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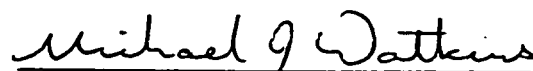
EFFECT OF LIST LENGTH PREDICTABILITY ON THE SUFFIX EFFECT:
A RECONSIDERATION OF TWO-COMPONENT THEORY

by

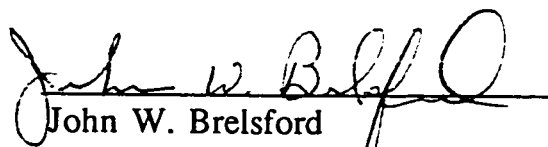
LANCE C. BLOOM

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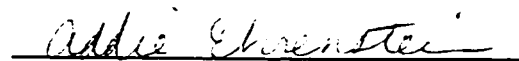
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ABSTRACT

Effect of List Length Predictability on the Suffix Effect: A Reconsideration of Two-Component Theory

by

Lance C. Bloom

The suffix effect refers to the forgetting of the last few items of a just-spoken list caused by appending a nominally irrelevant item. Several theorists hold that rememberer strategy affects only the preterminal component of the suffix effect and on this basis they have advocated a two-component theory of the effect. This theory has received significant support from the finding that rendering list length unpredictable eliminates the preterminal component while having little if any effect on the terminal component. Contrary evidence is reported here. Specifically, a robust preterminal suffix effect is demonstrated in each of three experiments regardless of list length predictability. The discrepancy with the earlier finding might be due, in part at least, to a confound in the earlier research between knowledge of list length during presentation and knowledge of list length during recall. Other evidence taken as supporting two-component theory is reviewed and similarly found wanting.

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Introduction

What determines what is and what is not remembered? In other words, how should the control of memory be conceived? Should theories of memory vest control in the stimuli of the outside world or in the rememberer?

Experimental psychologists have, at different times, asserted each of these conceptions. During the behaviorist era they paid little heed to the will of the rememberer and instead assigned control of learning and remembering to external stimuli. With the ascendance of cognitivism in the 1960s they did a volta face and cast the rememberer as an information-processing system that takes charge of the remembering process through such newly ceded capabilities as selective encoding and organization and rehearsal.

A case can be made for easing parsimony and allowing both the remember and external stimuli a full measure of control (see Watkins, 1989; 1990). Indeed, there can surely be no more prospect of satisfactorily accounting for control over the remembering process without reference to both the stimulus and rememberer than there can be of satisfactorily accounting for, say, intelligence without reference to both genetic and environmental factors. But such a two-factor theory of memory control has never won much favor. Contemporary theorists are every bit as committed to discounting the role of the stimulus as the behaviorists were to discounting the will and strategies of the rememberer. Showcasing this commitment is the treatment of the recency effect in immediate recall.

Recency Effect in Immediate Recall

The recency effect refers to the increasing recallability of the last few of a sequence of items. That the effect is in some sense stimulus-determined is nothing short of a truism, for the temporal position by which the effect is defined is a stimulus property. Were stimulus control a legitimate explanatory concept, the recency effect could plausibly be attributed to a tendency for recent stimuli to capture a place in mind: At any given instant during the presentation of a sequence of items, those presented most recently would have a relatively good chance of being in mind and hence of being reported. But so dominant is cognitivism that such direct stimulus control is not an acceptable mode of explanation and is seldom if ever invoked. Rather, appeal is made to the structure or state of the rememberer's information-processing mechanism--notably, a hypothetical short-term store capable of holding only a few items (Atkinson & Shiffrin, 1968; Waugh & Norman, 1965) or a temporarily active state of putative internal representations of the stimuli (Norman, 1968).

The recency effect is remarkably immune to all manner of variables that have clear and systematic effects on recall of items from earlier in the sequence (Glanzer, 1972). The exceptions to this rule are instructive for present purposes. By far the most studied exceptions are the effects of presentation modality and of post-presentation distraction: The recency effect is stronger if the sensory modality of list presentation is auditory rather than visual, and it is

sharply attenuated if attention is directed to other items interpolated between presentation and recall. Were stimulus-based theorizing in favor, the first of these findings could be said to arise simply from spoken items being more successful than written items in securing a place in mind, and the second would merely affirm the power of recency and hence of stimulus control relative to rememberer control.

If the theoretical treatment of the recency effect attests to the unmitigated dominance of the rememberer-based conception of memory, so too does that of the suffix effect.

Suffix Effect

The suffix effect is related to both the modality effect and the deleterious effect of post-list distraction. It refers to the attenuation of the recency effect upon the addition of a single, nominally irrelevant item, or "suffix," directly following list presentation (Crowder, 1967; 1971; 1972; Dallett, 1965). The suffix may occur after every list and thus be entirely predictable, and it does not have to be recalled. Often, it masquerades as an innocuous recall instruction, such as "recall" or "now." Most research on the effect has involved procedures in which both the list items and the suffix are presented auditorily, and in which the subject reports the items in their presentation order and gains credit only for those written in their correct position. Certainly, the effect is strong and reliable under these conditions--so much so, in fact, that it has become a favorite classroom demonstration.

The suffix effect appears to bear clear hallmarks of stimulus control. First, like the recency effect, it is tied to the end of the list and so is essentially defined in stimulus terms. Second, it is associated with a particular sensory modality, constituting as it does a rough nullification of the boost that auditory presentation brings to the recency effect. Third, it is sharply attenuated by changing a salient stimulus parameter for the suffix item--as, for example, by presenting the suffix in a different voice (Elmes, 1974; Greenberg & Engle, 1983; Morton, Crowder, & Prussin, 1971; Watkins & Watkins, 1980) or as coming from a different direction (Morton, et al. 1971). And fourth, it is just about as large as the effect of presenting an additional item requiring attention (Nairne & Crowder, 1982) or, indeed, of presenting an additional list item (Crowder, 1967), which implies virtually complete dominance of stimulus over willful control.

Yet in this era of cognitivism such findings are rarely cast in terms of stimulus control and never as a threat to the adequacy of rememberer-based theorizing. In the first place, they are seen as of only marginal theoretical significance, and of no relevance at all to the general principles of memory beyond the confines of immediate recall. Moreover, to the extent that the suffix effect and its characteristics cannot be accounted for by appeal to rememberer strategy and processing, some sort of structural configuration of the rememberer's information-processing system is invoked. Theories of the suffix effect have been reviewed elsewhere (e.g., Greene 1992)

and for the present purpose it is enough to acknowledge what remains by far the best known example, namely Crowder & Morton's (1969) theory of precategorical acoustic storage (see also Crowder, 1978; Greene, 1992; Greene & Crowder, 1984; Morton, Marcus, & Ottley, 1981). By this account the suffix erases transient acoustical information held in a conjectured store at a level of analysis prior to categorization into words or other meaningful units. So seductive is this mode of theorizing that it has effectively neutralized what in another era would have stood as striking and transparent evidence of stimulus control.

As if to acknowledge that, of all putative information-processing structures, the precategorical acoustic store could reasonably be construed as an evolutionary product of accommodation to the realities of the stimulus world and thus itself be stimulus-determined, suffix theorists seem to favor shifting as much explanatory burden as possible from rememberer structure to rememberer strategy. This they do by restricting to a minimum the contribution that the store makes to recall. Specifically, the suffix effect has been assumed to comprise two distinct components, with memory for the most recently presented item being structurally based and immune to rememberer strategy (Baddeley & Hull, 1979; Balota & Engle, 1981; Greene, 1992; Harris, 1989; Nairne, 1990; Penney, 1985, 1989; Penney & Godsell, 1993). Greene (1992) captured this two-component theory as follows:

There is a growing consensus that suffix effects at earlier positions reflects the use of particular strategies by the subjects; these preterminal effects can be influenced quite easily by changing the strategy that a subject is following. In contrast, the suffix effect at the last position is not influenced by these strategic manipulations and thus seems to be telling us something about relatively fixed structures in human memory (p. 26).

When List Length is Unpredictable

Two-component theory has drawn significant support from a study by Penney (1985, Experiment 1). At issue was how the suffix effect would respond to unpredictability of list length. Lists comprised 6 to 9 digits. A recall signal was given directly following each list, whereupon the subjects tried as best they could to write down the digits in their order of presentation. For half of the subjects, lists were blocked by length and the new list length announced before each change of block; for the other half, list length varied unpredictably from one list to the next. For half the subjects within each of these groups, the recall signal was the word "now"; for the other half it was a soft click. In this way predictability of list length was crossed with suffix condition.

The support that this experiment lends the two-component theory of the suffix effect derives from the way the suffix effect responded to unpredictability of list length. Specifically, removing predictability of list length eliminated the suffix effect at the preterminal serial positions (defined as the three immediately

preceding the last) but not at the last serial position. Predictability of list length is assumed to affect study strategy and, in keeping with two-component theory, study strategy is in turn assumed to affect the preterminal, but not the terminal, component of the suffix effect.

Given its central role in the formulation of two-component theory, it would seem prudent to check the generality of Penney's (1985, Experiment 1) finding, and this was the purpose of the research reported here. In particular, there are two worrisome details of Penney's methodology. First, the observed effects of varying list length could have arisen, not just from the strategies her subjects adopted during presentation of the list, but also from the way they responded at test. Consider a hypothetical situation in which two subjects hear the same list of nine random digits. Following list presentation, each subject remembers the first four and the last three digits and moreover knows them to be the first four and last three digits. The only difference between the subjects is that one knows the length of the list and the other does not. Both subjects would type the first four digits in their correct position. The one who knew the length of the list would leave two blanks for the forgotten digits and so type the last three digits in their correct position (see the upper panel of Table 1). The subject who did not know list length would either type just the first four digits or, more likely, guess the number of forgotten digits and hence the precise serial positions of the last three digits. With some probability the guess would be wrong, in which case the last three digits would be

assigned to the wrong positions and thus scored as incorrect (see the lower panel of Table 1). Clearly, then, the subjects' knowledge of list length at the time of test could affect, not only overall level of performance, but also the shape of the serial position functions and hence the apparent support for two-component theory.

Table 1

Hypothetical Serial Recall Performance with Known and Unknown List Lengths

<u>List length known</u>									
Subject . . .									
hears	9	7	0	4	8	3	6	5	2
types	9	7	0	4	-	-	6	5	2
scores	+	+	+	+			+	+	+
<u>List length unknown</u>									
Subject . . .									
hears	9	7	0	4	8	3	6	5	2
types	9	7	0	4	-	6	5	2	
scores	+	+	+	+					

The second worrisome detail of Penney's (1985) methodology is the use of different groups of subjects for the suffix and no-suffix conditions. With this design, the precise form of the suffix effect could reflect a difference in the way the two groups studied the list

items rather than just the effect of the suffix on memory for the already-presented items. In particular, the elimination of the preterminal suffix effect observed by Penney could be the product of a processing strategy devised to cope with not only list length unpredictability but also the disruptive effect of the suffix. If so, Penney's findings would tell us little about the retrograde effect of the suffix, and so would have little if any relevance to two-component theory.

The following three experiments were designed to shed more light on the effect that rendering list length unpredictable has on the preterminal and terminal components of the suffix effect. The first experiment was similar to that of Penney (1985, Experiment 1) except that list length was always specified at test, thereby unconfounding the effects of knowledge of list length at test and knowledge of list length during presentation. In the second and third experiments, suffix condition varied unpredictably from list to list, and list length was never predictable but for half of the subjects it was specified at test.

Experiment 1

The first experiment was designed to determine whether Penney's (1985) results would replicate when list length was specified at the time of test. Thus, the suffix effect was compared under two conditions: the unpredictable condition in which list length varied unpredictably from list to list, so that subjects did not know the length of a list during its presentation; and the predictable

condition in which lists were blocked by length, so that subjects did know the length of each list during its presentation. Unlike Penney's procedure, a sequence of position markers was shown directly following list presentation, with one marker for each item presented. This meant that if, say, the last three items of the list were known, they could be recorded in their proper position. At issue is whether unpredictability of list length would affect the suffix effect, and more particularly whether, as Penney found, it would selectively eliminate the preterminal component. Following Penney, suffix condition in this experiment was varied between subjects.

Method

The methodological details followed closely those of Penney (1985, Experiment 1). Aside from the provision of position markers at test, two differences warrant mention. First, predictability of list length was varied within rather than between subjects. The reason for this difference was to increase sensitivity to whatever effect this variable might have. For any given subject all trials of one predictability condition occurred before any of the other, with the order of the conditions counterbalanced between subjects. Consequently, the effect of predictability of list length could also be assessed as a between-subjects variable through the simple expedient of ignoring the second half of each subject's data. It turned out that none of the conclusions pertinent to the present concern would be compromised by restricting the analysis in this way, and therefore the order of the predictable and unpredictable

conditions will not be considered further. The other difference of note is that, whereas in Penney's predictable condition list length varied randomly from block to block, in this experiment it increased progressively from one block to the next. This change was intended to maximize the subjects' ability to anticipate the end of each list and thereby to maximize any difference in study strategy for the predictable and unpredictable conditions. Of course, such confounding of list length with block order meant that the interpretation of any effects involving list length required considerable caution, but such effects were not directly relevant to present purposes.

Subjects. The subjects were 48 Rice University undergraduates.

Materials. The digits 0 - 9 were recorded on the computer in a clear male voice for use as the to-be-remembered items. The duration of each digit was adjusted to approximately 400 ms. For each subject, the digits were randomly sampled without replacement to create 96 lists, 24 of each length (6, 7, 8, and 9). The lists of each length were randomly assigned to two sets of 12, one for use in the predictable condition and one for use in the unpredictable condition. For the suffix condition the word "now" spoken in the same voice as the digits served as the suffix. For the no-suffix condition this was replaced with a click made by pressing home the cap of a Paper Mate highlighting marker. Both the suffix and click were adjusted to last approximately 400 ms.

Design. The subjects were assigned to the suffix condition and

and no-suffix condition in a manner that was random within the constraint that there were 24 in each condition. Predictability of list length (predictable and unpredictable) and list length (6, 7, 8, and 9 items) were varied within subjects. In the predictable list length condition, the lists were blocked by length and list length was announced at the beginning of each block. List length increased across blocks, so that lists comprised 6 digits for the first block, 7 for the second, 8 for the third, and 9 for the fourth. In the unpredictable list length condition, list length was varied at random within the constraint that each consecutive set of four lists included one of each length. A separately randomized sequence of this sort was generated for each subject. Finally, the ordering of the predictable and unpredictable list-length conditions was counterbalanced across subjects, with 12 of the subjects in each suffix condition being tested first in the predictable condition and then in the unpredictable condition and the other 12 being tested first in the unpredictable condition and then in the predictable condition.

Procedure. The subjects were tested up to three at a time, although each worked independently at a separate computer. Lists were presented via headphones. The instructions were shown on the computers and also read aloud by the Experimenter. There followed four practice trials, one for each list length, with list length being specified prior to presentation for just two of these lists. The experiment proper involved the presentation of 96 lists, 48 blocked by length and 48 in random order. In the predictable condition, each

block of lists was preceded by a message on the computer screen specifying the length of the upcoming lists.

The subject initiated each trial by clicking a "start" button. After 0.5 s, the digits and recall signal ("now" or a click) were presented at a 0.5-s rate. Then, without loss of beat (i.e., 0.5 s after the onset of the recall signal), there appeared in the middle of the screen a row of dashes, which served as position markers. The number of position markers always equaled the number of digits presented. The subject attempted to type the digits in their order of presentation, using the hyphen key for each forgotten digit. Each typed response appeared in size 12 Monaco font above the corresponding position marker. At any point during recall the subject could press the Delete key to erase the last item typed; responses prior to the most recent could not be changed. No time limits were imposed. The subject clicked an "OK" button upon completion of the trial.

Results

Figure 1 summarizes the results in the form of serial position functions, which plot the probability of a digit having been correctly placed as a function of its position within the list. The functions on the left are for the predictable condition, in which lists had been blocked by length, and those on the right are for the unpredictable condition, in which list length had varied randomly from list to list. The top pair of panels are for the 6-digit lists, the next pair for the 7-digit lists, and so on. Suffix and no-suffix functions are shown separately within each panel.

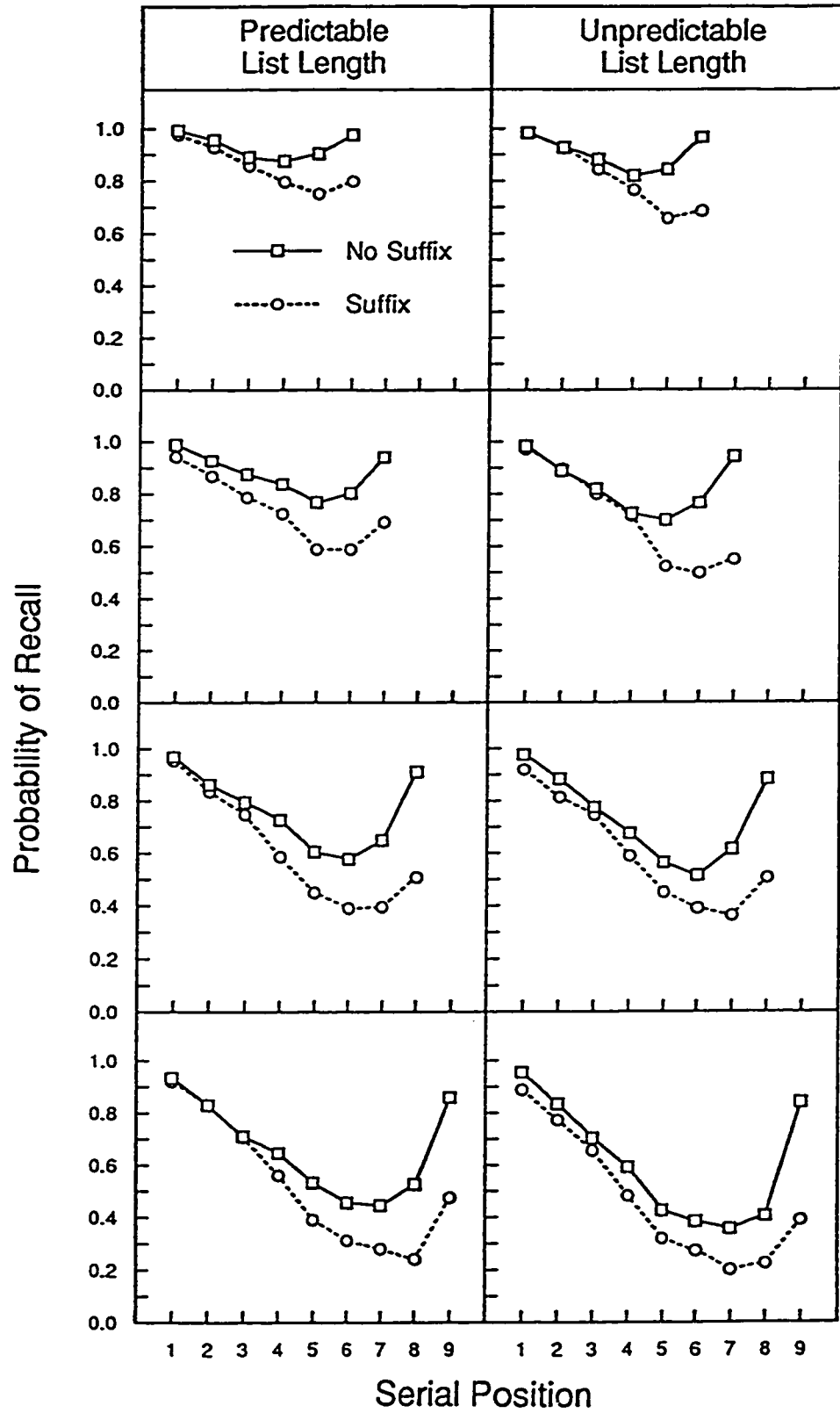


Figure 1. Serial recall as a function of suffix condition, list length, and predictability of list length (Experiment 1).

Following Penney (1985), analyses were confined to the last four positions, of which the three prior to the last were referred to as preterminal positions (or, in the context of analyses of variance, collectively as the preterminal position) and the last as the terminal position. The relevant findings can be stated in six points:¹

1. Mean probability of recall over the last four positions was lower in the unpredictable condition (.599) than in the predictable condition (.651). Almost certainly, this discrepancy did not arise by chance, $F(1, 46) = 21.56$, $MSE = 1.69$, $p = .0000$.

2. The suffix had a clear detrimental effect on performance over the last four positions. Probability of recall was .725 in the no-suffix condition and .526 in the suffix condition. This difference, too, was unlikely to have arisen by chance, $F(1, 46) = 25.69$, $MSE = 21.34$, $p = .0000$.

3. This suffix effect over the last four positions did not differ between the predictable and unpredictable conditions, as shown by the absence of a Predictability x Suffix Condition interaction, $F(1, 46) = 0.0001$, $MSE = 1.69$, $p = .9922$.

4. The suffix effect was not restricted to the terminal position

¹Each point was supported by a finding from one of four analyses of variance: Points 1 - 3 from a Predictability x Suffix Condition x List Length analysis over the last four positions; Point 4 from a Suffix Condition x List Length analysis over just the preterminal positions for the unpredictable condition; Point 5 from a Predictability x Suffix Condition x List Length analysis over just the preterminal positions; and Point 6 from a Predictability x Suffix Condition x Position x List Length analysis in which the preterminal and terminal positions were given equal weight. The analyses took account of the repetition of measures on all but the suffix variable. In no case was list length of particular interest, its inclusion having been merely to set up the informational variable. Other findings from these analyses can be found in the Appendix.

even under conditions of unpredictable list length. Thus, in the unpredictable condition recall of just the preterminal digits was discernibly less likely in the suffix condition (.490) than in the no-suffix condition (.632), $F(1, 46) = 10.82$, $MSE = 12.77$, $p = .0019$.

5. The preterminal suffix effect was of similar magnitude for the predictable (.165) and unpredictable (.142) conditions, as confirmed by a lack of significant Predictability x Suffix Condition interaction for the preterminal data, $F(1, 46) = 0.83$, $MSE = 2.18$, $p = .3658$.

6. Predictability of list length influenced the preterminal and terminal suffix effects to different extents, as indicated by a Predictability x Suffix Condition x Position interaction, $F(1, 46) = 14.49$, $MSE = 1.10$, $p = .0004$. This interaction cannot, however, be attributed to the preterminal suffix effect being susceptible and the terminal suffix effect being immune to predictability of list length, because predictability of list length affected the terminal suffix effect more than it affected the preterminal suffix effect.

In summary, Penney's (1985, Experiment 1) finding that rendering list length unpredictable selectively eliminated the preterminal portion of the suffix effect did not replicate under the conditions of this experiment. With list length indicated at the time of recall, the suffix effect was as pronounced and as extensive when list length was unknown during presentation as when it was known. As is suggested by the effect on average probability of recall over the last four positions, removing knowledge of list length during list presentation may well have influenced study strategy. But any such

influence did not discernibly diminish the suffix effect.

Experiment 2

Under conventional conditions of predictable list length, the results of Experiment 1 replicated those of Penney (1985, Experiment 1). This result was expected and not especially interesting. The important result was that, contrary to Penney's finding, the suffix effect was not discernibly changed when list length was not known during list presentation. The purpose of Experiment 2 was to confirm this finding and to obtain direct evidence on whether it is dependent on the specification of list length at test. It also served as a check that the apparent null effect of list length unpredictability was not a fortuitous result of an actual effect of unpredictability and an offsetting effect of a difference in study strategies induced by the suffix and no-suffix conditions.

To achieve these goals, both number of items per list and suffix condition varied unpredictably from list to list for all subjects. For half of the subjects the length of each list was indicated directly following its presentation and for the other half it was not. To the extent that Penney (1985) was correct in attributing her elimination of the preterminal suffix effect to a suboptimal study strategy and consequent poorer item memory when list length was unpredictable, it should replicate for both groups of subjects. On the other hand, to the extent that Penney was incorrect and elimination of the preterminal suffix effect was attributable to list length being unknown at the time of recall, elimination of the preterminal

suffix effect should occur for only those subjects who remain uninformed of list length during recall.

Method

Subjects. Forty-eight Rice University undergraduates participated in partial fulfillment of a course requirement.

Materials. The stimuli were as in Experiment 1. Thus, for each subject, 24 lists of each of the four lengths were created by randomly sampling without replacement the digits 0 through 9. Twelve of the lists of each length were assigned to the suffix condition, and 12 to the no-suffix condition.

Design. The subjects were randomly assigned to two groups of 24. Those in the informed condition were given the appropriate number of position markers at test. Those in the uninformed condition were given ten position markers at test regardless of list length.

In addition to the between-subjects informational variable, there were two within-subject variables: suffix condition (suffix or no suffix) and list length (6, 7, 8, or 9 items). Successive sets of eight lists included one from each combination of the levels of these two variables. The order of lists (and hence of combinations of suffix and list-length conditions) within each of these sets was separately randomized for each subject, with a fresh randomization for each set.

Procedure. With the exceptions that half of the subjects were always given ten position markers (and so were not informed of list length) at test and that suffix condition was varied within subjects,

the procedure was the same as that for the unpredictable list-length condition of Experiment 1.

Results

Figure 2 shows the suffix and no-suffix serial position functions for each list length. The functions on the left are for the informed group (for whom the number of position markers given at test corresponded to the number of digits in the list), and those on the right are for the uninformed group (for whom the number of position markers given at test was always ten). The pertinent aspects of these functions can be summarized in six points:²

1. The first point concerns the effect that not specifying list length at the time of test had on recall of the recency portion of the list. Mean probability of recall over the last four positions differed between the groups, $F(1, 46) = 4.17$, $MSE = 18.89$, $p = .0468$, being lower for the uninformed group (.562) than for the informed group (.637).

2. The informed group replicated the principal finding of Experiment 1, namely a suffix effect over the preterminal positions,

²These points are based upon selective results from five analyses of variance: Point 1 rests on an Information x Suffix Condition x List Length analysis of recall over the last four positions; Point 2 on a Suffix Condition x List Length analysis of recall over just the preterminal positions of the informed group; Point 3 on an Information x Suffix Condition x List Length analysis of recall for the preterminal positions; Point 4 on a Suffix Condition x List Length analysis of recall over the preterminal positions of the uninformed group; and points 5 and 6 on an Information x Suffix Condition x Position x List Length analysis. These analyses took account of the repetition of measures on all but the information variable. For those analyses that included position as a variable, the mean probability of recall for the preterminal positions was weighted the same as the probability for the terminal position. As in Experiment 1, list length was of no particular interest. Additional findings from each of these analyses are included in the Appendix.

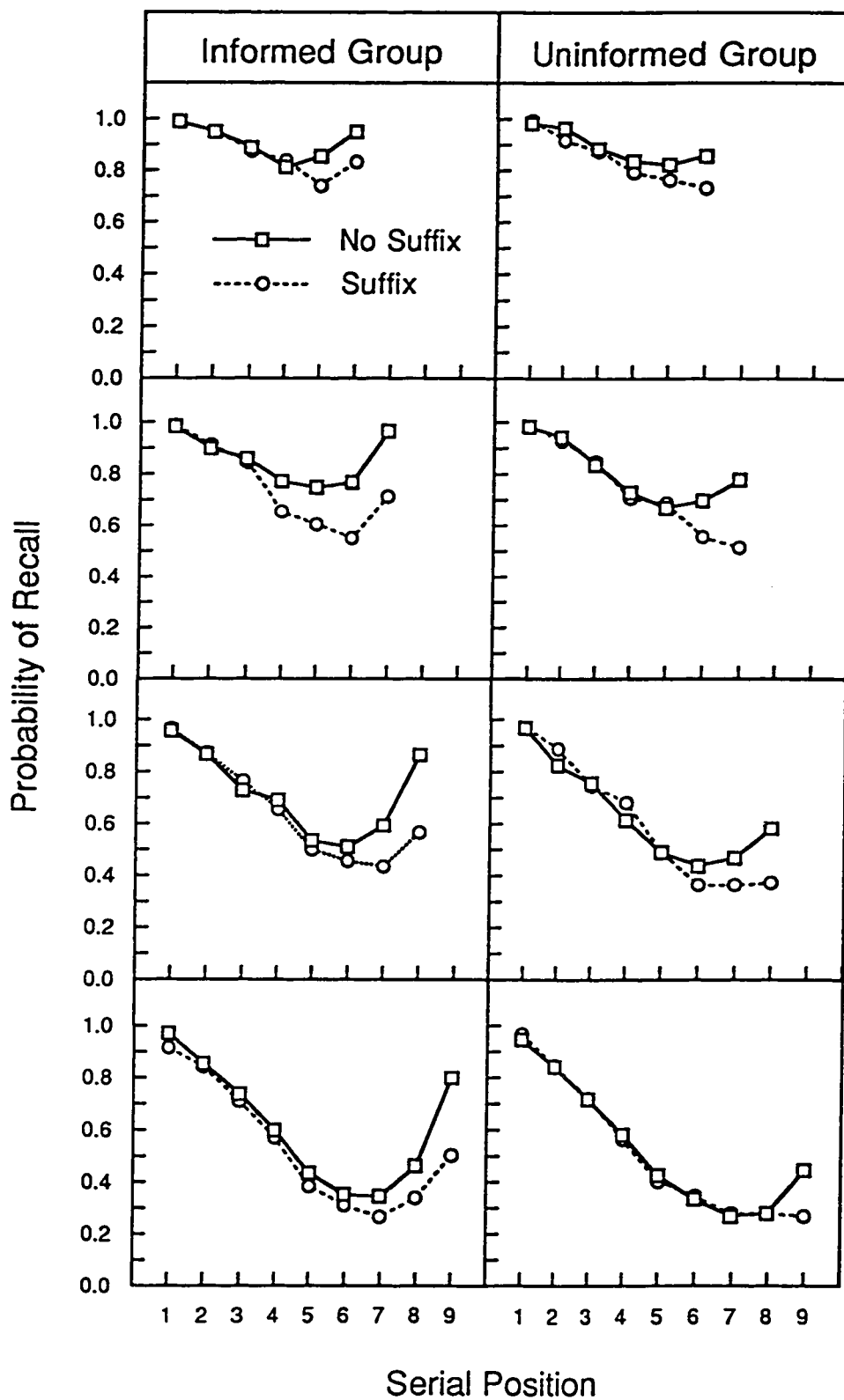


Figure 2. Serial recall as a function of suffix condition, list length, and availability of list-length information at test (Experiment 2).

even though list length was not known during list presentation. Mean level of preterminal recall was .546 in the suffix condition and .636 in the no-suffix condition. This difference almost certainly did not arise by chance, $F(1, 23) = 59.45$, $MSE = 0.942$, $p = .0000$.

3. The preterminal suffix effect was smaller for the uninformed group than for the informed group (.034 versus .090). The difference was manifested in an Information x Suffix Condition interaction in the preterminal data that was unlikely to have arisen by chance, $F(1, 46) = 8.49$, $MSE = 1.26$, $p = .0055$. This interaction is consistent with our conjecture that elimination of the preterminal suffix effect depends, at least in part, upon list length not being specified at test.

4. The preceding point notwithstanding, the uninformed group did show a preterminal suffix effect. Mean level of recall over the preterminal positions was .542 in the suffix condition and .576 in the no-suffix condition, $F(1, 23) = 5.18$, $MSE = 1.58$, $p = .0325$. This finding is at variance with Penney's (1985) data and by the same token attests to the robustness of the preterminal suffix effect.

5. With the data averaged over suffix condition, failure to specify list length at test had a greater effect at the terminal position than at the preterminal positions (.2057 versus .0322). The difference was manifested in an unequivocal Information x Position interaction, $F(1, 46) = 45.24$, $MSE = 4.61$, $p = .0000$.

6. The extent to which failure to specify list length at test reduced the suffix effect was virtually identical for the preterminal

(.056) and terminal (.047) positions. Thus, for the Information x Suffix Condition x Position interaction, $F(1, 46) = 0.0635$, $MSE = 2.09$, $p = .8022$. This finding runs counter to Penney's (1985) conclusion and to two-component theory in general.

These various observations illustrate the danger of confounding knowledge of list length during study with knowledge of list length at test. More specifically they seriously undermine one strand of evidence for the two-component theory of the suffix effect. It should be conceded, however, that the data on which these observations rest should not be considered as a faithful depiction of memory in some absolute sense. Performance as expressed in the serial position functions of Figure 2 reflects the criteria adopted in scoring the responses.

It is a matter of mere convention that responses are credited according to how they are positioned relative to the beginning of the list. When the wrong number of responses are given, a very different pattern of results can arise if the scoring criterion is changed to one in which responses are credited only if correctly positioned relative to, say, the end of the list. For example, the responses in the lower half of Table 1 are scored according to the conventional beginning-justified criterion. A response has been omitted from near the middle of the list with the result that the last three are not credited. With an end-justified criterion, on the other hand, the last three responses correspond to the last three digits presented and so would be credited, whereas the first four responses

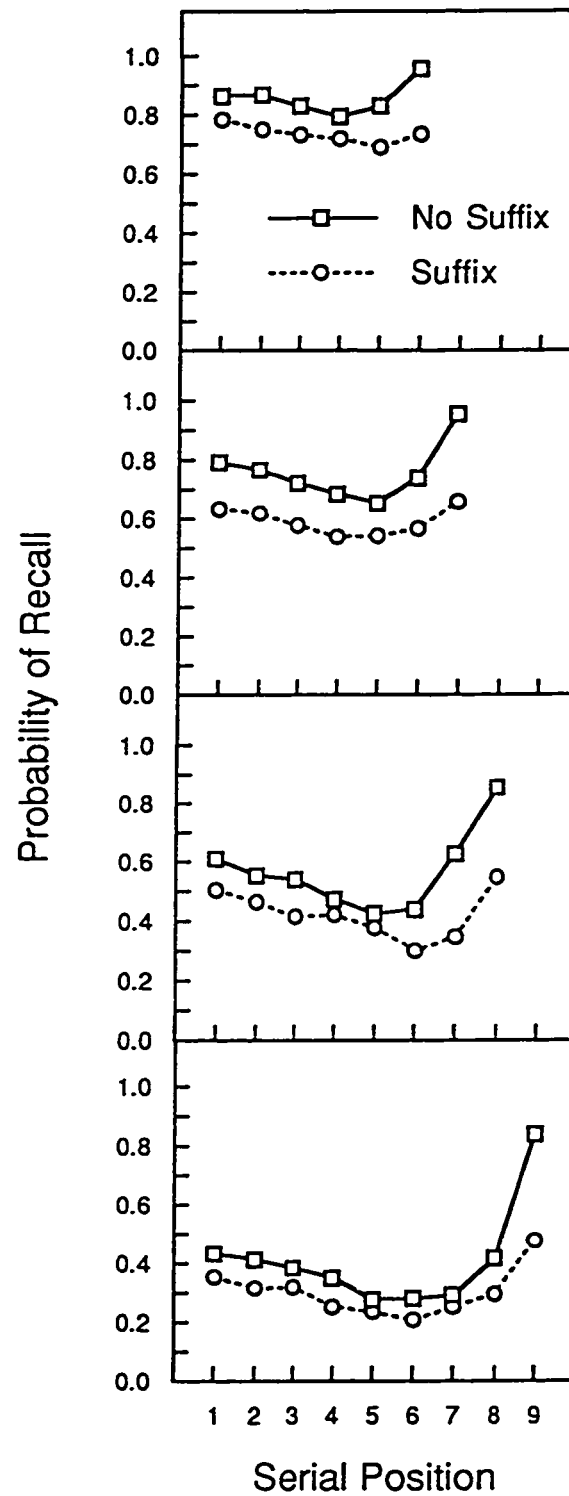


Figure 3. End-justified serial recall as a function of suffix condition and list length for uninformed subjects (Experiment 2).

(in the fifth, sixth, seventh, and eighth positions from the end of the list) all mismatch the digits in corresponding positions of the presentation list and so would not be credited. Subjects in the uninformed condition of the present experiment frequently gave the incorrect number of responses, and the pattern of results obtained with an end-justified criterion is shown in Figure 3. Note in particular that the modest preterminal suffix effect obtained with conventionally scored data is now greatly magnified and spans the entire length of the list. Thus, it is mere scoring convention that keeps the preterminal suffix effect of the uninformed subjects from exploding to dramatic dimensions.

Experiment 3

This experiment was essentially a replication of Experiment 2. The only difference was that no position markers were shown at test in the uninformed condition. This slight modification was made because of the possibility that the mere presence of position markers, even though in numbers unrelated to list length, could one way or the other affect the attention paid to list length and thereby, perhaps, the serial position function.

Method

The method was identical to Experiment 2 except that no position markers were provided in the uninformed condition. A fresh group of forty-eight Rice University undergraduates participated in partial fulfillment of a course requirement.

Results

Figure 4 shows the suffix and no-suffix serial position functions for each list length. The functions on the left are for the informed group, and those on the right are for the uninformed group. As in Experiment 2, the pertinent aspects of these functions can be summarized in six points:²

1. Mean probability of recall over the last four positions differed marginally between the groups, $F(1, 46) = 3.88$, $MSE = 20.34$, $p = .055$. As in Experiment 2, it was lower for the uninformed group (.554) than for the informed group (.629).

2. The informed group replicated the principal finding of Experiments 1 and 2, namely a suffix effect over the preterminal positions, even though list length was not known during list presentation. Mean level of preterminal recall was .556 in the suffix condition and .623 in the no-suffix condition. This difference almost certainly did not arise by chance, $F(1, 23) = 31.46$, $MSE = 0.937$, $p = .0000$.

3. Although the preterminal suffix effect was smaller for the uninformed group than for the informed group, the difference was small (.057 versus .067), and may well have arisen by chance, $F(1, 46) = 0.32$, $MSE = 1.26$, $p = .5753$.

4. Like the informed group, the uninformed group did show a preterminal suffix effect. Mean level of recall over the preterminal positions was .524 in the suffix condition and .581 in the no-suffix condition, $F(1, 23) = 14.04$, $MSE = 1.58$, $p = .001$. This finding is at variance with Penney's (1985) data and by the same token attests

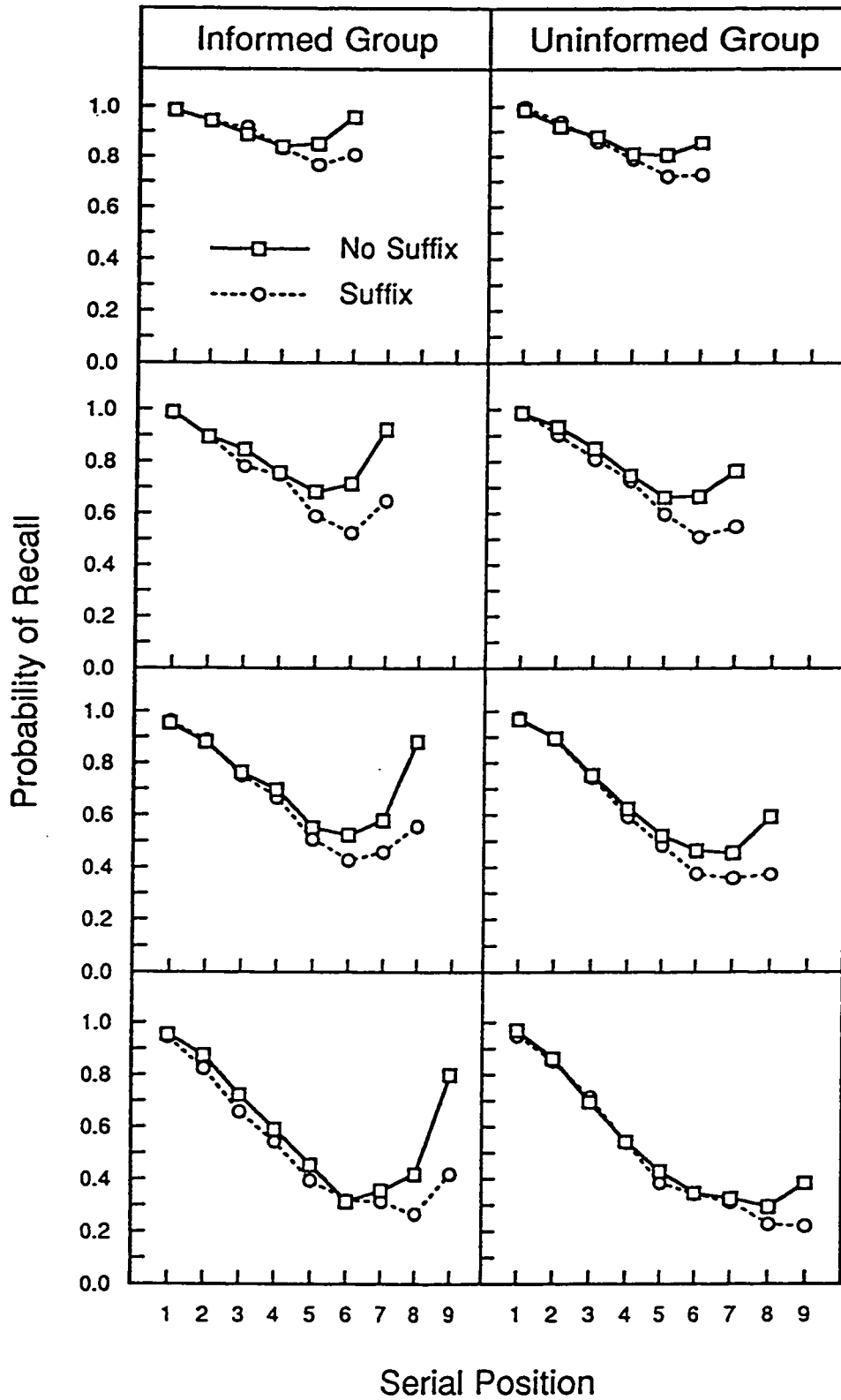


Figure 4. Serial recall as a function of suffix condition, list length, and availability of list-length information at test (Experiment 3).

to the robustness of the preterminal suffix effect.

5. With the data averaged over suffix condition, failure to specify list length at test reduced performance more at the terminal position than at the preterminal position (.1914 versus .0369). The difference was manifested in an unequivocal Information x Position interaction, $F(1, 46) = 52.26$, $MSE = 3.16$, $p = .0000$.

6. Failure to specify list length at test reduced the suffix effect more at the terminal position (.1015) than at the preterminal position (.0108). Thus, for the Information x Suffix Condition x Position interaction, $F(1, 46) = 8.69$, $MSE = 1.64$, $p = .0050$. This finding runs counter to Penney's (1985) conclusion and indeed to two-component theory in general.

Figure 5 replots the data for the uninformed group according to an end-justified criterion. As in Experiment 2, the effect is one of magnifying and extending the suffix effect.

In summary, the findings of principal relevance to two-component theory are consistent with those of Experiment 2. It would appear, then, that the conclusions arrived at in that experiment are robust with respect to how the uninformed condition is operationalized.

General Discussion

Recall of the last few of a just-spoken list of items is typically impaired if a nominally irrelevant "suffix" item is spoken directly after presentation of the list. According to two-component theory, there is a qualitative difference between the effect on the very last

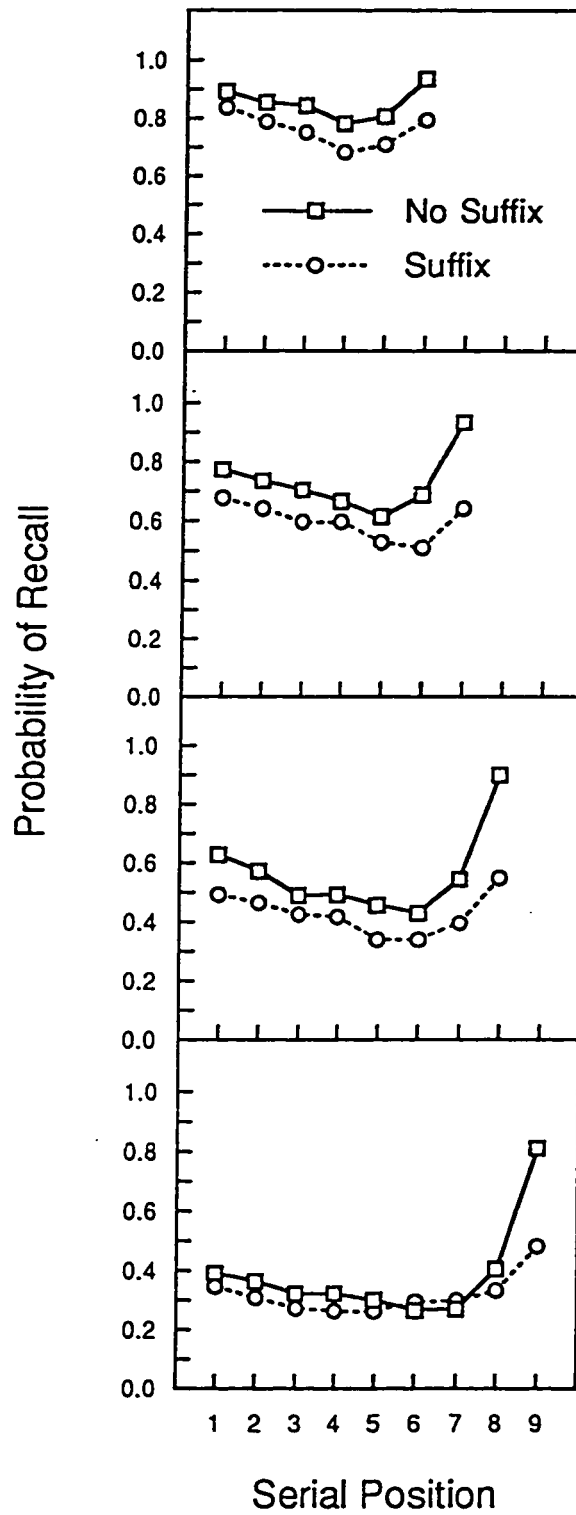


Figure 5. End-justified serial recall as a function of suffix condition and list length for uninformed subjects (Experiment 3).

item (the terminal suffix effect) and the effect on the immediately preceding items (the preterminal suffix effect). The terminal suffix effect is conceptualized as "structural," or fixed by the nature of the "memory system," whereas the preterminal suffix effect is regarded as mutable and susceptible to the rememberer's strategies.

The research reported here was designed to reevaluate one strand of evidence proffered in support of this theory, namely Penney's (1985, Experiment 1) finding that varying list length unpredictably and thereby denying the rememberer the ability to anticipate the end of the list served to abolish the suffix effect at preterminal positions but not at the terminal position. Penney argued that inability to predict the end of the list precluded adoption of the optimal study strategy and as a consequence eliminated the preterminal suffix effect. If Penney (1985) is correct, then her findings should hold up when subjects are informed of list length at the time they attempt recall, for by then study would be complete and hence study strategy could not be tailored to list length. The experiments reported here were designed to test this prediction. Experiment 1 examined the effect of rendering list length unpredictable at the time of study in what was essentially a replication of Penney's procedure, except that list length was indicated following list presentation and prior to recall. Although unpredictability of list length generally reduced recall at both the preterminal and terminal positions, it did not significantly reduce either the preterminal or the terminal portions of the suffix effect.

In Experiments 2 and 3 list length was always unpredictable at study, and half of the subjects were given the appropriate number of position markers at test and half were given either ten position markers regardless of list length (Experiment 2) or none at all (Experiment 3). Consistent with the implication of Experiment 1 that Penney's critical finding may have arisen (at least in part) from her subjects' lack of knowledge of list length at the time of test, the preterminal suffix effect showed at least a tendency to be smaller when list length remained unspecified at test. On the other hand, failing to specify list length at test reduced the terminal suffix effect as much (Experiment 2) or more (Experiment 3) than it reduced the preterminal suffix effect. In short, the findings of none of the experiments were consistent with two-component theory.

The findings reported here could be dismissed as being of little theoretical moment, in that two-component theory is generally regarded as secured by a variety of findings, most having nothing to do with list-length predictability. Satisfactory appraisal of such a charge would necessitate extensive additional research, but scrutiny of existing evidence suggests the need for an open mind.

Other than that of Penney (1985), the three studies most often cited as evidence for two-component theory are those of Baddeley and Hull (1979), Balota and Engle (1981), and Greenberg and Engle (1983). Baddeley and Hull reported that increasing the length of the suffix item (e.g., from "Rhyl" to "Abergavenny") increased the preterminal suffix effect but decreased the terminal suffix effect.

Balota and Engle reported that both presentation rate and practice have a consistent influence on the preterminal suffix effect but not on the terminal suffix effect. And from an investigation of the effects of changing the voice of presentation for the suffix item, Greenberg and Engle concluded that requiring attention to the suffix eliminated the difference between the same-voice and different-voice suffix effects at the preterminal positions but not at the terminal positions.

Thus stated, these studies appear to provide converging evidence for two-component theory. On closer examination, however, the evidence is less compelling. As in Penney's (1985) study, the variables of primary interest in each of these studies were manipulated either between subjects or between blocks of lists within subjects. With such designs, the observed differences in recall in the suffix and no-suffix conditions could be due to differences in the study strategies that subjects adopted in anticipation of suffix condition rather than to different retrograde effects of the suffix. Indeed, the effect of varying even an attribute of the suffix can depend on whether the attribute is predictable, and moreover it can do so to an extent that varies with serial position. For example, Morton, Crowder and Prussin (1971, Experiments 8 & 10) found that knowing that a suffix will come from a direction different from that of the list items differentially influenced the terminal and preterminal suffix effects. Clearly, then, it is possible that the very ability to predict whether list presentation will be followed by a

suffix--or, indeed, whether the suffix will be short rather than long or presented in the same or a different voice from the list items--could of itself influence the suffix effect, and it could do so to an extent that varies with serial position. In short, to ignore the potential effects of suffix predictability is to risk underestimating the reach of rememberer strategy and, more particularly, to risk false confirmation of two-component theory.

Aside from rendering suffix condition predictable, the Baddeley and Hull (1979) and Greenberg and Engle (1983) studies adopted unconventional distinctions between the terminal and preterminal components of the suffix effect. Baddeley and Hull defined the terminal position in terms of the difference between performance at the last position and performance at the immediately preceding position, and they defined the preterminal component in terms of performance across either all list positions (Experiment 2) or all positions except the last (Experiment 1). Greenberg and Engle defined the terminal and preterminal components in terms of performance at the last two positions and at the immediately preceding four positions, respectively. Scrutiny of the data (Figure 1 and Table 6 of Baddeley & Hull and Figure 1 of Greenberg & Engle) suggests that the critical patterns of findings taken as support for two-component theory would not be significant if the terminal and preterminal components were defined in the conventional way.

Even were it less equivocal, much of the evidence on which the case for two-component theory has been made may not be as

strongly supportive of the theory as it might appear. For example, neither Penney (1985) nor, to our knowledge, anyone else has explained why failure to optimize study strategy should diminish rather than enhance the preterminal suffix effect. Of course, like just about any other theory in contemporary psychology, two-component theory can extract nourishment from just about any relevant finding (see Watkins, 1990). Thus, it might be argued that the number of items that can be retained in mind, or primary memory, is inversely related to the depth with which they are processed, and that to maximize recall, a shallow mode of processing is adopted when the end of the list is known to be near. The items immediately preceding the terminal item (the terminal item being protected by its special structural status) would then be especially vulnerable to the presentation of a suffix. On the other hand, when the end of the list is unpredictable, such a strategy shift would be less likely and hence the suffix effect less marked. But no more tortured would be an argument that two-component theory would be supported by just the opposite finding, namely a finding that rendering list length unpredictable increased, rather than decreased, the preterminal suffix effect. Thus, it might be presumed that when the end of the list is known to be imminent, items are processed in a way that tends to protect against the effect of the suffix. If so, the preterminal suffix effect would be enhanced by unpredictability of list length. It would appear, then, that even had they been confirmed under conditions in which list length was specified at the time of recall,

Penney's findings would not be fully accounted for by two-component theory. Similar arguments can be made with respect to Balota and Engle's (1981) findings on the effects of presentation rate and practice and to Greenberg and Engle's (1983) findings on the effect that requiring attention to the suffix has on the relative effects of same-voice and different-voice suffixes.

In the case of Baddeley and Hull's (1979) findings, two-component theory does not tell us why increasing the acoustical length of the suffix should decrease the terminal suffix effect while increasing the preterminal suffix effect as opposed to, say, the other way around. Compared to a short suffix, a long suffix might be more distinctive and hence less interfering with memory for the (short) list items, but why only for the terminal position? More convincing, surely, would be the contrary argument that, unlike the preterminal items, the putatively structure-based retention of the terminal item would be at a precategorical level of analysis (cf. Crowder & Morton, 1969) and hence susceptible to such precategorical properties of the suffix as its acoustical length. In this sense, Baddeley and Hull's findings could be said to be contrary to, rather than supportive of, two-component theory.

Another strand of evidence proffered in support of two-component theory is the effect of varying the delay between the last list item and the suffix. Penney and Godsell (1993) compared the effects of four delays (0.4, 0.6, 0.8, and 1.0 seconds) and concluded that lengthening the delay systematically increased recall at the last

position but not at the two immediately preceding positions.³ They argued that delay of suffix affected the structural component of the suffix effect but not the strategical component. The problem here is that, although this argument follows from the theory, it does not provide convincing support for the theory. Consider again Balota and Engle's (1981) finding that presentation rate affects the preterminal component of the suffix effect. Balota and Engle cast this finding as support for the theory by assuming that the effect of presentation rate is mediated by subject strategy. This assumption is plausible, for varying the amount of time available per item will surely influence the extent to which, and perhaps even the manner in which, the subject thinks about the items. But a skeptic might surely be forgiven for suspecting rash judgment if not sharp practice when confronted with claims of support for one and the same theory from findings that (i) time between the presentations of successive items affects preterminal recall because time affects strategically-based recall (Balota & Engle, 1981), and (ii) time between the last list item and a following suffix affects terminal recall because time affects structurally-based recall (Penney & Godsell, 1993).

Theories are seductive and their advocates are apt not only to see support in ambiguous data but also to overlook contrary data. In the case of two-component theory, a variety of findings would seem

³Penney and Godsell's (1993) data at least hint at an effect at the preterminal position, albeit much weaker than at the terminal position. Using their definition of preterminal positions, recall increased systematically across the four delay conditions in each of their two experiments. The probability of two such trends occurring by chance alone would be 1 in $(4!^2 =) 576$.

more inconsistent than consistent with the theory's core assertion that the terminal suffix effect is a product of memory "structure" and immune to those variables that affect subject strategy. A few examples should make the point. First, mention has already been made of Morton, Crowder, and Prussin's (1971, Experiments 8 & 10) finding that knowing that a suffix will come from an apparent direction different from that of the list items serves to reduce the suffix effect. As it happens, the reduction is most pronounced at, if not restricted to, the terminal position, even though two-component theorists assume that an effect of being able to anticipate some aspect of the procedure is strategy-based (Penney, 1985; see also Morton, Crowder, & Prussin, 1971). Second, the effect of presentation rate has likewise been assumed to be mediated by strategy (Balota & Engle, 1981) and yet in some studies this variable has been found to influence the terminal suffix effect just about as much as the preterminal suffix effect (Engle, 1980; Harris, 1989). Third, the effect of practice has been assumed to be strategy based (Balota & Engle, 1981; Penney, 1985) and yet in some studies it has affected the terminal component of the suffix effect somewhat more than the preterminal component (Watkins & Sechler, 1989). Fourth, the order in which the list items are recalled is plainly a matter of strategy--even if as guileless as following instructions--and yet it does influence the terminal suffix effect. Thus, the terminal suffix effect in particular is reduced if, instead of being recalled in their presentation order, the list items are recalled from last to first

(Manning & Pacifici, 1983) or beginning with the last three (Manning & Turner, 1984) or without regard to presentation order (Roediger & Crowder, 1976). Fifth, research with certain cleverly chosen suffix items has shown that the suffix effect, and its terminal component in particular, is sharply dependent on whether the suffix is perceived as speech or as a nonspeech sound (Ayres, Jonides, Reitman, Egan, & Howard, 1979; Neath, Suprenant, & Crowder, 1993; Ottley, Marcus, & Morton, 1982). This finding, too, would appear contrary to two-component theory in that, if the terminal suffix effect were “structural,” then it should depend on the stimulus as presented rather than the stimulus as perceived.

To these examples may be added findings of Experiments 2 and 3 of the present research, namely that being informed of list length at test in a procedure in which list length is varied unpredictably enhances the terminal suffix effect at least as much as it enhances the preterminal suffix effect. In this connection it might be noted that although Penney (1985; see also Penney & Godsell, 1993) and others (e.g., Greene, 1992; Harris, 1989) have focused on Penney's finding that rendering list length unpredictable eliminated the preterminal suffix effect, it may also have reduced the terminal suffix effect, for her data show the terminal suffix effect to be 27% smaller in the unpredictable condition than in the predictable condition (see Penney's Table 1).

What, then, is to be said of two-component theory? The research reported here undermines one of its key strands of support,

and arguments have been made calling into question the remaining strands. However, the theory is not entirely groundless, for there is indeed something distinctive about the last part of whatever has just been experienced, and especially the last part of whatever has just been heard. This distinctiveness can be characterized in terms of a predominance of stimulus control rather than as the product of a structural component of some hypothetical memory "system," but either way the contrast is with memory that can be willfully controlled. Stimulus control is manifest in the recency effect (Murdock, 1968; Glanzer, 1972), and in the sensitivity of this effect to sensory modality (Conrad & Hull, 1968; Murdock & Walker, 1969). It is also manifest in the suffix effect, for comparison of the effect of the suffix and that of an additional list item (see Crowder, 1967) suggests a more or less complete inability to ignore the suffix.

But to concede that with recency of occurrence stimulus control increases relative to willful or strategic control is a far cry from conceding a sharp dichotomy between a strategy-sensitive preterminal component of memory and a strategy-independent terminal component. On the one hand, stimulus control is not limited to the single most recent item, as is clearly shown by the extension of the recency (e.g., Murdock, 1968), modality (e.g., Conrad & Hull, 1968), and suffix effects (e.g., Crowder, 1972) to preterminal positions. On the other hand, and as we have already seen, the rememberer's perceptions (e.g., Ayres et al. 1979) and strategies (e.g., Morton et al. 1971; Watkins & Sechler, 1989) can, under certain

conditions, affect recall of the most recent item as well as the preceding items. The shift in the balance of strategic and stimulus control would therefore appear to occur gradually over the most recent several items rather than, as two-component theory would have it, suddenly prior to the last item.

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APPENDIX

Reported here are additional findings from the analyses of variance.

Experiment 1

The 2 (predictability) x 2 (suffix) x 4 (list length) analysis in which the dependent variable was mean level of recall over the last four positions revealed: For the main effect of list length, $F(3, 138) = 212.72$, $MSE = 2.16$, $p = .0000$; for the Predictability x List Length interaction, $F(3, 138) = 1.16$, $MSE = 1.10$, $p = .3279$; for the Suffix x List Length interaction, $F(3, 138) = 4.22$, $MSE = 2.16$, $p = .0069$; and for the Predictability x Suffix x List Length interaction, $F(3, 138) = 0.73$, $MSE = 1.10$, $p = .5372$.

The 2 (suffix) x 4 (list length) analysis for just the unpredictable condition in which the dependent variable was mean level of recall over the preterminal positions revealed: For the main effect of list length, $F(3, 138) = 194.35$, $MSE = 1.62$, $p = .0000$; and for the Suffix x List Length interaction, $F(3, 138) = 1.11$, $MSE = 1.62$, $p = .3468$.

The 2 (predictability) x 2 (suffix) x 4 (list length) analysis in which the dependent variable was mean level of recall over the preterminal positions revealed: For the main effect of predictability, $F(1, 46) = 16.32$, $MSE = 2.18$, $p = .0002$; for the main effect of suffix, $F(1, 46) = 12.68$, $MSE = 25.49$, $p = .0009$; for the main effect of list length, $F(3, 138) = 239.94$, $MSE = 2.57$, $p = .0000$; for the Predictability x List Length interaction, $F(3, 138) = 0.84$, $MSE = 1.35$, $p = .4767$; for the Suffix Condition x List Length interaction, $F(3, 138)$

= 2.37, MSE = 2.57, p = .0732; and for the Predictability x Suffix Condition x List Length interaction, $F(3, 138) = 0.28$, MSE = 1.35, p = .8396.

The 2 (predictability) x 2 (suffix) x 2 (position) x 4 (list length) analysis revealed: For the main effect of predictability, $F(1, 46) = 24.11$, MSE = 2.93, p = .0000; for the main effect of suffix condition, $F(1, 46) = 44.89$, MSE = 37.45, p = .0000; for the main effect of position, $F(1, 46) = 107.99$, MSE = 6.36, p = .0000; for the main effect of list length, $F(3, 138) = 153.49$, MSE = 4.20, p = .0000; for the Predictability x Suffix Condition interaction, $F(1, 46) = 1.47$, MSE = 2.93, p = .2314; for the Predictability x Position interaction, $F(1, 46) = 0.00$, MSE = 1.10, p = .9729; for the Predictability x List Length interaction, $F(3, 138) = 1.20$, MSE = 2.27, p = .3126; for the Suffix Condition x Position interaction, $F(1, 46) = 38.15$, MSE = 6.36, p = .0000; for the Suffix Condition x List Length interaction, $F(3, 138) = 6.46$, MSE = 4.20, p = .0004; for the Position x List Length interaction, $F(3, 138) = 62.34$, MSE = 1.52, p = .0000; for the Predictability x Suffix Condition x List Length interaction, $F(3, 138) = 1.35$, MSE = 2.27, p = .2599; for the Predictability x Position x List Length interaction, $F(3, 138) = 0.42$, MSE = 1.10, p = .7364; for the Suffix Condition x Position x List Length interaction, $F(3, 138) = 2.55$, MSE = 1.52, p = .0586; and for the Predictability x Suffix Condition x Position x List Length interaction, $F(3, 138) = 1.54$, MSE = 1.10, p = .2070.

Experiment 2

The 2 (information) x 2 (suffix) x 4 (list length) analysis in which the dependent variable was mean level of recall over the last four positions revealed: For the main effect of suffix condition, $F(1, 46) = 107.26$, $MSE = 1.32$, $p = .0000$; for the main effect of list length, $F(3, 138) = 465.45$, $MSE = 1.27$, $p = .0000$; for the Information x Suffix Condition interaction, $F(1, 46) = 7.47$, $MSE = 1.32$, $p = .0089$; for the Information x List Length interaction, $F(3, 138) = 4.66$, $MSE = 1.27$, $p = .0039$; for the Suffix x List Length interaction, $F(3, 138) = 5.33$, $MSE = 0.88$, $p = .0017$; and for the Information x Suffix x List Length interaction, $F(3, 138) = 1.20$, $MSE = 0.88$, $p = .1173$.

The 2 (suffix) x 4 (list length) analysis for just the informed group in which the dependent variable was mean level of recall over the preterminal positions revealed: For the main effect of list length, $F(3, 69) = 201.81$, $MSE = 1.55$, $p = .0000$; and for the Suffix x List Length interaction, $F(3, 69) = 4.30$, $MSE = 1.07$, $p = .0077$.

The 2 (information) x 2 (suffix) x 4 (list length) analysis in which the dependent variable was mean level of recall over the preterminal positions revealed: For the main effect of information, $F(1, 46) = 0.67$, $MSE = 21.22$, $p = .4170$; for the main effect of suffix, $F(1, 46) = 42.44$, $MSE = 1.26$, $p = .0000$; for the main effect of list length, $F(3, 138) = 472.96$, $MSE = 1.48$, $p = .0000$; for the Information x List Length interaction, $F(3, 138) = 2.26$, $MSE = 1.48$, $p = .0837$; for the Suffix Condition x List Length interaction, $F(3, 138) = 3.17$, $MSE = 1.13$, $p = .0263$; and for the Information x Suffix Condition x List Length interaction, $F(3, 138) = 2.20$, $MSE = 1.13$, $p = .0909$.

The 2 (suffix) x 4 (list length) analysis for just the uninformed group in which the dependent variable was mean level of recall over the preterminal positions revealed: For the main effect of list length, $F(3, 69) = 276.72$, $MSE = 1.42$, $p = .0000$; and for the Suffix x List Length interaction, $F(3, 69) = 1.22$, $MSE = 1.18$, $p = .3102$.

The 2 (information) x 2 (suffix) x 2 (position) x 4 (list length) analysis revealed: For the main effect of information, $F(1, 46) = 11.04$, $MSE = 35.41$, $p = .0018$; for the main effect of suffix condition, $F(1, 46) = 142.87$, $MSE = 3.80$, $p = .0000$; for the main effect of position, $F(1, 46) = 55.55$, $MSE = 4.61$, $p = .0000$; for the main effect of list length, $F(3, 138) = 345.70$, $MSE = 2.83$, $p = .0000$; for the Information x Suffix Condition interaction, $F(1, 46) = 4.78$, $MSE = 3.80$, $p = .0338$; for the Information x List Length interaction, $F(3, 138) = 7.22$, $MSE = 2.83$, $p = .0002$; for the Suffix Condition x Position interaction, $F(1, 46) = 80.25$, $MSE = 2.09$, $p = .0000$; for the Suffix Condition x List Length interaction, $F(3, 138) = 7.21$, $MSE = 1.91$, $p = .0002$; for the Position x List Length interaction, $F(3, 138) = 26.41$, $MSE = 1.45$, $p = .0000$; for the Information x Suffix Condition x List Length interaction, $F(3, 138) = 1.79$, $MSE = 1.91$, $p = .1511$; for the Information x Position x List Length interaction, $F(3, 138) = 4.87$, $MSE = 1.45$, $p = .0030$; for the Suffix Condition x Position x List Length interaction, $F(3, 138) = 3.39$, $MSE = 1.30$, $p = .0198$; and for the Information x Suffix Condition x Position x List Length interaction, $F(3, 138) = 2.11$, $MSE = 1.30$, $p = .1015$.

Experiment 3

The 2 (information) x 2 (suffix) x 4 (list length) analysis in which the dependent variable was mean level of recall over the last four positions revealed: For the main effect of suffix condition, $F(1, 46) = 156.20$, $MSE = 0.97$, $p = .0000$; for the main effect of list length, $F(3, 138) = 426.06$, $MSE = 1.40$, $p = .0000$; for the Information x Suffix Condition interaction, $F(1, 46) = 3.97$, $MSE = 0.97$, $p = .0523$; for the Information x List Length interaction, $F(3, 138) = 2.29$, $MSE = 1.40$, $p = .0812$; for the Suffix x List Length interaction, $F(3, 138) = 4.12$, $MSE = 0.91$, $p = .008$; and for the Information x Suffix x List Length interaction, $F(3, 138) = 1.35$, $MSE = 0.91$, $p = .26$.

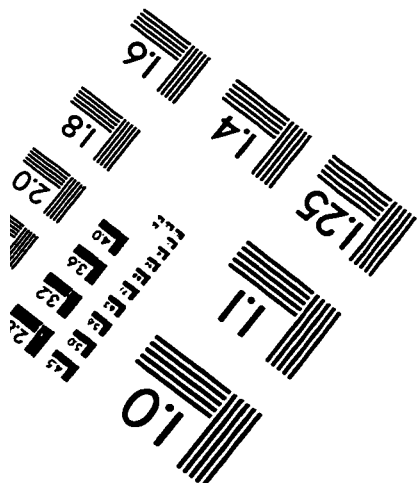
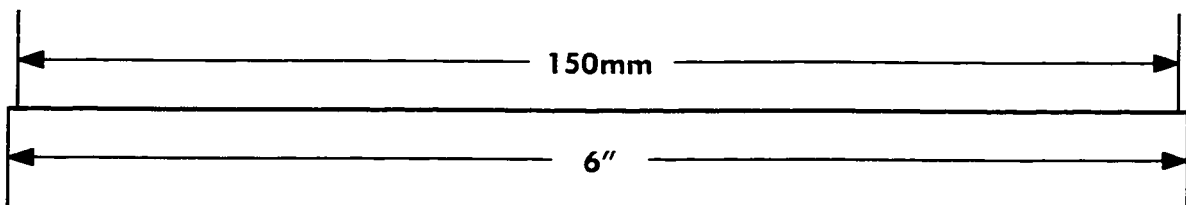
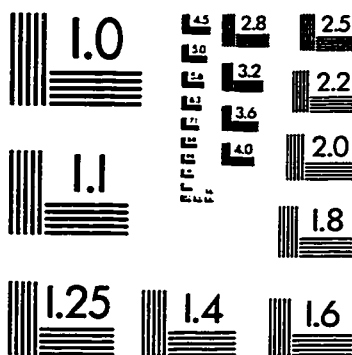
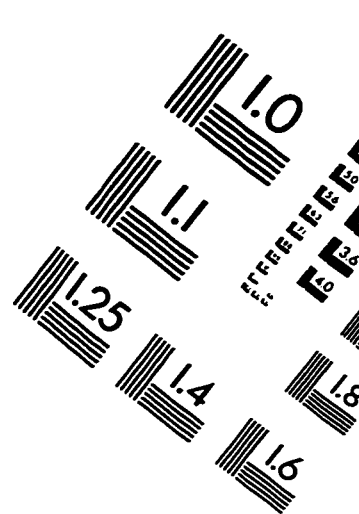
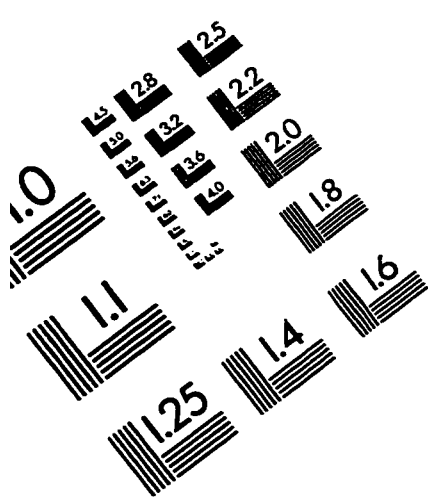
The 2 (suffix) x 4 (list length) analysis for just the informed group in which the dependent variable was mean level of recall over the preterminal positions revealed: For the main effect of list length, $F(3, 69) = 253.22$, $MSE = 1.35$, $p = .0000$; and for the Suffix x List Length interaction, $F(3, 69) = 1.77$, $MSE = 1.13$, $p = .16$.

The 2 (information) x 2 (suffix) x 4 (list length) analysis in which the dependent variable was mean level of recall over the preterminal positions revealed: For the main effect of information, $F(1, 46) = 0.89$, $MSE = 21.05$, $p = .3496$; for the main effect of suffix, $F(1, 46) = 42.29$, $MSE = 1.26$, $p = .0000$; for the main effect of list length, $F(3, 138) = 451.04$, $MSE = 1.52$, $p = .0000$; for the Information x List Length interaction, $F(3, 138) = 1.02$, $MSE = 1.52$, $p = .3880$; for the Suffix Condition x List Length interaction, $F(3, 138) = 2.44$, $MSE = 1.08$, $p = .0672$; and for the Information x Suffix Condition x List Length interaction, $F(3, 138) = 0.46$, $MSE = 1.08$, $p = .7119$.

The 2 (suffix) x 4 (list length) analysis for just the uninformed group in which the dependent variable was mean level of recall over the preterminal positions revealed: For the main effect of list length, $F(3, 69) = 204.18$, $\underline{MSE} = 1.68$, $p = .0000$; and for the Suffix x List Length interaction, $F(3, 69) = 1.09$, $\underline{MSE} = 1.04$, $p = .3587$.

The 2 (information) x 2 (suffix) x 2 (position) x 4 (list length) analysis revealed: For the main effect of information, $F(1, 46) = 8.82$, $\underline{MSE} = 40.85$, $p = .0047$; for the main effect of suffix condition, $F(1, 46) = 274.73$, $\underline{MSE} = 2.19$, $p = .0000$; for the main effect of position, $F(1, 46) = 59.12$, $\underline{MSE} = 3.16$, $p = .0000$; for the main effect of list length, $F(3, 138) = 323.51$, $\underline{MSE} = 3.18$, $p = .0000$; for the Information x Suffix Condition interaction, $F(1, 46) = 9.95$, $\underline{MSE} = 2.19$, $p = .0028$; for the Information x List Length interaction, $F(3, 138) = 5.71$, $\underline{MSE} = 3.18$, $p = .0010$; for the Suffix Condition x Position interaction, $F(1, 46) = 123.31$, $\underline{MSE} = 1.64$, $p = .0000$; for the Suffix Condition x List Length interaction, $F(3, 138) = 5.98$, $\underline{MSE} = 2.00$, $p = .0007$; for the Position x List Length interaction, $F(3, 138) = 20.54$, $\underline{MSE} = 1.24$, $p = .0000$; for the Information x Suffix Condition x List Length interaction, $F(3, 138) = 2.43$, $\underline{MSE} = 2.00$, $p = .0683$; for the Information x Position x List Length interaction, $F(3, 138) = 13.59$, $\underline{MSE} = 1.24$, $p = .0000$; for the Suffix Condition x Position x List Length interaction, $F(3, 138) = 4.27$, $\underline{MSE} = 1.04$, $p = .0064$; and for the Information x Suffix Condition x Position x List Length interaction, $F(3, 138) = 1.77$, $\underline{MSE} = 1.04$, $p = .1552$.

IMAGE EVALUATION TEST TARGET (QA-3)



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