.85	n.s.	0.25	n.s.
E_2 vs. E_3	7.92	n.s.	8.30	n.s.	2.10	n.s.

DISCUSSION

The results of this experiment clearly support the discrimination theory of serial position effect. When the cue value of the ITI is reduced, rate of learning drops and primacy-recency effects are curtailed; of considerable interest is the fact that E_3 learned no faster than the other E conditions although it was spaced. Primacy-recency effects are directly dependent upon the ITI for providing the order cue. When the ITI equals the ISI and when dummy items are introduced so that even on the first trial there is no "first" item, then primacy-recency effects are totally eliminated. In other words, seeing the first item as first on just one trial makes the first item more discriminable than the other words on the list. In condition E_2, Ss' only possible cue of this sort was their perception of an item's repetition; but since the first item so recognized was directly dependent upon individual differences and not upon a consistent, repeating cue in the list, primacy-recency effects were eliminated. The results from the plots from "objective first" generally support this assumption that S uses idiosyncratic primacy cues.

Finally, the results for group E_3 seem to indicate that Ss in serial learning situations will take a potentially confusing cue and convert it into a cue to facilitate learning. Specifically, in E_3, some Ss attended to the ITI as a cue to indicate "the next item to be learned", i.e., once an S learned the pattern of ITI relocation there was an extra cue for this S. To eliminate this possibility, in any future research the location of the ITI could be a random affair.

SUMMARY

A discrimination theory for serial position effect was developed. Basically, this theory stated that primacy-recency is primarily dependent upon the inter-trial interval (ITI) for providing a discriminable order cue. Experimental conditions, (1) where the ITI was set equal to the inter-stimulus interval, with and without (2) dummy items at the onset of learning, and (3) where the ITI was systematically varied through all positions in the list were compared to a control condition where the ITI was presented in a constant location as in traditional serial learning.

All experimental conditions significantly reduced primacy-recency effects and addition of dummy items further curtailed primacy effects. When the ITI was systematically relocated, learning was significantly slower than when the ITI maintained a constant position, thus indicating that rate of learning is more dependent upon consistent order cues than on massing or spacing. Finally, measures of "actual first" and "objective first" indicated that Ss utilize and, when necessary, establish discriminable cues for primacy. Reducing the applicability, availability, or saliency of these cues slows learning and reduces primacy-recency effects. Consequently, the discrimination theory was supported.

REFERENCES

Ebenholtz, S. M. Position mediated transfer between serial learning and a spatial discrimination task. J. exp. Psychol. 1963, 65, 603-608.

Edwards, A. L. Experimental design in psychological research. (Revised ed.), New York: Holt, Rinehart and Winston, 1960.

Eysenck, H. J. Serial position effects in nonsense syllable learning as a function of interlist rest pauses. Brit. J. Psychol. 1959, 50, 360-362.

Glanzer, M. and Peters, S. C. Re-examination of the serial position effect. J. exp. Psychol. 1962, 64, 258-266.

Hilgard, E. R. Methods and procedures in the study of learning. In S. S. Stevens (Ed.), Handbook of experimental psychology. New York: John Wiley & Sons, Inc., 1958, Pp. 517-566.

Hovland, C. I. Experimental studies in rote-learning theory. I. Reminiscence following learning by massed and by distributed practice. J. exp. Psychol. 1938a, 22, 201-224.

Hovland, C. I. Experimental studies in rote-learning theory. II. Reminiscence with varying speeds of syllable presentation. J. exp. Psychol. 1938b, 22, 338-353.

Jensen, A. R. Transfer between paired-associate and serial learning. J. verbal learn. verbal Behav. 1963, 1, 269-280.

Murdock, B. B., Jr. The serial position effect of free recall. J. exp. Psychol. 1962, 64, 482-488.

Osgood, C. E. Method and theory in experimental psychology. New York: Oxford University Press, 1953.

APPENDIX

INSTRUCTIONS

This is an experiment in learning a list of nonsense syllables, and not a psychological test. We are interested in certain complex relationships in the learning process which are common to all people, and are not concerned with your personal reactions.

Shortly after the apparatus starts you will see a three-letter syllable in the window. You are to spell this syllable and those that follow it. As you learn, you are to try to anticipate the syllables; in other words, as you see one syllable you are to spell the syllable that will follow it BEFORE it appears. If you think you know what a syllable will be, but are not sure, guess, because it will not hurt your score any more than to say nothing. And if you get it right it will count as a success. Always try to spell the syllables as distinctly as possible. You will continue anticipating the syllables until I tell you to stop.

Do not ask questions about the purpose of the study until the experiment is over. Do you have any questions regarding your task?