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Further tests of the generality of the principle of encoding specificity

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FURTHER TESTS OF THE GENERALITY OF THE PRINCIPLE OF ENCODING SPECIFICITY

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Abstract

A modification of the Peterson (1959) paradigm was employed to replicate and extend the findings of prior studies concerned with cueing in an investigation of the principle of encoding specificity. In four experiments the results indicated that recall and recognition latency for target items is facilitated in the presence of original input cues in comparison to extralist cues for both word pairs and CVC trigrams. These findings are discussed in relation to recent critiques of encoding specificity (Martin, 1975; Reder, Anderson, & Bjork, 1974).

This introduction is divided into three sections. The first section consists of a brief review of some of the major findings and theoretical significance of the cueing research in general. The second section consists of a review of the major theoretical explanations (and relevant data) proposed to account for the effects of cueing. In the third section, the rationale for the present research is discussed in some detail.

Major Findings and Theoretical Significance

As Postman (1972) has pointed out, the cueing experiment is of basic theoretical significance because it provides an operational means for differentiating between the availability and accessibility of information in memory and thus permits inferences about retrieval processes with the conditions of storage held constant. In particular, studies of cueing have provided impressive evidence which points to the importance of organizational processes for memory performance, and have provided support for the hierarchical models of free recall proposed by several authors. For example, in a well-known study, Tulving and Pearlstone (1966) presented their subjects with categorized lists for a subsequent free recall test. Both the category instances and category labels were presented during study. The important finding of this study was that when the subjects were provided with the category labels as retrieval cues, recall was greatly facilitated relative to noncued recall conditions. This result has

cues, the number of higher order units recalled increases, but not the number of items within higher order units (Tulving and Pearlstone, 1966; Tulving and Psotka, 1971). The usual interpretation given to this finding is that the retrieval cues provide more direct access to the higher order units, but not to items within these units. While the findings from the cueing studies cited above are supportive of hierarchical models of free recall, other findings are inconsistent with these models and have led to modifications in some of their major assumptions. These latter findings have demonstrated that under the appropriate conditions, cueing does not necessarily facilitate performance and can actually inhibit recall. For example, in a series of studies, Slamecka (1968; 1969) employed a part-list cueing paradigm to investigate the effects of contextual cueing in lists of unrelated items. The basic procedure in these studies was to present the subject with lists of items for subsequent recall, and during the recall test, provide some of the list items as retrieval cues. The major results of these studies indicated that cueing did not facilitate recall relative to noncued conditions. Moreover, cueing was found to actually inhibit performance. Other investigators (cf. Freund and Underwood, 1969; Wood, 1969) have obtained similar results.

Other studies (cf. Roediger, 1973; Smith, 1971) have demonstrated that cueing can also produce inhibitory effects in categorized lists. In the Roediger (1973) study, some

latter will thus be inhibited.

In general, it appears safe to conclude that retrieval cues will facilitate recall relative to noncued conditions only when they allow access to more higher-order units than could be recalled unaided (cf. Slamecka, 1972). If they provide more information than is necessary to simply gain access to a higher-order unit (i.e., as category instances), it is likely that they will impair recall (Roediger, 1973, 1974). As Roediger (1974) has pointed out, the relative effectiveness of retrieval cues in any particular situation should depend on these two factors.

Theoretical Explanations of Cueing

In brief, the encoding specificity principle developed by Tulving and his associated (cf. Tulving & Thomson, 1973) postulates that the effectiveness of a cue item is governed by the relation established between it and a corresponding target item during study. That is, in order to be effective, the information derived from a cue during a recall or recognition test must substantially overlap with the informational content of the memory trace encoded during input. in other words, the encoding specificity postulates that the effectiveness of retrieval cues are dependent upon coding processes occurring during input.

The derivation of the encoding specificity principle stems from several sources. One set of findings which have contributed to the development of this hypothesis is concerned with the effects of extralist cues on recall

performance. The encoding specificity principle predicts that an extralist cue will have facilitative effects on memory performance only to the extent that its relationship to a target item is specified during encoding and that such cues will not facilitate recall under conditions designed to minimize the probability that they will be encoded in relation to their targets. This prediction has been confirmed in several studies (cf. Tulving & Osler, 1968; Thomson & Tulving, 1970).

Another source of evidence which has contributed to the development of encoding specificity concerns the influence of context on recognition memory. Several studies (cf. Light & Carter-Sobell, 1970; Tulving & Thomson, 1971) have shown that recognition memory for an item will suffer to the extent that the context prevailing during the recognition test does not match that prevailing during study. The usual interpretation given to this result has been that in order to serve as an effective retrieval cue, the encoding of the target item during the recognition test must match that which was stored during study.

Encoding specificity phenomena such as recall failure with extralist cues and context effects in recognition memory have been interpreted as inconsistent with generation-recognition models of recall (cf. Bahrick, 1970; Anderson & Bower, 1972). Such models postulate that recall entails a two-stage process; 1) memory search, which consists of the implicity generation of response items: and 2) recog-

nition, in which a decision is made concerning the list membership of each generated item. These models would predict that strong associates provided as retrieval cues should facilitate memory performance independently of encoding events, since the target has a greater probability of being contained within the set of items generated in response to the cue.

A further assumption underlying generation-recognition models is that recognition entails "automatic access" to the representation of the item stored in semantic memory (Tulving, 1972), and that the recognition decision is made on the basis of the presence of "list markers" associated with the item which represent information that the item has occurred within a particular experimental situation. The context effects described previously violate this assumption since they suggest that, recognition, as well as recall, entails a retrieval process. Moreover, further extensions of these findings (cf. Tulving & Thomson, 1973; Watkins & Tulving, 1975), which have demonstrated the phenomenon of recognition failure of recallable words, have provided a further source of evidence which is damaging to generation-recognition models.

In response to these results, several authors (Martin, 1975; Reder, Anderson and Bjork, 1974), have proposed modifications of extant generation-recognition to models which can accommodate the findings cited above. According to these authors, during input, the nominal item per se

is not tagged with occurrence information; rather, it is the interpretation given a word within a specific context that is tagged. During recall, it is hypothesized that it is not the nominal word which is generated and subjected to a recognition check, rather, it is the functional version of the work which is generated and subjected to a recognition test. According to these authors, encoding specificity phenomena are hypothesized to occur to the extent that the semantic interpretation given a cue item does not match that which was tagged during input.

Several recent studies, however, have demonstrated that encoding specificity phenomena such as recall failure with extralist cues and context effects in recognition memory are only obtainable under a relatively restricted set of conditions, and therefore, suggest the possibility that the generality of this hypothesis is, in fact, quite limited. For example, Reder, Anderson, and Bjork (1974) presented their subjects with lists of either high or low frequency target items paired with weak input cues: the subjects were required to recall (or recognize) the targets in the presence of either the same cues, strong associates, or no cues. The important findings of this study demonstrated an interaction between frequency and cueing. That is, it was found that for both recognition and recall, the strong extralist cues were much less effective for high than for low frequency targets. In another study, Santa & Lamwers (1974) have demonstrated that strong extralist cues

were much less effective for high than for low frequency targets. In another study, Santa & Lamwers (1974) have demonstrated that strong extralist cues can facilitate recall under conditions where the subjects are provided with information concerning the associative relationship between the cues and targets. In this study, the encoding specificity phenomenon of recall failure with extralist cues was obtained only for subjects not provided with information concerning the extralist cue-target relationships.

The importance of these studies is that they suggest that the boundary conditions of encoding specificity, such as recall failure with extralist cues and context effects in recognition, might be quite limited, and furthermore, might in fact be the result of methodological flaws inherent in the typical encoding specificity paradigm. Similar conclusions have been reached in other studies concerned with the encoding specificity effect of recognition failure of recallable words (Postman, 1975; Santa & Lamwers, 1974).

The present research was motivated in large part by these concerns. The four experiments to be reported here were undertaken for the purpose of exploring the generality of the encoding specificity principle within the context of a paradigm and under conditions beyond the domain of those typically employed in its study.

The Present Paradigm

In the present research, a modified Brown-Peterson short-term memory paradigm (Brown, 1958; Peterson & Peter-

son, 1959), utilizing latency of recall as the primary measure of memory performance was employed. A major advantage of this paradigm lies in the fact that it appears to offer a means of extending the findings obtained in more conventional memory paradigms since there are several features of this paradigm which would seem to render it particularly well-suited for studying encoding specificity. In previous research employing this paradigm, (Scheirer, 1971) one consistent finding has been that latency and errors do not correlate significantly with each other; and it has been suggested that these measures might reflect separate aspects of the memory process (storage vs. retrieval, respectively). In addition, such factors as cueing and item concreteness have been found to produce significant effects on latency of recall (Scheirer, 1971; Macht & Scheirer, 1975). On the basis of these findings, it would seem reasonable to suggest that latency might be sensitive to factors known to influence retrieval processes, and therefore, would appear to be an appropriate measure with which to study cueing.

Another feature of the present paradigm which renders it particularly useful for the present purposes is that, in contrast to the typical paradigm used to study encoding specificity, the subject is required to study and respond to individual sets of verbal items. As several authors have pointed out (Humphreys & Galbraith, 1975; Underwood, 1972), the typical encoding specificity paradigm (cf.

Thomson & Tulving, 1970) implies a paired-associate model of recall, and therefore, to justify its use, one must assume that the coding processes involved in the two tasks are equivalent. There is at present no evidence supportive of this assumption. For example, Battig (1968) has identified several independent intralist subprocesses in the acquisition of paired-associate lists. Therefore, the present paradigm would appear particularly well-suited for studying encoding specificity since it would appear to provide a situation more akin to that of free recall because inasmuch as the subject is presented with individual sets of items, the role of intralist processes such as those postulated by Battig (1968) would appear to be minimized.

<u>General</u> <u>Method</u>

The procedure common to all experiments will be described in this section. On each trial, the subject was presented with an input item for 4 seconds. Following this study interval, a four-digit number appeared on a screen and the subject read this number aloud and proceeded to count backwards from it for eight seconds. After eight seconds of backward counting, the subject was provided with a signal to recall one of the items from the set during input. The signal was an "X" (in Experiments 1 & 2); or an asterisk (in Experiment 3) and it designated the target item the subject was to recall. The subject held a button in one hand and a microphone in the other. At

the time of recall, he pressed a button enabling a voice relay. Then, he vocalized his response into a microphone. This caused a digital timer to stop, and allowed for the recording of the subject's latency. The digital timer was activated when the test signal appeared.

In all four experiments, the cueing manipulation was treated as a within-subject factor. During recall (recognition in Experiment 4), the subject was tested in the presence of either the same input cues, extralist cues, or no cues on each trial. The cue items appeared along with the test signals. The within-subject conditions were counterbalanced with randomly selected Latin squares such that all conditions were replicated within blocks of trials and across blocks of subjects.

The input items and recall items were typed on onion-skin paper and mounted on cardboard slide frames. A Kodak Carousel projector was used to display the items onto a white screen at a distance of approximately 1 meter from the subject.

Upon arrival for the experimental session, each subject in all four experiments was given general instructions relating to the nature of the task. In order to minimize any confusion resulting from the presentation of the cues during recall, he/she was told that during recall, an item would sometimes appear on the screen which would help to remind him of the item he was to recall (or recognize). The subject then repeated these instructions to insure his

understanding of the task. Following this, the experimental session began. Within an experimental session, the subject received both practice trials and experimental trials. During practice in each experiment, the subjects were presented with the same set of items (representing all input conditions) and tested under all of the within-subject conditions. The order of the within-subject conditions was constant for all subjects. After practice, the subjects were presented with the experimental items, and were not informed of the transition from the practice trials to the experimental trials.

All subjects were undergraduates attending the State University of New York at Binghamton. They participated in this experiment in a partial fulfillment of course requirements in Introductory Psychology. Upon arriving for the experiment, each subject was randomly assigned to one of the between-subject conditions, with the restriction that all conditions were replicated before the next block began. Each subject was run individually.

Experiment 1

Experiment 1 was designed as a replication of the Thomson & Tulving (1970) study within the context of the present paradigm. In this experiment, on each trial the subjects were presented with one of three types of input pairs: to-be-recalled items paired with either strong associates, (e.g. STOMACH-ACHE) unrelated words, (e.g. FRAGRANT-ACHE) or single words, (e.g. ACHE). For each

of these three types of input items, recall was tested under one of three conditions: in the presence of the strong associates, (STOMACH), unrelated, (FRAGRANT), or no cues.

Method

In Experiment 1, there was one between-subject factor and a 3 X 2 arrangement of within-subject factors. The between-subject factor represented the type of input item presented to the subject on each experimental trial. That is, the subject was presented with an input list of either strong associate pairs (Group SA), unrelated word pairs (Group UR), or single words (Group S). The two within-subject factors, when crossed, yielded 6 within-subject conditions. These conditions represented the type of cue provided to the subject (strong, unrelated, or no cue), and the item in the pair (direction or recall) serving as the target item (either the left or right hand item). The purpose of the latter manipulation was to maximize the probability that the subjects would attend to both items during study, thereby increasing the chances of each being encoded in relation to the other. For Group S, the latter manipulation was reflected in the spatial position of the cues as they appeared to the subject during recall (e.e., the cue item appeared in either the left or right hand position).

Each subject was presented with a list of 46 items: 10 practice items and 36 experimental items. A pool of

36 pairs of high probability associates ($\bar{X}$=.33) were selected from the Bilodeau & Howell (1964) norms for Group SA. For Group UR, the pairs were constructed such that each pair member bore no obvious relation to the other. These two sets of items overlapped such that each pair of high probability associates was repaired to form a corresponding pair in Group UR, e.g., if Group SA had received the pair STOMACH-ACHE, the corresponding pair in Group UR was FRAGRANT-ACHE. The input list for Group S was constructed by selecting the item common to both Groups SA and UR, e.g., ACHE. In addition, a separate pool of input items were selected for the practice trials, and the three types of input items were constructed from this pool.

The subjects were 36 undergraduates.

Results

For the purposes of the analyses, several potential recall scores were examined. Mean latencies of recall of correct response were computed for each of the six within-subject conditions for each subject. For reasons discussed previously (Scheirer, 1971; Hanley & Scheirer, 1974), the harmonic mean latency of correct recall for each condition was chosen as the primary dependent variable. To take into account the time taken for the Carousel to advance, .5 sec. was subtracted from the latencies measured on each trial prior to the computation of the harmonic means. In addition, for each of the six within-subject

conditions, the proportion of trials on which errors occurred was computed for each subject. The results of the analyses on both of these measures will be reported here.

<u>Latencies</u>. An overall analysis of variance indicated that the latency means were affected by input conditions, $F(2.33) = 7.68$, p .05. The means for Groups S, UR, and SA were 2.00 sec., 3.14 sec., and 2.74 sec., respectively. The analysis also indicated that latencies were significantly faster in Group S than in Groups SA and UR. There were no significant differences between the latter groups.

To conform to the analysis employed by Thomson & Tulving (1970), the results of a repeated treatments analysis for each individual group is reported. The analyses revealed that direction of recall had no significant effect on latency of recall (as well as errors). The mean latency data for each input group are displayed in Table 1.

For Group S, neither of the within-subject conditions had significant effects on latency of recall. Neither the effects of cueing, or direction of recall, nor their interactions, was significant. This finding can be contrasted with that obtained by Thomson & Tulving (1970), who found that in their single input condition, strong cues facilitated recall in comparison to weak and no-cue conditions.

For Group UR, the effects of cueing were significant.

The analysis revealed that recall was faster in the presence of the original input cues than in the no-cue conditions, $F(1,11) = 11.78$, p .05. Furthermore, the results indicated that latency of recall in the presence of the strong cues was not significantly different from that in the no-cue condition, F 1 (see Table 1). This finding also contrasts with that obtained from Thomson and Tulving (1970), who found that strong cues facilitated recall in their weak input condition.

For Group SA, the analysis indicated that the effects of cueing were also significant. This analysis revealed that recall in the presence of the strong cues was significantly faster than in the no-cue condition, $F(1,11) = 6.39$, p .05. Furthermore, although not significant, the analysis indicated that recall in the presence of unrelated cue items tended to <u>slow</u> the subject's latency in comparison to the noncued condition, $F(1,11) = 4.39$, .05 p .10. This pattern of results tends to parallel those obtained by Thomson & Tulving (1970).

<u>Errors</u>. Errors occurred on 14% of all trials, and the means of each of the input groups are also displayed in Table 1. The overall mean proportion of errors for Groups S, UR, and SA were .08, .20 and .13 respectively.

The results of a repeated treatments analysis for each individual group will be reported here (see Table 1). For Group S, the effect of cueing was not significant. This finding contrasts with that obtained in the Thomson

& Tulving (1970) study. For Group UR, the analysis indicated that the effect of cueing was significant. That is, both strong extralist cues, $F(1,11) = 7.28$, p .05, and the unrelated input cues, $F(1,11) = 5.95$, p .05, significantly reduced the proportion of errors in comparison to the no-cue condition. In addition, the effect of strong cues was qualified by an interaction with direction of recall. Strong cues reduced error frequencies only for recall of the right hand member, $F(1,11) = 6.74$, p .05. For recall of the right hand item, the proportion of errors occurring was .10 and .35 for strong vs. no cues; whereas for recall of the left hand item, the corresponding means were .20 and .19. These findings essentially replicate those of Thomson & Tulving (1970), although these authors did not manipulate direction of recall in their design.

For Group SA, the analysis revealed that the effect of cueing was also significant. For this group, strong cues significantly reduced the proportion of errors in comparison to the no-cue condition, $F(1,11) = 9.77$, p .05. The unrelated extralist cue condition did not differ significantly from the no-cue condition. This result is in line with that obtained by Thomson & Tulving (1970).

<u>Experiment 2</u>

Taken as a whole, the results of Experiment 1 replicated those obtained by Thomson & Tulving (1970), and therefore, were successful in extending the generality

of encoding specificity to the present paradigm. Experiment 2 was designed as a further extension of these findings to new materials. In Experiment 2, the target items consisted of items which could be classified as representative of the class of sense impressions (e.g., wet, round, etc.); and were paired with nouns during input. The major manipulation involved the probability with which the noun cue item provided to the subject elicited the target as a sense impression (Underwood & Richardson, 1956).

The cueing manipulation was modified such that the extralist cues provided to the subject in each input condition elicited the target with both high and low probability. The purpose of this manipulation was to examine the performance decrement produced by the change from the input to the extralist output cues. That is, encoding specificity predicts that extralist cues which share semantic features in common with those of the input items should facilitate recall in comparison to those which do not share any substantial semantic overlap (Murphy & Wallace, 1974; Pellegrino & Salzberg, 1975b). Within the context of Experiment 2, encoding specificity predicts that a strong extralist cue should be more effective for high probability input pairs in comparison to low probability items.

Another purpose of Experiment 2 was to investigate the effects of the instructions given to the subjects.

Half of the subjects were informed of the relationship between the cue and target items (i.e., that at times, the target item was a dominant, or characteristic property of the cue word); whereas the remaining subjects were not informed of this relationship. The purpose of this manipulation was to investigate the generality of the findings obtained by Santa & Lamwers (1974) within the context of the present paradigm.

Method

The design of Experiment 2 was a 3 X 2 between-subject factorial. The two between-subject factors represented the type of input items presented to the subject and the instructional variable. The subject was presented with a list of high dominance pairs (the targets were high probability sense impressions); the same target paired with a low probability noun; or a target accompanied by a noun. For each of these three comditions, half of the subjects were informed of the relationship between the cues and targets, the remaining were not so informed. This arrangement resulted in six between-subject conditions: Groups H-I and H-NI were presented with a list of high dominant input pairs and were/were not informed of the cue-target relationship respectively; in Groups L-I and L-NI, the subjects were presented with low dominant input pairs; and in Groups S-I and S-NI, the subjects were presented with single input items.

The within-subject factor (cueing) was arranged as

follows: for the high dominance input groups (e.g. WATER-WET), the subjects were required to recall in the presence of the same input cue (WATER), a high probability extralist cue (PUDDLE), a low probability extralist cue (PICTURE), or no cue. For the low dominance groups (e.g. PICTURE-WET), the subject recalled in the presence of the same input cue (PICTURE), an extralist high probability cue (WATER), an extralist low probability cue (TREE), or no cue. For subjects in the single input groups, recall was tested in the presence of either strong (WATER), weak (PICTURE), or no cue.

Each subject was presented with a list of 12 practice trials and 30 experimental trials. For the experimental trials, the left-hand item served as the target on one-fifth of all trials for the double input groups. Inasmuch as direction of recall had no substantial effects on performance in Experiment 1, it was not treated as a factor in Experiment 2; however, both items were tested to insure that the subjects attended to both pair items during study. The data from trials in which the left-hand items served as the target was excluded from the analyses.

The input items were selected from the Underwood & Richardson (1956) norms. For the high dominance groups, the mean elicitation probability for the input items was .70; for the low dominance groups, the corresponding value was .10. In addition, the strong extralist cues in the high dominance input groups elicited the targets with a

probability of .71; in the low dominance groups, the corresponding value of the extralist low probability cues was .13. In Experiment 2, the input list were constructed such that the target items were common to all groups (e.g. WATER-WET, PICTURE-WET, and WET served as the input items in the high dominance, low dominance, and single input conditions, respectively).

The subjects consisted of 36 undergraduates.

Results

As in Experiment 1, the harmonic mean latency of correct response and the proportion of errors was computed for each of the within-subject conditions. In contrast to Experiment 1, errors occurred relatively infrequently (1% of all trials), and therefore, it is quite possible that ceiling effects might have obscured any effects. Thus, the results of the analyses for latency will be reported here. Separate overall analyses of variance were performed on the data from the single input groups and the double input groups.

Latencies. The mean latencies for each input group are displayed in Table 2. The analysis performed on the data from the single input groups indicated that the effects of the instructional variable was significant, $F(1,10) = 12.57$, p .05. This analysis indicated that the subjects in Group S-I responded slower than the subjects in Group S-NI (2.78 sec. vs. 1.77 sec.). No other effects reached significance in this analysis. The overall analysis per-

formed on the double input groups revealed the following: The effect of the strong (high dominant) cues was significant in all four input groups, $F(1,20) = 6.35$, $p \quad .05$. Thus, in the high dominant groups, providing the subject with the original input cue facilitated latency of recall relative to the no-cue condition. The same items serving as extralist cues in the low dominance input groups also facilitated performance (see Table 2).

The effect of the weak cues was also significant, $F(1,20) = 8.30$, $p \quad .05$, but only in the low dominance groups. As Table 2 shows, the weak cues facilitated latency of recall relative to the no-cue condition only in Groups L-I and L-NI. Therefore, taken as a whole, these results were successful in extending the findings of Experiment 1 to new materials, and, in general, are consistent with encoding specificity.

<u>General Discussion</u>

Taken as a whole, the results of Experiments 1 & w were successful in extending the generality of encoding specificity within the context of the present paradigm. The major findings to come out of these studies both replicate and extend the results of prior cueing studies. However, there are several features of the present findings which appear inconsistent with encoding specificity. For example, it was found that cueing with strong vs. weak extralist cues in Experiments 1 and 2 produced asymmetrical effects on recall performance. For both latency (Experiment

2) and errors, (Experiment 1) it was found that the strong extralist cues facilitated performance in the weak and unrelated input conditions. However, the unrealted (and weak) extralist cues did not facilitate performance in the strong input conditions. This same pattern was obtained by Thomson & Tulving (1970) in their study, and it is inconsistent with encoding specificity. The weak input conditions were designed to minimize the probability with which strong associates could become encoded in relation to their targets, and, according to this hypothesis, these cues should not have facilitated performance. In order to bring this data in line with encoding specificity, then, one would have to argue, as have Thomson & Tulving (1970), that the experimental manipulations were relatively unsuccessful in establishing effective control over encoding events at input, and as a result, the strong associates were in fact encoded in relation to their targets during input.

Another discrepant finding concerns the effect of the strong extralist cues provided to the subjects in the high dominance groups in Experiment 2. In these groups, the strong extralist cues did not facilitate performance relative to the no-cue conditions; whereas strong extralist cues did facilitate performance in the low dominance groups, as discussed above. Inasmuch as encoding specificity predicts the opposite pattern, namely, that the strong extralist cues should facilitate performance only

in the high dominance groups, these results can be interpreted as inconsistent with this hypothesis. Other investigators (cf. Murphy & Wallace, 1974; Tulving, 1974) have obtained comparable findings.

Another outcome of Experiment 2 indicated that the effects of instructions provided to the subjects did not conform to the findings of Santa & Lamwers (1974). These authors have proposed that any recall decrements produced by the switch from weak input to strong extralist cues is the result of confusion, i.e., the subjects tend to become confused when exposed to the strong extralist cues after learning and recalling a series of lists composed of weak associate input pairs. As a result, they tend to adopy inappropriate retrieval strategies in response to the strong extralist cues. These authors have found that when subjects are provided with appropriate information concerning the extralist cue-target relationships, the recall decrements are largely eliminated.

It is quite possible that methodological differences contributed to this discrepancy. For example, in Experiment 2 (and Experiment 1), the cueing variable was a within-subject factor, and therefore, the subjects could expect to be tested under all cueing within the list. This would tend to minimize any confusion resulting from the presentation of new cues, which, in turn might minimize any effect of the instructions. In contrast to this design,

in the Santa & Lamwers (1974) study, the strong extralist cues were provided to the subjects for the first time after they had learned a series of lists containing weak associate pairs. The results of Experiment 2 might suggest that the boundary conditions of the Santa & Lamwers (1974) findings are limited to conditions designed to produce maximal confusion in the subjects.

In both Experiments 1 & 2, the results indicated that for the single input conditions, no effects of cueing were obtained. This result can be contrasted with the results of prior cueing studies (cf. Thomson & Tulving, 1970) in which significant cueing effects were obtained for single input items. One possible explanation for this discrepancy concerns methodological differences between the present paradigm and thos employed in prior studies. In studies of short-term memory (cf. Murdock, 1961) one consistent finding has been that the rate of forgetting is markedly reduced for single chunks (Miller, 1956) relative to multiple chunks. This finding suggests that single chunks are being retrieved primarily from short-term storage after eight seconds of backward counting; with multi-chunk items being retrieved primarily from long-term storage after the same retention interval. If this hypothesis is tenable, then one would not expect any cueing effects in the single input conditions in Experiments 1 & 2, and it would seem that the present findings are consistent with previous studies of short-

term memory.

Experiment 3

The rationale for Experiment 3 stems primarily from the modifications of generation-recognition models recently proposed by Martin, (1975), and Reder, Anderson, and Bjork, (1974). These authors have proposed that encoding specificity phenomena can be interpreted within a generation-recognition framework when one shifts the level of discourse from the nominal to a functional level, or in other words, when one takes into consideration the fact that words are comprised of a number of different semantic senses, or meanings, in semantic memory. On the basis of these arguments, it would seem that encoding specificity phenomena are not necessarily antithetical to generation-recognition models so long as the emphasis is directed toward semantic factors. Therefore, Experiment 3 (and Experiment 4) was designed to investigate the generality of encoding specificity effects at a nominal level (i.e., under conditions designed to minimize the role of semantic factors). By nominal level, it is meant that the memory trace consists primarily of raw perceptual responses (visual, phonetic, and articulatory features) rather than more elaborative (semantic) information (Underwood, Kapelak, and Malmi, 1976). In Experiment 3, the subjects were presented with a set of three letters (CVC trigrams) on each trial, and were required to recall one letter from the original set. Recall of the target letter was tested

in the presence of either two of the letters of the original set or two extralist bigram cues which elicited the target with either high, medium, or low probability (Underwood & Schulz, 1960). Within the context of the present research, this manipulation was considered analogous to manipulations of associative strength (Experiment 1) and dominance value (Experiment 2).

Method

In Experiment 3, all of the factors were treated as within-subject variables, forming a 3 X 4 arrangement. The three level factor represented the meaningfulness of the CVC presented to the subject. That is, the input items were of high, intermediate, or low meaningfulness value (Archer, 1959). The four level factor reflected the type of cue provided during recall. That is, recall of a target letter was cued by the remaining letters of the input CVC; or by pairs of extralist letters which elicited the target with either high, medium, or low probability (the input bigram cues elicited the targets with medium probability).

Each subject was presented with a total of 44 trials; 8 practice and 36 experimental trials. For the experimental trials, the target letter occurred in the third CVC position on two-thirds of all trials, and the cueing variable was crossed completely only for recall of this item. For the remaining trials, the target occurred in either the first or second CVC position, and recall was

cued by the remaining CVC letters. (The data from these trials were excluded from the analyses.) A total of six recall conditions resulted from this arrangement which counterbalanced within each set of 12 CVC input items.

A pool of 36 CVC items of either high ($\bar{X}$=88%), intermediate ($\bar{X}$=63%), or low ($\bar{X}$=43%) meaningfulness value was selected from the Archer (1959) norms. In addition, for each of the three types of input items, a pool of bigram cues was selected such that the cue elicited the target letter with either high (20), medium (10-20), or low (10) probability as rated by the Underwood & Schulz (1960) Norms. The nature of each cue selected was restricted such that when combined with its respective letter, the meaningfulness value of the resultant CVC was equivalent to that of the original CVC.

The subjects were 36 undergraduates.

Results

Latencies. The results of Experiment 3 were quite straightforward. A repeated treatments analysis revealed that recall of the target letter in the presence of the remaining two letters was significantly faster than recall in the presence of a bigram cue which elicited the target with either high, $F(1,35)=6.73$, p .05; medium, $F(1,25)=8.39$, p .05; or low, $F(1,35)=6.33$, p .05, probability. The mean latency of recall for each of the cueing conditions is displayed in Table 3. The effect of meaningfulness was not significant.

<u>Errors</u>. Errors occurred on 9% of all trials. The results of a repeated treatments analysis revealed that significantly fewer errors occurred in the presence of the original bigram cues than in the presence of the medium probability cues, $F(1,35)-5.95$, p .05. In addition, this analysis revealed a significant interaction involving the meaningfulness and cueing variables, $F(1,35)=8.75$, p .05. This interaction indicated that for CVCs of intermediate meaningfulness value, more errors occurred in the presence of the original bigram cues (.13) than in the presence of the low probability extralist cues (.06). However, for low meaningfulness CVCs, this pattern was reversed; fewer errors occurred in the presence of the original cues (.04) than in the presence of the low probability cues (.13). No other effects reached significance in this analysis.

With respect to the latency data, the results of Experiment 3 were successful in demonstrating encoding specificity effects since they indicated that latency of recall of a target item is facilitated only in the presence of the original input context. This pattern was also partially obtained in the error data. Thus, the present results appear to have extended the generality of encoding specificity at a nomonal level, and therefore, are not readily accounted for by the alternative explanations of encoding specificity proposed by Martin, (1975) and Reder, et al. (1974).

Experiment 4

The results of Experiments 1, 2, and 3 were all successful in establishing the generality of encoding specificity under the present conditions, since the results of these experiments all demonstrated the latency of recall is facilitated primarily in the presence of the original input cues. This pattern was also partially obtained in the error data. Experiment 4 was designed to establish the generality of the encoding specificity phenomenon of context effects in recognition memory.

In Experiment 4, the subjects were again presented with a CVC on each trial, and were tested in the presence of the original or extralist cues. However, memory performance was measured by recognition latency (yes/no); the subjects were required to decide simply whether the target letters had been presented initially during input.

Method

The design of Experiment 4 was a 4 X 2 arrangement of within subject factors. The four level factor reflected the type of cue provided to the subject during the recognition test. Recognition was tested in the presence of either the remaining two CVC letters; or a strong, medium, or low probability extralist cue. The two level factor represented the nature of the target item, i.e., the target was either a positive or negative item.

Each subject was presented with a list of 44 trials (8 practice, 36 experimental trials). As in Experiment

3, the letter from the third CVC position served as the target on two-thirds of all trials, and recognition of this item was tested in the presence of all four types of cues. Only the data from these trials was included in the analyses. During the recognition test, the target was identified by a line drawn underneath it.

The input items and cues for both the practice and experimental trials were identical to those used in Experiment 3 (meaningfulness was not treated as a factor in Experiment 4). The negative items were selected such that the elicitation probability of each with its respective set of cues was equivalent to that of the corresponding positive item it replaced.

The subjects in Experiment 4 consisted of 24 undergraduates.

Results.

For each subject, the harmonic mean latency of correct recognition (yes/no) was computed for each of the within-subject conditions. In addition, the proportion of misses (for the positive targets) and the false alarms (for the negative targets) was computed for each of the cueing conditions.

Latencies. A repeated treatments analysis indicated that cueing had significant effects on recognition latency. Correct recognition was significantly faster in the presence of either the medium $F(1,23)=6.05$, p .05, or low probability cues, $F(1,23=37.57$, p .05. This pattern was

constant for both positive and negative targets. In addition, the analysis indicated a significant interaction when the high probability cues are compared with original cues for positive vs. negative targets, $F(1,23)=31.43$, p .05. Thus, for positive items, recognition latency was faster in the presence of the original bigram cues; but for negatives, this pattern was reversed. Table 4 displays the means corresponding to these effects. No other effects reached significance in this analysis.

Errors. A repeated treatments analysis revealed that overall, a significantly greater number of misses were committed (.16) than false alarms (.09), $F(1,23)$-4.29, p .05. With respect to the cueing manipulations, the results of the error analyses tended to parallel those obtained for latencies. The analysis indicated that significantly fewer errors (both misses and false alarms) occurred in the presence of the original bigram cues than in the presence of the high probability extralist cues, $F(1,23)=9.29$, p .05, and the medium probability extralist cues, $F(1,23)=24.08$, p .05. When compared to the low probability cues, significantly fewer misses occurred in the presence of the original cues, but no significant differences between these two cueing conditions were obtained for false alarms, $F(1,23)=6.57$, p .05. The means for these effects are also displayed in Table 4.

Overall, these results were successful in demonstrating context effects in recognition memory under the present

conditions, and therefore, these results have extended the generality of the findings from prior studies (cf. Tulving & Thomson, 1971; Light & Carter-Sobell, 1970) which have demonstrated that recognition is facilitated by contextual cueing. However, it should be pointed out that the results of Experiment 4 are open to an alternative interpretation. Recently, Pellegrino & Salzberg, (1975a, b) have suggested that context effects on recognition memory might be partially attributable to response bias factors, as well as item discriminability, which is tacitly assumed by encoding specificity. These authors have suggested that when a new cue or change in context occurs during the recognition test, the subject tends to adopt a more stringent criterion, and this contributes to the overall decrement in recognition performance.

This explanation is significant in relation to the results of Experiment 4, since one could argue that the context effects on recognition latency were primarily the result of criterion shifts in the extralist cueing conditions. For example, it is not unreasonable to postulate that the longer latencies in these conditions reflect a shift to a more stringent criterion (cf. Pastore & Scheirer, 1974) relative to that adopted for the original cueing conditions. This explanation would predict that for the extralist cueing conditions, a greater number of misses, but fewer false alarms, should occur relative to the original cueing conditions. However, the pattern of

results do not conform to this prediction since more false alarms, as well as misses, occurred in the extralist cueing conditions. Therefore, the findings of Experiment 4 would tend to rule out this explanation; and appear more in line with encoding specificity.

General Discussion

Since errors occurred relatively frequently in Experiments 1, 3, and 4, one could argue that the results of these experiments partially reflect a speed-accuracy trade-off (cf. Wicklegren, 1974). This arguement would be supported if a negative correlation were obtained between latency and errors. In all three experiments, however, a relatively low, but always positive intracell correlation between latency and errors was obtained (in Experiment 1, $r(30)=.51$, in Experiment 3; $r(36)-.18$; in Experiment 4, for positive items, $r(24)=.29$, and for negative items, $r(24)=.20$.

This pattern also essentially replicates the results of prior studies employing this paradigm (cf. Macht & Scheirer, 1975), and, as discussed previously, the low correlations obtained has led to the conclusion that latency and errors might reflect separate aspects of the memory process (i.e., errors reflect primarily storage processes, while latencies reflect primarily retrieval processes). However, in the present research, the fact that the cueing manipulation produced essentially equivalent effects for both latencies and errors would suggest

theses that can accommodate encoding specificity phenomena within a generation-recognition framework. In response to these issues, both Experiments 3 and 4 were designed to investigate the generality of encoding specificity at a nominal level.

In Experiment 3, the major results conformed quite well with encoding specificity, since the major findings of that experiment demonstrated that latency of recall of a target CVC letter was facilitated in the presence of the remaining two trigram letters, while in the extralist cueing conditions, it was found that neither the strong, medium, nor weak probability cues had any significant effects. In Experiment 4, this pattern was replicated when recognition, rather than recall, was tested. Thus, these findings appear to have extended the generality of encoding specificity to a nominal level, and, as noted previously, are not readily accounted for by the alternative explanations proposed by Martin (1975) and Reder, et al. (1974).

These results suggest a need for a modification of the encoding specificity principle which places emphasis upon the role of nominal factors in accounting for the effectiveness of retrieval cues. Furthermore, there are additional findings from the present, as well as prior research, which tend to add support to this notion. For example, in Experiment 2, it was found that the strong extralist cues in the high dominance input groups did

not facilitate recall performance. These cues shared a substantial degree of semantic overlap with the input items, and according to encoding specificity (as well as generation-recognition models), it would be expected that these cues should have facilitated memory for the target items. Other investigators (cf. Tulving, 1974; Murphy & Wallace, 1975) have obtained comparable findings. Therefore, if these results are to be incorporated within the framework of encoding specificity, it would seem that this hypothesis is incomplete so long as the emphasis is directed toward semantic factors, and, as Martin (1975) has argued, encoding specificity should be redirected at a nominal level in order to account for the effectiveness of retrieval cues.

As has been discussed previously, one of the purposes of the present research was to explore the generality of the encoding specificity principle within the contest of the present paradigm, since it was felt that the present technique has certain advantages over that typically used to study encoding specificity. The results of the present research were largely successful in demonstrating encoding specificity phenomena under conditions relatively free of some of the methodological concerns inherent within the typical encoding specificity. The present research represents just one example of how the present paradigm can be employed to evaluate the findings obtained in other paradigms. Aside from this instance, it is felt that the

present paradigm possesses several advantages over other, more conventional memory paradigms, and it would seem that this paradigm has the potential to function as a powerful analytic tool when applied to phenomena obtained in previous research. These advantages arise from several sources.

First, the present paradigm appears to offer an analytic means of extending the findings obtained from more standard paradigms such as paired-associate learning and free recall. As has been described previously, one of the features of the present paradigm is that the subject is required to respond to sets of verbal items on an individual basis, and therefore, it appears to offer a means of examining the role of factors under conditions relatively free from the contaminating influence produced by extraneous processes inherent within list-learning procedures. For example, with respect to paired-associate learning, the present paradigm appears to offer a means of examining prior findings under conditions relatively free from the effects of intralist processes such as those postulated by Battig (1968). With respect to free recall, a good deal of evidence has accumulated which suggests that output interference is a potential determinant of retention (cf. Roediger, 1973, 1974; Rundus, 1973), and furthermore, the results of several recent studies (Dalezman, 1976) suggest a need for reinterpretation of long-standing free recall phenomena (e.g. negative recency) to take into

account the influence of this factor. The present paradigm could be employed as a more sensitive procedure with which to investigate such phenomena.

An additional advantage of the present paradigm is the fact that it appears to offer a sensitive means with which to establish the locus in memory of factors known to influence performance in other paradigms. Since error frequencies are recorded in addition to latencies, an examination of the relationship between these two measures has the potential to determine whether a given factor influences storage processes, retrieval processes or both.

For example, Scheirer (1971) employed this paradigm to investigate the effects of cueing, modality of presentation, and duration of presentation. A striking feature of the results was the lack of any appreciable overlap between latency and error measures; in particular, out of 31 effects tested, only one reached significance for both the latency and error data. For example, there was a pronounced effect of cueing with latency as the dependent variable; while the reverse was true for duration and modeality of presentation, whose effects were reflected in the error data, but not in the latency data. In addition, errors and latency were found not to correlate significantly with each other. From these results, it was suggested that the two measures are relatively independent, with each reflecting separate aspects of the memory process. Specifically, it was suggested that latency might be sensitive

to factors known to influence retrieval processes (or accessibility of information), while errors might reflect factors influencing storage (or availiability of information). In a subsequent study investigating the effects of item concreteness and cueing (Macht & Scheirer, 1975), the results suggested that the effects of word imagery were localized in both storage and retrieval; the effects of cueing being localized solely in retrieval.

Perhaps the major advantage of the present paradigm arises from the use of latency of recall as the primary dependent variable. The use of latency reflects a process-oriented approach to the study of human memory, and in recent years, a good deal of research utilizing latency has been carried out within the framework of an additive stages model (cf. Sternberg, 1966, 1969). The major assumption underlying this approach is that the act of retrieving information from memory can be decomposed into a sequence of component subprocesses, and overall latencies are posited to reflect the time needed to carry out each state in the total sequence. As a means of studying the nature of these component subprocesses, or stages, the general procedure employed by many investigators has been to evaluate the selective influence produced by several factors manipulated concurrently within the same experiment (e.g. set size, stimulus clarity). For example, if two variables do not interact, this has been taken to mean that each influences separate stages within the overall

retrieval process.

In general, the additive states model has been applied most extensively to research employing a memory scanning paradigm (cf. Sternber, 1966, 1969); and, although not unambiguous (see Townsend, 1971), a good deal of evidence has been obtained which has contributed substantially to an understanding of the nature of the processes underlying the act retrieving information from memory. However, it would seem that a process-oriented approach has generality to areas outside the domain of the scanning paradigm. In particular, the present paradigm offers a means by which an additive-stage model can be applied to evaluate the findings and theory obtained in more conventional paradigms.

For example, the Macht & Scheirer (1975) study was concerned with investigating the effects of manipulations of word concreteness and cueing on latency of recall. Item concreteness is known to be a potent factor affecting performance in other paradigms (cf. Paivio, 1969, 1971). The major results of that study demonstrated that both factors produced significant, though non-interactive effects on latency, and it was suggested that both factors influenced separate stages of the retrieval process. This was interpreted as support for one explanation of imagery effects (cf. Bower, 1970) over another (cf. Paivio, 1969, 1971). This is just one example, and it is felt that a process-oriented approach can be applied to the analysis

of other areas, such as paired-associate learning (cf. Martin, 1971) and free recall (cf. Mandler, 1967).

It should be pointed out that the use of latency has been a target of recent criticism from several sources. In particular, several authors (cf. Murdock, 1966, 1968; Wicklegren, 1974) have argued that the interpretation of latency data is rendered ambiguous by speed-accuracy effects. That is, it can be argued that the effects of any given variable on latency of recall is confounded by shifts in the subject's subjective criterion. Several studies have provided evidence consistent with this notion (cf. Murdock, 1966, 1968). However, such arguments predict a strong, negative relationship between latency and frequency of errors. Prior studies (cf. Macht & Scheirer, 1975) as well as the present study have indicated that latency and errors do not correlate significantly. In fact, these results have suggested a weak, but positive correlation between these two measures. Therefore, the results obtained from the present paradigm do not support a speed-accuracy interpretation, and suggest that latency offers a potentially powerful means by which to investigate retrieval processes.

In sum, as has been demonstrated in the present and prior research, there are several features of the present paradigm which render it particularly useful as a biable means for the study of memory processes. It is felt that this paradigm offers a means of extending the findings

TABLE 1

HARMONIC MEAN LATENCY OF CORRECT RESPONSE (SEC.) AND PROPORTION OF ERRORS FOR THE THREE OUTPUT CUEING CONDITIONS IN EACH OF THE THREE INPUT GROUPS IN EXPERIMENT 1

INPUT CONDITION	OUTPUT CONDITION		
	STRONG	UNRELATED	NO CUE
GROUP S	1.92 (.04)	2.09 (.12)	1.99 (.09)
GROUP UR	3.48 (.15)	2.72 (.19)	3.23 (.27)
GROUP SA	2.41 (.02)	3.20 (.19)	2.75 (.19)

TABLE 2

HARMONIC MEAN LATENCY OF CORRECT RESPONSE (SEC.) FOR THE OUTPUT CUEING CONDITIONS IN THE SINGLE, LOW, AND HIGH DOMINANCE INPUT GROUPS IN EXPERIMENT 2

INPUT CONDITION	OUTPUT CONDITION			
	HIGH	LOW	NO CUE	EXTRALIST (HIGH: LOW)
SINGLES	2.16	2.27	2.40	
LOW DOMINANCE	2.77	2.41	3.00	3.15
HIGH DOMINANCE	2.08	2.65	2.54	2.19

TABLE 3

HARMONIC MEAN LATENCY OF CORRECT RESPONSE (SEC.) AND PROPORTION OF ERRORS FOR THE FOUR CUEING CONDITIONS OF EACH OF THE THREE TYPES OF INPUT ITEMS IN EXPERIMENT 3

INPUT CONDITION	OUTPUT CONDITION			
	SAME CUE	HIGH PROBABILITY CUE	MEDIUM PROBABILITY CUE	LOW PROBABILITY CUE
HIGH MEANINGFULNESS	2.66 (.02)	3.12 (.09)	3.15 (.13)	3.20 (.08)
INTERMEDIATE MEANINGFULNESS	2.56 (.13)	2.98 (.11)	3.06 (.13)	2.85 (.06)
LOW MEANINGFULNESS	2.59 (.04)	3.03 (.06)	3.06 (.13)	3.02 (.13)

TABLE 4

HARMONIC MEAN RECOGNITION LATENCY (SEC.) AND PROPORTION OF ERRORS IN EACH OF THE OUTPUT CONDITIONS FOR BOTH POSITIVE AND NEGATIVE DISTRACTOR ITEMS IN EXPERIMENT 4

TEST CONDITION	OUTPUT CONDITION			
	SAME CUE	HIGH PROBABILITY CUE	MEDIUM PROBABILITY CUE	LOW PROBABILITY CUE
POSITIVES	2.30 (.03)	2.75 (.15)	2.86 (.24)	2.91 (.22)
NEGATIVES	2.44 (.04)	2.22 (.12)	2.68 (.15)	2.87 (.05)

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