THE MASSED PRACTICE-DISTRIBUTED PRACTICE EFFECT: FURTHER TESTS OF THE INATTENTION HYPOTHESIS

by

Steven Kenneth Wenger

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Approved by:

Charles P. Thompson
Major Professor

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INTRODUCTION

A fundamental problem in the study of verbal learning is to specify the way in which repetition affects retention. A particular factor which has received much attention over the years has been the amount of temporal spacing that intervenes between the two presentations of a repeated event. Generally speaking, if two presentations of an event occur in close succession (Massed Practice or MP), later retention of the event is poorer than it is if the two presentations are spaced further apart (Distributed Practice or DP). This facilitative effect of distributed practice goes back to some of the very first memory experiments. Ebbinghaus (1885) found that when lists were learned on successive days, as opposed to concentrating a greater number of trials into one sitting, the number of trials to criterion was reduced. On the basis of Ebbinghaus' work and his own, Jost in 1897 formulated what has since become known as Jost's Laws: (1) "Given two associations of the same strength, but of different ages, the older one has greater value on a new repetition." (2) "Given two associations of the same strength, but of different ages, the older falls off less rapidly in a given length of time" (cited in Stevens, 1951, p. 649).

More than 50 years later, Underwood (1961) set out to systematically examine the effects of DP, as compared with MP, in the context of serial and paired-associate learning. This was a major effort involving more than twenty studies (sometimes referred to as the Northwestern studies) over a ten year period. The basic procedure used in all of the studies is as follows. A trial was defined as the single presentation of all the items in a list of verbal events. The critical variable was the length of the interval between trials. If the intertrial interval was short (between 2 and 8 seconds), learning was said to have occurred under MP. If the intertrial interval was longer (15 seconds or more), learning was said to occur under DP.

The results of the Northwestern studies indicated that consistent effects of DP were difficult to obtain, except when large amounts of response integration (typically found with low meaningfulness CCCs as response terms) or large amounts of proactive inhibition were involved in the new learning. This effort proved relatively disappointing for Underwood (1961) and he concluded that "facilitation by distributed practice in verbal learning occurs only under a highly specific set of conditions, and the magnitude of the effect when it does occur is relatively small" (p. 230).

Within the last fifteen years, there has been a shift in focus from the acquisition of multi-item lists to the learning of individual items within a list. In contrast to the small and marginally reliable DP effects reported by Underwood (1961), the effect of DP on retention of repeated verbal events within a single trial is large and occurs under an amazingly large number of conditions. In a typical single trial procedure, the subject is presented a list of to-be-remembered (TBR) items, one at a time, and later a long-term retention test is given. Within the list, some of the TBR items are presented two or more times and the presentation schedule may be MP or DP. Under MP, the successive occurrences of an item occupy adjacent positions in the list. Under DP, one or more items fall between the successive occurrences. Thus, if P_1 and P_2 represent the first and second presentations of an item, respectively, an example of an MP schedule would be: C, A, P_1, P_2, D, F, G, etc. For DP, an example schedule would be A, P_1, D, C, P_2, F, G, etc. Performance on the long-term retention test is a function of the type of presentation schedule, with the probability of recall for DP items greater than the probability of recall for MP items. This phenomenon has been variously referred to as the "MP-DP effect" or "spacing effect."

The generality of the MP-DP effect is truly remarkable as it has been found in continuous paired associate learning (e.g., Peterson, Wampler, Kirkpatrick, and Saltzman, 1963), in anticipatory paired associate learning (e.g., Greeno, 1964), in recognition memory (e.g., Underwood, 1969; Winograd and Raines, 1972; Kintsch, 1966; Davis, Lockhart, and Thomson, 1972), in free recall (e.g., Melton, 1967), in the distractor paradigm (e.g., Peterson, 1963), in verbal discrimination learning (e.g., Ciccone, 1973), for nonsense syllables (e.g., Kintsch, 1966; Tzeng, 1973), words (e.g., Melton, 1967), sentences (e.g., Underwood, 1970; Paivio, 1974), in both mixed and unmixed lists (e.g., Underwood, 1970), whether presentation is auditory or visual (Melton, 1970) or modalities are mixed in the same list (Hintzman, Block, and Summers, 1973), over a wide range of presentation rates (Melton, 1970), and whether subjects are children or college students (Shanunessey, Zimmerman, and Underwood, 1972). Dependent variables have included judged frequency (Hintzman, 1969b; Underwood, 1969), and recognition latency (Hintzman, 1969a) in addition to probability of recall and recognition. Further, the MP-DP effect has been found when the subject controls the degree of spacing between two presentations of the same item (Ciccone and Brelsford, 1976).

A phenomenon which is related to the MP-DP effect, but has been reported with less reliability, is the "lag effect" (sometimes referred to as the "Melton lag effect" in deference to its discoverer). A number of experiments have found the probability of recall to be a direct function of the number of intervening items (lag) between the first occurrence of a distributed item and its subsequent repetition (e.g., Melton, 1967; D'Agostino and DeRemer, 1973). The distinction between the "MP-DP effect" and "lag effect" is often confused, but most authors agree that the MP-DP effect contrasts spacings of zero intervening items (MP) with all spacings greater than zero (DP), while the lag effect compares different spacings of one or more intervening items (Hintzman, 1974). In other words, the lag effect is a phenomenon associated with distributed practice and refers to the increase in recall performance as a function of the lag between the first and second occurrence of a DP item. A number of researchers (e.g., D'Agostino and DeRemer, 1972; Hintzman, 1974) have argued that although the MP-DP effect is obtained in both free and cued recall, the generality of the lag effect (particularly long lag effects like those obtained by Melton (1967) is less clear. In a study by Peterson, Wampler, Kirkpatrick, and Saltzman (1963) and Young (1966), they found an optimum lag in continuous paired-associate learning of 7-8 intervening items when retention is measured 8-10 items after the second presentation, with a decrease in performance for longer lags. This inverted-U function in continuous paired-associate learning is contradictory to the Melton lag effect found in free recall and has compelled Hintzman (1974) to conclude that the lag effect is peculiar to free recall.

A recent study by Glenberg (1974) has helped to clarify the lag effect problem in continuous paired-associate learning by showing that the inflection point on lag functions is dependent upon the retention interval between the second presentation of the item and the time of test. Subjects were presented critical items separated by lags of 0, 1, 4, 8, 20, or 40 intervening items, with retention intervals of 2, 8, 32, or 64 items separating the second occurrence from the test. When the retention interval was short (2 or 8 items), an inverted-U lag function similar to those obtained by Peterson et. al. (1963) and Young (1966) was obtained. But with the longer retention intervals (32 or 64 items), the probability of recall showed a steady increase with increasing lags, just as Melton (1967) obtained for free recall.

THEORETICAL ALTERNATIVES

As can be seen from the previous discussion, the MP-DP effect occurs under an amazingly large number of conditions. In spite of its generality, and profound theoretical importance for learning and memory, no adequate explanation of the phenomenon has emerged. However, a number of explanations have been offered concerning the hypothetical mechanisms underlying the MP-DP effect. These hypotheses may be divided into two conceptual categories: (1) Those which attribute the MP-DP effect to negative factors associated with the massing of repetitions; (2) Those which attribute the MP-DP effect to positive factors associated with the distribution of repetitions (D'Agostino and DeRemer, 1974). The five major theoretical views which will be discussed in this section are categorized below according to their attribution of the locus of the effect.

I. Theories proposing facilitative factors associated with the distribution of repetitions.
   a. Varied context hypothesis
   b. Varied encoding hypothesis

II. Theories proposing inhibitory factors associated with the massing of repetitions.
   a. Consolidation hypothesis
   b. Rehearsal hypothesis
   c. Inattention hypothesis

An explanation of the MP-DP and lag effects which has been proposed by several investigators (e.g., Melton, 1967, 1970 ; Madigan, 1969) is based on the notion of differential encoding. The basic assumption is that there are a number of different ways in which a TBR item can be encoded, and the greater the number of different encodings given an item during the study phase, the greater the number of different ways in which it might be retrieved on the retention test (Hintzman, 1974). Unlike the hypotheses to be discussed in the later sections, the MP-DP effect is conceived to be a result of fundamental characteristics of man's processing of information into memory and retrieval of information from memory, rather than resulting from failure to control consolidation, attention, or rehearsal strategies (Melton, 1970). Within the notion of differential encoding, there are two separable hypotheses depending on the **definition** of differential encoding (Maskarinec and Thompson, 1976). These two hypotheses have been typically referred to as the varied context hypothesis and the varied encoding hypothesis. Although both hypotheses assume that distributed repetition allows changes to occur in the coding process, the varied context hypothesis emphasizes the effects of encoding an item in more than one context, while the varied encoding hypothesis emphasizes the effects of sampling of different dimensions of an item on its different occurrences. The two hypotheses will be discussed separately.

Varied Context Hypothesis

The varied context hypothesis as proposed by Melton (1967, 1970) states that the probability that a repeated item will be recalled is a function of whether the contexts in which the item occurred on its two presentations were the same or different. If they were different, the probability of recall should be greater than if they were the same. Furthermore, the chance that the contexts would be different is assumed to be an increasing function of the lag between the two occurrences of an item. The basic assumption is that the role of the context is that of providing a specific retrieval route for an item, and the more routes there are, the greater the likelihood that at least one will be effective in eliciting the item. Another possible interpretation is based on the widely observed finding that free recall learning involves subjective organization of word combinations and that these subjective units of two or more words serve as cuing systems at the time of recall (Tulving, 1968, 1974). Thus, the varied context resulting from distributed repetitions may permit the same item to be included within two different subjective encoding units. At the time of recall, the retrieval of either one or both of the units would result in recall of the item.

A study by Maskarinec and Thompson (1976, Experiment I) attempted to test the implications of the varied context hypothesis by experimentally controlling the list context rather than letting it vary haphazardly in terms of whatever items happened to be presented. Subjects were presented with a list of words, some of which were repeated at different lags. In the Different Context condition, the repeated items were preceded and followed by filler words which changed on each presentation. In the Same Context condition, the repeated words were preceded and followed by the same filler words on each presentation. The varied context hypothesis would predict that the items in the Different Context condition should be recalled better than the items in the Same Context condition since varying the context should increase the number of cues for retrieving the item. The results failed to support this prediction as there was no reliable difference in the recall performance between the Different Context and Same Context conditions. Thus, the results of this experiment suggests that list context may not be an important factor in the MP-DP effect.

Varied Encoding Hypothesis

The varied encoding hypothesis was first proposed by Melton (1970) and is an extention of Martin's (1968) stimulus encoding variability theory. Unlike the varied context hypothesis, the unit of analysis is the individual word rather than associations formed between list items. The critical feature of Martin's theory stems from the distinction between nominal and functional stimuli (Underwood, 1963), that is, between the stimuli as defined by the experimenter and those aspects of the experience the subject actually uses in learning the event. The basic assumption of the varied encoding hypothesis is that the same event may be coded along different attributes, on different occurrences of the event, that range from structural features (e.g., phonemes and syllables) to those features which eventuate in the meaning of the event (e.g., syntactic and semantic attributes). It is further assumed that encoding variability increases as a function of the time between the two occurrences of the nominal stimuli (Martin, 1968). Finally, an implicit assumption is that the probability of recall increases as a function of the number of attributes encoded for an event. The implication for the MP-DP is that the variability of the attributes used to code the DP items is greater than that of the MP items.

A number of studies have attempted to test the implications of the varied encoding hypothesis by presenting semantically ambiguous TBR items in the context of a specific cue word intended to bias the interpretation of the TBR item. The critical feature of this design was the provision of different cue words for repeated TBR items in some conditions. The underlying objective was to see if one could make the lag effect disappear by producing differences in the coding of repetitions regardless of lag. In a study by Madigan (1969), subjects were presented a list of pairs of words, with some of the pairs presented twice at different lags. Each pair consisted of a cue word and a TBR word. In one condition, the identical cue word was repeated with the TBR word on each of its two occurrences. In the other condition, the TBR word was presented with a different cue word on each of its two occurrences. For example, the TBR word "chill" might occur twice in the list, separated by a lag of 4 intervening items. In the Different condition, "chill" would be accompanied by the cue word "fever" on its first occurrence and the cue word "snow" on its second occurrence. In the Same condition, the cue word on both occurrences would be "fever." The results showed that providing different cue words improved recall performance of twice-presented items over the condition in which the same cue word was used each time, and this improvement was located primarily at the shorter lags. Madigan (1969) concluded that if we force subjects to use two different encodings, even at short lags or adjacent repetitions, we can simulate the advantage of the long-lag condition. Similar findings in experiments using similar manipulations have also been reported by Thios (1972), Gartman and Johnson (1972), D'Agostino and DeRemer (1973) and Johnston, Coots, and Flickinger (1972).

There are a number of problems that arise from these experiments in evaluating the varied encoding hypothesis. Hintzman (1974) has objected to a theory of variable encoding that depends on how a semantically ambiguous word is interpreted and argues that two different encodings of the same orthographic pattern should no more demonstrate a spacing effect than the presentation of two different words. He further observes that a homograph ought to be most variably encoded when the two occurrences lead to totally independent semantic interpretations such that the subject does not recognize the item as having been repeated on its second occurrence.

Contrary to this prediction, Madigan (1969) has reported that not only can subjects recognize repeated words over long lags, but only words judged as having been repeated show the lag effect. This would indicate that the twice-presented words are given essentially the same meaning on their two occurrences.

Maskarinec and Thompson (1976) have also pointed out that these studies have failed to provide a test of the varied encoding hypothesis which is independent of context effects. That is, they have addressed themselves to the combined effects of varied encoding and varied context. To provide a separate test of the variable encoding hypothesis, Maskarinec and Thompson (1976, Experiment II) attempted to eliminate any contribution of context while simultaneously assessing the effect of varied encoding. They varied the nature of an orienting task in an incidental learning paradigm in an attempt to manipulate the encoding of MP and DP items. It was assumed that the incidental learning task would greatly reduce any context effects and idiosyncratic methods of coding words for later recall. The orienting task was designed to require subjects to attend to physical, syntactic, or semantic attributes of the critical item. In the Varied Encoding condition, the subject was required to attend to all three different attributes of the critical item over its three repetitions. In the Same Encoding condition, the subject was required to attend to the same attribute of a critical item on each of its three presentations. The varied encoding hypothesis would predict that if both MP and DP items receive comparable variation in encoding (i.e., MP and DP items coded along three different attributes or coded along the same attribute), recall performance for MP and DP items should be comparable and the MP-DP effect should be eliminated. Contrary to this prediction, a large and highly reliable

MP-DP effect was obtained in both conditions. Thus, the results of this experiment suggest that varied encoding, as defined by variation in orienting tasks, may not play a major role in the MP-DP effect.

Consolidation Hypothesis

The fundamental hypothesis of consolidation theory is that learning is not really complete at the time an event is perceptually experienced. Rather, there is some period of time during which the consequences of learning perseverate. During this period of perservation, the memory trace becomes more securely fixed, or consolidated, resulting in better performance than would be possible without this activity. Consolidation theory as it applies to the MP-DP effect in verbal learning, was first proposed by Landauer (1969), and is an extention of Hebb's (1949) dual-trace hypothesis. According to the dual-trace hypothesis, perceptual experience is first recorded in the form of reverberating organized patterns of neurons which, if allowed to be active long enough, lead to the formation of structural changes in the nervous system that carry more permanent memory. It is further assumed that different occurrences of the same event are handled by the same consolidation mechanism. Thus, whenever the second presentation of an event occurs before consolidation of the first presentation is complete, the consolidation processes is reset as if the first presentation had never occurred. The implication for the MP-DP effect is that massed repetitions produce less total consolidation activity, and therefore a weaker long-term memory trace, than do distributed repetitions.

A study by Bjork and Allen (1970) attempted to test the theoretical implications of consolidation theory with respect to the MP-DP effect. Subjects were twice presented a three word unit (e.g., ARCH - NEWS - BAND) several seconds apart, and then later tested. The second presentation and test were separated by a moderately difficult distractor task. The independent variable was the relative difficulty of an interpolated task that intervened between the first and second presentation of the word triplet. In one condition, the interpolated task was easy and in the other condition the task was hard. The consolidation hypothesis would predict better test performance in the condition in which the interpolated task is easy than in the condition in which the task is hard. That is, the easy interpolated task should permit more consolidation, and therefore a stronger long-term memory trace, than should the hard interpolated task. Contrary to this prediction, performance was better when the interpolated task was hard than when it was easy. Similar studies by Robbins and Wise (1973) and Tzeng (1973) have also produced results inconsistent with the consolidation theory and have concluded in favor of an alternative explanation.

The consolidation hypothesis has not been widely investigated as an explanation of the MP-DP effect primarily because most researchers have tended toward an information processing approach to the problem. Melton (1970) has argued that the formulation of interpretations in terms of the information processing activities of the subject are more likely to expose the psychological factors underlying the MP-DP effect. In summary, the evidence reviewed above would tend to support the view that the consolidation hypothesis is not a viable explanation of the MP-DP effect.

Rehearsal Hypothesis

The rehearsal hypothesis is based on the model by Atkinson and Shiffrin (1968) which maintains that rehearsal is the process by which an event, as a member of a rehearsal set (approximately 3 to 6 chunks), can be prolonged in short-term memory after the stimulus it represents is no longer present. A basic assumption of the rehearsal hypothesis is that the longer an event remains in short-term memory, the greater the amount of information about that event which is transferred to long-term memory. It is further assumed that the probability that any given event is a member of the rehearsal set decreases as new events enter short-term memory. Now consider what happens in the case of repetitions. The first presentation of an event enters short-term memory and is rehearsed. The probability that the item remains a member of the rehearsal set decreases as new items enter short-term memory. Thus, if the second presentation of the event enters short-term memory after a number of intervening items (DP), both presentations receive the benefit of a full stay in the rehearsal set. However, if the second presentation of the event enters short-term memory immediately after the first presentation (MP), there is a high probability that the first presentation will already be a member of the rehearsal set. Since it is assumed that the subject will not simultaneously hold two identical copies of the same event in the rehearsal set, the second presentation will replace the first resulting in less total rehearsal for the repeated event and, therefore, less long-term trace strength.

Direct support for the notion of differential rehearsal for MP and DP events has been provided by Rundus (1971). Using his overt-rehearsal technique, he varied the spacing between repetitions and asked subjects to give a continuous running vocalization of their rehearsals. He found that MP items were given less total rehearsals than DP items and the difference could be attributed to differential rehearsal between the first and second presentations.

It should be noted that the rehearsal hypothesis and the consolidation hypothesis involve very similar notions. Although they differ in that consolidation is conceived to be an involuntary process whereas rehearsal is conceived to be voluntary, both hypotheses maintain that the differential processing favoring DP occurs in response to the first, rather than the second presentation of the repeated item. A study by Hintzman, Block, and Summers (1973), designed to determine which of the two occurrences suffered when items are massed, provides damaging evidence for both the consolidation and rehearsal hypotheses. Subjects were presented a list of items which were tagged with modality information (i.e., presentation was either visual or auditory) and on a later retention test asked to give both modality and frequency judgments. Some of the items within the list were repeated under the following conditions: visual-visual, visual-auditory, auditory-visual, and auditory-auditory, each represented at four different spacing intervals. Following presentation, subjects were asked to make a judgment as to the frequency of occurrence for each item and in what modality or modalities the item had occurred. Frequency judgments were affected by spacing, with estimates closer to 2.0 when the spacing interval was long, and the magnitude of this effect was the same for both the same modality and different modality conditions. But more important was the finding that in the different modality condition, the overall increase in frequency judgment accuracy could be attributed to an increase in the accuracy of modality judgments for the second occurrence of the item. In other words, the memory for the second occurrence has been reduced at the shorter spacing intervals. These findings are inconsistent with the consolidation and rehearsal hypotheses which would predict just the opposite outcome.

Another serious problem for the rehearsal hypothesis are the findings of Bjork and Allen (1970) reported previously. Since rehearsal is a conscious activity involving processing capacity in short-term memory, it is reasonable to assume that a difficult task would interfere more with rehearsal than an easy task. The findings of Bjork and Allen (1970) were in the opposite direction, with a difficult interpolated task between the first and second presentation leading to better retention than an easy interpolated task. In summary, the results of the Hintzman et. al. (1973) and Bjork and Allen (1970) experiments suggest that rehearsal may not be the key factor in the MP-DP effect.

Inattention Hypothesis

The inattention hypothesis, like the consolidation and rehearsal hypotheses, suggests that the MP-DP effect results from a negative factor in MP rather than from a positive factor in DP. But unlike these hypotheses, it predicts that it is the retention of the second occurrence rather than the first occurrence that suffers from massed repetitions. Waugh (1970), Greeno (1970b), and Underwood (1970) have suggested that the MP-DP difference may be produced by the subject failing to make adequate use of avilable time to process the MP item. As an item repeats itself in adjacent positions, subjects may lose attention or simply "turn off" whatever he normally does to learn the items (Underwood, 1970). The logic implicit in this position is that learning is a function of the total study time, that functional study time may be less than nominal study time, and that the difference between nominal and functional study time is greater for MP items than for DP items.

One source of indirect evidence for the inattention hypothesis is a study by Shaughnessy, Zimmerman, and Underwood (1972) in which subjects self-paced themselves through a long list of words that included both MP items and DP items, and were later given a free recall test. The amount of time the subjects spent studying each item was measured. It was found that subjects spend less time studying repeated items that had just occurred than studying repeated items that had occurred earlier in the series. The results of the recall test revealed that DP items were recalled better than MP items. These results support the finding by Hintzman et. al. (1973) that the locus of the inhibitory effects of massed repetitions is the processing of the second occurrence. The relevance of these findings with respect to the inattention hypothesis obviously requires the assumption that the termination of a slide exposure by the subject is a direct analog of the processing halt which the hypothesis asserts may occur when the word is presented for a constant period of time.

A number of studies have tested the inattention hypothesis by attempting to insure that the subject fully attends to all occurrences of an item. If attention is voluntary, then appropriate experimental instructions or other manipulations of subjects' strategies that insure the uniform allocation of attention should eliminate the MP-DP effect. In a study by Hintzman and Summers (reported by Hintzman, 1974), subjects were given monetary incentives for recognition of critically selected items in an attempt to insure attention to the second occurrence of repeated items regardless of spacing. No attentuation of the MP-DP effect was found. In a similar experiment Elmes, Sanders, and Dovel (1973) presented critical items in a distinctive way (distinctive voice in auditory lists or distinctive letters in visual lists) in an attempt to manipulate attention (von Restorff effect). Although they found that distinctive MP items were recalled better than nondistinctive DP items from the same list, the facilitative effects of distinctiveness on recall of DP items, in other lists, was even greater than that on recall of MP items. Taken as a whole, these data do not reveal an attenuation of the MP-DP effect.

One study that has provided at least partial support for the inattention hypothesis was reported by D'Agostino and DeRemer (1973). Subjects were given a long list of sentences, and later tested for retention of the object phrases either by free recall or by using the subject phrase of each sentence as the cue for recall of the object phrase. To gain control over the amount of attention given each sentence, the subjects were required to read each sentence aloud, to form a visual image of the context of the sentence, and then to spend the remainder of a 10 second study period describing the visual image to the experimenter. An MP-DP effect was found in free recall, but not in cued recall.

A slightly different version of the inattention hypothesis has been proposed by Hintzman (1974). His notion, called the habituation hypothesis, is like the inattention hypothesis in that it attributes the MP-DP effect to deficient processing of the second occurrence of massed repetitions. However, unlike the inattention hypothesis, this process is assumed to be involuntary. According to this hypothesis, whenever a stimulus item is studied some internal process involved in storing the memory trace of that stimulus becomes habituated (i.e., its threshold of activation is raised). This habituation continues for as long as attention is directed to the stimulus. When attention is directed elsewhere, or the stimulus is no longer present, recovery from habituation begins. The implication for the MP-DP effect is that if the second presentation of an item occurs before recovery from the habituation to the first presentation is complete (MP), encoding of the second presentation will be less effective than if its presentation is delayed allowing full recovery (DP). A study by Hintzman, Summers, and Block (1975) tested two predictions generated by the habituation hypothesis: (1) that "overhabituation" produced by prolonged or repeated exposure of a stimulus would affect recovery, and hence the form of the lag function; (2) that massed presentations would tend to be remembered as one long exposure. The results of this study failed to confirm either of these two predictions. Based on these findings, it would appear that the habituation version of the inattention hypothesis is not a viable explanation of the MP-DP effect.

As indicated previously, the inattention hypothesis states that massed repetitions lead to poorer recall performance than distributed repetitions because the second occurrence of an item receives less than a full share of attention. To the extent this occurs, a massed repetition may be treated as an opportunity to rest, which then enables the subject to devote more processing capacity to the next word in the list. In other words, if the subject takes time out from processing items for a short period of time , he may be able to operate at a higher rate when he begins reprocessing items. One strategy for testing this prediction has been the examination of recall performance on items presented adjacent to repeated items. If the MP-DP effect operates through less expenditure of effort on massed repetitions, there may be compensatory facilitation in recall performance on nearby items, specifically the item following the massed repetition. Elmes, Greener, and Wilkinson (1972) tested this prediction by examining recall performance for the items that immediately followed the second occurrence of critical items repeated at lags of 0, 3, and 10 intervening items. As expected, the probability of recall for repeated items varied from .12 to .21 to .23, respectively, as a function of the different lag conditions. But more importantly, the probability of recall for the items immediately following the second occurrence of the repeated items was .38, .25, and .18 for lags of 0, 3, and 10, just as the inattention hypothesis would require. We will refer to this phenomenon as the "inverse lag effect." Although these results are consistent with the inattention hypothesis, the authors observe that an extention of the varied encoding hypothesis might also accommodate these results. The varied encoding hypothesis would predict that the discovery of new encodings would result in the accrual of more retrieval cues to distributed repetitions than to massed repetitions. Furthermore, it may be assumed that the discovery of a new encoding for a repeated item has an inhibitory effect on learning the next item in the list. Given this additional assumption, the results of the Elmes et. al. (1972) study are also consistent with the varied encoding hypothesis. The evidence is lacking in the Elmes et. al. report to determine to what extent the inverse lag effect is the result of facilitation due to the attenuation of attention to massed repetitions or the result of inhibition due to the variable encoding of distributed repetitions.

PRESENT RESEARCH

The purpose of the two experiments reported here were to provide further tests of the inattention hypothesis as proposed by Waugh (1970) and Underwood (1970). The first experiment was designed to elucidate the nature of the inverse lag effect on recall of items immediately following massed and distributed repetitions (1) by determining to what extent the differential recall of these items reflects facilitation, inhibition, or both; and (2) by attempting to eliminate or greatly attenuate the inverse lag effect by insuring that subjects fully attend to both presentations of massed repetitions and thereby eliminate any facilitation due to released attentional capacity. The purpose of the second experiment was to test the prediction from the inattention hypothesis that the MP-DP effect can be eliminated when the items are presented visually at a fast rate of presentation.

Experiment I

As indicated previously, the study by Elmes et. al. (1972) is lacking the appropriate control condition to determine to what extent the inverse lag effect is the result of facilitation due to the attenuation of attention to massed repetitions or the result of inhibition due to the variable encoding of distributed repetitions. One purpose of Experiment I was to provide a condition in which the recall performance of critical items following the occurrence of single-presentation control items could be measured. This control condition provided a baseline by which the recall performance of critical items following massed and distributed repetitions could be compared, to determine whether the inverse lag effect reflects facilitation, inhibition, or both.

Waugh (1970) has shown that the MP-DP effect can be eliminated when the TBR items are presented auditorily at a 1-sec rate of presentation, but a clear effect is obtained when the presentation rate 4-sec. She hypothesized that under the time pressures of the faster presentation rate, subjects were forced to fully attend to both presentations of a massed repetition. Thus, there was no attenuation of attention and the MP-DP effect was eliminated. Furthermore, if there is no attenuation of attention to the second occurrence of a massed repetition, and therefore no released attentional capacity, the recall of the item immediately following the massed repetition should be unaffected. The second purpose of Experiment I was to test this hypothesis.

Free recall of critical items presented immediately after single-presentation control items, massed practice items, distributed practice item with a repetition lag of 3, and distributed practice items with a repetition lag of 10 was examined. All items were presented auditorily at either a slow rate of presentation (3-sec per word) or a fast rate of presentation (1-sec per word). The prediction from the inattention hypothesis is that recall of critical items in the slow presentation rate condition should show an inverse lag effect due to released attentional capacity at the shorter lags, while recall of critical items in the fast presentation rate condition should be unaffected by lag (i.e., comparable to recall of critical items following single-presentation control items).

METHOD

Subjects. The subjects were 64 general psychology students who participated to fulfill a course requirement. Thirty-two subjects were randomly assigned to each of the two presentation rate conditions.

Design. The experiment was a 4 x 2 factorial. Critical item location was a within-subjects factor with all subjects recalling lists in which the critical items occurred under one of the following four conditions: (1) after a single-presentation control item; (2) after a massed practice item; (3) after a distributed practice item with a repetition lag of 3; and (4) after a distributed practice item with a repetition lag of 10. Presentation rate was a between-subjects factor: in the slow presentation rate group, subjects were presented items at a rate of 3-sec per word; in the fast presentation rate group, subjects were presented items at a rate of 1-sec per word.

Materials. Sixteen lists were constructed from a pool of 416 four letter words taken from Thorndike and Lorge (1944) with a frequency count of at least 50 per 1,000,000 words. A complete listing of this pool may be found in Appendix I. The words were chosen such that the first letters of the words were approximately equally distributed across the letters of the alphabet. Each list contained 48 different words consisting of 24 experimental items (8 critical items and 16 practice items) and 24 filler items. Each list contained two critical items after single-presentation control items, two critical items after massed practice items, two critical items after distributed practice items with a repetition lag of 3, and two critical items after distributed practice items with a repetition lag of 10. All of the critical items were presented twice with a repetition lag of 13 intervening items. A portion of a sample list is presented in Table 1,

Table 1. A portion of a sample list showing the single-presentation control items, massed practice items, distributed practice items with a repetition lag of 3, distributed practice items with a repetition lag of 10, and the critical items presented thereafter.

	farm	
	rain	
massed practice	inch	
	inch	
	army	critical after MP
	moon	
single-presentation control	gold	
	salt	critical after single-presentation
	ring	
distributed practice (lag 3)	moon	
	foot	critical after DP (lag 3)
distributed practice (lag 10)	farm	
	bank	critical after DP (lag 10)
	fish	
	rose	
	yard	
massed practice	baby	
	baby	
	army	critical after MP
	lamp	
single-presentation control	girl	
	salt	critical after single-presentation
	bird	
distributed practice (lag 3)	lamp	
	foot	critical after DP (lag 3)
distributed practice (lag 10)	rose	
	bank	critical after DP (lag 10)

showing the single-presentation control items, massed practice items, and distributed practice items as well as the critical items presented thereafter. Four sets of four basic lists were constructed using a Greco-Latin square to counterbalance the assignment of critical and practice items to conditions. Within each list, each condition occurred once in the first half and once in the second half of the list. Across the four basic lists, the critical items in each condition occupied approximately the same serial positions within each list half. Five filler items were used to control for primacy effects and 8 for recency effects. Of the 24 filler items, one was used as an MP item in the primacy positions, one was used as an MP item in the recency positions, 9 were once-presented items in primacy and recency positions, and the remaining 13 were once-presented items inserted in the body of the list to satisfy the various lag conditions. To accomodate experimental and filler items, a total of 70 list positions were used.

Procedure. Subjects were tested in groups of 2 members. Each subject heard and recalled 4 different lists under fast presentation rate or slow presentation rate conditions. Counterbalancing assured that each list was presented first, second, third, and fourth equally often. The lists were recorded on magnetic tape by a male speaker and were later presented to the subjects by means of a tape recorder.

The subjects were given standard free recall instructions. They were told to listen carefully to each list and then following its presentation to write down as many words as they could recall from that list in any order they chose. Each list was to be recalled on a separate page of a specially prepared test booklet. At the end of the 3-min recall interval that followed every list, the subjects were instructed to turn over the page they had just written on. The subjects were also instructed that, although some words would appear twice within every list, they should write

RESULTS

Recall of practice items. The data are summarized in Figure 1. In addition to the mean probability of recall for repeated items, recall of once-presented (1P) items is shown for the two presentation rate conditions. Each data point is based on 512 observations (32 subjects x 4 lists x 4 items per list). A 2 x 3 analysis of variance performed on the raw numbers correct summed over 4 lists indicated a marked Lag x Rate interaction $F\ (2,124) = 5.84$, $MSe = 3.16$ (see Table 2). A $p < .05$ criterion was used for all statistical tests reported in this paper. Tests for simple effects of lag were significant for the slow presentation rate condition, $F\ (2,62) = 7.65$, $MSe = 3.98$, but were not significant for the fast presentation rate condition, $F < 1$, $MSe = 2.34$. A subsequent Newman-Keuls analysis indicated that in the slow presentation rate condition, recall performance at lag 0 differed significantly from recall performance at either lag 3 or lag 10. However, recall at lag 3 and lag 10 were not reliably different from each other (see Table 3). It is apparent that the MP-DP effect in the slow presentation rate condition was eliminated in the fast presentation condition. Lag effects were absent in both presentation rate conditions. As is typically the case, the overall level of recall performance was higher in the slow presentation rate condition ($M = .34$) than in the fast presentation rate condition ($M = .27$), $F\ (1,62) = 6.67$, $MSe = 10.16$. A comparison between recall performance for lag 0 and 1P items revealed no reliable difference in the slow presentation rate condition, $t(31) = 1.14$, but in the fast presentation rate condition, recall performance for lag 0 items was significantly higher than recall performance for 1P items, $t(31) = 6.07$.

Recall of critical items. The mean probability of recall for items following single presentation (1P), massed practice, and distributed practice

Figure Caption

Figure 1. Mean probability of recall as a function of lag for the Slow Presentation Rate (SPR) and Fast Presentation Rate (FPR) conditions in Experiment I.

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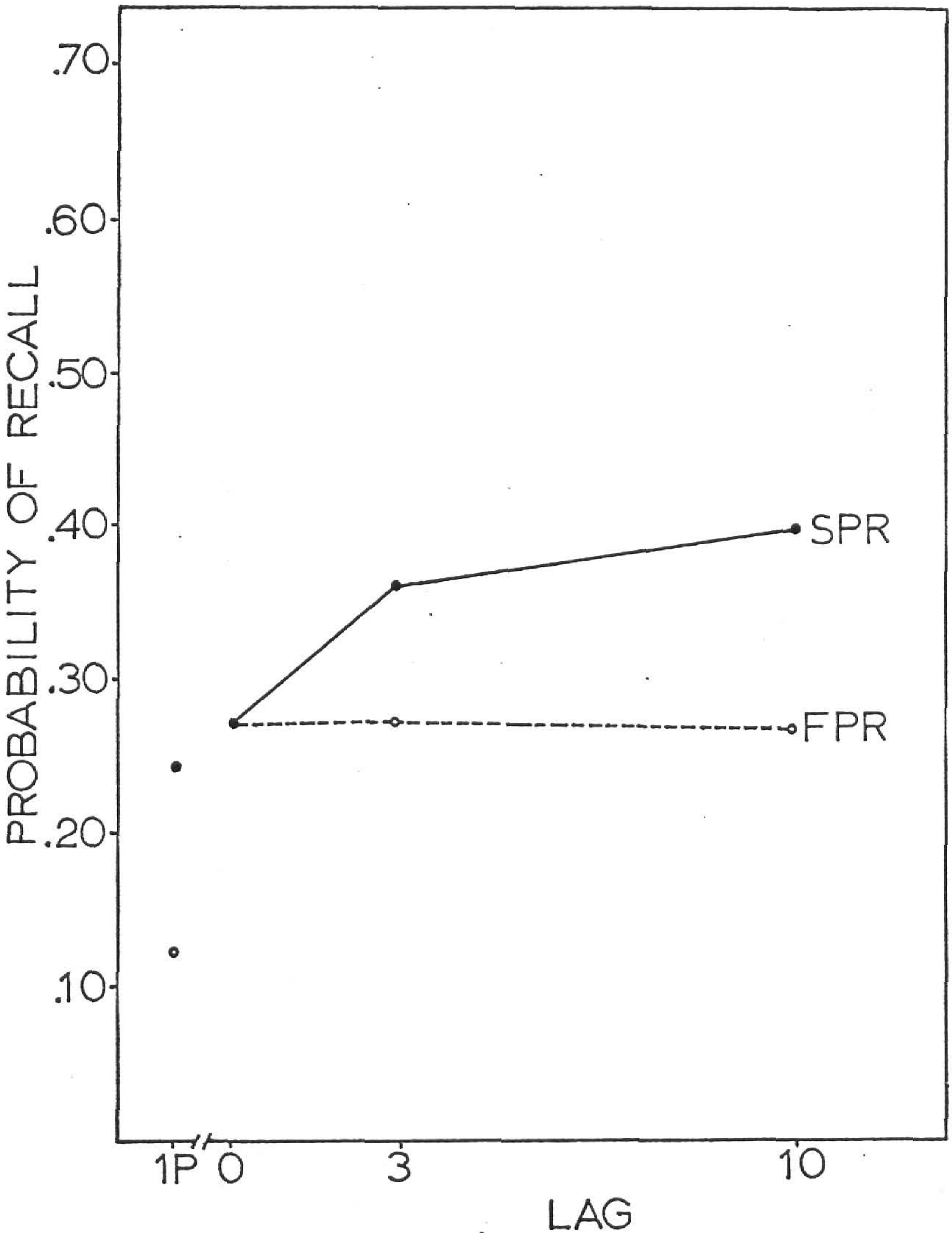

.70
.60
.50
.40
.30
.20
.10
PROBABILITY OF RECALL
SPR
FPR
1P
0
3
10
LAG

TABLE 2

Analysis of Variance

Recall of practice items in experiment I

Source	df	SS	MS	F
Between Subjects	63			
Rate	1	67.69	67.69	6.67*
Ss/Groups	62	629.62	10.16	
Within Subjects	128			
Lag	2	24.78	12.39	3.92*
Rate x Lag	2	36.97	18.48	4.84**
Lag x Ss/Groups	124	392.22	3.16	

*$p < .025$

**$p < .01$

TABLE 3

Newman-Keuls Test*

Mean probability of recall as a function of lag under the slow presentation rate condition in experiment I

Lag		
0	3	10
.27	.36	.39

*Means underlined by the same line are not reliably different. All other possible comparisons are significant at the $p < .01$ level.

items is presented in Table 4. Each data point is based on 256 observations (32 subjects x 4 lists x 2 items per list). A 2 x 4 analysis of variance performed on the raw numbers correct summed over 4 lists indicated a significant main effect of rate $F(1,62) = 9.19$, $MSe = 3.92$ (see Table 5). This effect reflects the higher recall performance for items under the slow presentation rate condition ($M = .47$) as compared with items under the fast presentation rate condition ($M = .38$). Contrary to expectation, neither the main effect of lag, nor its interaction with presentation rate were significant ($Fs < 1$), $MSe = 2.23$. In other words, recall performance for items following massed practice and distributed practice items was not reliably different from each other, nor was either reliably different from recall performance for items following single presentation items.

TABLE 4

Mean probability of recall for items following single presentation, massed practice, and distributed practice items for each presentation rate condition

	Lag			
	1P	0	3	10
Slow Presentation Rate	.46	.47	.46	.50
Fast Presentation Rate	.38	.34	.41	.38

TABLE 5

Analysis of Variance

Recall of critical items in experiment I

Source	df	SS	MS	F
Between Subjects	63			
Rate	1	36.00	36.00	9.19*
Ss/Groups	62	242.75	3.92	
Within Subjects	192			
Lag	3	3.38	1.13	.50
Rate x Lag	3	4.50	1.50	.67
Lag x Ss/Groups	186	415.09	2.23	

$^*p < .01$

DISCUSSION

Consistent with previous results (Melton, 1970), distributed practice resulted in higher free recall performance than did massed practice in the slow presentation rate condition. Also consistent with previous results (Waugh, 1970; Glenberg, 1974), the MP-DP effect was eliminated when the items were presented at a fast rate of presentation. Several investigators (e.g., Melton, 1970; Underwood, 1970), on the other hand, have reported no interaction between rate of presentation and the MP-DP effect. Underwood, Kapelak, and Malmi (1976) have pointed out that one characteristic of Waugh's work which differs from these latter studies is that subjects are tested across a number of short lists (10 lists each containing 33 items), and such a procedure may induce certain factors, such as between- list interference, which are necessary for the emergence of the interaction between rate and the MP-DP effect. The results of this experiment suggest that number of lists is not the critical factor, since the interaction was obtained even though the subjects were tested across only four lists, a procedure characteristic of the Melton and Underwood studies. Another difference, namely node of presentation, will be discussed in Experiment II.

We will now consider the recall performance for critical items following single presentation, massed practice, and distributed practice items (critical item location). The critical prediction from the inattention hypothesis is that recall of critical items in the slow presentation rate condition should show an inverse lag effect due to released attentional capacity at the shorter lags, while recall of critical items in the fast presentation rate condition should be unaffected by lag since the time pressures of the fast presentation rate should eliminate attenuation of attention. Contrary to expectation, no inverse lag effect was demonstrated in the slow presentation rate condition. The recall of items following massed practice repetitions did not reliably differ from the recall of items following distributed practice repetitions in either presentation rate condition.

It seems reasonable to presume that the discrepency between these results and the Elmes et. al. (1972) results reflect some critical difference in the two studies. Since the slow presentation rate condition in the present study was conceived to be a replication of the Elmes et. al. study, the differences between the two studies are small. Nevertheless, one possible candidate that emerges involves the assignment of critical items to conditions. In the present study, four different forms of the four basic lists were constructed using a Greco-Latin square to counterbalance the assignment of the four sets of eight critical items to conditions. In the Elmes et. al. study, three sets of six critical items were randomly assigned to conditions, but were not counterbalanced across conditions. Consequently, the recall performance for critical items in each condition is subject to confounding by critical item set recallability. Although this may not be a problem when the number of critical items per condition is large, it is clearly a problem when the number is small. To evaluate this possibility in the present experiment, a separate 4 x 4 x 4 x 4 (critical item location x critical item sets x practice item pairing x list form) analysis of variance was performed on the slow presentation rate condition (see Table 6). The results of this analysis revealed a significant main effect of critical item sets, $F\ (3,84) = 5.06$, $MSe = 1.61$. That is, at least one set of critical items was recalled significantly better than the other sets. All other main effects and the residual were not significant.

TABLE 6

Analysis of Variance

Recall of critical items under the slow presentation rate condition in experiment I

Source	df	SS	MS	F
Between Subjects	31			
List Form	3	9.56	3.19	.66
Ss/Groups	28	134.81	4.82	
Within Subjects	96			
Critical Item Location	3	2.81	.94	.58
Critical Item Sets	3	24.44	8.15	5.06*
Practice Item Pairing	3	13.19	4.40	2.73
Residual	3	13.12	4.37	2.72
Error (within)	84	134.94	1.61	

*$p < .01$

Had each set of critical items not been counterbalanced across conditions, and only one form of the list been used as in the Elmes et. al. study, this main effect of critical item sets would have been totally confounded with the main effect of critical item location. In the present experiment, confounding due to critical item set recallability has been controlled for by ensuring that each set of critical items appears equally often in each condition.

The second purpose of this study was to provide a single presentation control condition which serves as a baseline by which the recall performance for items following massed and distributed practice repetition could be evaluated. These results indicate that for both presentation rate conditions, the recall of items following massed and distributed practice repetitions did not reliably differ from the recall of items following a single presentation item. Some support for this conclusion has also been provided in a study by Potts (1972), in which he found evidence that pairs presented immediately after massed practice pairs were recalled no better than pairs presented farther back in the sequence.

In conclusion, the replication of Waugh's (1970) earlier finding that the MP-DP effect can be eliminated when the items are presented auditorily at a fast presentation rate provide additional empirical support for the inattention hypothesis. That is, if subjects are forced to fully attend to both presentations of a massed repetition, there should be no attenuation of attention and the MP-DP effect should be eliminated. With respect to the recall performance for items following massed and distributed practice repetitions, the results of this experiment are neutral with regard to the inattention hypothesis. That is, failure to demonstrate an inverse lag effect can not be taken as evidence against the inattention hypothesis.

It should be noted that while an inverse lag effect would be consistent with the inattention hypothesis, it is not a necessary consequence of the hypothesis. It is quite possible, for example, that the interval of "free" time during which the subject ceases to process a massed repetition is used to rehearse items presented earlier in the list. To the extent this occurs, there would be no released attentional capacity following massed repetitions and therefore no inverse lag effect. Furthermore, the results of this experiment provide indirect evidence to suggest that the inverse lag effect reported by Elmes et. al. (1972) may have been an artifact of list design.

Experiment II

The results of Experiment I and an earlier study by Waugh (1970) indicate that the MP-DP effect can be eliminated when the items are presented auditorily at a fast rate of presentation. To account for these results, Waugh hypothesized that at the faster presentation rate subjects had difficulty encoding the items to a level sufficient to recall them. Under the MP schedule, the item is presented again immediately and the subject fully utilizes this additional time for study. In other words, with the fast presentation rate there was no attentuation of attention and the MP-DP effect was eliminated.

Several investigators (e.g., Melton, 1970; Underwood, 1970) have failed to replicate this finding when TBR items are presented visually (as opposed to auditorily) at a fast presentation rate in a free recall procedure. These findings have prompted Melton (1970) to suggest that Waugh's findings may be peculiar to her auditory method of presentation. An alternative explanation might be that visual presentation at a rate of 1-sec per word does not impose sufficient processing demands to require the subject to fully attend to the second occurrence of a massed repetition. Some support for this notion is provided by the finding that recall performance is better with visual presentation than with auditory presentation when the type of verbal material and presentation rate are held constant (Melton, 1970). The present experiment differs from earlier attempts to replicate Waugh's finding using visual presentation in that a paired-associate task was employed. Underwood, Runquist, and Schulz (1959) have argued that in paired associate learning the subject first spends time learning the components of the pair, and then spends time associating the pair members. Given this two stage theory of paired-associate learning, it seemed reasonable to presume that the increased processing demands of this two-fold task should result in less attenuation of attention than the presentation of single items at a comparable presentation rate.

Subjects were presented visually a list of cue-TBR word pairs and later tested by a cued recall procedure. Within each list, the critical pairs were repeated a lag of 0, 3, and 8 intervening pairs. The pairs were presented under two presentation rate conditions: a slow presentation rate of 4-sec per pair; and a fast presentation rate of 1.3-sec per pair. The critical prediction from the inattention hypothesis is that recall performance of critical pairs in the slow presentation rate condition should show an MP-DP effect due to attenuation of attention to the second presentation of a massed repetition, while the MP-DP effect should be eliminated in the fast presentation rate condition since the time presures of the fast presentation rate should eliminate attenuation of attention.

METHOD

Subjects. The subjects were 48 general psychology students who participated to fulfill a course requirement. Twenty-four subjects were randomly assigned to each of the two presentation rate conditions.

Design. The experiment was a 3 x 2 factorial. Lag was a within-subjects factor, with all subjects recalling lists in which critical pairs were presented twice at each of 3 lags: 0, 3, and 8 intervening pairs. Presentation rate was a between-subjects factor: in the slow presentation rate group, subjects were presented pairs at a rate of 4-sec per pair; in the fast presentation rate group, subjects were presented pairs at a rate of 1.3-sec per pair.

Materials. The TBR words were common English words chosen from anong the stimulus words in the Bilodeau and Howell (1965) and Postman and Keppel (1970) free association norms. The cue word was selected for each TBR item from among the low frequency (less than 1%) responses for that item. Low frequency associates were used to minimize the opportunity for subjects to use some guessing strategy rather than recall of the specific list words presented. They were also used to minimize ceiling effects in the data.

Two basic lists were constructed and each list contained 40 different pairs consisting of 18 experimental pairs and 22 filler pairs. The 18 experimental pairs consisted of six repetitions at each of lags 0, 3, and 8 intervening pairs. Three sets of the two basic lists were constructed using a Latin square to counterbalance the assignment of critical pairs to conditions. Within each list, each condition occurred three times in the first half and three times in the second half of the list. Five filler pairs were used to control for primacy effects and 10 for recency effects. Of the 22 filler pairs, one was used as an MP pair in the primacy positions, one was used as an MP pair inthe recency positions, 11 were once-presented pairs in primacy and recency positions, and the remaining nine were once-presented pairs inserted in the body of the list to satisfy the various lag conditions. A total of 60 list positions were used to accomodate the experimental and filler pairs. Two different sequences of items were employed for the 18 repeated items and nine once-presented items in the middle portion of lists. The second within-list order of conditions was simply the reverse of the first order; it was generated by reversing the numbering of positions in the first order.

Procedure. Subjects were tested in small groups which varied in size from 2 to 4 members. Each subject saw and recalled 2 different lists under fast presentation rate or slow presentation rate conditions. Counter-balancing assured that each list was presented first equally often. The pairs were presented by means of Kodak Carousel projector at a rate of 1.3 or 4 sec per word(of which .8 sec was dark time involved in changing slides). Each cue-TBR pair was presented simultaneously, with the cue word printed in lower case letters directly above the TBR word which was printed in capital letters. Before the presentation of the first list, the subjects were instructed that following the presentation of each list, they would be given a list of the cue words, randomly ordered, and asked to recall for each cue word the appropriate TBR word from the list. At the end of the 4-min recall interval that followed each list, the subjects were instructed to turn over the sheet they had just written on.

RESULTS

The data of primary interest were the mean probability of correct recall of critical words by each subject in each condition in the list. Figure 2 summarizes the main results of the experiment. In addition to probability of recall of repeated (2P) items, recall of once-presented (1P) items is shown for the two presentation rate conditions. Each 2P data point is based on 288 observations (24 subjects x 2 lists x 6 items per list), while 1P data are based on 432 observations (24 subjects x 2 lists x 9 items per list). A 2 x 3 analysis of variance performed on the raw numbers correct summed over 2 lists indicated a significant Lag x Rate interaction, $F(2,92) = 6.20$, $MSe = 1.80$ (see Table 7). Tests for simple effects of lag were significant for the slow presentation rate condition, $F(2,46) = 18.11$, $MSe = 1.31$, but were not significant for the fast presentation rate condition $F < 1$, $MSe = 2.30$. A subsequent Newman-Keuls analysis indicated that for the slow presentation rate condition, cued recall at lag 0 differed significantly from cued recall at either lag 3 or lag 8, but there was no significant difference between lag 3 and lag 8 (see Table 8). In other words, the cued recall of pairs under DP were superior to the cued recall of pairs under MP in the slow presentation rate condition, but there was no difference between cued recall of MP and DP pairs in the fast presentation rate condition. Lag effects were not reliable in either presentation rate condition. The overall level of cued recall was higher in the slow presentation rate condition ($M = .61$) than in the fast presentation rate condition ($M = .41$), $F(1,46) = 20.57$, $MSe = 9.76$. A comparison between lag 0 items and 1P items revealed no significant difference in the slow presentation rate condition, $\underline{t}(23) = .92$, but in the fast presentation rate condition, cued recall of lag 0 items was significantly higher than cued recall of 1P items, $\underline{t}(23) = 3.72$.

Figure Caption

Figure 2. Mean probability of recall as a function of lag for the Slow Presentation Rate (SPR) and Fast Presentation Rate (FPR) conditions in Experiment II.

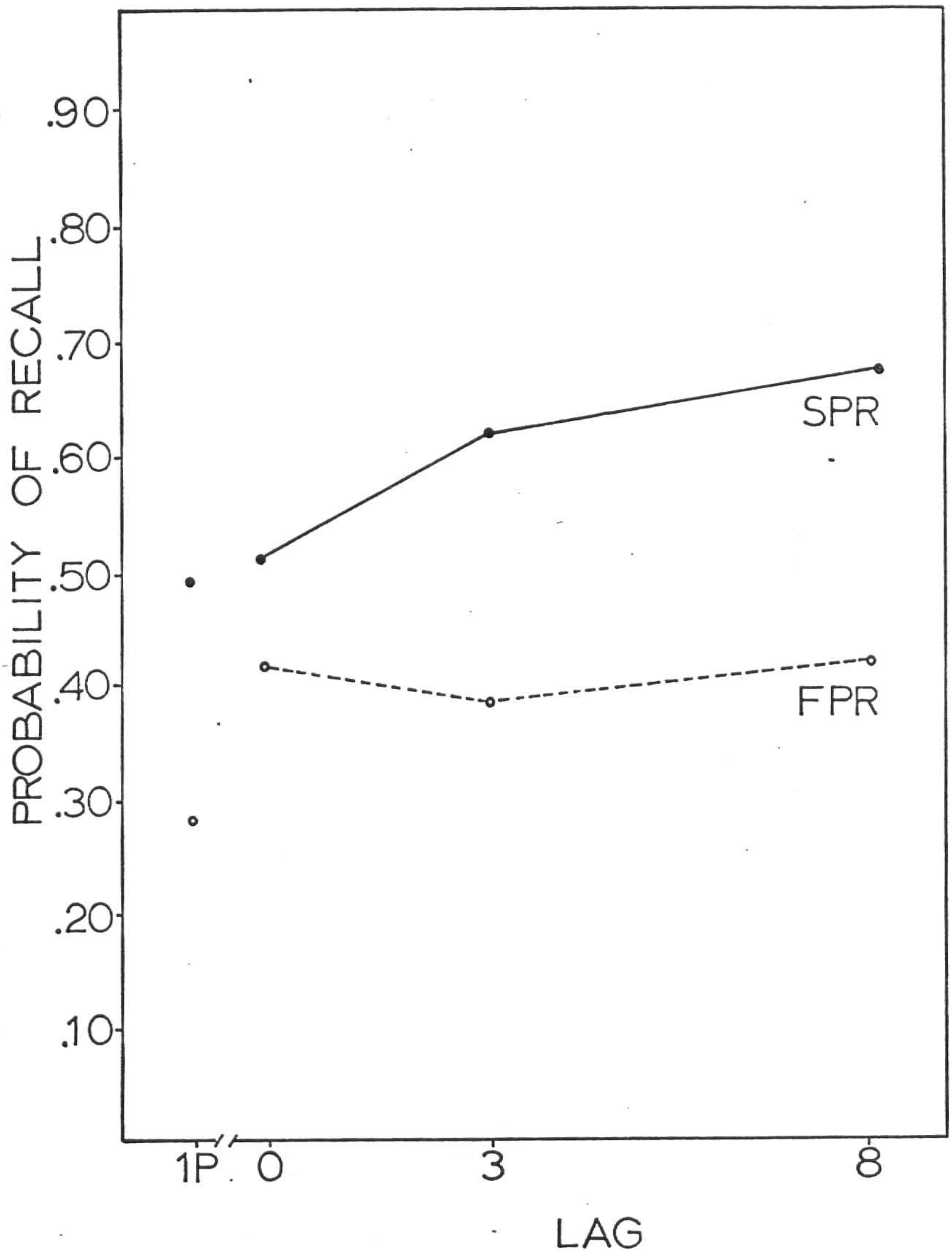
PROBABILITY OF RECALL
.90
.80
.70
.60
.50
.40
.30
.20
.10
SPR
FPR
1P
0
3
8
LAG

TABLE 7

Analysis of Variance

Recall of MP and DP pairs in Experiment II

Source	df	SS	MS	F
Between Subjects				
Rate	1	200.69	200.69	20.57**
Ss/Groups	46	448.86	9.76	
Within Subjects				
Lag	2	28.22	14.11	7.82**
Rate x Lag	2	22.39	11.19	6.20*
Lag x Ss/Groups	92	166.04	1.80	

*$p < .01$

**$p < .001$

TABLE 8

Newman-Keuls Test*

Mean probability of recall as a function of lag under the slow presentation rate condition in experiment II

Lag		
0	3	8
.52	.63	.68

*Means underlined by the same line are not reliably different. All other possible comparisons are signifianct at the $p < .01$ level.

DISCUSSION

The results of this experiment provide empirical support for the hypothesis that the MP-DP effect can be eliminated when the items are presented visually at a fast rate of presentation. These data show no MP-DP effect at a 1.3-sec rate of presentation, but a clear effect at a 4-sec rate of presentation. Furthermore, the results demonstrate that the interaction between rate of presentation and the MP-DP effect is not peculiar to an auditory method of presentation, as Melton (1970) had suggested, and thereby extend the generality of Waugh's (1970) findings.

To account for this interaction between rate of presentation and the MP-DP effect, Waugh hypothesized that there is some duration <u>d</u> during which the subject will fully attend to a newly presented item, and beyond which the subject ceases to process it for storage in long term store. If items are presented at a rapid rate, in excess of two every <u>d</u> seconds, then MP and DP items should be attended to for equal lengths of time and should therefore be recalled with equal probability. On the other hand, if items are presented at a rate of one every <u>d</u> seconds or slower, then a DP item may be attended to for a full 2<u>d</u> seconds while a MP item will be attended to for only half that interval.

Further support for this hypothesis is provided by the finding that when presentation rate is slow, the cued recall performance for MP (lag 0) pairs was not significantly greater than the cued recall performance for once-presented pairs within the list. That is, presenting a pair twice in adjacent positions within the list was no more effective in terms of cued recall performance than presenting the pair only once.

Indirect support for the hypothesis that encoding a cue-TBR word pair presented visually imposes greater processing demands (resulting in less attenuation of attention) than does the encoding of a single item presented visually can be found by comparing the results of this experiment with the results of a study by Melton and Shulman (reported in Melton, 1970). They had subjects learn lists containing both MP and DP items in a free recall task. The items were presented visually at rates of 1.3, 2.3, and 4.3 sec per word. Although a clear MP-DP effect was found, there was no interaction between presentation rate and the MP-DP effect. That is, the MP-DP effect was not eliminated when single items were presented visually at a 1.3-sec rate of presentation.

In conclusion, the results of this experiment are consistent with the inattention hypothesis that learning is a function of total study time, but that subjects seem disinclined to attend to any one item beyond a certain interval of time. Therefore, the subject fails to make adequate use of the available time to process MP items, which results in greater functional study time for DP items than for MP items.

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APPENDIX I

Word Pool

In the column after the word is a letter representing its frequency of occurrence in print. A = at least 50 per million and not so many as 100 per million; AA = 100 or over per million.

able AA	best AA	card A	dear AA	fair AA
also AA	bird AA	care AA	deep AA	fall AA
area A	blow AA	case AA	dish A	fame A
army AA	blue AA	cell A	does AA	fare A
aunt A	boat AA	cent AA	done AA	farm AA
away AA	body AA	city AA	door AA	fast AA
	boil A	club AA	down AA	fear AA
baby AA	bond A	coal AA	drag A	feed A
back AA	bone A	coat AA	draw AA	feel AA
bake A	book AA	coin A	drop AA	feet AA
ball AA	born AA	cold AA		fell AA
band A	both AA	come AA	each AA	felt AA
bank AA	bowl A	cook AA	east AA	fill AA
bare A	burn A	cool AA	easy AA	find AA
bark A	busy AA	cost AA	edge AA	fine AA
base AA			else AA	fire AA
bear AA	cake A	dare AA	even AA	fish AA
beat AA	call AA	dark AA		flag A
been AA	calm A	date AA	face AA	flew A
bell A	came AA	dead AA	fact AA	flow AA
bent A	camp AA	deal AA	fail AA	fold A

folk A
food AA
fool AA
foot AA
form AA
four AA
free AA
from AA
full AA

gain AA
gate AA
gave AA
girl AA
gift A
give AA
glad AA
goes AA
gold AA
gone AA
good AA
gray AA
grow AA

hair AA
half AA
hall AA
hang AA
hard AA
harm A
hate A
head AA
hear AA
heat AA
heel A
held A
help AA
here AA
hide A
high AA
hill AA
hire A
hold AA
hole AA
holy A
home AA
hope AA
hour AA
huge A
hunt A
hurt AA

idea AA
inch AA
into AA
iron AA

join AA
just AA

keep AA
kept AA
kill AA
kind AA
king AA
kiss AA
knew AA
know AA

lady AA
laid AA
lake AA
lamp A
land AA
last AA
late AA
lead AA
lean A
leap A
left A
less AA
life AA
lift AA
like AA
line AA
lion A
live AA
load A
lock A
long AA
look AA
lord AA
lose AA
loss AA
lost AA
loud A
love AA

made AA
maid A
mail A
main A
make AA
many AA
mark AA
mass A
mean AA
meat AA
meet AA
melt AA
mere A
mile AA
milk AA
mind AA
mine AA
miss AA
moon AA
more AA
most AA
move AA
much AA
must AA

nail A
name AA
near AA
neck AA
need AA
nest A
news AA
next AA
nice AA
nine AA
none AA
noon A

nose AA
note AA

obey A
once AA
only AA
open AA
over AA

pace A
pack A
page AA
paid AA
pain AA
pair AA
pale A
park A
part AA
pass AA
past AA
path AA
pick AA
pile A
pine A
pink A
pipe A
pity A
plan AA
play AA
poem A
poet A
pole A
poor AA
port A
post AA
pour A
pray A
pull AA
pure A

race AA
rail A
rain AA
rank A
rate AA
read AA
real AA
rear A
rest AA
rich AA
ride AA
ring AA
rise AA
road AA
roar A
rock AA
rode A
roll AA
roof AA
room AA
root A
rope A
rose AA
rule AA
rush AA

safe AA
said AA
sail AA
sake A
sale A
salt AA
same AA
sand A
save AA
seat AA
seed A
seek AA
seem AA
seen AA
self A
sell AA
send AA
sent AA
ship AA
shoe AA
shop AA
shot AA
show AA
shut A
sick AA
side AA
sigh A
sign AA
silk A
sing AA
size AA
skin AA
slip A
slow A
snow AA
soft AA
soil AA
sold AA
some AA
sort AA
soul AA
spot AA
star AA
stay AA
step AA
stir A
stop AA
such AA
suit AA
sure AA
swim A

tail A
take AA
tale A
talk AA
tall AA
team A
tear AA
tell AA
tend A
tent A
term A
test A
than AA
that AA
thee AA
them AA
then AA

they AA
thin AA
this AA
thou AA
thus AA
till AA
time AA
tiny A
tire AA
told AA
tone A
took AA
town AA

tree AA
trip AA
ture AA
turn AA
type AA

upon AA
urge A

vain A
vary A
very AA
view AA

vote AA

wage A
wait AA
wake A
walk AA
wall AA
warm AA
wash AA
wave AA
weak A
wear AA
week AA
well AA
went AA
were AA
west AA
what AA
when AA
whom AA
wide AA
wife AA
wild AA
will AA
wind AA
wine A
wing AA
wire A
wish AA
with AA
wood AA
wool A
word AA
wore A
work AA
worn A

yard AA
year AA
your AA

APPENDIX II

Experiment I

List 1

1. drag
2. also
3. nice
4. wish
5. wish
6. only
7. rear
8. talk
9. lamp
10. vain
11. park
12. coat
13. coat
14. abay
15. park
16. yard
17. came
18. king
19. ship
20. lamp
21. wife
22. like
23. meat
24. more
25. ring
26. coin
27. coin
28. baby
29. ring
30. yard
31. lard
32. gray
33. ship
34. meat
35. wife
36. tent
37. main
38. page
39. coal
40. flew
41. head
42. gift
43. gift
44. rain
45. head
46. bear
47. tent
48. poem
49. show
50. club
51. late
52. skin
53. coal
54. bird
55. flag
56. pipe
57. pipe
58. rain
59. flag
60. bear
61. club
62. poem
63. save
64. date
65. date
66. holy
67. case
68. soul
69. fact
70. walk

List 2

1. gave
2. join
3. join
4. rate
5. thin
6. fall
7. hour
8. pain
9. mass
10. soil
11. name
12. rich
13. rich
14. salt
15. name
16. iron
17. high
18. move
19. food
20. year
21. soil
22. team
23. over
24. cent
25. kill
26. vote
27. vote
28. salt
29. kill
30. iron
31. miss
32. girl
33. blue
34. year
35. cent
36. team
37. sing
38. east
39. east
40. aunt
41. sing
42. wood
43. girl
44. swim
45. leap
46. camp
47. pole
48. rose
49. sick
50. wire
51. trip
52. band
53. band
54. aunt
55. trip
56. wood
57. camp
58. swim
59. help
60. past
61. fool
62. rose
63. melt
64. fear
65. fear
66. cost
67. busy
68. roll
69. full
70. drop

List 3

1. good
2. hunt
3. wage
4. wage
5. down
6. mail
7. open
8. harm
9. cool
10. hill
11. bone
12. lion
13. even
14. hill
15. wool
16. left
17. mail
18. sand
19. care
20. tire
21. moon
22. moon
23. kiss
24. post
25. shop
26. lion
27. room
28. post
29. wool
30. fare
31. tire
32. sand
33. able
34. hole
35. gold
36. gold
37. kiss
38. room
39. book
40. rock
41. land
42. fire
43. army
44. rock
45. cake
46. foot
47. foot
48. milk
49. wild
50. suit
51. send
52. land
53. book
54. pink
55. tone
56. bark
57. army
58. pink
59. cake
60. town
61. town
62. milk
63. week
64. boil
65. pale
66. glad
67. glad
68. just
69. dead
70. load

List 4

1. kind
2. lost
3. area
4. area
5. easy
6. home
7. news
8. heat
9. rail
10. pair
11. fish
12. fish
13. ball
14. sold
15. door
16. shoe
17. home
18. lady
19. rope
20. wine
21. heel
22. fill
23. rope
24. snow
25. nest
26. nest
27. ball
28. star
29. wind
30. shoe
31. wine
32. lady
33. boat
34. work
35. road
36. farm
37. boat
38. snow
39. star
40. bowl
41. dark
42. gate
43. silk
44. bank
45. bank
46. love
47. silk
48. tree
49. wall
50. farm
51. mile
52. pray
53. gate
54. bowl
55. safe
56. calm
57. nail
58. roof
59. roof
60. love
61. nail
62. tree
63. part
64. test
65. hall
66. city
67. noon
68. noon
69. pile
70. seed

APPENDIX III

Experiment II

List 1

1. lady - QUEEN
2. hope - HIGH
3. whistle - BALL
4. whistle - BALL
5. think - STUPID
6. long - FAR
7. rough - HARSH
8. swift - GO
9. swift - GO
10. dark - ALLEY
11. rough - HARSH
12. foggy - MISTY
13. soft - QUIET
14. grass - MILK
15. long - FAR
16. country - OPEN
17. train - BLACK
18. grass - MILK
19. dark - ALLEY
20. stem - SHORT
21. stem - SHORT
22. soft - QUIET
23. cheese - GREEN
24. beat - PAIN
25. beat - PAIN
26. river - DAM
27. green - CHEESE
28. leaf - BOOK
29. noise - WIND
30. cave - WET
31. cave - WET
32. silk - HAT
33. cloth - SHEEP
34. ice - SLIP
35. home - SWEET
36. head - LIGHT
37. cloth - SHEEP
38. noise - WIND
39. home - SWEET
40. dry - RUB
41. moth - FOOD
42. tool - HAND
43. tool - HAND
44. crust - CAKE
45. head - LIGHT
46. adult - WORK
47. adult - WORK
48. crust - CAKE
49. rock - FISH
50. moth - FOOD
51. blow - HIT
52. ground - COLD
53. drink - SMOKE
54. memory - SLOW
55. white - CLOUD
56. cottage - LOVE
57. cottage - LOVE
58. beautiful - PICTURE
59. command - MAN
60. barn - DIRTY

List 2

1. mountain - TREE
2. wish - WASH
3. wish - WASH
4. yellow - CAB
5. cabbage - ROUND
6. door - RED
7. grasp - BABY
8. sun - DAY
9. brave - WEAK
10. brave - WEAK
11. blade - CUT
12. sun - DAY
13. pretty - BLUE
14. pretty - BLUE
15. door - RED
16. king - ARMY
17. glue - CHAIR
18. sharp - BLUNT
19. glass - HARD
20. blade - CUT
21. glue - CHAIR
22. lamb - WOLF
23. glass - HARD
24. box - BAG
25. sour - PICKLE
26. sour - PICKLE
27. sharp - BLUNT
28. eat - FAST
29. fruit - FLOWER
30. afraid - BOLD
31. heavy - FOOT
32. heavy - FOOT
33. fruit - FLOWER
34. loud - HORN
35. spider - BIRD
36. spider - BIRD
37. bitter - MAD
38. hungry - BEAST
39. high - LADDER
40. fear - WAR
41. butter - SMOOTH
42. hungry - BEAST
43. loud - HORN
44. sea - SAW
45. deep - SLEEP
46. bitter - MAD
47. plant - BUG
48. plant - BUG
49. deep - SLEEP
50. butter - SMOOTH
51. slow - TURTLE
52. whisky - WATER
53. roll - RUG
54. bath - NEED
55. bath - NEED
56. exist - BEING
57. stomach - LARGE
58. art - GIRL
59. covering - COAT
60. thirsty - HOT

APPENDIX IV

Instructions for Experiment I

This is an experiment in memory. You will be listening to lists of words which are tape recorded. There are four lists all together and each list contains a different set of 70 words. Some of the words are repeated within a list. That is, you may hear them more than once within a list, but no words are repeated across the four lists. You are to listen to each word carefully and try to remember as many of them as you can.

Each list in the experiment is preceded by the word "ready". This is a cue to tell you that the next thing you hear will be the first word in the list. Immediately after the last word in the list you will hear "recall". At that point you are to write down in any order all the words you can remember from the list. Please write down the words in the answer booklet provided. You will have three minutes to recall each list and I will tell you when that period of time has elapsed. Following the recall period, please turn your answer sheet over, and we will then go on to the next list.

If there ary any questions, please ask them before the experiment begins.

APPENDIX V

Instructions for Experiment II

This is an experiment in memory. You will be presented pairs of words by means of slide projector. you will see two lists and each list contains a different set of 60 word pairs. Each word pair consists of a cue word and a target word. The cue word is printed in lower case letters and appears directly above the target word which is printed in capital letters. Some of the word pairs are repeated within a list. That is, you may see them more than once within a list, but no word pairs are repeated across the two lists. You are to study each word pair carefully and try to remember as many of them as you can.

Following the presentation of each list, you will be given a list of the cue words, randomly ordered, and asked to recall for each cue word, the target word that was paired with it from the list. You will be given four minutes to recall each list, and I will tell you when that period of time has elapsed. Following the recall period, please turn your answer sheet over, and we will then go on to the next list.

If there are any questions, please ask them before the experiment begins.

APPENDIX VI

Answer Sheets for Experiment II

List 1

home ________	dark ________
ice ________	country ________
river ________	cloth ________
stem ________	silk ________
foggy ________	beat ________
beautiful ________	hope ________
noise ________	barn ________
lady ________	white ________
think ________	long ________
blow ________	cottage ________
cheese ________	tool ________
whistle ________	ground ________
adult ________	crust ________
head ________	swift ________
train ________	leaf ________
rough ________	moth ________
dry ________	rock ________
cave ________	command ________
drink ________	memory ________
soft ________	grass ________

List 2

sharp ______________	loud ______________
box ______________	covering ______________
slow ______________	roll ______________
cabbage ______________	spider ______________
fruit ______________	eat ______________
wish ______________	deep ______________
fear ______________	brave ______________
exist ______________	high ______________
pretty ______________	stomach ______________
lamb ______________	glass ______________
bitter ______________	bath ______________
plant ______________	blade ______________
sun ______________	thirsty ______________
yellow ______________	mountain ______________
grasp ______________	sour ______________
art ______________	king ______________
heavy ______________	sea ______________
whiskey ______________	glue ______________
hungry ______________	afraid ______________
door ______________	butter ______________

THE MASSED PRACTICE-DISTRIBUTED PRACTICE EFFECT: FURTHER TESTS OF THE INATTENTION HYPOTHESIS

by

Steven Kenneth Wenger

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Department of Psychology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

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ABSTRACT

Two experiments are reported that were designed to examine the effect of presentation rate (1) on the free and cued recall of massed practice (MP) and distribute practice (DP) items, and (2) on the free recall of critical items presented immediately after MP and DP items. In Experiment I, subjects free recalled lists containing critical items presented immediately after MP items, DP items with a repetition lag of 3, and DP items with repetition lag of 10. For independent groups, the lists were presented auditorily at either a slow or fast rate of presentation. The results indicated a clear MP-DP effect at the slow presentation rate which was eliminated at the faster presentation rate. These data support the prediction from the inattention hypothesis that when subjects are forced to fully attend to both presentations of a massed repetition, there will be no attenuation of attention and, therefore, the MP-DP effect will be eliminated. The recall performance on critical items immediately following MP and DP items did not differ under either presentation rate condition. This finding is inconsistent with the notion that a massed repetition serves as an opportunity to rest, which then enables the subject to devote more processing capacity to the next item in the list. In Experiment II, the MP-DP effect was eliminated when paired-associate lists were presented visually at a fast rate of presentation. These results provide further support for the inattention hypothesis. Although previous investigators had failed to find an effect of rate using visual presentation, the results of this experiment suggest they may not have used a sufficiently demanding task.