Cuing Effects in Short-term Recall

Gerald Tehan
University of Southern Queensland

Michael S. Humphreys
University of Queensland

Mailing Address:
Gerry Tehan
Faculty of Sciences
University of Southern Queensland
Toowoomba, Q. 4350
AUSTRALIA.

e-mail: tehan@usq.edu.au

Running Head: Cueing effects in STM
Abstract

Past research indicates that short-term memory can be immune to the effects of Proactive Interference. Past research also indicates that immunity to PI is found only in those circumstances where a phonemic representation of to-be-remembered items are present and provided discriminative information. The first three experiments demonstrate the existence of a further boundary condition. PI is only observed if interfering and target items are subsumed by the same cue. This finding suggests that short-term recall, like long term recall is cue dependent. Cuing effects are further explored in two experiments that manipulate category dominance. The finding that category dominance effects parallel PI effects exactly strongly suggests that retrieval cues play a critical role in short-term recall.
Cuing in Short-term Recall

Cuing Effects in Short-term Recall

Short-term episodic memory performance differs from long-term performance in a number of ways. Capacity limitations appear to differ, rapid forgetting is observed in the short-term domain, and phonemic information appears to be more prominent over short retention intervals. Recently it has become apparent that immunity to Proactive Interference (PI) can be added to this list. The empirical finding that immediate memory for span-length lists is not influenced by prior experience with similar materials serves as our operational definition of immunity to PI. While immunity to PI has not been as extensively studied as some of the other characteristics, it appears to be equally robust in that it is observed in short-term recognition (Halford, Maybery & Bain, 1988; Wickens, Moody & Dow, 1981), short-term serial recall (Humphreys & Tehan, 1992; Tehan & Humphreys, in press) and short-term cued recall tasks (Tehan & Humphreys, in press). While some explanations have identified storage in Primary Memory as the causal mechanism in producing immunity to PI (Halford, Maybery & Bain, 1988; Wickens, Moody & Dow, 1981), Tehan and Humphreys (in press) have attributed the cause to the presence of transient phonemic codes. This assertion is based upon the finding that immunity to PI is sensitive to manipulations that weaken or strengthen phonemic codes. In the present article we wish to demonstrate that there is a further boundary condition to observing PI in short-term memory. We first aim to show that short-term PI effects, irrespective of the codes available, are cue dependent. Secondly, we seek to explore the generality of the coding and cuing factors that influence PI with reference to a second cuing phenomenon, that of category dominance.

Phonemic Codes and Immunity to Proactive Interference

The role of PI in short-term retention tasks is well established, particularly with respect to the Brown-Peterson distractor task (Brown, 1958; Peterson & Peterson, 1959). Keppel and Underwood (1962) found that very little forgetting was observed on the first trial in the Brown-Peterson task irrespective of retention interval and that the traditional forgetting curve associated with this task emerged gradually over the three or four following trials. These findings strongly implicated PI as the causal mechanism.
for Brown-Peterson performance. The work of Wickens and his colleagues with the release from PI paradigm, of which more will be said later, confirmed the importance of PI in this task (Wickens, 1972; Wickens, Born & Allen, 1963).

The influence of PI, however, is attenuated under some conditions. For example, Wickens, Moody and Dow (1981) demonstrated that performance on an immediate recognition test of a subspan list of taxonomically related items was uninfluenced by previous study of similar lists. That is, it was immune to the effects of PI. This was not the case on a delayed test where PI effects were readily apparent. Halford, Maybery and Bain (1988), using the same task as Wickens et al., demonstrated that PI was observed even on an immediate test if the number of items to be remembered was above span. The conclusion that immunity to PI would only be observed on an immediate test of subspan lists has also been confirmed using serial recall tasks (Dempster & Cooney, 1982; Humphreys & Tehan, 1992). The apparent relationship between immunity to PI and span led Tehan and Humphreys (in press) to suppose that some mechanism or process that was involved in span might also be responsible for producing immunity to PI. Consequently, their experiments focused upon the role of transient phonemic codes in producing immunity to PI.

The Tehan and Humphreys (in press) argument was based upon the results of a number of experiments in which the basic task involved the presentation of lists that contained one or two four-word blocks. Interference was manipulated on the two block trials by presenting similar material in the first block to the target item or items in the second block. Directed forgetting instructions stressed that on two-block trials, subjects were to forget the first block items and concentrate on remembering the second block, for it would be this material that would be tested. Interest centered on the extent to which the to-be-forgotten material influenced recall of the target material. Tehan and Humphreys first demonstrated that PI effects in serial recall covaried with phonemic similarity effects on both immediate and delayed tests, where the delay involved two seconds of auditory shadowing. That is, they demonstrated that immunity to PI and
phonemic similarity effects were both observed on an immediate test, but that on a
delayed test, phonemic similarity effects were eliminated and PI effects emerged.

They next examined interference effects in a short-term cued recall task that
used materials from semantic categories (e.g. dog as the interfering item, cat as the
target and ANIMAL as the cue). The interfering foil was presented in the first block
amid unrelated fillers and the target item was embedded among unrelated filler items in
the second block. As was the case with serial recall, immediate cued recall
performance was immune to PI but PI was observed after a filled two second retention
interval. The explanation for these results was couched in terms of the presence of
discriminative phonemic information for the target item on an immediate test which
would allow that item to be easily discriminated from the interfering foil. However, on
a delayed test they assumed that the phonemic code would be absent due to retroactive
interference and hence discrimination would be more difficult. In making this argument
they first assumed, as have others (Crowder, 1989; Nairne, 1990), that in any short-term
memory task multiple codes are generated and that the joint contribution of these codes
determines performance. In addressing PI effects they suggested that in both short-term
and long-term domains, the long-term central representations of target and interfering
items would be present. These central representations contain, among other things,
information concerning the semantic nature or the category membership of the list
items. However, in the short-term domain, phonemic representations of the target item,
but not the interfering item, were assumed to be present. This latter assumption was
based on empirical indications that phonemic representations are very susceptible to
Given these assumptions, immunity to PI in short-term cued recall was explained by
arguing that, while there might be central information available for both target and
interfering items, the addition of target phonemic information to available central
information made the target item very distinctive.

A logical extension of this explanation is that PI should be observed on an
immediate test if the phonemic code for the target item does not discriminate between
Cuing in Short-term Recall

the interfering and target item. They confirmed this by showing that if the target and interfering items came from the same rhyming category and were cued with an ending cue (e.g. hand, sand, _AND), or the words came from a taxonomic category but rhymed (e.g. cat, rat, ANIMAL), then PI was observed on an immediate test as well as on a delayed test.

Another logical extension of these assumptions is that if the presence of phonemic information for the interfering item could be maintained discrimination problems would again occur. Their final experiment attempted to generate a phonemic code for the interfering item by having the subjects read the list containing the interfering item aloud and the list containing the target read silently. It is generally assumed in most short-term memory models that address the modality issue that auditory presentation produces a phonemic memory trace that is more resistant to other influences than that produced via visual presentation (Baddeley, 1986; Nairne, 1988, 1990). Consequently, it was anticipated that a phonemic representation of the interfering foil might survive subsequent learning. These assumptions were confirmed in that PI was observed on an immediate test. In assessing the overall pattern of their findings, Tehan and Humphreys concluded that immunity to PI would be observed only in the case where the phonemic representation of the target item alone was present, and even then the phonemic code had to uniquely specify the target item.

The Tehan and Humphreys explanation focuses primarily upon the coding aspects of short-term PI. There is, however, evidence to suggest that cuing aspects of memory also are a strong determinant of PI. It is to this issue that we now turn.

PI as a Cuing Effect

We have stated elsewhere (Humphreys & Tehan, 1992) that our preferred explanation of PI is a cuing explanation, although we acknowledge that this position is not universally accepted. At the theoretical level, cuing approaches to memory have enjoyed considerable general success. This success extends to explanations of PI in that O.J. Watkins and Watkins (1975) have demonstrated that the cue overload principle, a principle that has been successfully employed as a unified interpretation of such diverse
memory phenomena as the list length effect in free recall, the advantage of categorized lists, subjective organization, the effects of extra-list cuing, part-set cuing effects (M. J. Watkins, 1981), can also account for the build up and release from PI.

At the empirical level, there is also substantial support for a cuing explanation of PI. Much of this data is based upon the release from PI paradigm. In this paradigm, subjects receive a number of Brown-Peterson trials in which the materials come from a single category (e.g. animals). In this situation performance generally deteriorates across trials. If the materials change on any subsequent trial (e.g. flowers), performance returns to near original levels of performance. This increase in performance with a change in materials, has been termed "release from PI" (Wickens, Born & Allen, 1963).

With regards to the cuing issue, Gardiner, Craik, and Birtwistle (1972) varied the standard release from PI paradigm by switching sub-sets of more general categories on the build-up and release trials. For example, within the category of flowers, they gave their subjects garden flowers on the build-up trials, but switched to wild flowers on the release trials. Three groups of subjects were all given the general category label (e.g. flowers) on the first of the build-up trials. On subsequent build-up trials no cue was given. Prior to the release trial one of the three groups was given a subset name of the category (e.g. wild flowers) as the cue and substantial release from PI resulted. A second group was given the subset cue immediately after the release trial had been presented. This group, who could only use the subset label as a retrieval aide, unlike the first who could use the subset label to influence encoding, demonstrated an equivalent amount of release from PI as did the first group. The third group were not presented with any cue on the release trial and did not show any release from PI.

Dillon and Bittner (1975) replicated the Gardiner et al. study, but added an extra experimental condition, in which they presented the same subset materials on both build-up and release trials. More specifically, their subjects were given four trials that consisted of Eastern Canadian cities, with the general label "North American Cities" being presented at the first trial. Again, at the fourth trial some of the subjects were given the subset label, "Eastern Canadian Cities". As was the case with the Gardiner et
al. findings, providing the subset cue produced substantial release from PI. Furthermore, it did not seem to matter whether the subset cue was given at study or at test. The importance of this latter finding is that it not only supports a cuing explanation for PI, but it seriously questions a simple trace discrimination explanation of release from PI. The trace discrimination hypothesis suggests that release from PI can be attributed to the fact that a change in materials on a release trial makes it easier for the subject to discriminate the most recent trace from earlier traces. In the Dillon and Bittner study, where there is no change of materials on the release trial, the provision of the subset cue could not have improved discrimination, yet release from PI was found. The fact that a subset cue provided after the release trial produced as much release from PI as when the cue was presented before the trial, is taken as strong evidence for the cuing explanation. The primary conclusion of the Gardiner et al., and the Dillon and Bittner studies is that PI critically depends upon the retrieval cues used.

The above findings provide strong support of a cuing account of PI. In extending these findings to the short-term PI effects that Tehan and Humphreys have examined, we believe that a complete account must emphasize the role of category specific retrieval cues. Thus, the first three experiments utilize Tehan and Humphreys experimental methodology but manipulate retrieval cues instead of encoding factors. To foreshadow what emerges, PI effects depend critically upon the retrieval cue used. Interference will only occur if the retrieval cue subsumes both the target and interfering item.

General Method

The methodology utilized in the first three experiment is identical to that used in the Tehan and Humphreys (in press) cued recall experiments. The procedure in the last two experiments entail minor deviations from this standard.

The basic structure of the critical trials used in first three experiments is presented in Figure 1. Each trial involves memory for a four item block and each trial has either one or two such blocks. Category specific proactive interference is manipulated in the two block trials in that on an interference trial an interfering from
the same category as the target item is presented in the first block among three unrelated filler items. The target item also appears among three filler items in the second block. On control or no interference trials, a target item is presented in the second block with no related item in the first block. Directed forgetting instructions stress that subjects are always responsible for remembering the most recent block of four items. That is, on a two block trial they must forget the items in the first block and concentrate on remembering the second block for it is on this block that they will be tested.

-------------------------------

Insert Figure 1 about here

-------------------------------

Subjects

All the participants in the five experiments were first-year psychology students from the University of Queensland or the University of Southern Queensland. All participated for course credit. No student participated in more than one experiment.

Materials

The materials for the experiments are derived primarily from rhyme (Walling, McEvoy, Oth & Nelson, unpublished manuscript) and taxonomic category norms (McEvoy & Nelson, 1982) generated by Nelson and his colleagues at the University of South Florida.

In constructing the critical two block trials in any experiment, separate word pools were generated for filler and target items. There was no overlap between the category membership of filler and target items, thus ensuring that filler items were always unrelated to the critical items. For the critical items, two instances were sampled from each category. The interfering foil in block-one was usually a high dominant instance of the category (37% for taxonomic categories and 30% for ending categories), and the block-two target was usually a relatively weak member of the category (2% for taxonomic and 3% for ending categories). In other respects the targets and foils were very similar being concrete nouns that were matched for word frequency. The filler
items were also all concrete nouns. On the interference trials, foil and target always appeared in the same serial position in their respective blocks. To avoid possible primacy and recency effects, the target (and foil) appeared equally often in the second and third serial positions only. The assignment of materials to condition was randomized without replacement for each subject.

Most experiments also contain a number of one-block trials that are tested for serial order. These trials were included for two reasons. Firstly, it is important to ensure that subjects attended to the first block in a two-block trial. Secondly, the strongest evidence for the role of phonemic codes in short-term memory stems from performance on the serial recall task. Thus serial recall filler trials were used to ensure that phonemic codes were generated, and to encourage subjects to code all trials for serial order. Generally speaking performance on these trials indicated that they served their purpose and as such they are not considered any further in any of the analyses. The order of the filler trials and the four types of experimental trials were randomized for each subject. This ensured that subjects never knew in advance, whether the trial would be a one-block filler trial or a two-block interference or control trial.

**Procedure**

Each trial began with a READY sign displayed on the computer monitor for two seconds. The study items were then displayed individually at a rate of one word per second, and subjects were instructed to remain silent throughout the presentation of the study items. On two block trials, a block separator, usually an exclamation mark (!), was presented for one second after the fourth word in the first block and before the first word in the second block. On such trials subjects were instructed to forget the first block once the block separator appeared and to concentrate upon the next four words because it would be these words that they would be tested on. Recall instructions always appeared for two seconds in upper case. For serial recall the word RECALL was used, and in the case of the cued recall experiments the category cue was presented. On an immediate test the cue appeared immediately after the fourth item in the block. On the delayed trials, two four-digit strings appeared on the screen after the fourth word, at
the rate of one string per second. Subjects were required to read the digits aloud as they appeared on the screen. The recall cue appeared after this two seconds of shadowing activity. With the appearance of the recall cue, subjects were requested to either verbally recall the items from the block in serial recall, or on the cued recall trials, verbally recall the category instance from the most recent block. Subjects had five seconds to make a response before the next trial began. The experimenter recorded the subjects responses (correct recall, order errors, intrusion errors, omissions, etc) on a hard copy of the the subject's input file.

Experiment 1

Tehan and Humphreys used the short-term cued recall task to examine PI effects on immediate and delayed tests with both taxonomic categories and ending categories. When taxonomic categories were used immunity to PI was observed on an immediate test. The probability of recalling the target item in the no-interference condition was .87 and was .85 in the interference condition. However, after two seconds of distractor activity PI effects were observed in that the probability of recalling the target item in the no-interference condition was .79 and was .58 in the interference condition. The pattern was somewhat different when rhymes and ending cues were used, in that PI was observed on an immediate test as well as a delayed test. The probability of recalling the target item on an immediate test was .92 for the no interference condition and .85 for the interference condition, and on a delayed test it was .79 and .62 for the no-interference and interference conditions respectively.

Support for a cuing account of PI could be strengthened by demonstrating that the above PI effects are cue specific. To do this subjects would study the same trials as in the above experiments but would be required to use alternative recall procedures or cues that did not have any bearing upon the semantic or rhyming nature of the materials. In this first experiment, subjects studied similar trials to those used in the cued recall experiments, but serial recall of the most recent block was required rather than cued recall. We assumed that category information would not be all that useful with serial recall and thus subjects would not use this source of information.
Consequently, the expectation was that PI effects should not be evident on either an immediate or delayed test for either taxonomic or ending categories.

Method

Subjects

Forty subjects participated in this experiment. Twenty served in the condition where serial recall of trials in which interfering and target items came from taxonomic categories was required, and twenty served in the condition where interfering and target items came from ending categories.

Materials

In the condition in which taxonomic categories were used, subjects studied 82 trials and in the ending category condition subjects studied 80 trials. The important differences relate to the number of critical two block trials, for the taxonomic materials there were 48 trials and for the rhyming category there were 60 trials. For both sets of materials, there were twice as many interference trials as control trials. The reasons for this had to do with variables that were of interest in the Tehan and Humphreys (in press) experiments but are not crucial for present purposes. For each type of trial, half the trials were tested immediately after the second block had been presented and half were tested after a two second filled retention interval.

Results

The serial recall data are presented in Table 1 and represent the likelihood that the critical item in the second block has been recalled in its correct serial position. Recall of the target item out of position was also examined. Since the results mirrored the serial position data, the out-of-position scores are ignored.

The serial recall data were analyzed using planned comparisons that compared performance on the interference condition to performance on the no interference condition at both immediate and delayed tests. These comparisons are based upon an alpha level of .05, as are all subsequent comparisons.

On immediate tests there was no evidence that the presence of an interfering item from the same category as the target item had any effect upon recall of the target
item for taxonomic materials, $F(1, 19) = .25; MSe = .014$, or ending categories, $F(1, 19) = .12; MSe = .019$. Likewise, on the delayed tests, the interfering item had no effect upon serial recall of the target item for taxonomic categories, $F(1, 19) = .61; MSe = .016$, or for ending categories, $F(1, 19) = 1.09; MSe = .008$.

Discussion

The current results, together with the Tehan and Humphreys findings, provide initial support for the importance of cues in producing PI. Subjects can study a list in which an interfering foil and a target item are presented and if a cue subsumes both items, as was the case with the Tehan and Humphreys experiments, then PI is observed. If, however, the recall cue does not focus upon the relationship that exists between the target and the foil, as we assume happens with serial recall in the current experiment, then PI is not observed. Consequently, we tentatively interpret this result as an indication that PI effects are cue specific.

Our tentativeness is based upon the fact that cued recall and serial recall are quite distinct tasks and thus task differences might provide possible grounds for alternative explanations. For example, proactive interference effects might still occur in serial recall but these effects might be masked by other interference effects such as output interference. Given the possibility of alternative explanations, the principle aim of the next experiment was to demonstrate more directly that the effects of PI critically depend upon the retrieval cue presented.

Experiment 2

Experiment 2 is based upon the Gardiner, Craik and Birtwistle (1972) concept of equating encoding conditions and varying the retrieval cues presented. The experiment involves three critical interference conditions. In the first interference condition (same category interference), both interfering and target items are subsumed by the category cue, for example "hydrogen" and "zinc" are both subsumed by the
category label "CHEMICAL ELEMENT". In the second interference condition (different category interference), both interfering and target words are presented, but only the target item is subsumed by the category label, e.g. both "hydrogen" and "zinc" are presented but the cue is "TYPE OF METAL". Both these conditions are compared to a no interference condition in which there is no interfering item presented in the first block.

Given conditions in which PI can be observed using taxonomic materials, that is, a delayed test, the predictions from a cuing perspective are straightforward. If the category cue subsumes both the interfering item and the target items, then PI will be observed. If, however, the cue subsumes only the target item, then PI will not be observed.

Method

Subjects

Twenty first year psychology students from the University of Queensland participated in this experiment for course credit.

Materials

In this experiment there were thirty critical two block trials which were all tested via delayed cued recall. Ten of the critical trials involved the standard interference condition. Another ten trials involved the standard control trials. The final set of ten trials were similar in structure to the interference trials in that a potentially interfering item was present in the first block, and the target item was present in the second block. However, these trials differ in that the cue used at recall subsumed the target item but excluded the interfering foil.

In creating the critical materials for the above trials, attempts were made to match the category dominance levels between the target and both category cues. Using the McEvoy and Nelson (1982) norms this was possible for 18 out of the 30 target words. Preliminary analyses on these 18 items produced the same results as the full set of materials, thus for the 12 target words for which there was no normative data, the
attempts that were made to find a second category in which the target word was also a low dominant member seem to have been successful.

In addition to the critical trials there were 30 filler trials that were tested via serial recall. The sixty trials in the session were presented in a random order.

Results

A summary of performance on the cued recall trials is presented in Table 1. As is evident in the table, category specific interference appears to be limited to the case where the two items are subsumed by the same cue.

The correct recall data were analyzed by two planned comparisons. To establish the presence of PI in the experiment, the first comparison compared the same category interference condition with the no interference condition. This comparison indicated reliable effects of PI, $\text{F}(1,19) = 7.41; \text{MSe} = .0211$. The second, and more important comparison showed that there was no difference between the no interference and different category interference conditions, $\text{F}(1,19) = .01; \text{MSe} = .0211$.

The list intrusion data confirm that these differences are due to PI. Recall of the interfering foil represents a major source of error in the same category condition (.24), but not in the different category condition (.01).

Discussion

The current results are quite straight forward. When the retrieval cue subsumes the two items, then PI is observed, however, when the cue subsumes only the target item, PI is no longer evident. Given that encoding conditions have been held constant, the presence of PI in the same category condition but not in the different category conditions indicates that PI effects are cue specific. Such a finding also supports the idea that the differences between cued recall and serial recall in Experiment 1 can be conceptualized as cuing effects.

Tehan and Humphreys (Experiment 4) also examined PI effects using materials from rhyme categories and found that PI was present on both an immediate and a delayed test when an ending cue was employed. The results of this experiment are presented in italics in Table 1. By definition rhymes have the same sounding endings.
but different beginnings. Using the logic employed in the previous experiment, in the case where two rhyming items are present in the list, a stem cue, that is the first three letters in the word, should specify the target item alone. Consequently, the expectation would be that the differences that Tehan and Humphreys found between performance on interfering and control trials when ending cues were supplied, would be eliminated if a stem cue was provided instead.

Experiment 3

Method

Subjects

Twenty introductory level psychology students from the University of Southern Queensland participated in the experiment.

Materials

The materials used and the construction of the critical cued recall lists was identical to those used in Tehan and Humphreys' Experiment 4. Subjects studied 68 trials consisting of 48 two-block trials and 20 filler trials. For, the two block trials, half the trials contained an interfering item that rhymed with a target item in the list and half contained the target item alone. For each type of trial, half the trials were tested immediately after the second block had been presented and half were tested after a two second filled retention interval.

Procedure

Testing involved cued recall procedures in which a stem cue was provided. Thus, if the target word was "bench" the cue "BEN" was presented rather than the ending cue "ENCH".

Results and Discussion

Performance on the cued recall trials in this experiment is presented in Table 1. Planned comparisons established that the presence of a similar sounding item in the first block had no effect upon recall of the target item on both immediate, $F (1,19) = .66; MSe = .014$, and delayed tests, $F (1,19) = .75; MSe = .008$. These results suggest
that the PI effects found using instances from rhyming categories are cue specific in much the same way that semantic PI effects are cue specific.

To summarize the data to this point, it would appear that a necessary condition for PI to be observed in the short-term cued recall task is that a retrieval cue must elicit block-one and block-two items. It may be the case that a study trial will contain similar items, as is the case in Experiments 1, 2 and 3, but similarity will not have any effect upon performance if an alternative retrieval cue focuses on some other attribute of the target word.

The current experiments also question the need for some of the assumptions involved in encoding explanations of PI. Tehan and Humphreys (in press) were able to reject explanations of PI that were based upon storage in Primary Memory, or upon temporal discrimination. However, other explanations of PI stress encoding effects (Gorfein, 1987; Nairne, 1990). For example, Gorfein (1987) has argued that PI emerges primarily through encoding similarity. Briefly, attributes of an item are hierarchically organized and upon presentation a limited number of attributes become activated, notably the higher level attributes. Encoded attributes of one item will remain active for a period of time and influence the activation of attributes in later items, such that low level attributes of subsequent items can be activated instead of high level attributes. As a result, there is a tendency for all the to-be-remembered items to be encoded in similar ways, since the same limited set of active attributes are influencing the encoding of all items. For example, the encoding of "diamond" as a geometric shape and not as a precious gem is going to be highly likely if the other members in the memory set are "square" and "rectangle" and the items on the preceding trial were "circle, triangle, parallelogram". According to Gorfein, PI occurs because similarity in encoding results in problems with trace discrimination.

In applying Gorfein's argument to the same category condition in Experiment 2, studying "hydrogen" would influence the encoding of "zinc" such that it is encoded as a chemical element, not as a type of metal. Consequently, when the cue "CHEMICAL ELEMENT" is provided there are problems in discriminating between the two items.
Given that encoding conditions are equivalent for the same category and different category conditions, the encoding of "zinc" should still be as a chemical element. In the situation where the cue is type of metal, there should either still be problems associated with trace discrimination or, given transfer appropriate processing considerations, the mismatch between encoding and retrieval should produce poorer performance relative to the control condition. This was not found. The fact that a decrement in performance was observed with one cue and not another, indicates that encoding processes may not play a critical role in PI in short-term cued recall².

While short-term encoding processes may or may not occur in the standard release from PI paradigm, such assumptions do not need to be made to explain the current results. The findings of Experiments 1, 2 and 3 can simply be explained in terms of whether or not target and interfering items will be subsumed by a cue. Taken in conjunction, the results of the Tehan and Humphreys experiments and the current data indicate that short-term PI effects first depend upon the retrieval cue used and subsequently depend upon the presence or absence of phonemic codes for various list items. This explanation thus involves both cuing and coding components.

As indicated earlier, cuing explanations of PI are not universally accepted. The cuing account, however, could be strengthened if it could be demonstrated that the factors that influence short-term PI effects also moderate other, less controversial cuing effects. Consequently, the remaining two experiments focus on the category dominance effect. That is, the finding that in cued recall tasks the dominant items in a category are better recalled than weaker instances.

**Cues, Codes and Short-term Category Dominance Effects**

When a group of people are given a cue of some description and asked to respond with the first instance of the category which the cue specifies, invariably some responses are produced more frequently than others. Such procedures have been used to develop norms of associative strength for different classes of cues (e.g. taxonomic categories, word ending categories, word stem categories, word associates, ending fragments, etc). In cued recall the frequency with which a particular item is recalled is
well predicted by the frequency with which the response is produced in the association task. In other words, the high dominant instances in the category tend to be better recalled than the low dominant instances. The pervasiveness of the category dominance effect is such that cue based models of retrieval, be they direct access or generate-recognize models, make the assumption that cue-target strength is one of the prime determinants of successful recall.

Category dominance is, however, not the only determinant of cued recall. Nelson and McEvoy (1979) first demonstrated that the size of the category which was being cued was also an important predictor of successful recall. They found that a target item on a study list was less likely to be recalled if that item came from a large category (a category with many different instances) than if the item came from a small category. Nelson and Friedrich (1980) also demonstrated that when cue set size was controlled for, the associative set size of the target item influenced recall. Again large associative sets tended to inhibit recall relative to small associative sets. These results imply that when retrieval is initiated all instances of the category, including the target, are activated, as are all associates of the target. All these activated items then served as a source of inhibition for the target item (Nelson, 1989). On the basis of these and similar results, Nelson, Schreiber and McEvoy (1992) have suggested that cued recall performance is determined by the size of the category that is being cued, the associative set size of the target item and cue-target strength.

Given these findings, we make the assumption that the factors that influence long-term cued recall also influence short-term cued recall. Thus the first expectation is that cue-target strength effects will be evident in that high dominant instances of a category should be better recalled than low dominant instances. Secondly, although we do not directly test for cue set size or target set size, we assume that the pre-experimental sources of competition that are evident on the long-term task are also present on a short-term cued recall task. That is, when the cue is presented on the short-term task, all the items that are subsumed by that cue become competitors with the target item.
In making these assumption, the predictions concerning category dominance effects become very similar to those involving PI. In both cases, it is assumed that at retrieval the long-term representations of more than one item are activated and that discrimination can be enhanced if the phonemic code for the target item is available and provides discriminating information. The only real difference between the PI and category dominance effects concerns the origin of the source of competition. With PI that source is experimentally produced, whereas in a simple cued recall task where there is no interfering foil, the source is pre-experimentally based. Experiments 4 and 5 set out to explore the potential similarity between PI and category dominance effects.

Experiment 4

In the following two experiments, the cued recall task that was used earlier was modified slightly. Instead of studying two-block trials, subjects now studied trials that consisted of a single six item list. In all other respects the task was similar, in that the target item on each list was embedded amongst five filler items, and memory for the target item was tested either immediately or after a two second filled retention interval.

In the present experiment category dominance effects are explored using taxonomic categories. If it is true that non-target members of the category become competitors, the presence of phonemic codes for the target item should make it very distinctive and easily discriminable from all other competitors. Pre-existing strength effects might thus be eliminated on an immediate test in much the same way that PI effects were eliminated. However, on a delayed test it is expected that dominance effects will become evident when phonemic codes for the target item are no longer available.

We were still interested in the cuing aspects of this study by showing that category dominance effects depended upon the retrieval cue used. Consequently, one group of subjects in this study viewed a mixture of cued recall and serial recall trials, in which each trial had the same structure. Again the expectation was that category dominance effects would be apparent upon cued recall trials, but not on serial recall trials.
Method

Subjects

Sixty subjects participated in the experiment. For forty of the subjects retention interval was a between subjects variable, with cued recall and serial recall being varied within subject. Thus twenty of the subjects received immediate cued and serial recall tests and twenty received delayed tests. For the remaining twenty subjects, the critical trials were all cued recall trials and retention interval was manipulated within subject.

Materials

The materials for this experiment were the same as those used by Tehan and Humphreys. The basic word pool of a high and a low dominant instance from each of 48 different taxonomic categories was divided into two sub sets each consisting of 24 high dominant words and 24 low dominant words. The high dominant instance in one set was replaced by the low dominant instance in the second set, and vice versa. These two subsets served as word pools for the creation of the study lists. On each trial one target word was embedded among five filler items. Twenty four of the trials involved the high dominant item, each serial position being sampled four times. The same was true of the low dominant items. For two groups of subjects, half the trials of each type were tested via cued recall and half via serial recall, with one group being tested immediately and one group being tested after a delay. For the remaining group, all critical trials were cued recall trials, with half the trials being tested immediately and half tested after a delay. As was the case in previous experiments, the assignment of items to condition was randomized for each subject, as was the order of the 48 trials.

Results and Discussion

The data from the current experiment are summarized in Table 2, collapsed across serial position. Each mean represents the likelihood that the target item has been recalled in the case of the cued recall test, or has been recalled in correct serial position in the case of serial recall.

For cued recall, planned comparisons confirmed that category dominance effects were not present on an immediate test when retention interval was between
subjects, $F(1,19) = .10; \text{MSe} = .015$, or when within subjects, $F(1,19) = 1.48; \text{MSe} = .020$. However, high dominant words were better recalled than low dominant words on delayed recall when retention interval was manipulated between subjects, $F(1,19) = 11.18; \text{MSe} = .017$, and within subjects, $F(1,19) = 16.73; \text{MSe} = .031$. For serial recall, category dominance had no effect upon performance on either an immediate test, $F(1,19) = .32; \text{MSe} = .009$, or a delayed test, $F(1,19) = 1.54; \text{MSe} = .004$.

While there appear to be differences in the levels of performance when retention interval is between subjects rather than within subjects, the similarity of the findings is emphasized when a subjects analysis is done. Thus on an immediate test when retention interval was between subjects, 8 subjects produced an advantage for high dominant words over low dominant targets, 3 subjects had tied scores, and 9 subjects produced an low dominant advantage over high dominant. When retention interval was within subject, 9 subjects produced a high dominant advantage, again there were 3 tied scores and 8 subjects produced a low dominant advantage. On a delayed test, the pattern for within and between conditions was identical, that is, 15 subjects produced a high dominant advantage, there was one tied score, and there were 4 subjects who produced a low dominant advantage.

The results are entirely consistent with predictions. Category dominance effects, when they appeared, were limited to the cued recall data, confirming the cue-specific nature of these effects. Furthermore, the category dominance effects in cued recall parallel the PI results found by Tehan and Humphreys (in press). That is, high and low dominant items are equally well recalled on an immediate test when there is discriminative phonemic information available for the target item. When this information is no longer present, category dominance effects emerge.

If category dominance and PI effects parallel one another because they both reflect the same underlying cuing and coding processes, the critical test should come
Cuing in Short-term Recall

when rhyming categories are used. In the case where PI was manipulated, PI effects were present on an immediate test as well as a delayed test. The argument made was that although there was phonemic information present for the target item, that information did not specify the target item alone. If our assumptions are correct, the same pattern of performance should be observed with category dominance effects. Thus although, phonemic information for the target item might be present, it will not uniquely specify one member out of a group of rhyming competitors. Consequently, category dominance effects would be expected on an immediate test as well as on a delayed test where the phonemic information is not present. The final experiment tested this prediction. Again the cuing account was tested by having a group of subjects study equivalent trials but respond with serial recall rather than cued recall.

Experiment 5

Method

Subjects

Forty subjects participated for course credit. Twenty subjects were given cued recall trials and twenty were given serial recall trials.

Materials

The materials used in the current experiment were those used in Tehan and Humphreys' Experiment 4 and the current third experiment. The procedure for creating the trials was identical to that employed in Experiment 4.

Results and Discussion

The data from the current experiment are summarized in Table 2, again collapsed across serial position. Each mean represents the likelihood that the target item has been recalled in the case of the cued recall test, or has been recalled in correct serial position in the case of serial recall.

For cued recall, planned comparisons indicated that high dominant instances of a category were better remembered than low dominant items on both an immediate test, $F(1,19) = 10.23; \text{MSE} = .007$, and a delayed test, $F(1,19) = 9.46; \text{MSE} = .019$. For serial recall, category dominance had no effect upon performance on either an
immediate test, $F(1,19) = 2.45; MSe = .017$, or a delayed test, $F(1,19) = .45; MSe = .037$.

A subjects analysis indicated that on an immediate test 14 subjects demonstrated a high dominant advantage over low dominant targets, there were two tied scores, and 4 subjects demonstrated a low dominant advantage. On a delayed test, 13 subjects produced a high dominant advantage, 3 produced tied scores and 4 produced a low dominant advantage. It would appear that performance on an immediate test is very similar to that on a delayed test, and very different to an immediate test using taxonomic cues.

Again the results conform to expectations in all respects. Dominance effects are cue dependent in that they are only observed with the appropriate cue. Moreover, dominance effects parallel the PI effects exactly.

**General Discussion**

In exploring short-term immunity to PI, Tehan and Humphreys (in press) concluded that PI effects in a short-term cued recall task were determined by three factors: retention interval, rhyming instances and variables that influence the strength of phonemic codes. The results of the first three experiments indicate that the retrieval cue utilized at test represents a fourth determinant of short-term PI effects. The importance of cues rests firstly upon the demonstration that PI effects in short-term cued recall are not evident in serial recall. Secondly, the results of Experiments 2 and 3 indicate that PI effects in cued recall only emerge if both the target and interfering foil are subsumed by the same cue. Consequently, the first tenet of any theory of short-term PI must indicate that category specific PI can only emerge if target and interfering items are related to and subsumed by the same cue. If this precondition is met, then short-term PI effects will emerge in a way that corresponds to the influence of phonemic codes.

Before arguing that the results of the current experiments are cuing effects, it is important to address some methodological issues. Much of the argument in the present set of experiments rests upon accepting the null hypothesis. In so doing, the issues of power and sensitivity become relevant and need to be considered.
The experimental conditions in which PI has been observed are virtually identical to the conditions in the current experiments. Thus, the Tehan and Humphreys (in press) experiments and the current experiments usually have the same number of subjects and involve roughly the same number of trials per experimental condition. With cued recall we have, with one exception (Tehan and Humphreys, Experiment 5), always observed PI effects on a delayed test when they have been predicted (Tehan and Humphreys, Experiments 3 and 4; current Experiment 2). In the current Experiments 4 and 5, category dominance effects were also predicted and observed on a delayed test. Likewise on an immediate test PI effects have emerged where predicted (Tehan and Humphreys Experiments 4, 5 and 6) and category dominance effects have emerged when predicted (current Experiment 5). Moreover, the times that PI has not been observed on an immediate test were instances where theory indicated there should be no difference (Tehan and Humphreys, Experiments 2 and 5). In short, the bulk of the evidence suggests that the experimental procedures used, do have the sensitivity and power to detect the influence of both proactive interference and category dominance. Thus, the failure to find category dominance effects in the current Experiment 4 or PI effects in the different-category condition in the current Experiment 2, and in Experiment 3, are more likely to be the result of the proposed mechanisms that underlie performance on this task, rather than a lack of sensitivity, power or ceiling effects.

With regards to serial recall, such factors as output interference may make this task insensitive to possible encoding differences that might make items become more similar and thus harder to discriminate. Serial recall may be less sensitive, but the critical issue is that with a more sensitive test our cuing assumptions have been supported. That is, the results of Experiments 2, 3, 4 and 5, in which cued recall has been employed, conform to our predictions concerning cuing effects. Given the parallel findings of cued recall and serial recall with respect to PI, parsimony would suggest that the lack of proactive interference and category dominance effects in serial recall are a result of the cuing requirements of serial recall, rather than any insensitivity of the task.
The reason that power and sensitivity issues are important here is that they impact upon encoding explanations of PI. That is, if PI effects are due solely to coding effects, then PI should be observable irrespective of the cues used. The only reason this might not occur is if the test was not sensitive enough. Consequently, in asserting that our tests are sensitive, we reject the notion that PI effects are due solely to encoding processes. The encoding explanations have typically emerged from the release from PI paradigm in which all the items on each trial are related, e.g. three flowers, three professions, etc. Under such experimental conditions it is likely that subjects are encoding category information. In fact, in many experiments a category label precedes the items (Gardiner et al; 1972; Dillon & Bittner; 1975). We think that this is less likely to be happening in the current experiment. Firstly, instructing subjects to study all trials for serial recall and the unpredictable presence of serial recall filler items, encouraged subjects to encode all trials for serial recall. Under these conditions it is doubtful that subjects are encoding information about category membership. Even if subjects are processing categorical information, only two of the eight items in the list are related, and these are always separated by three intervening items. Furthermore, each target is an instance of multiple categories (e.g. in Australia zinc can be a chemical element, a type of metal, a type of protective cream, a type of roofing material, etc). Consequently, given the instructions to encode for serial recall and the time constraints involved, it seems unlikely that the specific relationship between the target and foil would be encoded. Given the experimental procedures used, we think that the current findings are more consistent with a cuing perspective than with an encoding perspective.

The present finding that short-term PI effects vary primarily as a function of the retrieval cue is strong evidence for a cuing account of PI and compliments other empirical evidence that supports such a position (Dillon & Bittner, 1975; Gardiner, Craik & Birtwistle, 1972; O. C. Watkins & Watkins, 1975). The cuing account is strengthened by the demonstration that category dominance effects parallel PI effects exactly. The processes that are operating in short-term PI also appear to be acting in exactly the same way in the experiments manipulating category dominance. Again
parsimony would demand that if category dominance effects are cuing effects, and there are few researchers who would argue that category dominance effects are not cuing effects, then PI effects are cuing effects as well.

There are ramifications in accepting cuing effects in short-term memory. At the general level, there appears to be little doubt that long-term retrieval is cue dependent (e.g. Tulving, 1983), and that a cue-based approach to memory has been quite successful at explaining many disparate findings in the memory literature (Humphreys, Bain & Pike, 1989; Watkins, 1981). However, and in contrast to the long-term domain, the dominant explanation for short-term retrieval still appears to be based upon a search process rather than via direct access (Nairne, 1990). The current data clearly implicate the role of cues in short-term recall and thus the results complement the Lewandowsky and Murdock (1989) demonstration that a direct-access, cue-based theory of long-term retention (TODAM) can model many short-term phenomena, including the build-up and release from PI.

While we have tended to concentrate on the PI aspects of the data, the category dominance data are important in their own right. Most traditional explanations of category dominance effects in cued recall focus entirely upon cue-target strength. From this perspective there would be very little reason to expect that dominance effects would interact with the type of cue and retention interval. The differences on an immediate test between ending and taxonomic cues do not appear to be due to ceiling effects in that with taxonomic cues we have one group that performs at the same level as the group who had ending cues and one group who performs below this level. However, in both cases, statistical analyses indicate the absence of dominance effects with taxonomic cues. Furthermore, the subjects analyses indicates that the two taxonomic groups are very similar to one another and very different to the group who were given ending cues. Also, in terms of statistical and subject analyses, all groups appear to be very similar to each other on a delayed test. Clearly, something is interacting with cue-target strength to influence performance on an immediate test.
The absence of category dominance effects on an immediate test with taxonomic cues does not appear to be due to item selection processes either. Finding dominance effects on a delayed test rules out the possibility that the high and low dominant items have been confounded with category set size or target set size.

The pattern of category dominance effects appear to require the same set of assumptions that have been used to explain PI effects. That is, that at recall the representations of more than just the target item are elicited and that phonemic information can provide discriminative power.

Of these two assumptions the first is probably the more controversial, in that few discussions of category dominance involve the activation of non-presented instances of a category. The idea that non-presented items can have an inhibitory effect upon episodic performance is not new. For example, in the part-set cuing paradigm, Watkins (1975) presented his subjects with lists composed of six instances from six different categories, the instances from all categories being presented in a randomized fashion. At test, subjects were given the names of the categories and either zero, two or four instances from each category. The instances chosen were either list items or items from the category that were not on the study list. The typical inhibitory part-set cuing effect was observed, in that the probability of recalling the noncued items on the study list decreased as the number of instances presented as cues increased. For present purposes, the important finding was that the strength of the inhibitory effect was just as strong for non-studied instances as for studied instances. In other words, items from a particular category inhibited recall performance on a subsequent cued recall test, even though these items had not been studied. Of course, one important difference between the current experiment and the part-set cuing task is that the non-studied items in the part-set task do have an episodic component in that they were presented at test. We are assuming that non-presented items have an influence on performance even though there is no episodic component.

Generally speaking, the idea of inhibitory effects due to semantic memory factors is not new either. The "fan" effects that Anderson (1974) has postulated in his
descriptions of interference effects in long-term retrieval, is one such example. However, in spite of demonstrations like Anderson's, most of the current models of episodic memory make very little provision for semantic memory effects in general, and with the exception of the connectionist model of Chappell and Humphreys (1994) and the PIER model of Nelson, Schreiber and McEvoy (1992), none specify the simultaneous activation of all members of a category in cued recall with a category cue. The work of Nelson and his colleagues is particularly relevant in that they have provided the most detailed examination of the cued recall task and have convincingly demonstrated that cued recall with an extralist cue is determined by three independent factors: cue set size, target set size and cue-target strength. Both the cue set size and target set size effects reflect the influence of what Nelson et al. (1992) call pre-existing implicit memories, that is, associatively related items that are not episodically present in the cued recall task.

The Chappell and Humphreys (1994) connectionist model also allows for the effects of pre-existing memories. The concept of an intersection (Humphreys, Wiles & Dennis, in press) is essential component of the retrieval process in the Chappell and Humphreys model. In the case of cued recall with an extralist cue they assume that all associates of a cue are activated and all other words are suppressed. Likewise, all items associated with a context cue (all items in the current list) are activated and all other words suppressed. When the two sets are intersected, only those items that are common to both sets survive (i.e. the item from the list that was an instance of the category). However, pre-existing memories can interfere with list memories if there is some degree of overlap in the representations of pre-existing and episodic items. The model has been successful not only with cued recall but also in accounting for much of the recognition data, similarity effects, the dissociation between recognition and frequency judgements, and retroactive interference effects.

Consequently, given Nelson's work in which pre-existing memories play an integral role in cued recall and Chappell and Humphrey's successful treatment of quite diverse memory phenomena with a model that incorporates both pre-existing and
Cuing in Short-term Recall

episodic memories, we think that our assumption that the representation of all members of a category are activated by a retrieval cue in short-term cued recall is reasonable.

Our assumptions concerning the role of phonemic codes in the task are probably less controversial. The role of phonemic codes in short-term memory has been most evident in immediate serial recall. Baddeley (1986), in developing of the concept of the articulatory loop, has demonstrated the way in which phonemic codes interact with other variables in immediate serial recall. The influence of these codes in the Brown-Peterson task has also been established (1972) and the transience of these codes has likewise been well documented (Conrad, 1967; Estes, 1973; Nairne, 1988; 1990; Tell, 1972). If our assumption is correct proactive interference and category dominance effects indicate that phonemic codes may well have a generalized impact upon short-term episodic memory performance. In any event the current results provide a challenge to those models of short-term memory that are based upon the immediate serial recall task. Phonemic coding effects appear to extend beyond the phonemic similarity effect and beyond immediate serial recall.

In conclusion, the finding that short-term PI effects and short-term category dominance effects parallel one another is a significant finding. These results, together with the results of the first three experiments reported here, strongly implicate the role of cues in short-term memory performance. The fact that both PI and category dominance appear to be affected by the presence or absence of phonemic information again confirms the generally recognized importance of phonemic codes in short-term memory. Reviewing a recent symposium on short-term memory, Craik (1991) addressed the issue of how short-term memory could at the same time look very much like long-term memory and very dissimilar to it. His response was that "One way in which short-term and long-term memory could 'look the same' would be if the principles that govern performance were identical at all retention intervals......short-term and long-term retention could still 'look different' because of a change in the relative usefulness or salience of the underlying memory codes" (p201.). We think that the PI and category dominance data support Craik's observations. If it is assumed that
retrieval is cue based at both short and long retention intervals, but that phonemic codes tend to be particularly salient at short retention intervals, then quite disparate memory phenomena such as immediate serial recall, proactive interference and category dominance can be related to one another in a principled way.
References


Cuing in Short-term Recall


Tehan, G. & Humphreys, M. S. (in press). Transient phonemic codes and immunity to proactive interference. *Memory and Cognition*


Table 1
Mean Probability of Recalling the Target Item as a Function of Proactive Interference, Type of Test and Retention Interval.

<table>
<thead>
<tr>
<th>Retention Interval</th>
<th>Immediate</th>
<th>Delayed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment 1 (Serial Recall)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Taxonomic Materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Interference</td>
<td>.76</td>
<td>.23</td>
</tr>
<tr>
<td>Interference</td>
<td>.74</td>
<td>.26</td>
</tr>
<tr>
<td><strong>Ending Categories</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Interference</td>
<td>.81</td>
<td>.35</td>
</tr>
<tr>
<td>Interference</td>
<td>.82</td>
<td>.32</td>
</tr>
<tr>
<td><strong>Experiment 2 (hydrogen zinc TYPE OF METAL)</strong></td>
<td></td>
<td>.69</td>
</tr>
<tr>
<td>No Interference</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Different Category</td>
<td>-</td>
<td>.70</td>
</tr>
<tr>
<td>Same Category</td>
<td>-</td>
<td>.57</td>
</tr>
<tr>
<td><strong>Experiment 3 (wrench bench BEN)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Tehan &amp; Humphreys Exp.4.</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Interference</td>
<td>.92</td>
<td>.79</td>
</tr>
<tr>
<td>Interference</td>
<td>.85</td>
<td>.62</td>
</tr>
<tr>
<td>No Interference</td>
<td>.94</td>
<td>.89</td>
</tr>
<tr>
<td>Interference</td>
<td>.91</td>
<td>.87</td>
</tr>
</tbody>
</table>
Table 2
Mean Probability of Recalling the Target Item as a Function of Category Dominance,
Type of Test and Retention Interval.

<table>
<thead>
<tr>
<th>Retention Interval</th>
<th>Immediate</th>
<th>Delayed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Experiment 4 (Taxonomic Categories)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cued Recall</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Retention Interval Between Subjects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Dominance</td>
<td>.83</td>
<td>.73</td>
</tr>
<tr>
<td>Low Dominance</td>
<td>.81</td>
<td>.60</td>
</tr>
<tr>
<td><strong>Retention Interval Within Subjects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Dominance</td>
<td>.77</td>
<td>.73</td>
</tr>
<tr>
<td>Low Dominance</td>
<td>.71</td>
<td>.50</td>
</tr>
<tr>
<td>Serial Recall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Dominance</td>
<td>.49</td>
<td>.29</td>
</tr>
<tr>
<td>Low Dominance</td>
<td>.50</td>
<td>.26</td>
</tr>
</tbody>
</table>

| **Experiment 5 (Ending Categories)** |           |         |
| Cued Recall                     |           |         |
| High Dominance                  | .88       | .76     |
| Low Dominance                   | .79       | .63     |
| Serial Recall                   |           |         |
| High Dominance                  | .67       | .39     |
| Low Dominance                   | .62       | .42     |
1. One methodological explanation for the absence of interference effects might stem from the fact that only the second and third serial positions were cued. If subjects were aware of this they might be able to restrict their answers and thus know with some assurity which items to focus upon. While this may occur, it does not explain why subjects do produce PI effects in the different category position nor does it provide an adequate explanation of the PI effects on an immediate test that were present in the Tehan and Humphreys (in press) experiments.

2. Gorfein (personal communication, 1990) has suggested one way in which the current data might be explained from the encoding similarity perspective. He suggests that the presence or absence of PI in the different category condition will depend upon which attributes are activated at encoding. Other dominant attributes in the hierarchy are activated in addition to the interfering attribute. If those attributes are cued then no PI is expected. To explain performance on the different category trials, the assumption would have to be made that the attribute that was being cued was high in the target's hierarchy of attributes. As an ad hoc test of this position two groups of about 40 students each were presented with the 30 target words from Experiment 2. The first group were requested to write down five attributes of the target word as quickly as they could. The second group were asked to name as many categories as possible to which the target word belonged. When subjects were asked to name the attributes, the cue used in the different category condition was hardly ever produced, but then again neither was the cue used in the same category condition. When subjects were asked to name the categories about half of the categories used in the different category conditions were produced very frequently. However, for the remaining items the relevant category label was produced only on rare occasions. These findings suggest that Gorfein's assumptions were met for approximately half the categories but not for the other half. Given this pattern and Gorfein's assumptions, it should be expected that some evidence for the effects of PI should be present in the data. The fact that no such
effect was found leads one to the conclusion that perhaps Gorfein's model cannot account for all PI related effects.

The encoding position is further weakened in that a need for cues is apparent in these models. The finding that PI effects can be ameliorated by increasing the inter-trial interval (Loess & Waugh, 1967) must be due to something other than encoding differences. Thus, the encoding of "diamond" on a trial that includes "square" and "rectangle" should be the same irrespective of the inter-trial interval separating it from similar trials. Gorfein acknowledges this in his treatment of temporal release from PI by suggesting that rapidly changing contextual cues, rather than short lasting coding influences, lead to better list discrimination when retention intervals are longer rather than shorter. We assert that in the current experiments, the category cue is necessary to explain the pattern of PI effects, just as Gorfein suggests that contextual cues are involved in temporal release.
Author Notes

This research was supported by Australian Research Council grant No. 634 to the second author. The experiments reported here are part of the first author's doctoral dissertation at the University of Queensland. Reprint requests should be addressed to Gerry Tehan, Department of Psychology, University of Southern Queensland, Toowoomba. 4350. Australia. e-mail tehan@usq.edu.au
Figure Caption.

Structure of the two-block trials in Experiments 1, 2, and 3.
Cuing in Short-term Recall

Filler
Filler
Filler or Foil
Filler
!
Filler
Filler
Filler
Target
Filler

Retention Interval
6719
3824

Study

RECALL

CUE

Test

TYPE OF METAL

jail
silk
hydrogen
peach
!
page
leap
zinc
witch

6719
3824