DECAY OF THE SEMANTIC PRIMING EFFECT IN MEMORY

By

JAMES JOHN NEISER, JR.

Bachelor of Science in Liberal Arts
University of Southwestern Louisiana
Lafayette, Louisiana
1973

Master of Science
University of Southwestern Louisiana
Lafayette, Louisiana
1975

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
May, 1979

DECAY OF THE SEMANTIC PRIMING

EFFECT IN MEMORY

Thesis Approved:

Robert F. Stanners
Thesis Advisor

Robert J. Weber

Larry Hochhaus

[illegible]

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

It is with sincere appreciation that I would like to thank all the members of my committee for their support and encouragement in completing this study. Dr. Robert F. Stanners, who served as my advisor, displayed tremendous patience in helping me to deal with the frustrations that must necessarily accompany any worthwhile research endeavor. His ideas, advice, and calming words were major factors in the development and completion of this study. Gratitude is also extended to Drs. Robert Weber, Larry Hochhaus, and William Warde for their encouragement and moral support throughout the course of this research.

In addition, I want to thank my committee, and especially Dr. Stanners, for letting me have the freedom and financial support to develop the minicomputer software necessary for this research.

Finally, but not least of all, I want to thank my parents for their understanding, support, and wisdom in letting me be who I am.

TABLE OF CONTENTS

Chapter | Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

There has been an increasing focus in the past decade on using reaction time methodologies to help determine the structure and processing parameters of semantic memory. The method of measuring stimulus processing time is not a new approach (Donders, 1868/1969), but was largely superseded by memory experiments involving an error methodology (cf., Cofer, 1971) until several refinements were introduced such as the additive factor method of Sternberg (1969). The reaction time method along with the ideas of linguists, artificial-intelligence, and information-processing disciplines, have led to several attempts to develop models of long-term memory. (e.g., Anderson & Bower, 1973). Of particular interest to these models is how the semantic relationships between words affects the speed of various mental processes. In general, the present paper is concerned with using a reaction time method (i.e., the lexical decision task) to determine a specific time parameter (i.e., the decay of the semantic priming effect) that is assumed in several models of semantic processing.

CHAPTER II

REVIEW OF THE LITERATURE

The Semantic Priming Effect

The effects of semantic context on word recognition has been reliably demonstrated by numerous investigators (Becker & Killion, 1977; Meyer & Schvaneveldt, 1971; Meyer, Schvaneveldt, & Ruddy, 1972, 1975; Rosch, 1975). The specific phenomenon of interest is the facilitation effect of context that is observed when the priming paradigm is employed in a reaction time task. The typical result is that a target word (e.g., Butter) is recognized more quickly when it is preceded by a semantically related word (e.g., Bread), than when it is preceded by an unrelated word (e.g., Nurse). The preceding related word is assumed to activate or <u>prime</u> the following target's representation in memory and thus facilitate recognition.

The semantic priming effect has been found using a variety of different tasks, grammatical units, and with various semantic relationships between the prime and target units. In a seminal experiment, Meyer & Schvaneveldt (1971), used a lexical decision and same/different lexical tasks in response to the simultaneous presentation of stimuli pairs to demonstrate the effects of associative facilitation. The lexical decision task requires the subject to judge whether or not a presented string of letters is a word or nonword. The same/different lexical task required the subject to judge if the pair of letter strings were the same (both words or nonwords) or different (word-nonword pairs). A significant facilitation in the decision latency was indicated for associated pairs in both tasks. The facilitation effect using a lexical decision task has been replicated when the prime and target were associatively related (Meyer et al., 1972; Tweedy, Lapinski, & Schvaneveldt, 1977); when the prime is a superordinate of the target (Neely, 1976); and when the prime and target are semantically but not associatively related (Fischler, 1977b; Becker & Killion, 1977).

Several variations of a same/different categorization task have been employed where the judgement is to decide whether or not two simultaneously presented words are from the same category. Schaeffer & Wallace (1969) demonstrated that semantic similarity facilitated classification of pairs of items as same (belonging to the same category, i.e., "living" or "nonliving") as opposed to different. Rosch (1975) presented category names as primes prior to the presentation of a pair of category exemplars either belonging or not belonging to the primed category. Facilitation of the decision task was observed when the words to be judged were from the primed category.

Finally, pronunciation latency has been used as a measure of target word activation. Target naming latency has been shown to be faster when the prime is associatively related to it (Jacobson, 1973; Meyer et al., 1975; Warren, 1977b); when the prime is the superordinate of the target words (Warren, 1970); when the priming words are antonyms or synonyms of the targets (Warren, Green, & Bresnick, 1977) and when the target and the prime are identical (Warren, 1970, 1977b). The evidence clearly suggests that semantic facilitation effects of comparable size occur for similar word stimuli in tasks with different response requirements.

Spreading Activation Theory

A spreading activation theory of semantic processing was originally proposed by Quillian (1962, 1965, 1969) in an attempt to implement computer simulations of memory search. A more formal and testable theory has been presented by Collins & Loftus (1975) as an extension and elaboration of the work by Collins & Quillian (1969, 1970a, 1970b, 1972). Two basic assumptions are inherent in the model of Collins & Loftus: (a) Words are stored in distinct "locations" in lexical memory and organized semantically; and (b) Accessing information from a given location results in a spread of neural excitation which facilitates subsequent recognition of words semantically related to the previously evoked representation. Thus, the facilitation effect found in the semantic priming paradigm would be characterized as a "spread of activation" from one node or location in semantic memory to a nearby node or location. These two assumptions have been adopted by various investigators (Collins & Quillian, 1970; Becker & Killion, 1977; Loftus, 1973; Meyer, 1970, 1973; Meyer & Schvaneveldt, 1976; Morton, 1969, 1970; Norman, 1968; Rumelhart, Lindsay, & Norman, 1972; Warren, 1972). However, several models have been proposed to explain the facilitatory effects of semantic context that do not incorporate a spread of activation conceptualization (Schaeffer & Wallace, 1970; Smith, Shoben, & Rips, 1974).

Meyer et al. (1972) performed an experiment designed to distinguish between the spreading activation model, the location shifting model, and the semantic comparison model as alternative explanations of the semantic priming effect. The location shifting model assumes a serial search of memory locations with retrieval time related to the amount of time required to shift from one location to the next and the distance between locations. According to the semantic comparison model (Schaeffer & Wallace, 1970), a lexical decision on the simultaneous presentation of words involves a comparison of semantic features. Semantically related words induce a facilitative response bias during the comparison process toward answering "Yes" that both letter strings are words, and against answering "No". The semantic priming effect is explained by the change in the subject's response criterion.

Meyer et al.'s (1972) experiment involved the simultaneous presentation of three letter strings in a vertical array. The arrays consisted of all combinations of words and nonwords with the task requiring a "Yes" response if all the letter strings were words, and a "No" response otherwise. Contrary to the prediction of the location shifting model (i.e., no difference), reaction times (RTs) to associated-unassociated-associated triplets were shorter than RTs to triplets composed of three unassociated words. A second comparison revealed shorter RTs for associated-associated-nonword triplets than unassociated-unassociated-nonword triplets which failed to support the semantic comparison model. Meyer et al. concluded that these and other results supported a spreading activation model. However, when the three letter strings were successively presented with a word or nonword response required for each item, the association effect was eliminated when the treatment consisted of two associated words separated by a nonword, but was significant when the intervening item was an unrelated word. Meyer et al. performed a second experiment where they eliminated the intervening item but retained a comparable time interval between the associated words. Since the results of this manipulation indicated a significant facilitation effect, Meyer et al. noted that a trace decay assumption of the spreading activation model could not explain the elimination of the effect in their first experiment. Subsequent research by Davelaar & Coltheart (1975) comprised a partial replication of the study by Meyer et al. (1972) with an additional manipulation involving pronounceable and unpronounceable nonwords as an intervening unit between two semantically related words. Their results indicated that the word association effect was significant regardless of whether the intervening item was a word or various possible nonwords and concluded that the spreading activation model was supported.

Decay of the Facilitation Effect

Of specific interest to the present study is the facilitation of a positive response to a target word as a function of the elapsed time since the presentation of a prime. This approach should not be confused with studies that have examined the time course of the facilitation effect for very short stimulus onset asychrony (SOA) times. These studies have been concerned with establishing the _minimum_ SOA needed to produce a significant semantic priming effect on lexical decision latency (Fischler & Goodman, 1978; Neely, 1976, 1977; Warren, 1977a). The present study is concerned with the _maximum_ amount of time for the decay of the facilitation effect _after_ a significant semantic priming effect has been established. Several studies have attempted to examine the decay time course of this facilitation effect using various tasks and experimental manipulations.

Cramer (1966, 1969) has investigated the effects of time lapse, interpolated activity, and semantic and associative relationships on _mediated_ priming. However, the dependent variable in Cramer's experiments did not involve an RT methodology. Instead, a standard word association task with frequency of a class of responses relative to normative data was used as the dependent measure.

In the first study by Cramer (1966), the procedure was to auditorily present two priming words and a cue-stimulus word to which the subject was to give the first associative response which came to the individual's mind. The interval between the priming words and the cue-stimulus word consisted of either a zero or a 15-second delay involving either (a) an unfilled interval; (b) an unrelated nonverbal filler task consisting of crossing out "c's" on a page of random letters; or (c) a verbal task requiring the subject to silently read and check off a list of 126 words for subsequent recall. End of the delay was signaled by a pencil tap followed by the critical cue-stimulus word. Cramer found that the mediated priming increased the probability of occurrence of the associated responses. The priming effect did not decrease over the 15-second delay with either an unfilled interval or nonverbal filler task. However, the verbal task during the time interval did decrease the priming effect until there was no significant difference from a nonprimed condition (norms).

In a later study, Cramer (1969) employed the same dependent measure to investigate the effects of mediated priming over a longer time interval. The procedure consisted of two prime words which the subject pronounced, an asterisk, a delay with a "c-circling" distractor task, and then the critical cue-stimulus word. The experimental manipulation of interest to the present study was the use of 0, 30, and 60 second intervals between the priming words and the critical cue-stimulus word. A No-Primed control group consisted of presenting three asterisks, a 60-second delay with the distractor task, and then the cue-stimulus. Zero delay primed-for responses produced significantly more associates than the No-Primed group and the effect was no longer significant by 30 seconds.

Cramer's results indicate that the priming effect, as measured in his studies, dissipates between 15 and 30 seconds. Additionally, any attempt to measure the decay of the priming effect should take into consideration the type of activity during the intervening time period within the critical pair. While Davelaar & Coltheart (1975) found no difference in the priming effect with one intervening item, Cramer's (1966) results suggest that the use of more than one verbal item may have an inhibitory effect on the priming phenomenon.

Cramer's results do not allow a more precise determination of when the priming effect is no longer significant between the 15 and 30 second intervals. It is quite possible that the decay function is different between 0 and 15 seconds, than between 15 and 30 seconds, as suggested by Loftus (1973). However, since the semantic priming effect as revealed by RT measures has been shown to be approximately a 50 millisecond effect, it is questionable whether the task employed by Cramer is sensitive enough to be a precise measure of the degree of activation and thus accurately determine the decay function. The use of two priming words poses an additional problem since the relative effects of two primes on the activation level and the concomitant decay function introduces an inseparable confounding within Cramer's experiments.

Ashcraft (1976, Experiment II) manipulated lag with separations of either one or four unrelated trials between a prime and its target. Ashcraft's experiments involved an RT measure for true-false verification of normatively defined high-low property dominance sentences (e.g., high property dominance - A sparrow has wings; low property dominance - A sparrow has feet) with all factorial combinations of prime and target sentences being presented. In general, Ashcraft found that high-property dominant target sentences were primed regardless of the dominance of the priming sentence, while low-property dominant sentences were not significantly primed by either low or high dominant sentences. While this finding generally supports Collins & Loftus (1975), some detailed results of Ashcraft's study are unclear relative to the spreading activation model.

Examination of the facilitation effect across lags in Ashcraft's study indicates an average of 128 milliseconds at Lag 1 and a decrease to 53 milliseconds at Lag 4. Ashcraft contends that the decay of facilitation is approximately complete by Lag 4 for high-dominant target sentences if low-dominant prime sentences are considered as a baseline RT. Since Ashcraft's procedure involved a constant five second inter-stimulus interval (ISI) after the subject made his response, at least 20 seconds would occur between the prime and target sentence for the critical comparison of interest at Lag 4. The variable time parameter involved in the subject's decision latency does not allow an accurate determination of the time interval for each lag, nor can the decay function be plotted with the limited sample of time intervals. While the approximate time interval for decay is consistent with Cramer (1966,1969), the criticism of an inability to accurately determine the decay function applies as well.

Several other factors contribute to problems in evaluating Ashcraft's results. For example, the property statements consisted of the syntax: subject-verb-object. Ashcraft contends that the pattern of results implies that the subject noun is the functional source of priming. Direct evidence is lacking for this conclusion and the influence of the subject noun versus the object noun on the priming effect cannot be directly assessed in Ashcraft's study. There is also some question as to the exact comparison being made to determine the priming effect. It is not exactly clear whether the target sentence is presented under a control condition where it is preceded by a completely unrelated sentence. Ashcraft states that his measure of facilitation is the difference between sentence 1 (prime) and sentence 2 (target) yet the correct comparison would be sentence 2 (a high or low property dominant sentence) under two different treatment conditions, i.e., preceded by a related versus unrelated priming sentence. It is suggested by

Ashcraft that the low-dominant property statements are manipulated in order to provide the proper control comparisons, but again this is unclear. In addition, a bias may have occurred if a subject noun was a word of the same category as the subject noun of another target sentence. Finally, there is the unknown effect of the intervening sentences between the critical pairs (Cramer, 1966).

A more direct assessment of the decay function was performed by Loftus (1973). Loftus had the subject produce an instance of a category and after zero, one, or two intervening trials, produce a second instance of the same category. A stimulus consisted of a category and a letter (e.g., fruit-A) with the subject required to produce a member of the category that began with that letter (e.g., apple). After one of three intervening periods, the same category paired with a different letter was presented and the subject had to produce a different instance. Filler trials were of the same construction but semantically unrelated to the critical stimulus pairs. Analysis of the response latencies indicated that the subjects were able to produce the second instance more quickly than the initial instance. A significant linear loss of the facilitation effect was indicated over the examined time intervals. Unfortunately, no information was given as to the inter-trial interval involved in the presentation procedure and therefore it is impossible to estimate the amount of time involved over the critical trials. The fact that the decay was not complete within the examined lags, may be attributable to a facilitation effect due to the repetition of the category name. Also, there is the unknown effect of the intervening items even though Loftus specifically used unrelated items for the intervening trials.

A discrete trial Stroop color-naming task has been used by Warren (1972, 1974) and Warren et al. (1977) to investigate the spread of activation in lexical memory. Target words were presented printed in color and color-naming latency was the dependent measure. An increase in the latency was shown to occur in this task when the preceding prime was semantically related in some manner. The assumption is that the prime activates the target resulting in interference with the appropriate color-name response. Warren (1972) used this paradigm in a series of experiments to study the decay of activation.

Warren's (1972) first experiment simply confirmed a semantic priming effect using the Stroop task. Experiment II examined the decay of activation over five lags. The procedure consisted of presenting eight blocks of 20 trials; each trial consisting of a one-second beep followed by the presentation of a word printed in a color. Each block further consisted of 10 trial groups constructed as a "miniature controlled lag list". Five different words with each word repeated once as an old item (in a different color) for one of five possible lags comprised each 10 trial group. The ten words (with repetitions) were permutated to construct five lags of different orders. Ten seconds occurred between each trial resulting in delays of 10, 20, 30, 40, and 50 seconds. The results indicated no loss of activation over the time period studied. However, Warren concluded that the discrepancy between his results and Cramer (1969) may have been due to the intentional recall task requirement, which was not a demand in Cramer's (1969) study.

Experiment III (Warren, 1972) was designed to study the decrease in activation with no recall demand. The procedure in the third experiment consisted of auditorily presenting the word "ready"; another word; a one second tone, and then visually presenting a word printed in a color. The critical targets were presented at lags of zero, one, or two trials, representing delays of 1, 26, and 31 seconds respectively. Control words consisted of words never presented as auditory primes. Results indicated that activation declined sharply in a linear rate over the 30 second period with an estimated 33.2 seconds necessary for complete loss as compared to the control group. Further examination of the data indicated a more rapid decay occuring between the 1 and 16 second dealys, than between the 16 and 31 second delays. Warren (1972) suggests that the first rapid loss involves a quickly decaying short term memory trace and the second a more stable long term memory trace.

While Warren's third experiment was essentially a repetition priming paradigm, Experiment IV involved semantic priming with the same presentation procedures and lag manipulations of Experiment III. Warren auditorily presented word triads as primes consisting of exemplars of a specific category. The critical targets were either controls (unrelated) or related category names. A spread of activation to related category names was confirmed. Approximately the same rate of loss of activation was found to occur for category names as the word itself (repetition priming of Experiment II), and decay was almost complete after 30 seconds with a complete loss of activation estimated to occur at 40.7 seconds.

A major discrepancy between the 30 second decay in Warren's repetition priming experiment (Experiment III) and more recent literature is immediately apparent. For example, studies by Forbach, Stanners, & Hochhaus (1974) and Scarborough, Cortese, & Scarborough (1977) have indicated that the repetition priming effect is a very reliable and robust phenomena persisting at least for 10 minutes and up to two days respectively. Unlike Warren's (1972) study, Forbach et al. and Scarborough et al. required a lexical decision task in their experiments which may have contributed to the discrepancy.

Experiment IV by Warren (1972) is consistent with Cramer (1969) indicating a decay of the semantic priming effect over 30 seconds, although the estimated zero facilitation effect occurred at a somewhat longer interval in Warren's study. Several procedural problems confound the results presented by Warren (1972). First, the criticism of Cramer's (1966, 1969) use of multiple primes is applicable. Second, the procedure involved presentation of primes and targets in different modalities (auditory and visual respectively). Kirsner & Craik (1971) have reported differential priming effects for different modality combinations. Finally, while the interference effects of the Stroop task is a robust phenomenon, the latency measure cannot necessarily be considered a direct measure of semantic priming effects. The rationale for this statement rests on at least two arguments. First, the task involves response competition and as a result possibly unknown processing effects. Second, the task requires the repetitive use of identical colors. While the same colors were not used within the critical pairs, the repetition priming effect of repeated colors throughout the experiment may have influenced subsequent naming latency (Lockhead, Gaylord, & Evans, 1977). Thus, the latency measure may be confounded by color repetition priming and semantic priming.

All of the previously cited studies suggest a 30 second time interval before the semantic priming effect completely decays. However, Meyer et al. (1972) have found results indicating a much faster loss of activation. Meyer et al. varied the interval (0, 1.5, and 4 seconds) between the successive presentation of a semantically related prime and target stimulus. A lexical decision was required for each stimulus. The results indicated that the semantic priming effect was only half its original magnitude after four seconds. The most prominent criticism, besides the inability to determine the decay function over the sampled time intervals, was the failure by Meyer et al. to control the subject's activity during the intervening time interval within the critical pairs.

A major difference between Meyer et al. and the previously cited studies, was the type of task and procedures used to study the decay function. The lexical decision task used by Meyer et al. is considered to be an experimental task that cannot be performed in the absence of lexical access but which requires little else (Coltheart, in press). Therefore, any additional processing such as the comparison of two word meanings, or deciding whether a sentence is true or false which may occur after lexical access and thus influence the degree of activation, are presumably eliminated when using the lexical decision task.

CHAPTER III

STATEMENT OF PURPOSE

The focus of interest stemming from Collins & Loftus (1975) spreading activation theory is on the time course of the semantic priming effect in lexical memory. Collins & Loftus suggest that the spread of activation fades over time. If spreading activation fades over time, then the semantic priming effect should also fade.

The purpose of the present series of experiments was to examine the decay function of semantic priming by varying the time interval between a prime word and its related target word. Specifically, this study was concerned with establishing the maximum time interval needed to eliminate the semantic priming effect under controlled conditions. These conditions included the presentation of a single prime, the use of an unrelated filler task in order to minimize rehearsal and control for interference effects, and the use of a lexical decision task. The present study used a series of experiments in order to plot the decay function over several time intervals.

CHAPTER IV

EXPERIMENT I

The first experiment used three different time intervals between the prime word and its target word. For the shorter interval a delay of one second was chosen to replicate the semantic priming effect of earlier studies. The longer interval was fifteen seconds which was substantially longer than the maximum time used by Meyer et al. (1972) with a similar task. A six second time interval was used as a midpoint. Except for the one second delay, the interpolation of a filler task between the prime and target was used to minimize rehearsal and control the effects of interference. For all three delays, an asterisk for one second served as a fixation and warning signal that a decision was required on the following letter string target. The asterisk served as the filler task for the one second delay and was included to keep the task consistent across the different delays in the present experiment.

It was considered desirable that the priming effect for the one second delay reflect the fullest level of activation. An assumption made by spreading activation models is that activation continues as long as the prime is in active memory (Collins & Loftus, 1975). Studies by Neely (1976) and

Warren (1977a) have indicated that an individual does not have to be informed of the relationship between the prime and target items, nor is an overt response to the prime necessary in order for the priming effect to occur. However, Warren (1977a) has suggested that the manner of processing the prime may determine how long activation is maintained. When the subject is not required to respond to the priming word, it is not clear in what manner the subject will respond, or whether the individual even attends to the priming word. In the present experiment, the subjects were instructed to use the information in the prime to help them make a decision (Becker & Killion, 1977). In addition, they were required to pronounce the prime which stayed on the screen for two seconds. Neely (1976) has presented evidence that the automatic and attentional components of the facilitation effect are maximal by two seconds. While a pronunciation task does not necessarily require accessing the meaning representation (see Coltheart, in press), this method does insure that the subjects will attend to the prime.

Method

Subjects

Twenty-four Oklahoma State University undergraduates were recruited from Introductory Psychology courses. They were given a small amount of extra credit toward their course grade in exchange for participation.

Stimulus Materials and List Construction

Seventy-two words and their associates were selected from free association norms (Bousfield, Cohen, Whitmarsh, & Kincaid, 1961). For the associated pairs the second word of the pair was given as a primary associate to the first an average of 71% of the time. These words were two to eight letters in length with a frequency of occurrence ranging from 6 to 547 and a mean of 139.76 (excluding four outliers over 600) according to Kucera & Francis (1967). A second set of 108 individual words of similar length and frequency but unassociated with the previous 72 pairs was compiled. In selecting the materials, items that might serve as associates or be highly related to any item other than within their own pair were excluded. For example, "male-female" was included but not "boy-girl". Also, while an effort was made to insure that any item in the second set of 108 items was not associated to any other item in the second set, nor in the first set, no effort was made to control for whether they had a high probability of eliciting an associative or semantically related response.

Two presentation lists of 108 pairs were constructed. Each list consisted of three different sets of word pair types: 36 Associated-Prime (AP) word pairs; 36 Unassociated-Prime (UP) word pairs; and 36 Word-Nonword (WN) pairs. The 36 AP word pairs were generated for each list by sorting of the set of 72 AP word pairs on frequency and association value. Stimuli for the UP trials were generated by initially culling 36 words from the second set of 108 individual words. These 36 words were used as primes for the UP pairs in both presentation lists. The targets for the UP primes in each list were the AP target words from the opposite presentation list. Pairing of the UP primes and AP targets was random. For the WN trials, 36 pronounceable nonwords were created from the remaining 72 words of the 108 individual word set. The nonwords were created by replacing a single letter with a different letter of the same class, e.g., "theft" became "thaft". The remaining 36 words of the 108 word set were used as primes for the WN trials.

To construct the experimental trials, each list was divided into six blocks of 18 trials. Within each block, two AP trials, two UP trials, and two WN trials occurred for each delay. Thus a total of six AP trials, six UP trials, and six WN trials occurred in each block. Assignment of a word pair type to a specific trial within a block was random with the restriction that no more than three of the same word pair type occurred on consecutive trials. For each presentation list any particular word pair (e.g., dog-cat) was randomly assigned to one of the five blocks with the restriction that it occur on a trial designated for that word type (e.g., AP). This random assignment of word pairs was done individually for each subject.

Eighteen trials of word pairs balanced across word pair types and delays were constructed in a manner similar to that used above for use as a set of practice trials.

Procedure

Subjects were run individually in a darkened room in a single 40 minute session. All facets of the experiment except the subject were controlled by an on-line ADS 1800-E minicomputer. Materials were presented on an ADM-3 CRT display in lower case letters. The dependent measure of reaction time for the critical targets was recorded when the subject released one of two buttons to indicate whether or not a letter string on the CRT was a word or nonword. Word/nonword position was counterbalanced across subjects.

At the beginning of the session, each subject was told that the study concerned how quickly they could decide whether or not a stimulus was a word. Subjects were informed that the pairs would sometimes be related and were instructed to attend to the semantic information in the first word of the pair in order to possibly aid their lexical decisions. They were told that a time interval may occur between the first word and the second word on each trial. During this time interval, either an asterisk, or a series of one digit numbers and then an asterisk would appear on the screen as a filler task. The filler task consisted of a series of one digit numbers from one to nine, successively presented in a random order for each trial. The subjects were told that if a series of numbers followed the first word in the trial, they were to then add one to the number that appeared on the screen and state the results orally. They were told that they would have only one second to perform the task and were assured that this would be ample time. The presentation of an asterisk served as a fixation point and warning signal that a lexical decision would be required for the following letter string.

Each subject was presented with the same practice trials followed by one of the two presentation lists. On each trial, the following events occurred: a) "READY" appeared centered on the CRT screen. The subject initiated a trial by pushing and holding down both buttons. The "READY" signal served as a fixation point for subsequent stimului. b) Immediately following, a prime word replaced the ready signal in the center of the screen, and remained on for 2.0 seconds during which the subject pronounced the word. c) Following the offset of the prime, one of three time intervals occurred with the appropriate filler task. For a one second delay, the interval was filled by the presentation of an asterisk for one second. For the six second delay, the interval was filled with the successive presentation of five one digit numbers in a random order for one second each; an asterisk for one second; and then the target letter string. Fifteen second delays were similar with 14 digits being presented in a random order and then an asterisk. d) Presentation of the target letter string required that the subject release the appropriate word/nonword button. e) The target was immediately replaced by feedback for 1.5 seconds indicating whether the subject was "CORRECT" or "WRONG". f) A blank screen followed for 1.5 seconds and then the ready signal.

Design

A 3 X 2 factorial design was employed with Delay (1, 6, & 15 seconds) and Prime Type (Associated, Unassociated) as within subjects factors. The dependent measure was the decision latency in milliseconds to the target

To insure that all AP pairs would occur under all delay conditions, the 36 AP and UP pairs for each list were subdivided into three subsets of 12 pairs and counterbalanced within each presentation list according to a latin square design across delays. Similarly, the WN primes were divided into three subsets and counterbalanced. The nonword targets for the WN pairs were simply randomized across delays within a list for each subject. The UP primes and the WN pairs were identical for all subjects and differed between subjects only in the counterbalancing across delays.

One half of the subjects received one presentation list and the other half the other list. Thus every pair of subjects constituted a complete set of target words under both an associated and unassociated prime condition. Three pairs of subjects were required to achieve the complete counterbalancing of priming conditions across delays. This guaranteed that each subject saw each word only once in a list, and allowed each target of interest to occur under all experimental and control conditions. As a result, while an effort was made to approximately match word sets on variables such as frequency, this control was not crucial since comparisons were made on latencies to exactly the same words under different priming conditions.

Results

The mean latencies collapsed across subjects for each condition are displayed in Figure 1 (see Appendix B), along with the error percentages. The mean for an individual subject was calculated by excluding misclassification errors and latencies which were above or below two standard deviations of a given subject's mean latency. The error percentages were not analyzed since 72% of the error data matrix were zero entries. The overall error rate was 5.4% for the AP condition and 6.6% for the UP condition, thus giving no evidence for a speed-accuracy tradeoff.

The analysis of variance summaries are presented in Table I (see Appendix A) for the by-subjects and by-items analyses. The means entered into the analysis of variance for the by-subjects analysis were calculated by collapsing on items for each condition. Thus, each subject would have a mean entered for each condition based on several items. For the by-items analysis, the means were calculated for each item by collapsing on subjects under each condition. Thus, each item would have a mean entered for each condition based on several subjects. The conservative min <u>F</u>' statistic (Clarke, 1973) was calculated in order to allow generalization of the results both to the populations of subjects and items. To assess the priming effect, the comparison is between the target preceded by an associated prime versus an unassociated prime. A significant main effect for Prime Type was indicated, min $\underline{F}'$ (1, 93) = 4.91, $\underline{p} < .05$, MSe = 1626. The other significant effect was the interaction of Delay by Prime Type, min $\underline{F}'$ (2, 159) = 3.15, $\underline{p} < .05$, MSe = 1422.

To determine where the differences between Prime Types within a Delay existed, least significant difference (LSD) tests were made on all these comparisons for the by-subjects analysis. The MSe term used in calculating the critical LSD value for these comparisons was the pooled error term from the Prime Type main effect and the Prime Type by Delay interaction. The critical LSD, $\underline{df}$ = 69, $\underline{p}$ = .05, was 22.29. The differences between the AP and UP conditions was significant at the one second delay, 60.22; the six second delay, 28.52; but not at the fifteen second delay, 1.06. The next comparison of interest is between the same Prime Type across delays. Pooling the error terms for the Delay and the Prime Type by Delay interaction resulted in a critical LSD, $\underline{df}$ = 92, $\underline{p}$ = .05, of 28.5. The only significant difference was between the one and fifteen second delays for the UP condition, 34.98. The difference between the one and fifteen second delays for the AP condition, 24.18, failed to reach statistical significance.

Discussion

There was a reliable and substantial semantic priming effect at the one second delay similar to several previous studies (Becker & Killion, 1977; Meyer & Schvaneveldt, 1971; Meyer et al., 1972, 1975). These studies measured semantic priming by the difference between the latencies to targets of related and unrelated primes. The principle effect of interest is the apparent increase in the mean latencies for the AP condition. At six seconds the net facilitation effect was still significant but had decreased to slightly one half of its original magnitude when compared to the net facilitation at the one second delay. A decrease of this magnitude by six seconds is similar to that reported by Meyer et al. (1972), for a four second delay using a lexical decision task. The apparent rate of increase depicted in Figure 1 (see Appendix B) for the AP condition also indicates that the facilitation effect may no longer be statistically significant after a few more seconds. By fifteen seconds the facilitation effect is no longer significant. The decrease in the semantic priming effect over the sampled time intervals is consistent with a spreading activation model explanation.

Of particular interest in interpreting the semantic priming effect is the apparent inhibition displayed by the unassociated priming condition. Individuals took significantly longer to make a positive response to an unassociated target after one second than after a fifteen second interval. The usual comparison for the semantic priming effect involves the same targets under different priming conditions at the particular interval of interest. The present data suggests that the comparison is composed of both a facilitatory and an inhibitory effect. The failure to find a significant difference in the present experiment between the one and fifteen second delays for the AP condition further suggests that the semantic priming effect may be in large part a function of the inhibitory effect in the comparison.

Posner & Snyder (1975) have suggested an alternative to a spreading activation or location shifting explanation of the semantic priming effect. They propose that both a spreading activation process and a limited-capacity attentional mechanism are operating in the lexical decision task to produce the semantic priming effect. In the present experiment, the decrease in the unassociated target latencies over time would lend support to the filler task's effectiveness in occupying the person's limited-capacity attentional system. However, the design of Experiment I did not include the necessary manipulation that would have allowed the relative contributions of these two processes to be assessed. Experiment II was designed to investigate the roles of a limited-capacity attentional mechanism and a spreading activation process in the semantic priming effect in a lexical decision task over several intervals of delay. In addition, the sampled time intervals in Experiment II were selected to further investigate the reliability of the decay function, and to determine at what point the facilitation effect would no longer be statistically significant.

CHAPTER V

EXPERIMENT II

The two-factor theory of Posner & Snyder (1975) incorporates Morton's (1969) concept of "logogens". Logogens are memory representations of information (words or, possibly, morphemes) in long-term memory that are activated when visual and/or auditory feature detectors are incremented to some threshold value. This theory maintains both the spatial metaphor and spread of activation concept previously mentioned. The facilitation effect can involve an automatic, out of awareness, and fast acting spread of activation, and/or a conscious, slower acting, attentional mechanism. The time course of the automatic spread of activation has been shown to begin as early as 40 to 100 milliseconds after the onset of the prime (Fischler & Goodman, 1978; Warren, 1977a). The attentional factors may influence retrieval as early as 250 milliseconds (Neely, 1977). In order that the information be retrieved, the limited-capacity attention mechanism must be directed to the activated logogen. Presumably, less time is required to shift attention between semantically related logogens than between unrelated ones. Posner & Snyder suggest that in tasks involving a prime, subjects use this information to direct their attention to semantically related logogens. When the prime and target are related, the attention is appropriately directed, and the relatively shorter "shifting" of attention to the related logogens along with the spread of activation both contribute to the facilitation effect. When the prime and target are unrelated, attention is misdirected by the prime, and a greater shift of attention which requires additional time is necessary before the information from the unattended logogens of the unrelated target can be retrieved.

This inhibition of retrieval of unrelated logogens is a crucial component of the two-factor theory. Posner & Snyder recommend including a condition with a neutral prime which would not direct the limited-capacity attention mechanism to any specific set of words or logogens, nor activate the logogen of the target word via spreading activation. Theoretically, the latencies for the targets to this neutral prime provide a baseline for assessing the effects of the two processes. The comparisons of interest would be those between the associated and unassociated targets, and targets which follow neutral primes. When making comparisons with the neutral baseline, shorter latencies to the target letter string under the associated prime and longer latencies to an unassociated prime would argue for respective spreading activation and limited-capacity attention processes. In the latter comparison, the prime is said to have inhibited the processing of the target. However, if there were no differences between the target latencies in the unassociated and neutral conditions, then the implication is that spreading activation is the sole contributor to the facilitation effect.

Neely (1976) incorporated the use of a neutral prime (XXX) in an experiment designed to evaluate the role of the limited-capacity attention system in the semantic priming effect in a lexical decision task. Besides replicating the semantic priming effect, further comparisons indicated longer latencies to targets preceded by an unrelated prime than a neutral prime. The difference between these conditions was small but significant (16 milliseconds) and suggested that a limited-capacity attention mechanism was involved in the semantic priming effect.

Neely (1977) elaborated on this paradigm in a more rigorous test of the assumptions of the two-factor theory. In this experiment, the priming event was either a neutral prime (XXX) or a semantic category (e.g., BIRD). In a "Shift" condition, the subjects were told to focus their attention on exemplars of another category, e.g., part of a building. The "Nonshift" condition had the subjects focus their attention on exemplars of the same category. A second variable was whether the subject received a target exemplar that was "Expected" or "Unexpected" on the basis of the Shift/Nonshift prime condition. A third variable was whether this exemplar was "Related" or "Unrelated" to the prime. The results indicated that, for example, in the "Shift, Expected, Unrelated" condition where the prime was "BIRD", and the individual expected a building part as a target, latencies were shorter for the target "door", and longer when the target was "robin" as compared to a neutral prime. In addition, in the "Nonshift, Expected, Related" condition, "BIRD-robin" type trials were faster than XXX-prime trials (a facilitation effect) whereas, "BIRD-arm" trials were slower than the XXX-prime trials (an inhibition effect). In general, support was given for both the limited-capacity attention mechanism and an automatic spread of activation as being involved in the semantic priming effect.

In the present study, Experiment II was designed to investigate the relative contributions of these two processes in the semantic priming effect and their concomitant decay functions by including the suggested neutral prime condition. To argue for the limited-capacity attention system as an explanation for an inhibition effect would require first, that the inhibition effect be greater at the shorter delays and decrease as the intervals increased. Such an effect, as found in Experiment I, indicates that the filler task is effectively committing the limited-capacity attention system. Second, the neutral priming condition would be expected to result in latencies similar to the associated and unassociated conditions at the longer delay intervals. Third, at the shorter delays, the associated prime should produce shorter latencies than the neutral condition (a facilitation effect), and the unassociated condition should result in longer latencies than the neutral condition (an inhibition effect). Thus, as the delay intervals increase, an interaction should be evident where both effects decrease in size.

Experiment II included the one second delay in order to replicate the semantic priming effect and provide a necessary point of comparison for the two new delays. The results from Experiment I indicated that the net facilitation effect might no longer be statistically significant shortly after six seconds. Therefore an eight second delay was selected. Eighteen seconds was chosen as the other delay in order to maximize the information about the asymptote of the AP curve since the previous experiment left some question about the failure to find a significant difference between the one and fifteen second delays for the AP condition.

Method

Subjects

The subjects were 15 undergraduates and three graduate students (n = 18) from Oklahoma State University. The undergraduates received a small amount of extra credit toward their course grade in exchange for participation.

Stimulus Materials and List Construction

An additional 36 associated word pairs were selected from the free association norms bringing the total to 108 pairs. The new frequencies for this list ranged from 6 to 547 with a mean of 114.7 (excluding four outliers). The second word of the pair was a primary associate 62.77% of the time on the average. An additional 36 items of similar length and frequency were selected and combined with the second set from Experiment I; bringing the total to 144 words in the second set. The same restrictions used in Experiment I applied in compiling this second set.

Initially the items were separated into three base presentation lists of 180 pairs. Each list consisted of five different sets of word pair types: 36 Associated-Prime (AP) word pairs; 36 Unassociated-Prime (UP) word pairs; 36 XXX-Prime (XP) word pairs; 36 Word-Nonword (WN) pairs; and 36 XXX-Nonword (XN) pairs. The assignment of the 36 AP pairs to each list was accomplished by sorting the set of 108 AP pairs on frequency and association value. Each of the 36 AP subsets were further divided into 12 AP pairs for assignment to delay conditions. Stimuli for the UP trials were generated by randomly selecting 36 words from the second set of 144 individual words to be used as primes for the UP pairs in all three presentation lists. The targets for the UP trials in each list were the AP targets of one of the other presentation lists. The pairing of UP primes and AP targets was random. For the XP trials the targets were also generated by randomly pairing the AP targets of one of the other presentation lists. For example, the first subject might see "dog-cat" as an AP trial; "thick-nurse" as an UP trial; and "XXX-light" as an XP trial. The second subject would see "doctor-nurse", "thick-light", and "XXX-cat" respectively. Finally, the third subject would receive "dark-light", "thick-cat", and "XXX-nurse" as the respective AP, UP, and XP trials.

Seventy-two pronounceable nonwords were created from the remaining 108 words of the second 144 word set and randomly assigned as targets for the WN and XN trials. The remaining 36 words of the second set were used as primes for the nonword targets of the WN trials.

Each of the three base presentation lists of 180 pairs was further divided into two sublists of 90 pairs each. Each sublist was presented to a subject in one of two separate sessions. Division of a base list was accomplished with an effort to maintain similar mean frequency and association values across the sublists. To construct the experimental trials for a sublist, each sublist was divided into three blocks of 30 trials. Within each block two AP, UP, XP, WN, and XN trials occurred for each delay. Thus, a total of six AP, UP, XP, WN, and XN trials occurred in each block. Assignment of a word pair type (e.g., AP) to a specific trial within a block was random with the restriction that no more than three of the same word pair types occurred on consecutive trials. In addition, no more than four nonword responses were allowed on consecutive trials. Random assignment of word pair types to blocks was accomplished for the two sublists. For each sublist, any particular word pair (e.g., dog-cat) was randomly assigned to one of the three blocks restricted to its respective word pair type (e.g., AP). This random assignment of word pairs was accomplished for each sublist for each individual subject.

Fifteen trials of word pairs balanced across word pair types and delays were constructed in a manner similar to that used above for use as practice trials for each session.

Procedure

The procedure was the same as in Experiment I with the following differences: a) Each subject participated in two sessions separated by approximately 24 hours. Each session took about 40 minutes and consisted of a set of practice trials and the presentation of a sublist. The sublists were counterbalanced across sessions. b) The delays were 1, 8, and 18 seconds. c) The following was integrated into the instructions: If a series of X' (XXX) appeared as the first item of a trial, the subject was to say outloud "X".

Design

A 2 X 3 X 3 within subjects design was employed. The respective factors were List Sets (sublist 1, sublist 2), Delay (1, 8, 18 seconds) and Prime Type (Associated, Unassociated, XXX).

In a fashion similar to Experiment I, the AP, UP, and XP pairs of a sublist were divided into three subsets of six pairs and counterbalanced according to a latin square design across delays. The WN and XN primes were also divided and counterbalanced. The nonword targets were randomized across delays and primes for WN and XN pairs. The UP primes and WN and XN pairs were identical for all subjects and differed only in the counterbalancing across the delays.

Three subjects were required in order to achieve a complete set of target words under the Associated, Unassociated, and XXX prime conditions. Three triplets of subjects (9 subjects) were required to achieve the counterbalancing of priming conditions across the three delays. Finally, an additional set of three triplets were required to achieve the counterbalancing of sublists across the two sessions. As a result, 18 subjects were necessary to obtain a complete set of data where the target word appeared under all priming conditions, across all delays, and the sublists were counterbalanced across sessions.

Results

The means were calculated for each condition as in Experiment I. Since the overall response times appeared to be faster in Experiment II than in Experiment I, a Sessions X Delay X Prime Type analysis of variance was performed. A significant main effect for Sessions was indicated, F (1, 17) = 22.51, $p < .001$. Target latencies averaged 60.29 milliseconds faster across the treatments in Session 2. None of the interactions involving the Sessions factor was significant. Thus the overall faster latencies in Experiment II could probably be attributed to a practice effect.

A analysis of variance based on List Sets X Delay X Prime Type, revealed no significant main effect for List Sets nor were any of the interactions involving the List Sets factor significant. Since the statistical analysis for both sessions produced the same results and there was no effect due to List Sets, the sublists were combined to improve the reliability of the means and lessen the influence of outlying latencies. The resulting mean latencies for each condition, along with the error percentages in parantheses, are displayed in Figure 2 (see Appendix B). The Delay X Prime Type analysis of variance summaries on the combined sublists are presented in Table II (see Appendix A) for the by-subjects and by-items analyses. In the by-items analysis, the means for each cell were based on no more than two latencies. Since six cells resulted in missing data, the procedure developed by Yates (1933) was used to estimate the missing values and the degrees of freedom for the error term was reduced by the appropriate number. A significant main effect for Prime Type was indicated, min F' (2, 120) = 6.75, $p < .005$, MSe = 1379. The effect of Delay was not significant for the by-subjects analysis, F (2, 34) = 2.03, MSe = 2400, but was for the by-items analysis, F (2, 211) = 3.34, $p < .05$, MSe = 9108. The interaction of Delay X Prime Type was significant, min F' (4, 245) = 2.47, $p < .05$, MSe = 939.

The first comparisons of interest are between the Prime Types within a Delay. The critical LSD, df = 102, p = .05, was 21.75. The difference between the AP and UP conditions was significant at the one second delay, 72.64, but not at the eight second, 20.69, nor at the eighteen second delays, 14.49. The difference between the AP and XP conditions was significant at the one second delay, 51.91, but not at the eight second, 16.26, nor at the eighteen second delay, 12.72. The difference between the UP and XP conditions failed to reach statistical significance at either the one second, 20.73, eight second, 4.43, or eighteen second delay, 1.77.

The next comparisons of interest are between the Prime Types across the different delays. The critical LSD, df = 102, p = .05, for these comparisons was 24.93. There was a significant difference between the one and eighteen second delays for the AP condition, 28.04, and the UP condition, 30.11, but not for the XP condition, 11.15. The difference between the one and eight second delays was significant for the UP condition, 40.96, but failed to reach statistical significance for the XP condition, 24.66, or the AP condition, 10.99.

The error rate patterns indicated more errors for the UP condition (9.1%), than the XP condition (6.8%), and the fewest occurring in the AP condition (5.1%). Thus a speed-accuracy tradeoff was not indicated.

Discussion

The results confirm and extend the findings of Experiment I for the AP and UP conditions. Again, the comparison between the AP and UP condition at the one second delay revealed a significant semantic priming effect similar to the previously cited research. The increase in the mean latencies over the delay intervals for the AP condition replicates Experiment I. Consistent with a decay interpretation, the AP-UP comparisons at the eight second and eighteen second delays were no longer significant.

The trends for the AP and UP condition are generally consistent with Experiment I. For the UP condition, subjects took significantly longer to respond at the one second than at the eighteen second delay. For the AP condition and contrary to Experiment I where the difference was not significant, the mean latencies were significantly shorter for a positive response at the one second than at the eighteen second delay. The significant increase in the latencies for the AP condition and significant decrease in the UP condition, would seem to argue for a respective decay of spreading activation, and a limited-capacity attention mechanism being effectively occupied by the filler task.

However, as suggested by Posner & Snyder (1975), the appropriate comparisons involving the XP condition should be considered in order to determine if an automatic spread of activation process and/or an inhibition effect due to the limited-capacity attentional system are involved. At the one second delay, the comparison between the AP and XP conditions revealed significantly faster latencies for the AP condition. Assuming the XP condition is neutral, the significant AP-XP difference would suggest a spread of activation component. The comparison between the UP and XP conditions at the one second delay was not signficant. Thus the UP-XP comparison in the present data would not suggest an inhibition effect due to a limited-capacity attention mechanism as operative in the semantic priming effect.

The failure to find a significant UP-XP difference in the present study is contrary to the results presented by Neely (1976, 1977) which generally supported an inhibition effect. One possible explananation for this inconsistency is that the significant inhibition effect in Neely's (1976) study is relatively small (16 milliseconds) and could be attributable to a Type II error. As a result, in Neely's study, the slight decrease in the latencies for the XXX-prime condition as compared to the unassociated condition may not be attributable to the operation of a limited-capacity attention mechanism. Neely (1976) points out two results in his study which are also incongruent with predictions involving a limited-capacity attention mechanism. The first was that the inhibition effect in his study did not increase as SOA increased. According to the two-factor theory, the attentional mechanism should become more fully operative as SOA increases since the individual would have more time to consciously direct his attention. Secondly, Neely (1976) found faster latencies for nonword targets with a word prime as opposed to a neutral prime. According to Neely, an inhibition effect should also occur for nonword targets, as well as semantically related word targets, if the priming word was depleting some of the subject's limited-capacity attention system.

While the comparison between the UP and XP condition did not indicate an inhibition effect in the present experiment, several other results suggest the role of a limited-capacity attention mechanism. First, the XP latencies are shorter than the UP latencies which is consistent with the predictions of the two-factor theory. Second, the latencies for all three condition are not significantly different from each other at the longer delays indicating a decrease in the net difference between the conditions as the delay increases; again suggestive of a limited-capacity attention mechanism. Finally, when the evidence presented in Neely's (1977) "Shift/Nonshift" study for an inhibition effect attributable to a limited-capacity attention mechanism is considered, it could be argued that perhaps a Type I error has occurred in the present experiment. The difference between the XP and Up conditions at the one second delay in the present experiment failed to reach statistical signifcance by a very slight margin, even though the present difference was slightly larger than the difference reported by Neely (1976).

Another possible explanation for the inconsistency between the present experiment and Neely's (1976) study involves the specific time intervals used as delays. The study by Neely (1976) used a zero delay interval between the offset of the prime and the onset of the target. The comparable manipulation in the present experiment involved a one second time interval. It is possible that the inhibition effect derived from the UP-XP comparison may be significant at a zero delay. A significant inhibition effect along with a decrease in the UP target latencies over the delay intervals would argue quite convincingly for the operation of a limited-capacity attention mechanism. However, this arguement also implies that at the zero delay, either the UP condition latencies must increase, and/or the XP latencies must decrease. The former seems unlikely since the difference between the AP and UP conditions in the present experiment compared favorably with Experiment I and the previous literature. However, the XP latencies remain questionable. In either case, the question is empirical and Experiment III was designed to investigate the preceding alternatives.

CHAPTER VI

EXPERIMENT III

The design of this experiment involved a zero delay interval between the offset of the prime and onset of the target. If the difference between the XP and UP conditions is significant, then it could be argued that an inhibition effect does occur and a limited-capacity attention mechanism is implicated as a viable explanation. If the difference is not significant, then the evidence would suggest some process other than a limited-capacity attentional mechanism being operative in the present experimental manipulations.

Method

Subjects

Nineteen undergraduates and two graduate students (*n* = 21) from Oklahoma State University served as subjects. Ten of the undergraduates received a small amount of credit toward their course grade in exchange for participation. The remaining subjects were volunteers.

Stimulus Materials and Design

Thirty-six associated pairs were randomly selected from Experiment I. The frequency of the targets ranged from 17 to 547 with a mean of 206.9 (excluding four outliers). The targets were primary associates for 72.9% of the time on the average. These 36 pairs were further divided into three subsets of 12 pairs by sorting on frequency and association value. Twenty-four words were randomly selected from the words used as primes for the UP pairs in Experiment I. Twelve of these words were randomly assigned as primes for the UP condition and the remaining twelve were used as primes for the WN condition. Twenty-four nonwords were randomly selected from the nonwords used in Experiment I. Twelve were randomly assigned as targets in the WN condition with the remaining twelve for the XN condition.

Three presentation lists of 60 pairs were constructed. Each list consisted of 12 AP, UP, XP, WN, and XN pairs. The experimental trials for a list were constructed by dividing each list into three blocks. Within each block, four pairs of each condition occurred. The same restrictions and randomization procedures were followed as in the previous experiments.

The design was a single factor repeated measures design with Prime Type (Associated, Unassociated, XXX) as the within subjects factor. Since the delay factor was not involved in this experiment, the only counterbalancing involved the presentation of the lists in triplets of subjects in order to achieve a complete set of targets under all the priming conditions.

Fifteen trials of word pairs balanced across word pair types similar to Experiment II, but without the delays, were constructed for use as practice trials and were identical for all subjects.

Procedure

The procedure differed from the previous two experiments by employing a zero delay after the two second presentation of the prime before onset of the target for all priming conditions. Thus any mention of a filler task was simply eliminated from the instructions used in Experiment II. A session lasted 15 minutes.

Results and Discussion

The same procedure as in the previous experiments was used to calculate the means which are presented in Table III (see Appendix A) along with the error percentages. No speed-accuracy tradeoff was indicated since fewer errors occurred in the AP condition (3.97%) than either of the other two conditions (7.54% & 7.94% for the UP & XP conditions respectively). Table IV (see Appendix A) presents the single factor (Prime Type) repeated measures analysis of variance summaries for the by-subjects and by-items analyses. The main effect for Prime Type was significant, min F' (2, 109) = 10.14, $p < .001$, MSe = 1433. The critical LSD, df = 40, p = .01, was 31.59. The difference between the AP and UP conditions was significant, 74.83, as well as the difference between the AP and XP condition, 84.78. The difference between the UP and XP condition was not significant, 9.95.

There was a semantic priming effect comparable to the previous experiments at the zero delay. The UP-XP comparison not only failed to reach statistical significance, but was in the wrong direction as well. Thirteen of the 21 subjects had a higher mean latency for the XP condition as compared to the UP condition. Therefore, when the XXX-Prime is used as a neutral condition and the UP-XP comparison as advocated by Posner & Snyder (1975) is performed, the present data does not support a limited-capacity attention system as being involved in the semantic priming effect.

However, there is other evidence which does implicate an attentional process in the semantic priming effect. The decrease in the UP latencies across delays in Experiments I and II indicate that some process is producing an inhibition effect. If this is happening then the question is why was the inhibition effect not evident from the UP-XP comparison?

One possible explanation is that the subjects in the present series of experiments were processing the primes in the UP and XP conditions in a similar manner. In effect, the XXX-primes were not "neutral". The task requirements in the present study for processing the primes could have contributed to the results. In Neely's (1976) first study, the subject made no overt response to the priming stimulus, nor were there any specific instructions on how to process the priming item. Therefore, there is no way to determine the extent to which the primes were processed. The inhibition effect was small (16 milliseconds) but significant. In Neely's (1977) second study, the subjects were given explicit instructions to "shift" to "not shift" their attention which maximized the use of any attentional system. The comparisons to determine whether an inhibition effect had occurred involved the conditions where a category prime preceded an unexpected exemplar from another category as the target, and the XXX-Prime condition for the same target items. The resulting comparisons revealed more substantial inhibition effects averaging from 59 to 72 milliseconds for the 2000 millisecond SOA group.

In the present study, having the subjects pronounce the prime might have increased the likelihood that the semantic representation of the letter "X" was accessed. If that were indeed the situation, then no difference would necessarily be expected between the UP and XP conditions since the "XXX" would be similar to an unrelated prime. Therefore, the XXX-Prime condition may not be a sufficiently "neutral" condition to allow the proper comparisons. Rather, it may be more appropriate to consider the target latencies at the 15-18 second delay points as "neutral" conditions. When these delays are considered as the baseline conditions in the comparisons, then both spreading activation and limited-capacity attention mechanisms are implicated and the two-factor theory remains a viable explanation.

At least two additional explanations could account for the present findings. One is the semantic-matching strategy offered by Neely (1976, 1977) and the other is the Verification model of Becker & Killion (1977). Neely has argued that while the evidence in his studies in general support the two-process theory of Posner & Snyder (1975), allowances must be made for a semantic matching strategy (cf., Smith, Shoben, & Ripps, 1974) in order to explain the facilitation of non-word targets that occurred in his experiments. According to the semantic matching hypothesis as described by Neely (1976, 1977), a subject's response could have been made on the basis of a match between the semantic features of generated targets to the prime (internally generated via conscious attention), and the semantic features activated by the target letter string. If a match based on similar features would occur, then the subject would have the tendency to respond "yes" or "word". If the semantic features were dissimilar and a mismatch would occur, there would be a tendency to respond "no" or "nonword". While Neely (1976, 1977) is not exactly clear as to what mechanisms are involved, Smith et al. (1974) more specifically suggest the manner in which such a strategy would operate.

Accordingly, the comparison process between the semantic features would have a positive criterion and a negative criterion. If a match is above a positive criterion, the subject responds "yes" or "word"; if it is below a negative criterion, the subject answers "no" or "nonword". Thus the subject's response criterion would be biased toward answering "word" when a match occurs, but "nonword" when a mismatch occurs. If neither criterion are met, then the subject continues processing until a decision can be made. If a match or mismatch can be reached based on the subject's response criterion, the reaction time will be faster than if he must continue processing. This latter condition could occur when the prime was semantically unrelated to a word target. Since neither criterion would be met, the subject would have to continue processing in order to make the correct "word" response. In the case of a neutral prime, the subject would not necessarily generate possible targets for comparison to the presented target. As a result, the response to the following target should be neither facilitated nor inhibited by a match/mismatch strategy based on semantic features. In effect the subject's response criterion would be neutral since adopting a semantic matching strategy would not prove beneficial. Thus when compared against the appropriate neutral conditions, the induced bias based on a match/mismatch strategy would result in shorter latencies (a facilitation effect) for semantically related word targets and nonword targets that have been preceded by a word prime. Longer latencies (an inhibition effect) would result for word targets that have been preceded by a semantically unrelated prime when compared against a neutral condition. Neely (1976) argues that the subject could benefit from such a strategy in his study since 75% of his word prime trials involved associated or nonword targets.

In the present study the use of high probability associates and specific instructions to use the information in the primes may have encouraged the use of a matching strategy. It would also be expected that the facilitation and inhibition effects would decay over time since the subjects were not allowed to maintain conscious attention on the generated targets.

While the present data generally conforms to this explanation, the semantic matching strategy does not seem to be able to adequately explain the failure to find a UP-XP difference. Even if the XXX-prime was not "neutral" and the subject accessed semantic information in pronouncing the letter "X", the XXX-prime could not provide any information that would lead a subject to generate possible targets for any kind of successful matching strategy. Thus while the semantic matching strategy would predict a UP-XP difference (longer UP target latencies), the present data failed to confirm this prediction. Unfortunately, it was not possible in the present study to examine the prediction of a facilitation effect for nonword targets when preceded by a word prime. The nonwords were completely randomized across nonword target conditions (and delays in Experiments I and II) for each subject and as a result the necessary information was not available.

A final model to consider is the Verification model of Becker & Killion (1977). When an item is presented, the first stage involves formation of a visual icon. This is followed by a featural analysis which activates word detectors in a manner similar to the logogen model. However, unlike the logogen model, the featural information is not precise enough to allow a single word detector to exceed some threshold and instead a subset of items (the sensory subset) are designated by incrementing their word detectors. The next stage (the verification stage) results in a serial search of the subset which is compared with the contents of visual memory. Recognition occurs when a match is found. Semantic context results in partial activation of the detectors for the related word as in the logogen model. The verification process can proceed with this semantic subset before the sensory subset has been designated. When a matchup occurs for the semantic subset, the savings in time involved in setting up the sensory subset would be the facilitaiton effect. When the prime is unrelated, the semantic subset is exhaustively sampled and no match being found, the sensory subset is sampled. The additional time would correspond to an inhibition effect. The decay of the facilitation and inhibition effects would be explained in terms of the decay of activation of the semantic subsets.

Becker & Killion also argue that "expectancy effects" could be handled by the mechanisms invoked for semantic context effects. A subject could include the expected stimuli in the semantic subset and recognition would result from sampling the semantic subset and thus bypassing formation of the sensory subset through the feature extraction process. In this way a facilitation effect would occur for expected items, and an inhibition effect for unexpected items, since additional time would be required to sample the sensory subset in the latter case.

Becker & Killion do not explore the possible effects of a "neutral" prime on subsequent word recognition. A reasonable explanation would suggest that a neutral prime does not result in partial activation of word detectors for any particular semantic subset; nor would it allow the subject to include any expected stimuli in a semantic subset. As a result, the response time would only involve the feature extraction processes and a subsequent sensory subset search. Presumably, the resulting response time would be longer than searching an already partially activated semantic subset, but shorter than if both a semantic and sensory subset search were required. Comparisons between these response times would reflect respective facilitation and inhibition effects.

The failure to find a significant UP-XP difference could be explained if the XXX-primes were not being treated as completely neutral. Pronunciation of the letter "X" might result in the detectors for this item being activated. Therefore, as in the UP condition, the total response time involved for the exhasutive search of the semantic subset and the subsequent sensory subset search may be similar.

While this theory is appealing because it can account for both the facilitation effects in the AP condition and the inhibition effects in the UP condition (when the longer delays are used as neutral points), it seems unlikely that the semantic subset activated by an XXX-prime would be very large. Thus searching it should take far less time and result in shorter latencies than for the UP condition. Also, it is not exactly clear whether the limited-capacity attention mechanism could initiate and/or maintain the spreading activation, or whether this mechanism would operate in a different manner than the automatic component.

CHAPTER VII

GENERAL DISCUSSION AND CONCLUSION

In general, the present experiments support a decay interpretation of the semantic priming effect. When the comparisons between the associated and unassociated conditions at a specific delay are considered, the evidence indicates that the semantic priming effect is no longer significant by eight seconds. However, as displayed in Figure 3 (see Appendix B), an approximately zero effect may not occur until 15 to 18 seconds.

The present data also suggests that both facilitatory and inhibitory effects are involved in the semantic priming effect. An XXX-Prime condition was implemented in Experiments II and III to separate out the facilitation and inhibition effects. This manipulation failed to support an inhibition effect due to a limited-capacity attention mechanism as advocated by Posner & Snyder (1975) and previously supported by Neely (1976, 1977). Since there was some question as to the neutrality of the XXX-prime, it was suggested that the 15-18 second delays be considered as alternative neutral comparison points. When the comparisons within a prime type are considered across delays, the curves suggest that both automatic spreading activation and limited-capacity attention mechanisms may be operative to produce the semantic priming effect. Both components may contribute to the facilitatory effect; and the limited-capacity attention mechanism to the inhibition effect. Such an interpretation is consistent with several previous studies (Fischler, 1977; Fischler & Goodman, 1978; Neely, 1976, 1977; Posner & Snyder, 1975; Warren, 1977a).

When the longer delays are used as neutral comparison points, it is important to consider the significant difference for the associated condition between the one and 18 second delays in Experiment II, but the failure to find a significant difference between the one and 15 second delays in Experiment I. While the associated versus unassociated comparisons in the present study indicate that the facilitation effect has decayed by eight seconds, the comparisons across delays for the associated conditions suggest that the facilitation effect may have decayed by less than one or two seconds after offset of the prime. This of course assumes that the individual is processing the prime for the two second presentation time and that this maintains the full activation level. If this were not the case, then complete decay may occur at even a shorter delay. Neely (1977) has found results indicating that by 750 milliseconds the attentional component is fully operative. Therefore it is conceivable that the automatic spread of activation component may have already decayed somewhat by the one second delay in the present study. This suggests that the facilitation effect observed over the time intervals in the present study, may

may be due to some process other than simply an automatic spread of activation. The implications are that attentional mechanisms are operative and that an individual can use conscious "expectancies to modulate their performance in a binary classification task" (Neely, 1977, p. 253). However, it is not readily determinable whether these attentional mechanisms initiate and/or maintain spreading activation, or involve some other kind of process or strategy on the part of the subject.

Neely (1977) argues that the attentional component does not maintain the spread of activation but instead involves a semantic matching strategy that is employed by the subject. While the semantic matching strategy was offered by Neely as a parsimonious effort to explain with one underlying mechanism both the inhibition effect for unrelated word targets and the facilitation of nonwords in his experiments, the present evidence did not support such a strategy. The semantic matching strategy, as well as the Verification model also presented as an alternative explanation, cannot accomodate the failure to find a significant difference between the XXX-prime and the unassociated prime conditions in the present study.

In summary, while the role of a limited-capacity attention mechanism in maintaining and/or producing facilitation effects is not exactly clear, the two-factor theory of Posner & Snyder (1975) provides a reasonable explanation for the present results if the XP condition is not necessarily assumed to be neutral, and the longer delays are considered as neutral points for the comparisons of interest. Further research should consider that both facilitatory and inhibitory effects are involved in the usual comparisons for the semantic priming effect. Also, it may prove beneficial to consider the time course of the facilitation effect as a function of the type of prime and manner of processing performed by the individual. Important information could be provided about the organization of semantic memory and the influence of subject's strategies on subsequent processing of semantic information. It is conceivable that a particular subject strategy may be useful in a task such as reading. This would seem to be especially relevant since in a reading task the subject may generate hypotheses based on the previous semantic context and thus prime semantic representations about the forecoming passages. If the automatic spread of activation component does not maintain the facilitation effect for longer than a few seconds, then other processes may have to be operative in order to maintain a facilitation effect to aid subsequent processing of semantic information. Research concentrating on the attentional mechanisms would seem to be a useful point of departure.

SELECTED BIBLIOGRAPHY

Ashcraft, M H. Priming and property dominance effects in semantic memory. Memory and Cognition, 1976, 4, 490-500.

Anderson, J. R., & Bower, G. H. Human associative memory. Washington, D. C.: V. H. Winston, 1973.

Becker, C. A., & Killion, T. H. Interaction of visual and cognitive effects in word recognition. Journal of Experimental Psychology: Human Perception and Performance, 1977, 3, 389-401.

Bousfield, W. A., Cohen, B. H., Whitmarsh, G. A., & Kincaid, W. D. The Connecticut free association norms. Technical Report, No. 35, University of Connecticut, 1961.

Clarke, H. H. The language-as-fixed-effect fallacy: A critique of language statistics in psychological research. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 335-356.

Cofer, C. N. Properties of verbal materials and verbal learning. In J. W. Kling & L. A. Riggs (Eds.), Woodworth and Schlosberg's experimental psychology. New York: Holt, Rinehart, & Winston, 1971.

Collins, A. M., & Loftus, E. F. A spreading-activation theory of semantic processing. Psychological Review, 1975, 82, 407-428.

Collins, A. M., & Quillian, M. R. Facilitating retrieval from semantic memory: The effect of repeating part of an inference. Acta Psychologica, 1970a, 33, 304-314.

Collins, A. M., & Quillian, M. R. Does category size affect categorization time? Journal of Verbal Learning and Verbal Behavior, 1970b, 9, 432-438.

Collins, A. M., & Quillian, M. R. How to make a language user. In E. Tulving & W. Donaldson (Eds.), Organization of memory. New York: Academic Press, 1972.

Coltheart, M. Lexical access in simple reading tasks. In G. Underwood (Ed.), Strategies of information processing. New York: Academic Press, in press.

Cramer, P. Mediated priming of associative responses: The effect of time lapse and interpolated activity. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 163-166.

Cramer, P. The determinants of mediated priming: Time interval, semantic and associative relationships. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 266-271.

Davelaar, E., & Coltheart, M. Effects of interpolated items on the association effect in lexical decisions tasks. Bulletin of the Psychonomic Society, 1975, 6, 269-272.

Donders, F. C. (On the speed of mental processes.) In W. G. Koster (Ed. & trans.), Attention and performance II. Amsterdam: North Holland, 1969. (Reprinted from Acta Psychologica, 1969, 30; originally published in 1868.)

Fischler, I. Associative facilitation without expectancy in a lexical decision task. Memory and Cognition, 1977b, 3, 18-26.

Fischler, I. Semantic facilitation without association in a lexical decision task. Memory and Cognition, 1977b, 5, 335-339.

Fischler, I., & Goodman, G. O. Latency of associative activation in memory. Journal of Experimental Psychology: Human Perception and Performance, 1978, 4, 455-470.

Forbach, G. B., Stanners, R. F., & Hochhaus, L. Repetition and practice effects in a lexical decision task. Memory and Cognition, 1974, 2, 337-339.

Jacobson, J. Z. Effects of association upon masking and reading latency. Canadian Journal of Psychology, 1973, 27, 58-69.

Kirsner, K., & Craik, F. I. M. Naming and decision processes in short-term recognition memory. Journal of Experimental Psychology, 1971, 88, 149-157.

Kucera, H., & Francis, W. N. Computational analysis of present day American English. Providence: Brown University Press, 1967.

Lockhead, G., Gaylord, S., & Evans, N. Priming with non-prototypical colors. Paper presented at the meeting of the Psychonomic Society, Washington, D. C., 1977.

Loftus, E. F. Category dominance, instance dominance, and categorization time. Journal of Experimental Psychology, 1973, 97, 70-74.

Meyer, D. E. On the representation and retrieval of stored semantic information. Cognitive Psychology, 1970, 1, 242-300.

Meyer, D. E. Correlated operations in searching stored semantic categories. Journal of Experimental Psychology, 1973, 99, 124-133.

Meyer, D. E., & Schvaneveldt, R. W. Facilitation in recognizing pair of words: Evidence of a dependence between retrieval operations. Journal of Experimental Psychology, 1971, 90, 227-234.

Meyer, D. E., & Schvaneveldt, R. W. Meaning, memory structure, and mental processes. In C. N. Cofer (Ed.), The structure of human memory. San Francisco: W. H. Freeman, 1976.

Meyer, D. E., Schvaneveldt, R. W., & Ruddy, M. G. Activation of lexical memory. Paper presented at the meeting of the Psychonomic Society, St. Louis, Missouri, 1972.

Meyer, D. E., Schvaneveldt, R. W., & Ruddy, M. G. Loci of contextual effects in visual word recognition. In P. Rabbit (Ed.), Attention and performance V. New York: Academic Press, 1975.

Morton, J. Interaction of information in word recognition. Psychological Review, 1969, 76, 165-178.

Morton, J. A functional model of memory. In D. A. Norman (Ed.), Models of human memory. New York: Academic Press, 1970.

Neely, J. H. Semantic priming and retrieval from lexical memory: Evidence for facilitatory and inhibitory processes. Memory and Cognition, 1976, 4, 648-654.

Neely, J. H. Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. Journal of Experimental Psychology: General, 1977, 106, 226-254.

Norman, D. A. Toward a theory of memory and attention. Psychological Review, 1968, 75, 522-536.

Posner, M. I., & Snyder, C. R. R. Facilitation and inhibition in the processing of signals. In P. M. A. Rabbit and S. Dornic (Eds.), Attention and performance V. New York: Academic Press, 1975.

Quillion, M. R. A revised design for an understanding machine. Mechanical Translation, 1962, 7, 17-29.

Quillion, M. R. Word concepts: A theory and simulation of some basic semantic capabilities. CIP Paper No. 79, Carnegie Institute of Technology, 1965.

Quillion, M. R. The teachable language comprehender: A simulation program and theory of language. Communication of the ACM, 1969, 12, 459-476.

Rosch, E. Cognitive representations of semantic categories. Journal of Experimental Psychology: General, 1975, 104, 192-233.

Rumelhart, D. E., Lindsay, P. H., & Norman, D. A. A process model for long-term memory. In E. Tulving & W. Donaldson (Eds.), Organization and memory. New York: Academic Press, 1972.

Scarborough, D. L., Cortese, C., & Scarborough, H. S. Frequency and repetition effects in lexical memory. Journal of Experimental Psychology: Human Perception and Performance, 1977, 3, 1-17.

Schaeffer, B., & Wallace, R. Semantic similarity and the comparison of word meanings. Journal of Experimental Psychology, 1969, 82, 343-346.

Schvaneveldt, R. W., & Meyer, D. E. Retrieval and comparison processes in semantic memory. In S. Kornblum (Ed.), Attention and performance IV. New York: Academic Press, 1973.

Smith, E. E., Shoben, B. J., & Rips, L. J. Structure and process in semantic memory: A feature model for semantic decisions. Psychological Review, 1974, 81, 214-241.

Sternberg, S. Memory scanning: Mental processes revealed by reaction-time experiments. American Scientist, 1969, 57, 421-457.

Tweedy, J. R., Lapinski, R. H., & Schvaneveldt, R. W. Semantic-context effects on word recognition: Influence of varying the proportion of items presented in an appropriate context. Memory and Cognition, 1977, 5, 84-89.

Warren, R. E. Stimulus encoding and memory. Doctoral dissertation, University of Oregon, 1970.

Warren, R. E. Stimulus encoding and memory. Journal of Experimental Psychology, 1972, 94, 90-100.

Warren, R. E. Assocaition, directionality, and stimulus encoding. Journal of Experimental Psychology, 1974, 102, 151-158.

Warren, R. E. Time and the spread of activation in memory. Journal of Experimental Psychology: Human Learning and Memory, 1977a, 3, 458-466.

Warren, R. E. The time course of antonym and synonym encoding. Paper presented at the meeting of the American Psychological Association, San Fransico, California, 1977b.

Warren, R. E., Green, J. P., & Bresnick, J. H. Activation of antonyms and synonyms. Paper presented at the meeting of the Psychonomic Society, Washington, D. C., 1977.

Yates, F. The analysis of replicated experiments when field results are incomplete. Empire Journal of Experimental Agriculture, 1933, 1, 129-142.

APPENDIX A

TABLES

TABLE I

ANOV SUMMARIES FOR THE BY-SUBJECTS AND THE BY-ITEMS ANALYSES IN EXPERIMENT I

Source	SS	*df*	MS	*F*
By-Subjects Analysis				
Subjects	1282653.00	23	55767.52	
Delay (D)	982.75	2	491.37	<1
Error	163348.81	46	3551.06	
Prime Type (PT)	32250.25	1	32250.25	19.84**
Error	37388.50	23	1625.54	
D X PT	21030.24	2	10525.12	7.39**
Error	65428.63	46	1422.36	
By-Items Analysis				
Items	909478.56	71	12809.55	
Delay (D)	1726.00	2	858.00	<1
Error	1231433.00	142	8672.06	
Prime Type (PT)	84211.00	1	84211.00	5.31*
Error	1125277.00	71	15848.97	
D X PT	64693.37	2	32346.69	5.49**
Error	836246.75	142	5889.06	

*$p < .05$
**$p < .005$

TABLE II

ANOV SUMMARIES FOR THE BY-SUBJECTS AND THE BY-ITEMS ANALYSES IN EXPERIMENT II

Source	SS	*df*	MS	*F*
By-Subjects Analysis				
Subjects	933445.81	17	54908.57	
Delay (D)	9748.13	2	4874.06	2.03
Error	81620.56	34	2400.60	
Prime Type (PT)	37782.52	2	18891.26	13.70**
Error	46883.55	34	1378.93	
D X PT	19143.05	4	4785.76	5.10**
Error	63857.07	68	939.07	
By-Items Analysis				
Items	2094602.00	107	19575.72	
Delay (D)	58988.00	2	29494.00	3.28*
Error	1921994.00	214	8981.28	
Prime Type (PT)	255532.00	2	127766.00	13.23**
Error	2066114.00	214	9654.74	
D X PT	170519.00	4	42629.75	4.78**
Error	3766473.00	422	8925.29	

[a] Degrees of freedom for error term has been corrected for missing data.

*$p < .05$
**$p < .001$

TABLE III

MEAN LATENCIES (IN MILLISECONDS) FOR CORRECT WORD RESPONSES FOR EXPERIMENT III; MEAN PERCENTAGE ERRORS ARE GIVEN IN PARANTHESES

	Prime Type		
	Associated	Unassociated	XXX
	605.22 (3.97)	684.04 (7.54)	694.48 (7.94)
Net Difference	74.83 (Associated vs. Unassociated)		9.95 (Unassociated vs. XXX)
	84.78 (Associated vs. XXX)		

TABLE IV

ANOV SUMMARIES FOR EXPERIMENT III

Source	SS	*df*	MS	*F*
By-Subjects Analysis				
Subjects	418806.63	20	20940.33	
Prime Type	90210.50	2	45105.25	31.48*
Error	57314.92	40	1432.87	
By-Items Analysis				
Items	159935.69	35	4569.59	
Prime Type	171435.19	2	85717.56	14.96*
Error	401090.87	70	5729.87	

*p $< .001$

APPENDIX B

FIGURES

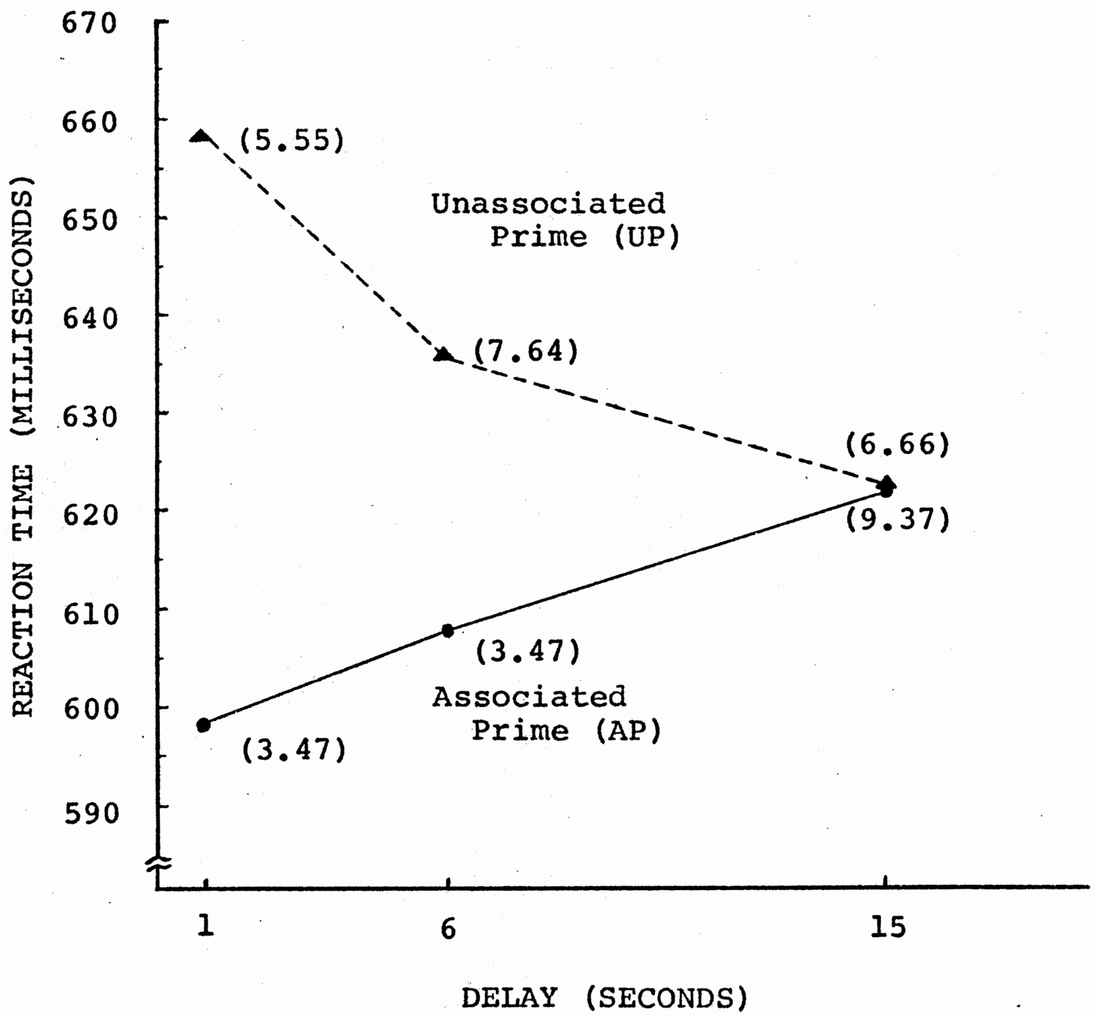

Figure 1. Mean Latencies and Error Percentages for the AP and UP Conditions in Experiment I

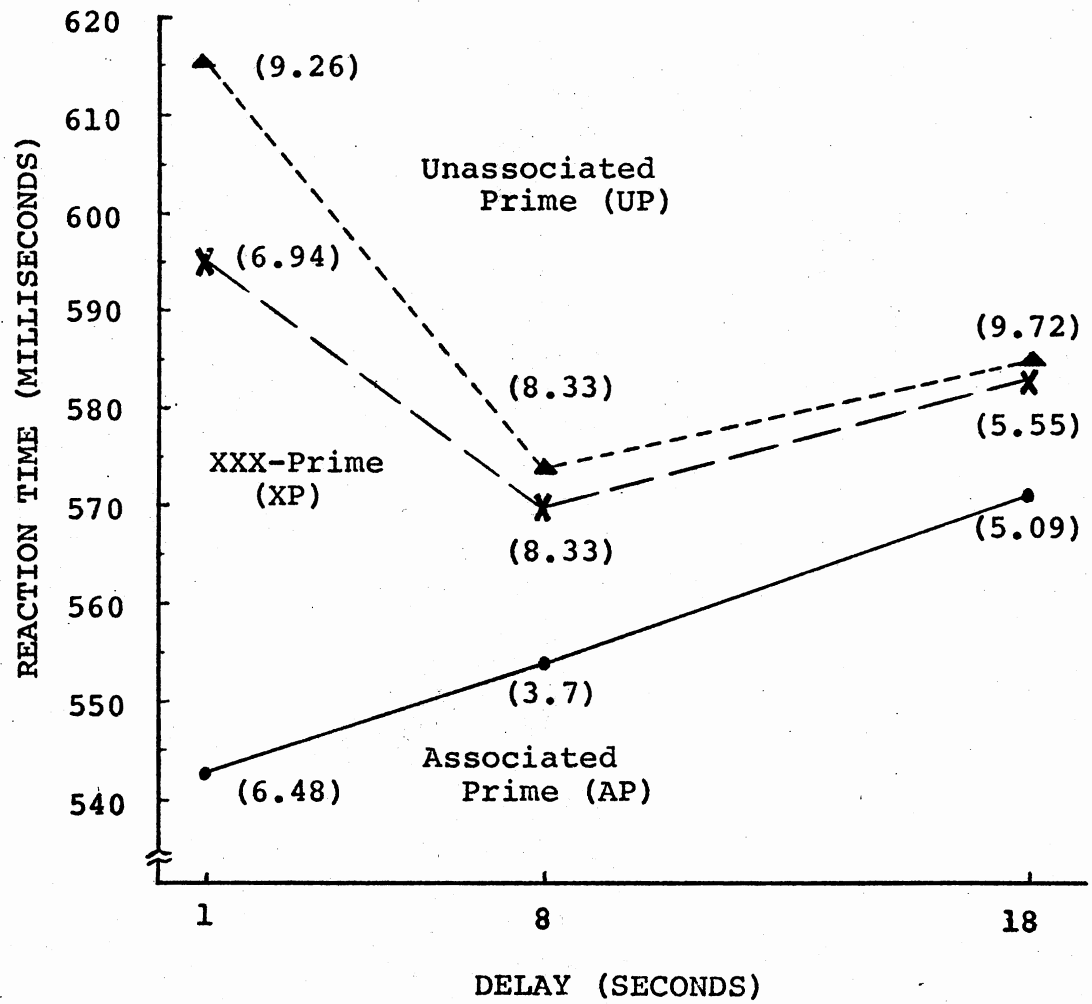

Figure 2. Mean Latencies and Error Percentages for the AP, UP, and XP Conditions in Experiment II

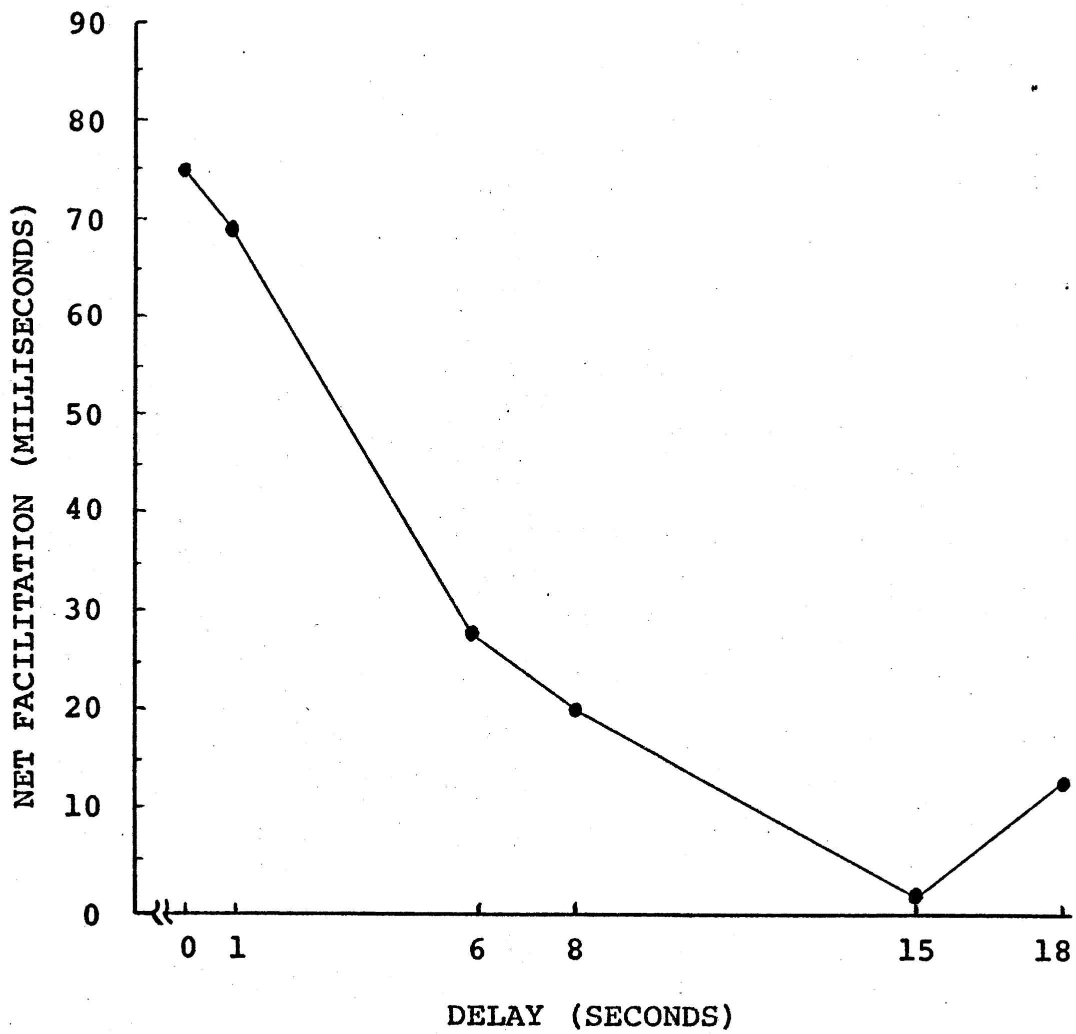

Figure 3. Net Facilitation Effect Between the AP and UP Conditions Across the Delays in Experiments I, II, and III

VITA

James John Neiser, Jr.

Candidate for the Degree of

Doctor of Philosophy

Thesis: DECAY OF THE SEMANTIC PRIMING EFFECT IN MEMORY

Major Field: Psychology

Biographical:

Personal Data: Born in Houston, Texas, January 31, 1951, the son of James and Henrietta Neiser.

Education: Received the Bachelor of Science in Liberal Arts degree in Psychology in May, 1973, and the Master of Science degree in Psychology in August, 1975, from the University of Southwestern Louisiana. Enrolled in the Doctor of Philosophy degree program in Psychology at Oklahoma State University and completed the requirements in May, 1979.

Professional Experience: Served as a graduate teaching assistant at the University of Southwestern Louisiana, 1973-1975; instructor at the University of Southwestern Louisiana, summers of 1974-1977; graduate teaching assistant and research associate at Oklahoma State University, 1975-1978; instructor at the University of Wisconsin-Platteville, 1978-1979.