SEMANTIC PRIMING IN A LEXICAL DECISION TASK

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SEMANTIC PRIMING IN A LEXICAL DECISION TASK

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INTRODUCTION

Among man's most remarkable talents is his ability to identify verbal materials quickly and accurately. Early research in the area of character and word recognition used a threshold procedure in an effort to determine the time necessary to identify an item. Since there are several procedural difficulties with threshold studies (e.g., accumulation of information on repeated exposures, response biases), investigators have turned to choice reaction time studies as a more accurate and sensitive measure of the mental operations involved in character recognition. In this procedure stimulus processing time is a dependent variable and successive repetitions of a given item are not necessary for an accurate response.

Several recent theories of choice reaction time are related to the additive model first recommended by Donders (1868). Donders proposed that the time required for a choice reaction is the sum of components: (a) simple reaction time, (b) the time required for stimulus categorization, and (c) the time required for response selection. Further, these processes were hypothesized to be sequential, non-overlapping, and additive. While Donders' deletion method (the subtraction procedure) was criticized by many investigators, the basic conception of choice reaction time as the sum of durations of a series of reactions or stages is still very popular today (e.g., Smith, 1968; Sternberg, 1966, 1969).

The additive factor method proposed by Sternberg (1969) is an elaboration on Donders' original additive model. Sternberg's method provides a way to test for additive choice reaction time components without procedures that add and subtract stages. The major assumption of his additive factor method is that simultaneous manipulation of independent variables affecting the same stage should produce positive interaction effects as evidenced by the dependent variable. In addition, a simultaneous manipulation of variables affecting different stages should produce additive effects on choice reaction time. In a series of experiments using choice reaction time tasks, Sternberg (1966, 1969) and others have found systematic patterns of addivity and interaction between several independent variables. These results are consistent with the additive factor hypothesis for a simple character recognition task. The Sternberg (1969) additive factor method is of central importance and has, therefore, been applied to the two word recognition studies reported in this paper.

Several investigators have recently studied the process by which subjects decide that a string of letters is a word (e.g., Landauer and Freedman, 1968; Rubenstein, Garfield, and Millikan, 1970; Stanners, Forbach, and Headley, 1971; Meyer, Schvaneveldt, and Ruddy, 1972). Two basic types of decision tasks have been employed. In the <u>semantic-decision task</u> (e.g., Meyer and Ellis, 1970; Landauer and Freedman, 1968) the reaction time (RT) required to judge a letter string (e.g., PEAR) as being a member of a specified category (e.g., FRUIT) is measured. The <u>lexical-decision task</u> on the other hand, involves measuring the RT to judge a string of letters as a word (e.g., HAIL) or not a word (e.g., HACP). It is the lexical-decision task that was employed in the present experiments.

Investigators have studied many factors that influence RT in a lexical-decision task. Rubenstein, Garfield, and Millikan (1970) manipulated word frequency and found that RT varied inversely as a function of word frequency. Rubenstein et al. (1970) propose that the lexical-deicision task is actually a search of long-term memory and that word frequency determines the order in which words are searched in memory.

Another factor that influences RT in a lexical task is the degree of association between two words. Originally, Meyer and Schvaneveldt (1971) used simultaneous presentations of two letter strings. In Experiment I, subjects were to respond "yes" if both letter strings were words; otherwise "no." In Experiment II, subjects were to respond "same" if the two letter strings were either words or nonwords; otherwise "different." If the pairs of letter strings were words commonly associated (e.g., BREAD-BUTTER), both "same" and "yes" responses were faster than if the two words were not associated. Meyer and Schvaneveldt (1971) discuss two possible models (the spreading excitation model and the location-shifting model) to explain the results of their data, but offer no direct test between the two.

Meyer, Schvaneveldt, and Ruddy (1972) consider a third model to account for the priming effect and through a series of studies provide a test for the three models. First, a brief explanation of the three models should be helpful. The spreading excitation model suggests that the retrieval of an item from memory produces neural excitation that spreads to the associated items in memory, thereby facilitating their subsequent recognition. The location-shifting model assumes that memory locations are searched serially and that associated items are retrieved faster because a shift in location is not necessary. This is a process similar to that used in retrieving information from a magnetic tape or disk. The semantic comparison model suggests that a subject undergoes a change in response bias as a function of semantic similarity during the comparison process. In other words, a positive response bias is produced by processing and comparing semantically related words; therefore, the comparison process is facilitated.

For the sake of brevity, the results of the first two studies reviewed by Meyer, Schvaneveldt, and Ruddy (1972) favored the spreading excitation model. A third experiment was performed (Meyer et al. (1972) using successive presentations of letter strings and 0, 1500, or 4000 msec. delay between the letter strings. The results of this experiment further supported the spreading excitation model since the association effect was shown to decay over time.

In a fourth experiment, Meyer et al. (1972) addressed the question concerning the locus of the association effect which is of major concern to the research reported here. In this experiment, subjects made word-nonword judgements on two successively presented letter strings with the second string in some of the pairs degraded. Not only were there significant main effects for association and degradation, but the interaction of association and degradation was also significant at the .01 level.

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Insert Figure 1 about here

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A graphic representation is presented in Figure 1. These results were interpreted, in light of the additive factor method, as indicating that the association effect somehow primes the encoding mechanisms for certain relevant visual features common to various associated words. This interpretation, also given in the subsequent research of Meyer, Schvaneveldt and Ruddy (1974), is based on the additive factor assumption that if two variables interact they can be interpreted as affecting the same stage, otherwise their effects would be additive.

It is assumed that there are structures in the brain that store information about whether a string of letters has been seen before. This storage has been referred to as lexical memory. Further, the structures in lexical memory for associated words are assumed to be, in some respect, in close proximity. The neural signals that encode and transmit information about such words may share a common pathway even before lexical memory. The spreading excitation model could operate to increase the speed and sensitivity of visual-feature analyzers that form graphenic representations of associated words. This would then account for the interactions between the effects of semantic context and stimulus quality.

While Meyer, Schvaneveldt, and Ruddy (1974) offer three possible explanations of the data (and remain loyal to their encoding hypothesis of priming), they overlook what does appear to be a viable fourth alternative for explaining the data. In both of their studies on priming, the median word frequency was relatively high (59/million) which for the intact condition would result in very fast RTs. Also, the subjects were given $3 at the beginning of the experiment and were penalized 1¢ for each .1 second lost in mean RT on each trial block and 3¢ for each error. Third, the probability of a word (versus nonword) and the contingent word probability within pairs were such as to promote a response bias favoring fast RT for the words in the intact condition. In short, it could be argued that due to stimulus sampling and task demands, the subjects were operating at an almost optimum level in the intact condition for unassociated words. Therefore, when presented with an associated set of words in the intact condition, there was not a large opportunity for improvement in RT such as that available in the degraded condition. A floor effect could then explain the results of the two studies and suggest that the data be considered an artifact of the methodology used.

An unpublished study (Becker, 1974) suggests that the mechanisms involved would have to be very complex to account for the encoding hypothesis of priming. In this study, a word like BuTteR in an intact condition without a primer item had longer RTs than a word like BUTTER. However, if presented intact with a primer like BREAD, there was almost no effect of letter case. If priming affected the encoding mechanisms, then not only would the features for upper case items have to be primed, but also the features for lower-case items mixed in an uppercase context would have to be primed. This would seem to be a very complicated procedure (especially if the initial item were uppercase) if priming did not simply affect the lexical search task, but instead affected the peripheral encoding mechanisms.

The two experiments to be described represent an effort to re-examine the semantic priming effect in more detail. In light of the above notions, the general rationale was that if one could raise the mean RT in the intact/unassociated condition, then the subjects would have more opportunity to improve (i.e., decrease) RTs when presented with intact/associated items. In addition, the size of this priming effect should then be as large as that observed for the same items in a degraded condition. In other words, the interaction between stimulus quality and degradation should not be as large as that reported by Meyer et al. (1974). If the interaction of association and degradation where reduced or negated by somehow elevating RTs for the intact/unassociated condition, then there will be little or no evidence to suggest that semantic priming in turn affects the peripheral encoding mechanisms.

EXPERIMENT I

In an effort to provide a situation that would allow for a larger improvement in RT for intact/associated items relative to intact/unassociated items, two changes were made in the Meyer et al. (1974) procedure. The first and most theoretically important manipulation was to add word frequency as an independent variable. Low frequency unassociated items should have longer RTs (Rubenstein, Garfield, and Millikan, 1970) than the high frequency unassociated items used by Meyer et al. (1974). Thus, when subjects are presented with the same low frequency items in an associated context, there will be an opportunity for a greater priming effect than for high frequency items.

Assume that the total RT is made up of three general time components (Donders, 1868). The first is a simple reaction time (e.g., time required to detect a flash of light). The processing time for this stage (T_1) can be assumed to remain constant in the intact condition, since there is no difference in the physical (intensity, contrast, etc.) stimulus between associated and unassociated items. The third stage, that of response selection and the processing time (T_3) associated with it, can also be assumed to remain constant since response probability and the type of response is constant across conditions. If the second step of stimulus categorization is a very simple task (i.e., minimal processing being required) like that of the lexical decision, it is possible that the processing time (T_2) associated with that stage is already close to the minimum T_2. Thus, if T_1 and T_3 represent constants and T_2 is already operating at a close to optimum level for the task required, then it does seem possible that by increasing T_2 (in this case by using low frequency words) there will be an opportunity for a larger association effect to occur for the intact condition. This would decrease or remove the interaction of association and stimulus quality. According to the additive factor model, there would be little or no evidence to suggest that the association effect operates at the encoding stage, as suggested by Meyer et al. (1974) in the stage model shown in Figure 2.

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Insert Figure 2 about here

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The second change in the Meyer et al. (1974) procedure was necessitated by the lack of money to pay subjects. Therefore, any subject strategies that were contingent on the Meyer et al. (1974) payoff system were most likely not adopted by the subjects in the present study, who received extra credit for participation regardless of performances. A slight procedural change that might also be mentioned was that in the degraded condition both the first and second item in a pair were degraded while Meyer et al. (1974) only degraded the second item in each pair.

In summary, four changes were made in the Meyer et al. (1974) procedure. First, word frequency was added as an independent variable. Second, the subjects were not paid in a manner contingent on their performance. They simply received extra credit for participation. Third, both of the stimulus items in a pair were degraded; and fourth, one-half of the subjects view only degraded items while the other one-half viewed only intact items.

METHOD

Subjects. The subjects were 40 volunteers (18 males, 22 females) from the introductory psychology classes at Oklahoma State University. All subjects received extra credit for participation in the experiment and reported no serious reading deficiencies that might have hindered their performance.

Apparatus. A Kodak carousel projector was used to present each item on a rear projection screen. The control system, consisting of a Lafayette ight Bank Timer and a series of latching relays, initiated (upon the subject pushing a thumb button) a Wollensak solenoid shutter mounted on the lens of the projector, started and stopped a Lafayette digital clock-counter, advanced the slides for each trial, and provided feedback to the subject concerning the status of his response, correct or incorrect.

Materials. The letter strings (all upper case) were typed using an IBM Executive typewriter. The letter strings were placed on transparencies using the diazachrome method and then mounted in slide holders for the carousel projector.

The 40 high frequency words were of either A or AA frequency, according to Thorndike-Lorge (1944) and a mean 198.35 according to Kučera and Francis (1967). The 40 low frequency words had a mean frequency of 17 per million, according to Thorndike-Lorge (1944) and a mean of 13.95 according to Kučera and Francis (1967). In addition, all 80 words (high and low frequency items) were among the top three responses given to corresponding stimulus items in the Connecticut Norms (Bousfield, Cohen, Whitmarsh, and Kincaid, 1961). The word pairs used are shown in Appendix B.

Nonwords were constructed by replacing one vowel in a word to make it a novel letter string.

Procedure. The subjects were seated in front of the rear projection screen and heard a tape recorded version of the instructions presented in Appendix A. To initiate a trial, the subject pushed a thumb button held in his non-preferred hand. There was a 500 msec. delay, then the first item appeared. The subject's response via a three-position toggle switch, terminated the first stimulus and began an 800 msec. interstimulus interval. At the end of this interval, the second stimulus was automatically presented and a clock-counter began. Again, the subject's response terminated the stimulus and stopped the clock-counter. A green light, below the viewing screen, was illuminated after each correct response; otherwise, a red light would come on. There was a 2-second delay, then a white ready light would terminate, indicating that the subject could begin the next trial.

All subjects received 40 practice trials followed by 180 test trials. There was a brief (2-min.) rest period every 40 trials while the experimenter changed slide trays. The experiment lasted approximately one hour, with a full debriefing of each subject at the end of the hour. The reaction times were recorded in msec. and trials on which errors occurred were not repeated. Twenty subjects received items which were degraded by placing an approximately fifty percent density dot pattern on the rear projection screen. The other 20 subjects received all intact stimuli.

Design. A 2 x 2 x 2 factorial design was employed. The variables of the experiment were (a) the relationship between the two letter strings within a trial (associated or unassociated) as measured by the Bousfield, Cohen, Whitmarsh, and Kincaid (1961) norms; (b) the frequency of the words measured by Thorndike-Lorge word count and by the Kučera and Francis (1967) norms, and (c) the quality of the stimulus (intact or degraded). The first two variables were within-subjects and stimulus quality was between-subjects. One-half of the subjects received one-half of the high and one-half of the low frequency words in an associated context and the other one-half in an unassociated context. The other one-half of the subjects received the same items with context reversed (i.e., counter-balanced).

There were 20 subjects in the intact condition, and 20 subjects in the degraded condition. Each subject received 40 practice trials and a toal of 180 test trials; 20 unassociated/hi frequency word pairs, 20 unassociated/lo frequency word pairs, 20 associated/hi frequency word pairs, 20 associated/lo frequency word pairs, 80 word-nonword pairs, 10 nonword-word pairs, and 10 nonword-nonword pairs. This particular design allows equal probability that the second response is a word or a nonword while keeping it necessary for the subject to process the first item without using an unreasonable amount of trials. In other words, even though the probability of a word is .80, the contingent probability of a word given a word is .50. For a given subject, there were 20 observations per cell, making a total of 80 observations and 100 filler trials.

RESULTS

The overall error rate was less than five per cent. The latencies on error trials were omitted from the analysis.

The F tests were performed using the method recommended by Clarke (1973). This method allows for joint inferences to be made to the population of subjects as well as the population of stimulus items. The ANOVA table for the by subject and by item analysis is presented in Tables 1 and 2, respectively. The Min F' values calculated according

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Insert Tables 1 and 2 about here

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to Clarke (1973) were as follows: for the association variable, the Min $F' = 32.553$ $p < .001$. For the variable of frequency, the Min F' was 56.773, $p < .001$. All other possible Min F' tests were non-significant.

Figure 3 presents a graphic representation of the cell means. The

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Insert Figure 3 about here

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average association effect was 82 msec. The average frequency effect was 71 msec. and the average degradation effect was 41 msec. The two variables of frequency and association are equally potent in their effects on RTs in the lexical decision task. While the main effect of degradation was reasonably large (41 msec.), the between-subjects variation was too large for the effect to be statistically significant.

DISCUSSION

Interpreting the results in light of Sternberg's (1969) additive factor method and the model of word recognition proposed by Meyer, Schnaveveldt, and Ruddy (1974), a few modest comments can be made. First, it is interesting to note that the association effect is extremely consistent for high frequency as well as low frequency items. The lack of a significant interaction between association and frequency leaves one with no evidence to suggest that both affect the same stage of processing. It is very difficult, however, to pinpoint the locus of the association effect and the locus of the frequency effect given the nonsignificant degradation effect.

As suggested by Stanners, Jastrzembski, and Westbrook (1975), the results of the present study are consistent with the idea that word frequency affects lexical search. However, both Stanners et al. (1975) and the present study are in the position of supporting the null hypothesis. While the theoretical problems involved with this position can be lessened by the useful concept of power, there are other possible approaches suggested by the additive factor model. One such approach that might possibly yield supportive evidence in a lexical task would be to manipulated, simultaneously, the variables of set size (i.e., category size) and word frequency. It seems safe to say that the number of items to be searched in memory would definitely affect the time to search that set (Landauer and Freedman, 1968). Thus, if word frequency and set size interacted, then one would have supportive evidence for the hypothesis that the lexical search stage is the locus of the frequency effect. Quite regretfully, no such evidence currently exists.

The lack of a significant main effect of degradation further complicates the interpretation of the present data. While it is possible to obtain a statistically significant interaction and simultaneously have no significant main effect, it is difficult to interpret a lack of interaction of either variable with degradation when no significant main effect exists for degradation. In trying to interpret the present data, one is faced with the argument that there might be no significant interaction between stimulus quality and either variable because the experiment did not successfully manipulate stimulus quality.

With a degradation main effect of 41 msec., it is very likely that an effect of that size would be significant in a within-subjects design. However, such speculation is of little value. A more profitable approach would be to create a degradation condition that would result in a 100 msec. or greater increase in RTs. This is the approximate magnitude of the degradation effect reported by Meyer et al. (1974) and Stanners et al. (1975).

It is difficult to say what a 60 msec. increase in the degradation effect would produce in the way of an interaction with frequency and association. However, it is very likely that there would still be no interaction of degradation and frequency or degradation and association. The present data suggest this, since given the 41 msec. degradation effect, the degradation effect (collapsing across frequency) for associated items is 40 msec. while the same effect for unassociated items is essentially equal (42 msec.). It would seem likely that if a significant interaction was going to exist with a larger degration effect, there would be a larger hint of an interaction in the present study.

A final aspect of the results that should be noted is the lack of an interaction between association and word frequency. If both association and frequency were believed to affect the same stage of processing (lexical search), then it would be hypothesized that the two variables should interact. Yet, there is no evidence of an interaction of the two variables in the present study. It is possible that both association and frequency affect the lexical search stage in a manner that would not produce an interaction.

Assume that semantic priming operates in a manner similar to that suggested by Meyer et al. (1974)--that is, associated items share a common neural pathway up to a certain point. Once a pathway has been fired by a previous item, it is more sensitive (i.e., quicker) for following items that share that pathway. Borrowing the notion from Morton (1969) that item frequency determines the threshold for that item, one can then offer a viable explanation of one aspect of the present data.

If one defines lexical search as the process of eliminating alternatives until a target is reached, the lexical search stage could encompass both the effects frequency and association in an additive manner. Consider Figure 4, the diagram below. Say, for example, the

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Insert Figure 4 about here

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subject has just been presented the item "CAT" in the lexical decision task. The arrows indicate the theoretical neural path to identify the item "CAT" correctly. Next, the subject is presented with the item

"DOG." Since the item "CAT" and "DOG" share common pathways for parts 1 and 2 of the lexical search, transmission of information through those pathways will be facilitated according to Meyer et al. (1974). However, the critical factors for part 3 of the lexical search stage will be the number of final items (set size) and the individual item threshold (determined by word frequency according to Morton, 1969). Thus, semantic priming or context can be said to speed neural transmission along common pathways, while frequency determines the amount of information necessary (threshold) to identify an item. Operating in this manner, the variables of frequency and association would not be expected to interact, even though they both operate to facilitate the same stage of processing. What this means functionally, according to the additive factor model, is that there are two or more separate stages.

In summary, Experiment I replicated the findings of Rubenstein, Garfield, and Millikan (1970)--that is, high frequency items are responded to faster in the lexical task than are low frequency items. In addition, the results of Meyer et al. (1972, 1974) were also replicated by the demonstration of a significant semantic priming effect in the lexical decision task. It can also be stated that the present results are consistent with the hypothesis that the locus of priming is not the encoding stage, as suggested by Meyer et al. (1974). An alternative explanation of priming is offered and a study was suggested to examine the alternative.

EXPERIMENT II

In a further effort to create an optimum situation for the priming effect to occur for intact stimuli, Experiment II employed another variable which has been previously shown to slow RTs in a lexical decision task. Becker (1974) reported on an interaction of letter case and semantic context. Specifically, RTs for words like "BuTteR" in related and unrelated context (i.e., primed or unprimed) were compared to RTs for words like "BUTTER" in related and unrelated context. Not only was there a significant main effect of letter case, but there was also a significant interaction of context and letter case. The letter case manipulation then appeared to be another independent manipulation available to slow RTs for intact stimuli.

Experiment II then employed three variables--that of the letter case, semantic context, and degradation. Word frequency was held constant in this study. Based on the contention that semantic priming does not affect stimulus encoding, the folowing hypotheses were tested: First, there should be a significant main effect of association, degradation, and letter case. Second, there should be an interaction of letter case and degradation, and no further interactions.

METHOD

Subjects. The subjects were 40 volunteers from the introductory psychology classes at Oklahoma State University. All subjects received extra credit for participation in the experiment, and reported no serious reading deficiencies that might have hindered their performance.

Apparatus. The same rear projection apparatus and control system used in Experiment I was employed in Experiment II.

Materials. The letter strings were typed on an IBM sign typewriter and then prepared for slides by the diazachrome method. The 40 high frequency words used in Experiment I were also used in this study. The items were typed in both pure upper case letters (e.g., NURSE, BUTTER, etc.) or mixed upper-lower case letters (e.g., NuRse, doCToR, etc.). Nonwords were constructed by replacing one letter in a word to create a novel letter string. The degraded condition consisted of the items being projected onto a fifty per cent density dot pattern attached to the rear of the viewing screen.

Procedure. The procedure was identical to that in Experiment I; subjects heard the same taped instructions which are reproduced in Appendix A. The number of trials differed, however. All subjects received 40 practice trials followed by 100 test trials. There was a brief (2-min.) rest period every 40 trials while the experimenter changed slide trays. The experiment lasted approximately 40 min. with a full debriefing of each subject at the end of the session. The RTs were recorded in msec. and error latencies were not included in the analysis.

<u>Design</u>. A 2 x 2 x 2 factorial design was employed. The variables of the experiment were (a) the relationship between two successively presented letter strings (associated or unassociated) as measured by Bonsfield, Cohen, Whitmarsh, and Kincaid (1961), and (b) letter case (pure upper case or mixed upper-lower case), and stimulus quality (intact or degraded). There were 20 subjects in the intact condition and 20 subjects in the degraded condition. The other two variables were manipulated within-subjects.

Each subject received 40 practice trials and a total of 100 test trials consisting of 10 associated/mixed case word pairs, 10 associated/pure case word pairs, 10 unassociated/mixed case word pairs, 10 unassociated/pure case word pairs, 40 word-nonword pairs, 10 nonword-word pairs, and 10 nonword-nonword pairs. As in Experiment I, this design was chosen to provide an equal probability response to the second item, while keeping it necessary for the subject to process the first item without using an unreasonable amount of trials. The context and case variables were balanced between subjects so that each item appeared in all four possible conditions, associated/pure, associated/mixed, unassociated/pure, and unassociated/mixed.

RESULTS

The overall error rate was less than six per cent. The latencies from error trials were omitted from the analysis.

The F tests were performed using the method recommended by Clarke (1973). The ANOVA table for the by subject and by item analysis is presented in Tables 3 and 4. The Min F' values calculated according to

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Insert Tables 3 and 4 about here

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Clarke (1973) were as follows: for the context effect, the Min F' = 18.266, $p < .001$. For the main effect of letter case, the Min F' was 17.290, $p < .001$. The degradation effect had a Min F' = 6.681 $p < .025$. While the Min F' for the interaction of degradation and case approached significance, none of the possible interaction terms were significant at the .05 level.

Figure 5 presents a graphic representation of the cell means for

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Experiment II. The average association effect was 70 msec. The average letter case effect was 130 msec., and the average degradation effect was 98 msec.

The association effect (71 msec.) was approximately the same as that reported in Experiment I (82 msec.). The degradation effect (98 msec.), on the other hand, was over twice that reported in Experiment I (41 msec.) and is probably attributable to the large interaction with letter case. The letter case variable provided a substantial main effect (130 msec.), but did not interact with association, as reported by Becker (1974).

DISCUSSION

Interpreting the results in light of the Sternberg (1969) additive method and the Meyer, Schvaneveldt, and Ruddy (1974) stage model, there are at least three interesting aspects of the data that deserve discussion.

First, the association manipulation (context variable) appears to be very robust across a variety of situations. The association effect in Experiment II was only 11 msec. different from that reported in Experiment I. In addition, the variables of frequency and letter case did not seem to influence the association effect. The short durations (interstimulus intervals) in which the association effect can occur and the stability of the effect suggest that the process is probably automatic and not under conscious control. In other words, it is likely that the association effect is a manifestation of some central automatic fixed process that occurs during information processing. The association effect observed by Meyer et al. (1974) was strongest at the 0 sec. interstimulus interval. There is scarcely enough time for the subject to consciously free associate to a stimulus item in that situation, however, there may be some underlying process common to free association and priming. It is fortunate that the association norms of Bohsefield et al. (1961) provide what appears to be a very accurate tool for the investigation of the association effect.

Another aspect of the association effect that deserves some speculative discussion is the apparent lack of an interaction between association and the other variables used in Experiments I and II. An explanation of the lack of an interaction between association and word frequency has already been offered in the discussion of Experiment I. The data for Experiment II fail to replicate another interaction reported by Becker (1974)--that of association and letter case.

It is curious that two previous studies (Meyer et al.,1974; Becker, 1974) reported two very substantial interactions involving association and the two present studies reveal results contradictory to their findings. While all four studies used very similar (if not exactly the same) items, there is a basic difference in design between the two 1974 studies and the two present studies. The studies of Meyer et al. (1974) and Becker (1974) used a completely within-subjects design where a single subject randomly viewed both degraded and intact items. In the two present studies, the stimulus quality variable was manipulated between subjects such that a given subject viewed either all intact or all degraded items.

It is possible that subjects would somehow adopt a different strategy, depending on characteristics of the total population of stimulus items. Thus, if a subject is forced to view both intact and degraded items, he may process the items differently than if he had to process only intact or only degraded items. Some unpublished data (Stanners, 1975) in a similar word recognition task that manipulated stimulus quality within as well as between subjects, supports the hypothesis of differing strategies for the two designs. The additional data of Pickering (1975) also supports the above contention. Pickering (1975) found that when words were presented (in a lexical decision task) in the context of phonologically and orthographically irregular nonwords, the responses to word items were faster and showed less of a word frequency effect than if the same words were presented in the context of regular nonwords. Again, it appears that subjects may process the same items differently, depending on the characteristics (context) of the total stimulus sample. This would explain the lack of agreement between the two previous studies (Meyer et al., 1974; Becker, 1974), and the present two studies. Since a given subject in the present study viewed only a subset (intact or degraded) of the items viewed by the subjects in the Meyer et al. (1974) and the Becker (1974) studies, the possibility of differing processing strategies does exist.

Another interesting aspect of the present data is the nonsignificant but rather large interaction of stimulus quality and letter case. The pure case items show a degradation effect (summing across the context variable) of 70 msec. while the mixed case item shows a degradation effect of 125 msec. While this interaction is not significant, it is in the direction that should be expected. If one accepts the general notion that physical stimulus characteristics affect the encoding stage, then according to Sternberg's (1969) additive factor method, one should expect two physical stimulus variables such as degradation and letter case to interact.

The lack of statistical significance for the stimulus quality by letter case interaction could be attributed to the large variance for the subjects in both of the mixed-degraded conditions. The subject means (collapsing across items onto subjects) that went into the calculation of the cell mean for the associated-mixed-degraded condition ranged from 361 msec. to 1031 msec. Also, the subject means that make up the cell mean for the unassociated-mixed-degraded condition ranged from 394 msec. to 1213 msec. In the above two conditions, it is interesting to note that the lowest RTs were attributable to a single subject with the next nearest subject mean being 557 msec.--almost 200 msec. above the lowest subject mean in the associated-mixed-degraded condition. Likewise, in the unassociated-mixed-degraded condition, the same subject again had the lowest mean RT at 394 msec. with the next highest subject mean RT being 614 msec.--a gap in the data of 220 msec. In addition, it was not realized until after completion of the experiment that the outlying subject was a non-native speaker of English (Oriental). It is possible that the subcondition variance created by that single subject could produce the lack of a significant stimulus quality by letter-case interaction as well as the relatively small main effect for stimulus quality. However, the former effect is of more interest in the present study since the main effect of stimulus quality ($F\ (1/47) = 6.681$, $p < .025$) was almost identical to the stimulus quality effect ($F\ (1/65) = 6.78$, $p < .025$) observed by Stanners et al. (1975) in the same lab.

In an effort to further examine the above contention, the data from the subject in question were removed from the degraded condition. The data from a randomly selected subject in the intact condition were omitted to provide an equal number (19) of subjects in both conditions. The by subjects analysis was again calculated and the ANOVA table is presented below. The recalculation of the Min F's resulted in a main

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Insert Table 5 about here

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effect for degradation, Min $F'\ (1/27) = 12.254$, $p \leq .005$. The main effect for letter case was significant, Min $\underline{F}'$ $(1, 42) = 44{,}484$, $p < .001$, as well as the main effect for context, Min $\underline{F}'$ $(1,47) = 10.611 = \underline{p} < .005$. The Min $\underline{F}'$ recalculated for the stimulus quality by letter-case interaction was significant, Min $\underline{F}'$ $(1,53) = 4.306$, $\underline{p} < .05$. A graphic representation of the cell means is presented in Figure 6.

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Insert Figure 6 about here

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The effect of removing the two subjects (one outlier in the degraded condition, and one randomly selected subject in the intact condition) was very noticeable in the increase of the main effect of stimulus quality and the stimulus quality by letter-case interaction. All other main effects and interactions remained virtually unchanged.

The second analysis of Experiment II provides support for the notion that stimulus quality and letter case affect the encoding stage. According to Sternberg (1969), this is evidenced by the significant stimulus quality by letter case interaction. Further support for the locus of the letter case effect is provided by the lack of a significant letter case by association interaction, suggesting that the letter case effect operates solely at the encoding stage. This seems intuitively correct since the letter case manipulation is actually a manipulation of the physical characteristics of the stimulus.

The data are, however, still partially contradictory to the findings of Becker (1974)--that is, the present study failed to replicate the interaction of letter case and association observed by Becker (1975). As previously stated, the association effect does not appear to be under conscious control, however, it is possible that with a given set of task demands (e.g., view both degraded and intact stimuli) the association effect could allow the subject to operate with less information when the signal-to-noise ratio is low.

When subject views only degraded or intact items, the association effect appears to remain a central process, most likely affecting lexical accessing. In this situation where the signal-to-noise ratio is constant, the processing system could adopt a conservative fixed mode of operating where context solely aids lexical accessing. The major change in the mode of processing would come when the subject is in a situation where the signal-to-noise ratio is not constant. In other words, the encoding stage would be in a state of flux, oscillating between situations of easy and difficult encoding.

In an effort to stabilize this fluctuation, the processing system could adopt a more liberal mode of processing when presented with a degraded stimulus. Processing would be more liberal in that less information may be required from the encoding stage, thus allowing it to encode only the partial information that is clearly available from the degraded stimulus.

The key to the operation of the proposed information processing system is then seen as the detection of a state of flux at a particular stage of processing. In a situation where the subject views only intact or degraded items, the encoding stage can adopt a fixed mode of operating and maintain it. The stage of processing which is not constant in this situation would be the lexical search stage. Since some of the stimulus items are more familiar or more meaningful than others, this could create a situation of easy access on one item versus a more difficult access on another item. With the lexical search stage the most variable (when a constant signal-to-noise ratio is used for a given subject), the additional information provided by context (i.e., priming) could then be used to stabilize lexical accessing.

On the other hand, when the subject is faced with a large change in the signal-to-noise ratio from trial to trial, the encoding stage would probably be in the largest state of flux. Since the encoding stage could be somewhat stabilized by allowing it to process only partial information, the association effect appears to influence the encoding stage by reducing the encoding time proportionally more for degraded items than for intact items.

A diagram of the proposed model is presented in Figure 7. While

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Insert Figure 7 about here

- -

it is possible that context could somehow facilitate encoding by creating a set or expectancy for particular features, it seems more plausible that there is simply a change in processing demands when there is a changing physical stimulus situation. It is possible that when subjects view both degraded and intact items, they are very aware of their slower performance on degraded items. With the payoff contingencies set forth by Meyer et al. (1974) the subject could somehow try to rush or speed-up the degraded trials by starting lexical search with less encoded information. On the trials where the items are associated, this strategy pays off, while on trials where the items are unassociated, the subject first searches a falsely primed set and finally encoding more to make an accurate decision.

The speed-accuracy paradigm could possibly shed some light on the variability of subjects' strategies. For example, if the above propositions are accurate, one might expect the data for subject viewing both intact and degraded items with an accuracy set, to not exhibit the interaction of stimulus quality and association as reported by Meyer et al. (1974). Since with the accuracy set the subject would have no reason to begin lexical search with only partial information, the encoding process would probably be fully operative. On the other hand, the data for subjects given a speed set would expect to exhibit a large interaction of stimulus quality and context, since it would be to their advantage to start lexical search with only partial information wherever possible.

In summary, the combined results from Experiment I and Experiment II suggest (a) that word frequency and context affect independent aspects of the lexical search process, (b) that letter case affects the encoding stage, and (c) that the apparent locus of the association effect is dependent upon task demands. In light of previous as well as present results, a model of human information processing, the "flux model" is proposed to account for apparent inconsistencies in the word-recognition data.

REFERENCES

Becker, C. A. Personal Communication on October 22, 1974.

Bousfield, W. A., Cohen, B. H., Whitmarsh, G. A., & Kincaid, W. D. The Connecticut Free Association Norms. Report No. 35, Department of Psychology, University of Connecticut, Storrs, 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, 335-359.

Donders, F. C. Over de snelheid van psychische processen. Onderzoekingen gedaan in het Psysiologisch Laboratorium der Utrechtache Hoogeschool, 1868-1869, Tweede reeks, II, 92-120. Translated by W. G. Koster in W. G. Koster (Ed.), Attention and performance II. Acta Psychological, 1969, 30, 412-431.

Kučera, H., and Francis, W. N. Computational Analysis of present-day American English. Rhode Island: Brown University Press, 1967.

Landauer, T. K., and Freedman, J. L. Information retrieval from long-term memory: Category size and recognition time. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 291-295.

Meyer, D. E., and Ellis, G. B. Parallel processes in word recognition. Paper presented at the meeting of the Psychonomic Society, San Antonio, November, 1970.

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

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

Morton, J. Interaction of information in word recognition. Psychological Review, 1969, 76, 2, 165-178.

Pickering, J. Frequency and lexical access in visual word recognition (in press).

Rubenstein, H. R., Garfield, L., & Mullikan, J. A. Homographic entries in the internal lexicon. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 487-494.

Smith, E. E. Choice reaction time: an analysis of the major theoretical positions. Psychological Bulletin, 1968, 69, 77-110.

Stanners, R. F., Forbach, G. G., & Headley, D. B. Decision and search process in word-nonword classification. Journal of Experimental Psychology, 1971, 90, 45-50.

Stanners, R. F., Jastrzembski, J. E., and Westbrook, A. Frequency and visual quality in a word-nonword classification task (in press).

Stanners, R. F. Personal communications, Fall, 1974.

Sternberg, S. High speed scanning in human memory. Science, 1966, 153, 652-654.

Sternberg, S. The discovery of processing stages: Extensions of Donders' method. In W. G. Koster (Ed.), Attention and Performance II. Amsterdam: North Holland Publishing Co., 1969.

Thorndike, E. L., and Lorge, I. The teacher's word book of 30,000 words. New York: Teachers College, 1944.

APPENDIX A

INSTRUCTIONS

INSTRUCTIONS

This is an experiment concerned with simple judgments about verbal materials. It is not an intelligence test of any kind and should not be interpreted as such. Also, there is no electric shock nor any other unpleasant stimulus involved. Although the task may seem to be a very simple one, our research indicates that it can provide important information concerning language behavior. If for any reason during the course of the experiment you feel that you cannot fully cooperate, please let the experimenter know.

When the white light in front of you goes off, then you can press the thumb button held in your non-preferred hand. A string of letters will appear on the screen in front of you. Your job is to decide as quickly as possible whether or not the item is a word in your vocabulary. If you decide the item is a word, move the switch in the direction indicated on the card (E indicates). If the item is not a word, move the switch in the opposite direction. Make your judgment on the basis of whether the item is a complete unit in your memory without adding anything to it. On this basis, the item S-P-A-R-C would not be in most people's vocabulary even though it is similar to and may remind you of the word S-P-A-R-K. First or last names should also not be treated as complete words.

When you make your response, move the switch back to the center position to be ready for the second item. Make the same type of judgment about the second item as quickly and as accurately as possible. Then return the switch to the center position. The white light will appear for two seconds. During this time, the thumb button will not work. Once the white light goes off, you may then start the next trial. Note, also, that after each response the green light will come on if the response is corrrect, and the red light will come on if the response is incorrect.

Make sure that when you press the thumb button you are paying close attention to the screen and that you are holding the switch between the thumb and the forefinger of your preferred hand (E indicates). If you are ready to respond when you press the thumb button, your switch responses will be faster. It is very important for a successful experiment that you concentrate fully on each item, and classify it as quickly and as accurately as possible. You do not have to start another trial immediately after the white light goes off. If you want to take a short break, that is OK.

I will not attempt to trick or confuse you by repeating items. Are there any questions?

APPENDIX B

LIST OF STIMULUS ITEMS

High Frequency Associated Pairs

ARMY - NAVY	HOUSE - HOME
BAKE - CAKE	BARN - COW
BOOK - READ	BAD - GOOD
BLACK - WHITE	FOOD - EAT
BOTTOM - TOP	BED - SLEEP
DAY - NIGHT	MALE - FEMALE
DOCK - BOAT	LAKE - WATER
FALSE - TRUE	WINTER - SUMMER
FAR - NEAR	SELL - BUY
FLYING - PLANE	SUN - MOON
HAND - FOOT	TABLE - CHAIR
KEY - LOCK	TALL - SHORT
ONE - TWO	STRONG - WEAK
POOR - RICH	SMALL - LARGE
SOFT - HARD	ROSE - FLOWER
BOY - GIRL	OPEN - CLOSE
DOG - CAT	MOTHER - FATHER
BREAD - BUTTER	MAPLE - TREE
DOCTOR - NURSE	MAD - ANGRY
ICE - COLD	CITY - TOWN

Low Frequency Associated Pairs

LARCENY - THEFT	ATOM - BOMB
KNUCKLE - FIST	BARE - NUDE
KNIFE - FORK	BEAR - CUB
LAKE - POND	BEAVER - DAM
LIZARD - SNAKE	BEGGAR - THIEF
MAID - BUTLER	BELLY - STOMACH
MALLET - CROQUET	FOX - SLY
MEASLES - MUMPS	IGLOO - ESKIMO
MUSIC - PIANO	JELLY - JAM
PAIN - ACHE	FAT - SKINNY
PANSY - DAISY	DEAR - FAWN
REAL - FAKE	CORK - SCREW
ROUGH - TOUGH	COURAGE - BRAVERY
SIMPLE - COMPLEX	CANDY - CANE
TACK - THUMB	BEER - MUG
TANGO - WALTZ	BITTER - SOUR
WALNUT - PEANUT	WEB - SPIDER
WINDOW - PANE	TENNIS - RACKET
ANT - BUG	TIE - KNOT
APPLE - PEAR	LION - TIGER

APPENDIX C

TABLES

Table 1

BY SUBJECTS ANALYSIS OF VARIANCE SUMMARY TABLE
EXPERIMENT 1

Source	SS	d.f.	M.S.	F
D	66,463.25	1	66,463.25	1.148
F	199,303.70	1	199,303.70	66.038**
A	272,332.40	1	272,332.40	121.054**
S(D)	2,200,758.00	38	57,914.68	
DF	10.50	1	10.50	0.004
DA	37.13	1	37.13	0.017
FA	209.44	1	209.44	0.108
FS(D)	114,684.50	38	3,018.13	
AS(D)	85,487.87	38	2,249.68	
DFA	4,526.06	1	4,526.06	2.326
FAS(D)	73,928.50	38	1,945.49	
Total	3,017,787.00	159		

Note: D = Degradation (stimulus quality), F = Word frequency, A = Association.

S(D) = Subjects nested in levels of D.

**$p < .001$

Table 2

BY ITEMS ANALYSIS OF VARIANCE SUMMARY TABLE
EXPERIMENT 1

Source	SS	d.f.	M.S.	F
I	243,792.93	39	6,251.10	
A	565,572.38	1	565,572.38	106.776**
F	416,810.56	1	416,810.56	64.203**
D	125,571.56	1	125,571.56	21.584**
IA	159,654.25	39	4,093.70	
IF	262,396.44	39	6,728.11	
AF	1,098.90	1	1,098.90	
ID	265,592.13	39	6,810.05	
AD	39.90	1	39.90	
FD	1.13	1	1.13	
IAF	253,496.94	39	6,499.92	
IAD	107,312.50	39	2,751.60	
IFD	188,186.88	39	4,825.30	
AFD	7,910.25	1	7,910.25	
IAFD	254,710.44	39	6,531.04	
Total	2,852,141.00	319		

Note: I = Items, A = Association, F = Word Frequency, D = Degradation (stimulus quality).

$^{**}p < .001$

Table 3

BY SUBJECTS ANALYSIS OF VARIANCE SUMMARY TABLE
EXPERIMENT 2

Source	SS	d.f.	M.S.	F
S	1,202,134.00	19	63,270.21	
A	191,891.69	1	191,891.69	22.335**
C	679,253.88	1	679,253.88	72.184**
D	377,622.00	1	377,622.00	7.280*
SA	248,449.00	19	13,076.26	
SC	189,106.31	19	9,952.96	
AC	10,840.55	1	10,840.55	2.344
SD	768,926.06	19	40,469.79	
AD	9,563.55	1	9,563.55	1.113
CD	30,719.30	1	30,719.30	3.264
SAC	86,409.75	19	4,547.88	
SAD	78,030.25	19	4,106.85	
SCD	168,483.00	19	8,867.52	
ACD	4,295.25	1	4,295.25	0.928
SACD	89,324.00	19	4,701.26	
Total	4,135,044.00	159		

Note: S = Subject, A = Association, C = Letter case, D = Degradation (stimulus quality).

*$\underline{p} < .025$

**$\underline{p} < .001$

Table 4

BY ITEMS ANALYSIS OF VARIANCE SUMMARY TABLE
EXPERIMENT 2

Source	SS	d.f.	M.S.	F
I	685,215.00	39	17,569.61	
A	1,396,560.00	1	1,396,560.00	22.662**
C	400,869.56	1	400,896.56	110.044**
D	827,431.19	1	827,431.19	73.032**
IA	494,948.00	39	12,690.97	
IC	689,673.88	39	17,689.07	
ID	441,861.56	39	11,329.78	
AC	19,034.45	1	19,034.45	1.256
AD	78,312.56	1	78,312.56	2.594
CD	23,667.20	1	23,667.20	8.085*
IAC	591,148.63	39	15,157.66	
IAD	377,730.94	39	9,685.41	
ICD	355,784.31	39	9,122.67	
ACD	11,737.00	1	11,737.00	0.961
IACD	476,358.63	39	12,214.32	
Total	6,870,527.00	319		

Note: I = Items, A = Association, C = Letter case, D = Degradation (stimulus quality).

*$\underline{p} < .01$

**$\underline{p} < .001$

Table 5

REVISED BY SUBJECTS ANALYSIS OF VARIANCE SUMMARY TABLE
EXPERIMENT 2

Source	SS	d.f.	M.S.	F
S(D)	1,310,112.00	36	36,392.00	
D	535,859.30	1	535,859.30	14.725**
C	570,360.00	1	570,360.00	74.669**
A	187,954.00	1	187,954.00	19.956**
DC	74,405.69	1	74,405.00	9.741*
DA	10,728.06	1	10,728.06	1.139
CA	10,829.50	1	10,829.50	2.072
CS(D)	274,988.30	36	7,638.56	
AS(D)	339,056.90	36	9,418.25	
DCA	5,175.38	1	5,175.38	0.990
CAS(D)	188,200.10	36	5,227.78	
Total	3,507,669.23	151		

Note: S(D) = Subjects nested in levels of D, D = Degradation (stimulus quality), C = Letter case, A = Association.

*$p < .005$

**$p < .001$

Table 6

REVISED BY ITEM ANALYSIS OF VARIANCE SUMMARY TABLE
EXPERIMENT 2

Source	SS	d.f.	M.S.	F
D	1,251,000.00	1	1,251,000.00	139.857**
C	1,261,024.00	1	1,261,024.00	93.076**
A	388,368.40	1	388,368.40	19.865**
I	552,637.00	39	14,170.18	
DC	175,969.00	1	175,969.00	18.607**
DA	17,939.62	1	17,939.62	1.992
CA	20,800.62	1	20,800.62	1.211
DI	348,849.00	39	8,944.84	
CI	528,385.00	39	13,548.33	
AI	762,473.00	39	19,550.59	
DCA	9,031.37	1	9,031.37	0.686
DCI	368,834.00	39	9,457.28	
DAI	351,208.00	39	9,005.33	
CAI	669,952.00	39	17,178.25	
DCAI	513,449.00	39	13,165.36	
Total	7,219,920.01	319		

Note: D = Degradation (stimulus quality), C = Letter-case, A = Association, I = Items

$^{**}\underline{p} < .001$

APPENDIX D

FIGURES

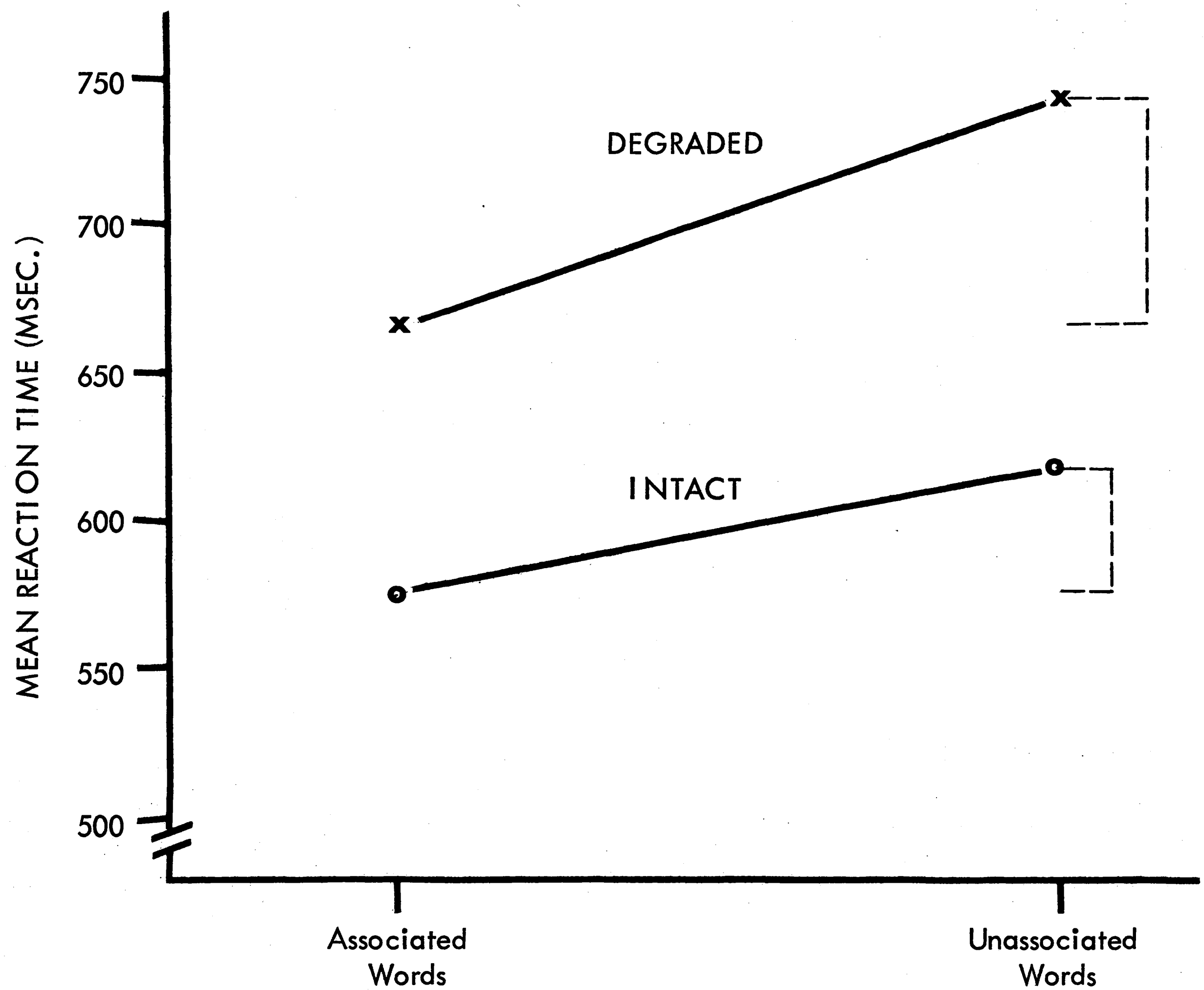

Figure 1. Mean RT as a Function of Association and Degradation From Meyer et al. (1974)

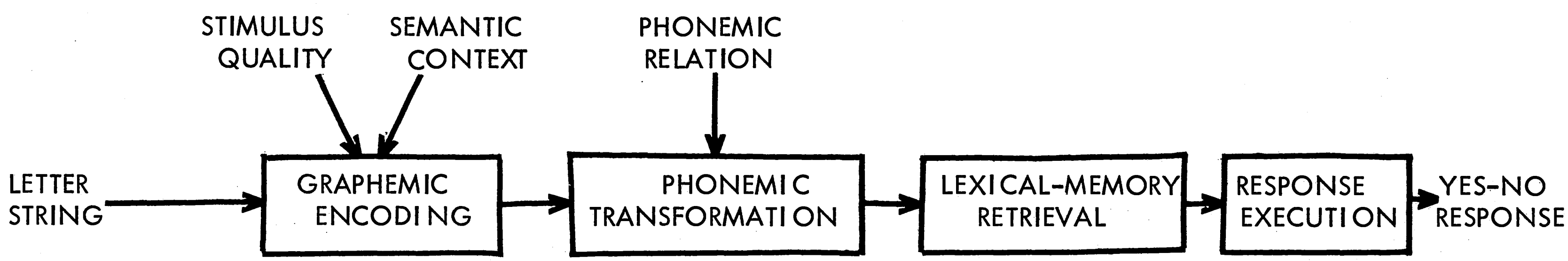

Figure 2. Human Information Processing Stage Model From Meyer et al. (1974)

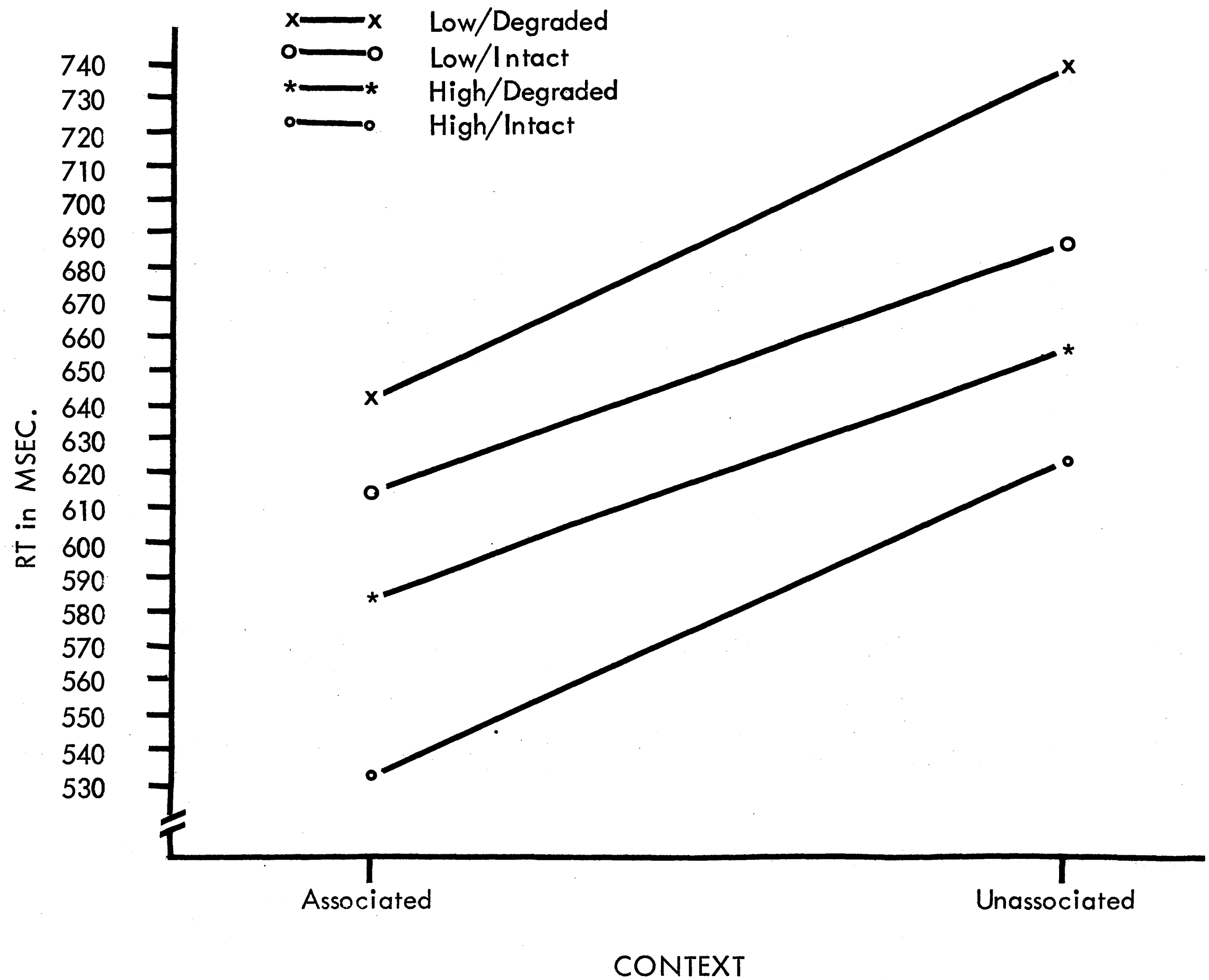

Figure 3. Mean RT as a Function of Association, Frequency and Degradation - Experiment 1

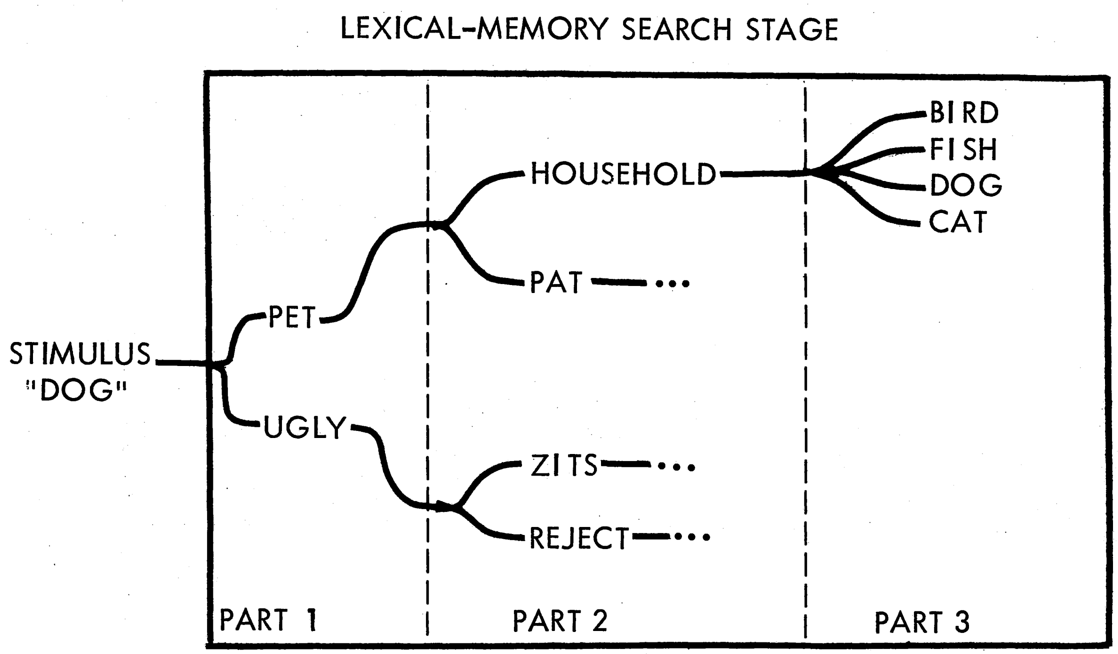

Figure 4. A Diagram of Theoretical Neural Paths in Lexical Memory

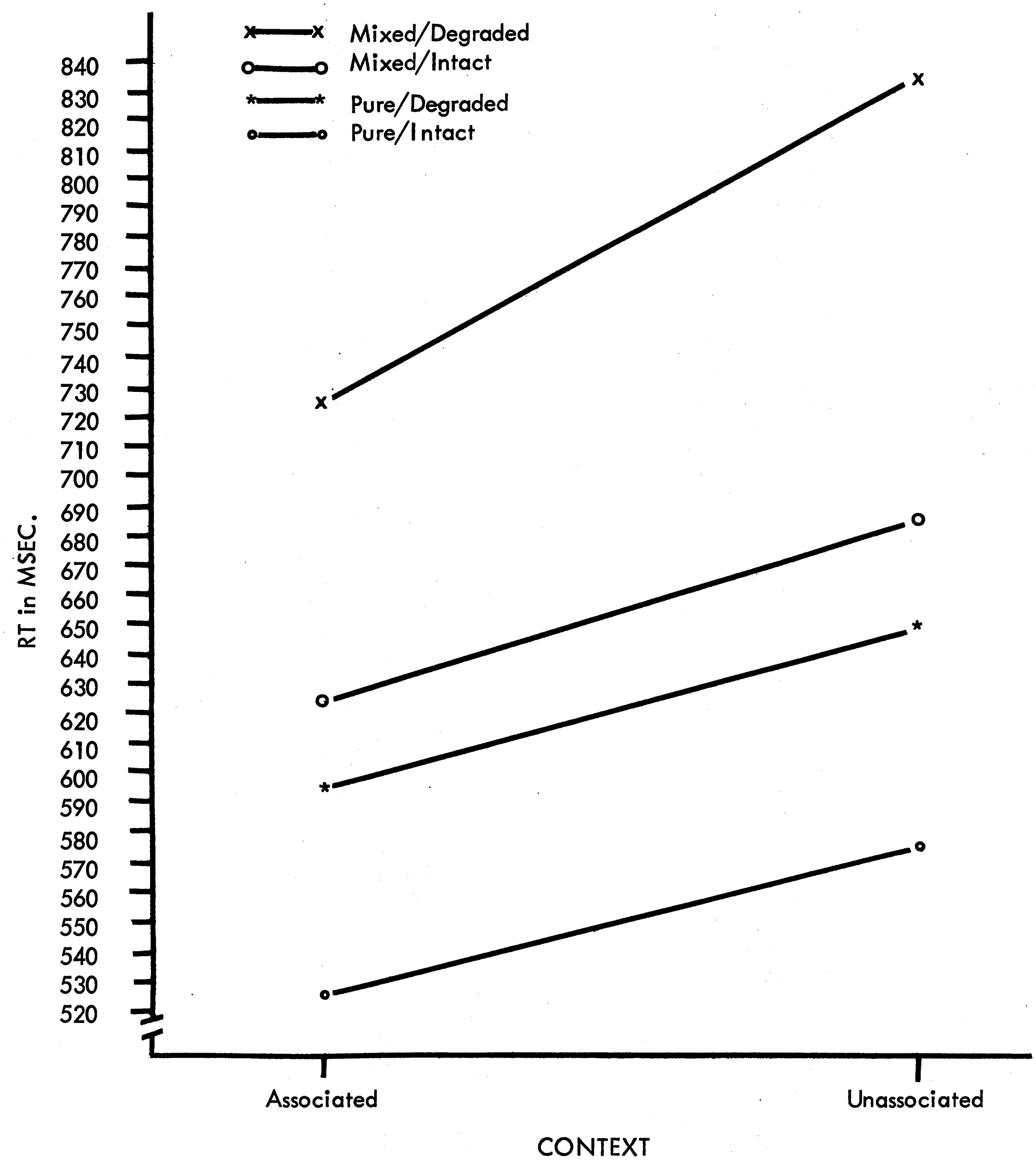

Figure 5. Mean RT as a Function of Association, Letter-Case, and Degradation-Experiment 2

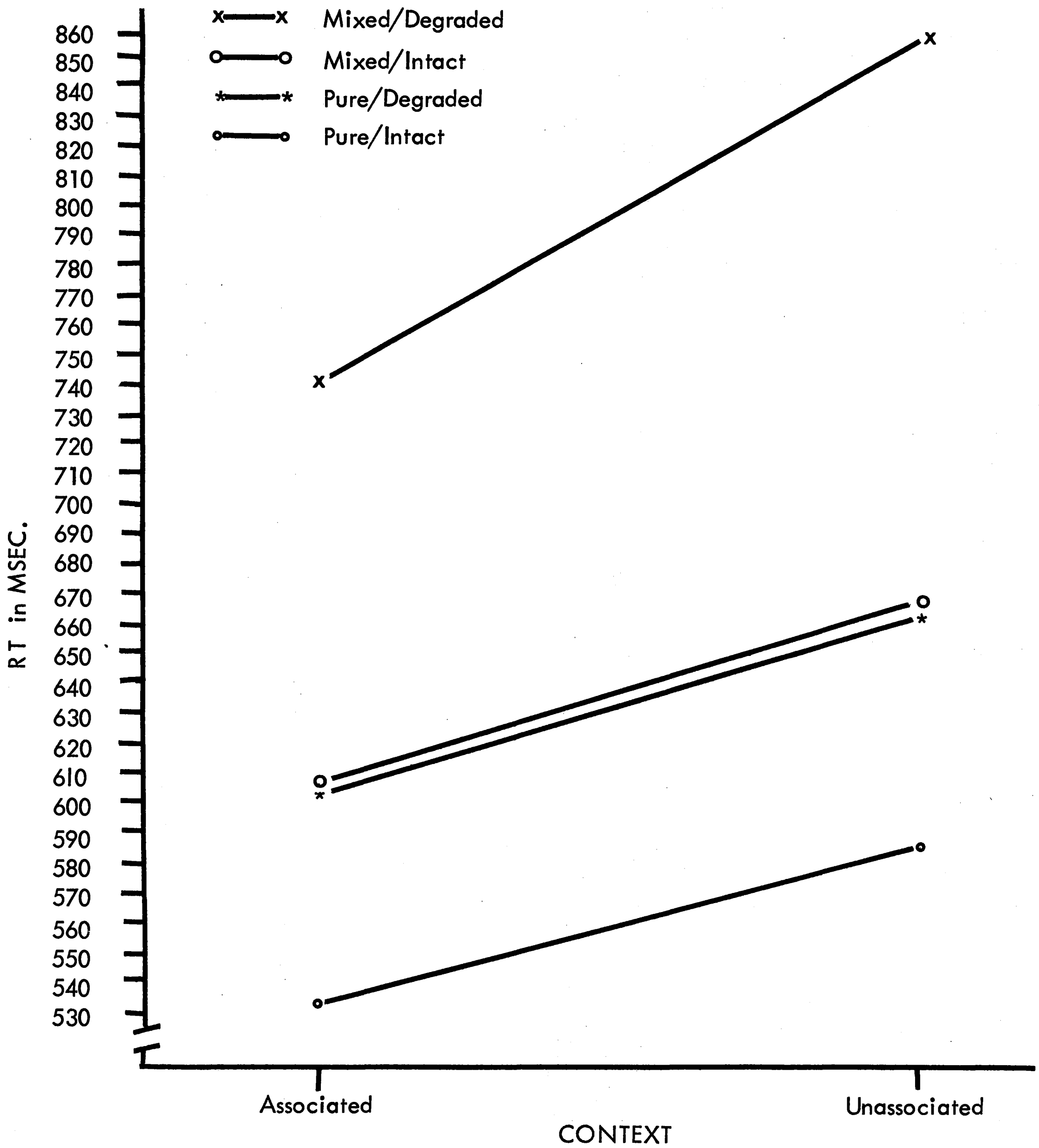

Figure 6. Mean RT as a Function of Association, Letter-Case, and Degradation-Experiment 2 Revised

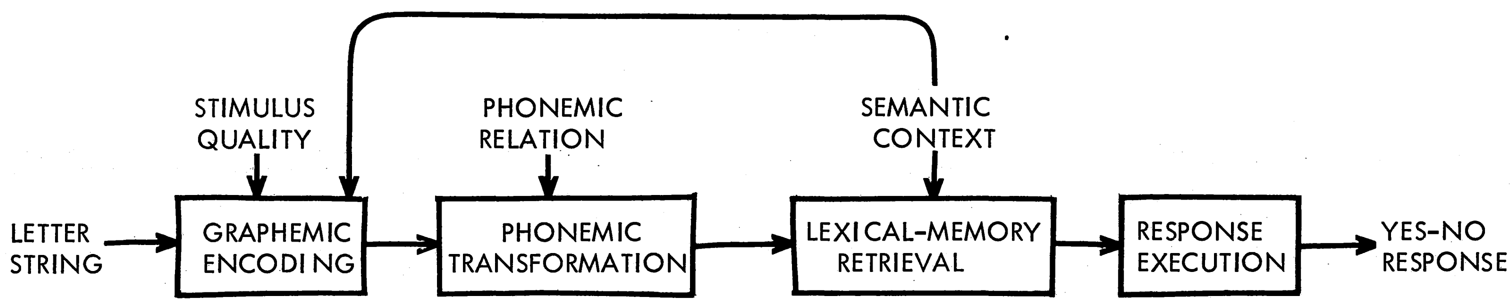

Figure 7. Proposed Model of Information Processing Based on Current Data

VITA

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