The Role of Context in Producing Item Interactions and False Memories.

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Abstract

Cued recall with an extralist cue poses a challenge for contemporary memory theory in that there is a need to explain how episodic and semantic information are combined. A parallel activation and intersection approach (PAI) proposes one such means by assuming that an experimental cue will elicit its pre-existing semantic network and a context cue will elicit a list memory. These two sources of information are then combined by focusing on information that is common to the two sources. Two key predictions of that approach are examined. Firstly, that combining semantic and episodic information can lead to item interactions and false memories and that, secondly, these effects are limited to memory tasks that involve an episodic context cue. Five experiments demonstrate such item interactions and false memories in cued recall but not in free association. Linkages are drawn between the use of context in this setting and in other settings.

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In cued recall with an extralist cue a subject typically studies a list of single words. Then at test a cue that is related to one of the list words in some way (e.g., an associate; a taxonomic category label, etc.) is provided. The subject is informed about the relationship between the cue and the list word and is asked to use the cue to help them recall the related word from the list. Although the cued recall task is quite simple and straightforward, it has proven to be a challenge for contemporary memory theory.

The challenge for contemporary memory theory is threefold. First, there is a need to explain the similarities and differences between cued recall and primed free association and more generally between direct/explicit tasks and indirect/implicit tasks. Secondly, there is a need to explain how the pre-existing semantic information about the cue- target relationship is combined with the current episodic information from the study trial in order to produce performance that is better than that obtainable with free recall or free association instructions. Thirdly, there is a need to explain how the pre-existing semantic networks associated with the cue and with the target impact on performance. It is well documented that size of the semantic network of a target word in a list influences both cued recall and primed free association. Similarly, the number of items subsumed by a cue can affect performance in cued recall (Nelson, McKinney, Gee, & Janczura, 1998; Nelson, Schreiber, & McEvoy, 1992). Such target and cue set size effects and other item interactions such as the mutual blocking of two targets subsumed under the same cue (Humphreys, Tehan, O'Shea, & Boland, 2000) and the facilitation of recall due to the provision of phonological similar words in the study list (Tehan & Humphreys, 1998) provide a distinct challenge to all current models of memory. The current experiments deal primarily with the latter two issues

of how semantic and episodic information are combined and how pre-existing semantic networks influence episodic recall.

Several attempts have been made to address some of the above issues. The Transfer Appropriate Processing approach (Morris, Bransford, & Franks, 1977; Roediger, Weldon, & Challis, 1989) provides an explanation for the different types of cues (perceptual versus conceptual) on different types of memory tasks (indirect versus direct) but it does not provide an explanation as to how episodic and semantic information are combined. The generate-recognise approach formalised by Bahrick (1970) accounts for some of the unique characteristics of cued recall and free association, and many of the predictions of the generate-recognize model have been largely confirmed (Jacoby & Hollingshead, 1990; McKenzie & Humphreys, 1990; Roediger, Weldon, Stadler, & Riegler, 1992). However, this approach is seen to be deficient in many domains and it cannot account for a variety of item interaction effects (Humphreys, Tehan, O'Shea & Boland, 2000). Both of the above mentioned approaches would have to be further developed if they are to explain the type of item interaction effects that are the focus of the current study.

PIER 1 and PIER 2 represent the most complete attempt to handle cue and target networks under cued recall and free association instructions (Nelson, et al., 1998, Nelson, et al., 1992) and set the standard for other theories to aspire to. The heart of the PIER-2 model is that the implicit activation of associates contributes to recall. That is, recall is influenced by non-studied associates of a both the cue and the target word. They have found that a cue that comes from a category that has few members is more likely to be successful than if the cue comes from a category that has a large number of instances. Similarly, if a target item has many associates it is less likely to be recalled than a target that has few associates. Thus both cue set size

and target set size are strong determinants of successful recall in the cued recall task in most instances.

Cue and target set size effects are basically pre-experimental (semantic memory) effects. The PIER-2 model explains how information about a recent episodic event combines with pre-existing information to produce a response by assuming that when a familiar word is encountered in a new context, two independent representations are formed. An implicit representation is unconsciously formed and at which time activation spreads to pre-existing associates such that these items also become partially activated, which in turn can alter target strength through a resonance process. The second representation of the item is consciously formed. It incorporates contextual information as well as relational connections to other list items via rehearsal, etc. That is, it produces a list memory. Retrieval is depicted as a search process in which test instructions determine which representation is contacted. When cued recall is requested, it is assumed that both explicit and implicit representations can contribute independently of each other. However, if free association is required, it is assumed that only the implicit representations are accessed.

In sum, the model does address the primary issues we identified earlier. It addresses the distinction between direct and indirect tests of memory; it provides a mechanism by which semantic and episodic information can be combined; and it explains how pre-existing networks impact upon performance. In spite of this, there are some areas in which the model has difficulties.

The ideas about implicit representations account for many of the effects involving cue and target set sizes. However, the ideas about the explicit representations are less well developed than are the ideas about the implicit representations. As we see it there are two problems. First explicit retrieval is

supposed to be modelled by SAM (Raaijmakers & Shiffrin, 1981; Gillund & Shiffrin, 1984). "PIER 2, like its predecessor, assumes that SAM provides an effective means for describing the relative contribution of the explicit representation to performance in these tasks, and so we focus exclusively on the role of the implicit representation" (Nelson et al., 1998, p 303). However, Humphreys, Wiles, and Bain (1993) showed that SAM could not use both episodic and semantic associations without predicting overwhelming interference in the crossed-associates task, a finding that is not empirically supported. It is thus not clear within the PIER framework just what the role is for the cue in retrieving an answer from the explicit system. In addition, both versions of PIER as well as SAM only allow for associative relationships. The similarity of representations is not considered in either model. As will become evident later, this distinction is crucial in explaining some item interactions in cued recall. In contrast, both associative and similarity relationships feature in a set of models and theoretical ideas put forward by Humphreys and his colleagues (Chappell & Humphreys, 1994; Humphreys, et al., 1993; Humphreys, Wiles & Dennis, 1994; Wiles, et al., 1991). Interactions between items that have similar representations fall naturally out of the assumptions of such models.

Humphreys and his colleagues started with the assumption that words were represented as patterns of activation (distributed representations) that could be superimposed into a composite memory. Similarity among representations is modelled directly by assuming that similar items will have higher overlap amongst the features in each pattern than dissimilar items. They also assumed that there were associations between patterns (e.g., between words or between a modality specific representation and a central representation of the same word). Thus they could accommodate both similarity and associative relationships within their models.

Retrieval from a composite memory critically depended upon the type and number of cues involved. For example in both cued recall and free association an experimental (category) cue would require the person to either recall an instance of the category from the list or to produce the first instance of that category that came to mind. In order to explain the difference between cued recall and free association instructions they assumed that a contextual cue was used with cued recall instructions but not with free association instructions. Thus, cued recall and free association were similar in that the category cue was the same in each case. They differed in that with cued recall a context cue was involved but not with free association.

The specific means of retrieving an item in cued recall involved combining the information from the two cues. The contextual cue was assumed to elicit episodic information by activating the list items and inhibiting non-list items. The experimental cue was assumed to elicit pre-existing semantic information by activating the set of words to which it was related (e.g., the associates of a word cue, the members of a taxonomic category, or the words which complete the part word cue) and inhibit unrelated items. The next step was to combine the two patterns of activation. Inhibition from two sources ensured that the only words that remained active were those that were subsumed by both cues. That is, the instance from the category that was on the study list. These processes and assumptions will be referred to as parallel-access-intersection (PAI) approach.

The PAI approach makes several predictions that are not made by other models, including SAM and PIER-2. For a start it predicts that there will be interactions between the items activated by the cue and the items in the list. Moreover, it asserts that such item interactions are limited to tasks in which the context cue is utilised. That is, item interaction effects should be limited to cued recall

and not to free association. Thirdly, this approach predicts that people can combine semantic and episodic information in a way that produces false memories, but only in the case of cued recall. In what follows we explain what type of item interactions we have in mind.

Support for the PAI approach has come from a series of experiments using a short-term cued recall paradigm in which items from within the list interacted with each other (Humphreys, Tehan, O'Shea, & Boland, 2000; Tehan & Humphreys, 1995; 1996; 1998; Tolan & Tehan, 2002). Tehan and Humphreys (1995) introduced a short-term cued recall paradigm in which they manipulated proactive interference (PI). Subjects studied a number of trials in which each trial consisted of either one or two 4-word lists. On the critical two-block trials participants were instructed that they could forget the list because they would never be tested on it. Instead they were to concentrate on the second block because they would be tested on that block. At the end of the second block they were either tested immediately or after a two-second delay filled delay. At test a cue (either a taxonomic category label or a word ending) was presented and participants were asked to recall an item from the last block of four items that was related to the cue. Tehan and Humphreys (1995) established that PI effects could be found with this paradigm by including a second item from the category in the first to-be-forgotten block. For example, the cue might be ANIMAL, the block-2 target *cat* and in the interference condition block 1 would contain a foil, *dog*. PI emerged either through depressed recall of the target item (*cat*) or increased recall of the foil (*dog*), or both. They observed that with taxonomic category cues these PI effects only emerged strongly after the two-second delay; on an immediate test there was little evidence that the presence of the foil had any impact upon target recall. In contrast when they used ending cues (the cue is ENCH, the List-2 target is

wrench and the List-1 foil is *trench*) PI was evident on the immediate test and there was little or no increase over the delay. Their interpretation of this finding was that a short lasting phonological code differentiated between *cat* and *dog*, protecting the target from PI on the immediate test. Because it was short lasting it did not protect the target from PI on the delayed test. However, this short lasting phonological code would not protect the target from PI with an ending cue on the immediate test because the two words subsumed under the cue were phonologically similar.

Evidence for interactions among items within the list was provided by Tehan and Humphreys (1998) when they showed that they could enhance PI on an immediate test with taxonomic categories by providing a rhyme of the foil in block-2. In this instance, the cue might be ANIMAL, the block-2 target *cat*, the block-1 foil *dog*, and the rhyme of the Block-1 foil *log*. The reason they predicted this effect is via the assumptions that the list context cue would activate all of the block-2 words including both *log* and *cat* and that the category cue would activate its associates including *dog* and *cat*. Because both *log* and *cat* were in block-2 it was assumed that for both items both the semantic code and the phonemic code would be activated. In the case of *cat* these two codes will tend to reinforce each other making the target *cat* a potential candidate for recall.. However, the semantic code for *dog* is assumed to be supported by the phonemic code for *log* and thus a competitor for the target item is produced. This manipulation produced PI on an immediate test, dog was produced as a response more often when log was in the list than when it was absent. These results indicate that semantic and phonological codes for an item could come from different sources. In a further demonstration of this effect Tehan and Humphreys spread the phonemic code across three different Block-2 words. Again the cue might be ANIMAL, the block-2 target *cat* and the block-1 foil *dog*. Now the three phonemes

in dog were present in three different block-2 filler words (*dart*, *mop*, and *fig*). The presence of these phonemes in the block-2 words had a significant effect on the amount of PI that was observed.

This pattern of PI effects, particularly when phonemes are distributed across fillers, provide relatively direct support for the idea that at retrieval all items in the second block are simultaneously activated. To us this implies that something like a context cue is required. Furthermore, the PI effects emerge as a result of information being elicited by both category cue and context cue being combined. One resultant implication of these ideas is that if only one of the cues is required in a memory task, the item interaction effects should not be present. For example, in free association where only the category cue is required to do the task and not the context cue, item interaction effects should not be present.

In the above experiments a target and foil were always presented and the presence of a rhyme or distributed phonemes was assumed to strengthen the representation of the foil. A second, and stronger, test of the PAI ideas concerns what will happen if neither a target nor foil is presented in the list. According to the PAI assumptions, the category cue will elicit the semantic representations of all instances of the category and the context cue should elicit the phonological representations of list items. Take for example an instance where *log* is one of the filler items in the second block and the cue in ANIMAL, but no animal has been presented anywhere in the list. According to our retrieval assumptions, the cue ANIMAL should activate the semantic representations of all animals including *dog*. The list cue should activate the phonological representations of all the list items including a rhyme *log*. The presence of semantic and partial phonological information post-intersection, on some occasions may be sufficient to lead to the construction of an item that is an instance of the

category but was not present on the list. That is, the PAI assumptions indicate that false memories may well be created. However, note that these false memories should only be present under intersection conditions where both category and context cue are utilised. That is, false memories can be constructed with cued recall but they should not be present on free association task. The following experiments are aimed at directly testing these predictions of the PAI assumptions.

Experiment 1.

The cued recall task manipulating PI is not adequate to test either the assumption that target interactions will be limited to cued recall or that false memory can be constructed. For a start there seems no straightforward, convincing rationale for asking participants to study two blocks and then give a free association task instead of a cued recall task. With memory for only four items being required we also felt that participants would soon notice if no target item was presented anywhere in the list. Likewise, with only four items in a list we felt that when the target was present in the second block, participants in a free association condition would soon realise and attempt cued recall rather than free association. As a consequence we have had to develop a new task that would provide a believable cover story for introducing cued recall and free association.

The new task was a running memory span task. Again participants studied lists that ranged from 4 items to 12 items, never knowing in advance what the list length was going to be. The instructions required them to keep track of the last three items that they had seen and that they could be stopped at any stage and asked to recall the last three items that they had seen in forward serial order. They were also instructed that some trials were going to be made more difficult by adding a brief retention interval, but their primary task was still to keep track of the last three items. They

were told that the distractor task would involve a cue word being provided at the end of the list and that they would have to respond to the cue and then attempt recall of the last three words they had seen. One group of subjects was instructed to free associate to the cue. Thus on critical trials after the items on the list had been presented a category cue appeared in upper case for two seconds. Subjects were instructed to give a rapid response to the cue and then attempt to recall the last three list items. The other group was instructed to use the cue to recall a related word from the list. Again, after the list items had been presented the category cue was presented for two seconds and participants made a quick attempt to recall an item from the list before attempting serial recall of the terminal three list items.

Humphreys, Tehan, O'Shea, and Boland (2000) used this procedure to test other assumptions of the PAI approach; specifically that if two items in a list were present and subsumed by the same category cue they would block each other and consequently recall would suffer. They found that the running memory span task provided a believable cover story for the free association task. In addition, because delayed running memory span was so difficult, participants would respond as quickly as possible to the cue so that they could return to running memory span before they lost access to the memory trace. This helped to keep them from realizing that some of the words they were producing had been in the prior list. Several aspects of the data also indicated that the free association and cued recall participants were following instructions. First, the cued recall participants produced very few extra-list intrusions. Second, when a target word was repeated after a few intervening items it nearly doubled the probability of cued recall but had no discernable impact on the free association probability. Finally it affected the pattern of results when two targets were subsumed under the same cue, which was the primary focus of the study. That

is, the presence of two similar items in a list blocked each other in cued recall, but not in free association.

The Humphreys, et al. (2002) results show that one form of item interaction effects are limited to cued recall and are not found in free association. However in that study the lists always contained at least one target item. In the current experiments we want to extend the Humphreys et al. findings and test the idea that false memories can be constructed. To do this, we need to present trials in which no target item is presented anywhere on the list. As such four different types of trials were utilised that manipulated the presence or absence of a target word and the presence or absence of a phonologically similar word (PSW) to the target. In the control lists neither the target nor PSW was present. In other lists the PSW was present but the target was not. In other lists the target was present but the PSW was not. In other lists both the target and the PSW were present. The experiments differ in whether category or ending cues are used and where in the list the PSW occurs. The later manipulations were designed to rule out the use of the PSW word as an auxiliary cue and to rule out participants noticing the relationship between the target and the PSW while studying the list.

As outlined above, we predicted that the presence or absence of the PSW would have little or no effect on free association. However, based on the assumption that in cued recall the words activated by the cue and the words in the list interact we predicted that the target would be produced more often in the condition where both the target and the PSW were present than in the condition where the target alone was present. We also predicted false memories. That is, we predicted that in cued recall the target would be produced more often in the condition where the PSW alone was present than in the condition where neither the PSW nor the target was present. This

is predicted because the list context cue will activate the PSW, which will result in the activation of some of the features of the non-presented target. The cue will likewise activate the features of the target. If sufficient features remain active, it is possible that the non-presented target item will be produced.

In order to maximize the chances of observing an effect due to the presence of a PSW in the study list the PSW was placed in the last position of an eight-item list to ensure that phonological codes were at their strongest. The target was always presented early in the list, thus placing the PSW in the final position also helped to ensure that participants did not rehearse the PSW and the target together. It did, however, raise the prospect that participants would form a compound cue out of the PSW and the category cue (Dosher and Rosedale, 1989; Ratcliff and McKoon, 1988) or additively combine the PSW and the category cue (Humphreys et al., 1989). This possibility was examined in Experiments 3A and 3B.

Method

Participants

Forty introductory psychology students at the University of Southern Queensland participated in the experiment as part of a course requirement. An equal number of participants were randomly assigned to the Free association and Cued recall conditions.

Materials and Lists

Forty taxonomic cue-target pairs were selected from the University of South Florida Norms (McEvoy & Nelson, 1982). The targets were weak associates (produced by 1.5% of participants and were the twelfth most frequently produced instance in their category, on average) of the cue terms. In addition a concrete PSW (in this case a rhyme) for each of the target terms was generated. The 40 cue, target,

and PSW triples are referred to as the experimental word sets. A pool of filler items to be used in each list was also produced. The pool of filler items were selected from the unused categories from the South Florida Norms and from the Shapiro and Palermo (1970) taxonomic category norms. The fillers were selected such that they were concrete nouns like the targets but that there was no overlap in category membership with the targets. This ensured that the filler items were always unrelated to the targets.

For each participant 52 lists of words were prepared. There were 12 filler lists, which ranged in length from 4 to 8 words and 40 experimental lists each of which contained 8 words. To construct the experimental lists, 8 filler words were randomly paired with each of the 40 experimental sets. Experimental set filler pairings were then randomly assigned to one of four experimental conditions with the proviso that there were an equal number of lists in each condition. The four types of experimental lists defined the within subject conditions. In the Target and Target plus PSW conditions, the target word from the experimental set replaced the second or third filler item in each list. In the Target plus PSW condition, the PSW word for that target replaced the final filler item in the list. Thus five or six filler items separated the target and the PSW. This ensured that they would not be rehearsed together. In the remaining two conditions there was no instance of the category in the list. In the PSW condition, the PSW for that target replaced the last item in the list, but the target was not presented. In the control condition, none of the items in the list were instances of the category nor rhymes of an instance of the category.

Whereas unique sets of critical lists were created for each participant, the 12 filler lists were the same for all subjects and all were tested immediately. The order of the 52 lists was randomised for each person.

Procedure

Participants were instructed that they would be presented with a series of words on the screen one at a time. They were told that the lists would vary in length from four to eight items and that they would never know in advance how long the list would be. They were instructed that when a prompt appeared on the screen their task was to recall the last four words in the list in the order in which they were presented. If they could not recall all of the indicated words they were to recall as many as possible. If they were unable to recall any, they were instructed to respond by saying "none". They were also instructed that some of the trials would be tested immediately but others would be tested after a brief filled retention interval. Instructions stressed that the distractor activity was intended to make the task harder but that their primary task was still to recall the last four words that they had seen.

The words in the study list were presented in lower case at a one second rate. On an immediate test a row of question marks appeared after the final word in the list and subjects had nine seconds to recall the most recent four items. The parameters of the delayed test were identical save that a category cue appeared for two seconds after the final word in the list had been presented. The experimenter recorded the participants' verbal responses to the cue and the running-memory span task on a hard copy of the input file.

Free Association Instructions. Participants were instructed that if a word appeared in capital letters they were to respond by saying the first related word that came to mind. They were given two seconds to respond to the cue at which point the cue disappeared and they were required to perform the running-memory-span task.

Cued Recall Instructions. Participants were instructed that if a word appeared in capital letters they were to respond by recalling a list word that was an instance of

the category cue. If they could not recall a related word they were told to report this by saying the word "none". All other details were the same as with the free association instructions.

Results

The probability of producing the target item in each condition is summarised in Table 1. Two trends appear to be present in the data. First there seems to be a target effect in that target recall is more likely when the target is present in the list than when it is absent. Secondly, when the target is present in the list, the PSW strongly enhances cued recall but not free association.

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Insert Table 1 about here

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A straight forward 2x2x2 analysis of the data was precluded by the fact that very few participants produced the target in the Control or PSW only conditions. Because our hypotheses deal directly with the influence of the PSW on performance, we combined the two conditions that did not involve a PSW (Control and Target only) and the two conditions that did include a rhyme (PSW only and Target plus PSW). Combining the data in this way doubled the number of data points in the analysis and ensured that we had more reliable measures. Thus, the methodology we use in this and all subsequent experiments is to first complete a 2x2 analysis of variance with the presence or absence of a PSW as one variable and cued recall or free association as the second. An alpha level of .05 is used in this and all subsequent experiments to determine statistical reliability. Our hypotheses require planned comparisons between the two conditions for both the cued recall and free association. Our hypotheses also make predictions concerning false recalls of the target in the PSW only condition of

the cued recall test. We use a Wilcoxon test, reporting a Z statistic, to compare differences between the Control and PSW only condition to test for the false memory effect. In all analyses an alpha level of .05 was used to determine statistical reliability.

The initial analysis indicated that the presence of a PSW in the list had an overall facilitative effect upon performance, F (1,38) = 8.27, MSE = .02, and target recall was more likely under cued recall than free association, F (1,38) = 3.32, MSE = .04. The interaction only approached statistical significance, F (1,38) = 3.77, MSE = .02, p = .059. The planned comparisons indicated that the presence of the PSW in the list facilitated target recall in cued recall, t (19) = 3.49, but not under free association, t (19) = .64.

A Wilcoxon test indicated that the difference between target recall in the Control and PSW only conditions was significant in the cued recall task, Z = 2.27.

The running memory span results are presented in Table 2 as a function of task (cued recall versus free association), the presence or absence of the target, and the presence or absence of the PSW. We report these data for completeness and because in the Humphreys et al. (2000) data RMS performance was consistently better after cued recall than free association. A 2x2x2 ANOVA indicated that none of the main effects or interactions were significant, all F's <1, save for task where F (1, 38) = 2.39, MSE = .07.

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Insert Table 2 about here

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Discussion

The presence of the PSW in the list enhanced cued recall but not free association. In addition there was evidence for a false memory effect in that the target was produced more often when the PSW alone was present than in the Control condition. These results clearly conform to predictions of the PAI approach.

With respect to the running memory span data, Humphreys et al. (2000) found that running memory span was significantly better after cued recall than after free association, in spite of a longer retention interval associated with cued recall. They argued that one explanation involved the difference between reactivating a context cue and maintaining that context throughout the experiment. Thus, after free association participants would have to reinstate the list context cue in order to do the running memory span task. However, because both cued recall and running memory span require activation of the list items, the context cue would not need to be reinstated in order to do the running memory task. In the current experiment the analysis of the running memory span results did not show a reliable difference in favour of the cued recall condition as had been observed in Humphreys et al. (2000). Nevertheless the trend was in the same direction.

Experiment 2

As predicted, the presence of a rhyme of the target enhanced target recall in the Cued Recall Condition but not in the Free Association Condition. Moreover, false memories were produced in that when there was no target in the list, target recall was still more likely when a rhyme was in the list. To check on the generality of this finding in Experiment 2 and instead of using a PSW that shared an ending with the target we used a PSW that shared a beginning stem with the target.

Method

Participants

Forty psychology students at the Australian Catholic University participated in the experiment as part of a course requirement. An equal number of participants were randomly assigned to the free association and cued recall conditions.

Materials, Lists and Procedure

Forty Rhyme cue-target pairs were selected from the University of South Florida Rhyme Norms (Walling, McEvoy, Oth, & Nelson, 1984). The targets were weak associates (produced by 2 % of participants and were the seventh most frequently produced instance in their category, on average) of the rhyme cue terms. In addition a word that shared the same word stem of each of the target terms was generated (e.g. Cue: _AME; target: blame; stem: blade). The pool of filler items was selected from the unused categories from the South Florida Rhyme Norms. The fillers were selected such that they had the same characteristics as the targets but that there was no overlap in category membership with the targets.

Randomising fillers, targets and stems was not possible because of the limited pool of initial phonemes of words. Consequently, one master file was generated along the same lines as those used in Experiment 1. This file contained 50 trials in which there were 10 filler trials (the same as in Experiment 1), 10 Control trials, 10 PSW trials, 10 Target trials and 10 Target plus PSW trials. The order of the 50 trials was randomised.

The filler items on each trial were carefully scrutinised to ensure that there was no overlap between the stems of the fillers and the target. Any filler that had the same stem as the target was replaced by an alternative filler that did not have any overlap with the target. Once we had ensured that the fillers bore no relationship to the targets, three additional forms of the file were generated. If a trial was a Target trial in the master file, it became a Target plus PSW trial in the second set, by

replacing the final filler with the PSW word. In the third set it became a PSW trial by replacing the target with a filler and in the fourth set it became a Control trial in which both the target and the stem were replaced by fillers.

In sum, the order of the trials was identical for each participant, and the fillers and cues were also identical for all. All that changed was the presence or absence of the target and PSW. These were counterbalanced across the four variants of the master file.

The procedure was the same as in Experiment 1 except for two changes. The first involved the reduction of the number of items that had to be recalled in the running memory span task from four to three. The second was that the cues were word ending cues (e.g. __AME). In the cued recall task participants were instructed to recall the word from the list that had the appropriate ending. In the free association task, participants were asked to respond with the first word they could think of that ended with that ending.

Results

The cued recall and free association results are summarised in Table 1. The overall pattern of performance is quite similar to that obtained in Experiment 1. The target was more likely to be produced when it was in the list than when it was absent and the phonologically similar word influenced cued recall but not free association. The initial analysis indicated that target recall was more likely under cued recall than free association, $\underline{F}$ (1,38) = 8.53, $\underline{MSE}$ = .07. The presence of a PSW in the list had an overall facilitative effect upon performance, $\underline{F}$ (1,38) = 12.95, $\underline{MSE}$ = .03, and the interaction was statistically significant, $\underline{F}$ (1,38) = 5.42, $\underline{MSE}$ = .03. The planned comparisons indicated that the presence of the PSW as the final item in the list

facilitated target recall in the cued recall condition, t (19) = 4.27, but not under free association, t (19) = .88.

A Wilcoxon test indicated that the difference between target recall in the Control and PSW only conditions was significant in the cued recall task, Z = 2.94.

The running memory span results are presented in Table 2. The presence of the PSW in the list had a significant effect on running memory span performance, F (1,38) = 20.30, MSE = .10. Again there was a trend for running memory span to be better following cued recall than free association. However, it was not significant, F (1,38) = 1.68, MSE = .06.

Discussion

This experiment provided further support for an effect of the PSW on cued recall but not free association and for a false memory effect. Again the results are consistent with the PAI expectation that target interactions should be limited to direct tests. With respect to running memory span again there was a non-significant trend for performance to be better following cued recall than following free association. We have no explanation as to why the presence of the PSW affected running memory span except to note that the PSW is one of the words that should be recalled in running memory span so a variety of explanations are possible. We will explore this issue in the next two experiments.

Experiment 3A and 3B

In Experiments 1 and 2 the presence of the PSW increased target recall in the cued recall conditions. Because the PSW was in the final list position just before the cue it seemed possible that the PSW could be used as part of the cue. For example, Ratcliff and McKoon (1988; also see Dosher & Rosedale, 1989) proposed that in priming paradigms the prime and the target form a compound cue that is evaluated for

familiarity. Humphreys et al. (1989) had also proposed that a word and its context might combine additively to enhance cued recall performance. To eliminate these possibilities in Experiments 3A and 3B the PSW was moved to the fourth from the last position. This also has the effect that the PSW is now not one of the items that has to be recalled during the running memory span phase of the experiment. However, placing the PSW in that position may decrease the strength of the phonological code and thereby weaken any target interactions. To guard against this possibility, participants were required to say the list words out loud as they appeared on the computer screen. This manipulation appears to enhance the strength of the phonological code (Tehan & Humphreys, 1995).

Method

Participants

Eighty introductory psychology students at the University of Southern Queensland participated in the experiment as part of a course requirement. An equal number of participants were randomly assigned to the Free association and Cued recall conditions in each part of the experiment. Forty participants were given taxonomic category cues (Experiment 3A) and the other 40 were given word ending cues (Experiment 3B).

Materials, Lists and Procedure

The materials, lists and procedures were identical to those used in Experiment 2 (recall 3 most recent items in running memory span) with only two modifications. The PSW, if it was present in the list, appeared in the fourth from last item. Secondly, to ensure that phonological representations of the rhyme or stem would remain at relatively high levels of activation, the participants read the items aloud as they appeared on the computer monitor.

Results

Taxonomic Cues (3A)

The data involving taxonomic categories are presented in Table 1. The pattern is very similar to that obtained in Experiment 1. The analysis indicated that the overall difference between cued recall and free association was not reliable, F (1,38) = .60, MSE = .05. The presence of a PSW in the list had an overall facilitative effect upon performance, F (1,38) = 10.26, MSE = .03, and the interaction was significant, F (1,38) = 7.24, MSE = .03 The planned comparisons indicated that the presence of the PSW in the list facilitated target recall in the cued recall condition, t (19) = 5.13, but not under free association, t (19) = .31.

A Wilcoxon test indicated that the difference between target recall in the Control and PSW only conditions was significant in the cued recall task, Z = 2.17.

The running memory span results are presented in Table 2. Again there was a non-significant trend for performance to be better following cued recall than free association F (1,38) = .06, MSE = .09. None of the other main effects or interactions were significant.

Ending Cues (3B)

The data for the ending cues are summarised in Table 1. The overall pattern of performance is quite similar to that obtained in Experiments 1 and 2.

Target recall was more likely under cued recall than free association, F (1,38) = 28.90, MSE = .05. The presence of a PSW in the list had an overall facilitative effect upon performance, F (1,38) = 16.98, MSE = .04, and the interaction was significance, F (1,38) = 11.37, MSE = .04. The planned comparisons indicated that the presence of the PSW facilitated target recall in the cued recall condition, t (19) = 4.78, but not under free association, t (19) = .60.

A Wilcoxon test indicated that the difference between target recall in the control and PSW only conditions was significant in the cued recall task, Z = 3.54.

The running memory span performance is presented in Table 2. This time performance following cued recall was significantly better than following free association, F (1,38) = 7.06, MSE = .09. There was also a main effect for the presence or absence of a target item in the list, F (1,38) = 5.83, MSE = .05.

Discussion

The results from Experiments 3A and 3B also show a PSW effect in cued recall but not free association and a false memory effect. We placed the PSW earlier in the list to test the idea that subjects were using a compound cue consisting of the cue and the PSW to access memory. These findings show that the effect of the PSW was not due to its being used as a retrieval cue.

Across the four experiments only one of the four comparisons between the cued recall and free association conditions involving running memory span was significant. However, we have no doubt that there is a general trend for running memory span to be easier when it follows cued recall as opposed to free association. That is, in addition to the significant comparison in this series of experiments two out of the three comparisons in Humphreys, et al., (2000) were significant and the trend has been the same in all seven experiments. These results suggest that a distinction can be made between maintaining a context cue and having to reinstate it at test, the former leading to better memory performance.

The finding that the presence of the PSW significantly impaired running memory span performance in Experiment 2 was not replicated in Experiments 3A and 3B. This may well be due to the fact that in Experiment 2 the PSW was one of the words to be recalled in running memory span whereas it was positioned well before

the running memory span words in Experiments 3A and 3B. We have no explanation as to why in Experiment 3B running memory span performance was better when the target was present than when it was absent.

Experiment 4

In Experiments 3A and 3B where there is relatively small separation between the target and the PSA it was possible that some participants were noticing that there was a relationship amongst some of the words in the lists. It is possible that this knowledge could induce participants to treat the task as a problem solving activity, producing the word they thought the experimenter wanted produced, instead of a retrieval task. To eliminate this possibility in Experiment 4 the phonological information was decomposed into three components and was embedded in irrelevant speech. Tolan and Tehan (2002) have shown that the item interactions that we have been observing here are also observed when the phonologically similar material is embedded in irrelevant speech. That is, the PSWs were presented not as filler items in the second block but in an auditory stream that presented during the study phase of each cued recall trial. As Tolan and Tehan note, to explain the enhanced PI effects from the PAI approach, it has to be assumed that the list context cue is associated with the irrelevant material, such that at retrieval, the irrelevant material is activated as well as the list items.

Because irrelevant speech interferes with short term memory tasks such as running memory span our assumption is that participants would be doing their best to ignore the irrelevant speech. In addition, there was a minimal degree of overlap between any one word in the irrelevant speech stream and the target. Under these conditions it is extremely unlikely that participants would ever become aware that

words in the irrelevant speech stream overlapped phonologically with the target or a potential target.

Method

Participants

Forty psychology students at the Australian Catholic University participated in the experiment as part of a course requirement. An equal number of participants were randomly assigned to the Free association and Cued recall conditions.

Materials

One set of materials that was used by Tolan & Tehan (2002) was adapted for the current task. These materials all involved taxonomic cues and the target item was again a low dominant instance of the category.

All subjects saw the same set of 52 trials in the same randomised order. The trials consisted of 12 filler trials that were all 4 items in length and 40 experimental trials that were all 10 words in length. For 20 of the experimental trials, the target was present in either the second or third position on the list and the remaining 20 trials contained no instance of the category on the list. Two versions were created such that if the target appeared on a trial in one version, it was absent on the second version, and vice versa.

In this experiment, the target phonemes appeared in a stream of irrelevant speech rather than as a filler item in the list. Furthermore, the phonological information was decomposed into its component parts and presented across five different words. Two of the five words had the same word stem as the target, another two words shared the same word ending and the remaining word shared the same consonants but differed in the vowel used. Thus, the initial consonant, vowel and terminal consonant appeared more than once through out the presentation of the five

irrelevant speech items (PSWs). The PSWs were presented in the order of stem, ending, stem, ending, and consonants. For example, the five PSWs and order of presentation in irrelevant speech for the target item DOVE were **du**mp l**ove**, **du**st, gl**ove,** and **d**i**v**e.

The auditory stream for each trial consisted of 20 words, of which 15 were filler items and five items shared phonological features with the target. These five words appeared in the 14th to 18th position in each stream. Thus the components of the rhyme were never presented as the final items in the auditory stream. An auditory sequence with the above characteristics was created for each of the 40 target items.

Pairing a trial and an auditory sequence determined Control, PSW, Target and Target plus PSW conditions. In the 10 control trials for each participant, the list sequence contained no instance of the category and there were no PSWs of that target in the auditory sequence. This was done by randomly allocating 10 of the auditory sequences to the 10 trials. In the 10 PSW trials, the target was absent from the list, but the PSWs for that target were present in the auditory stream. In the 10 Target trials, the target was present in the list but the PSWs for that target were not present in the auditory stream. In the 10 Target plus PSW trials, the target was present in the list and the PSWs for that target were present in the auditory stream. Counterbalancing the assignment of targets and PSWs to trials resulted in the use of four sets of materials.

Procedure

The procedure was the same as that employed in Experiment 2. That is, the list words appeared on the screen at the rate of 1 word per second and the instructions stressed that participants should attempt to keep track of the last three words that they had seen. They were told that they would hear a male voice reading a list of words over the computer speakers, but they were told to ignore this material.

The irrelevant speech was presented in a male voice. He spoke the irrelevant items at a rate of 2 words per second. The target item was always presented as the second or third item in the list and the PSW was always presented towards the end of the auditory stream. Thus in the Target plus PSW condition, there was always a substantial delay between the presentation of the target and the PSWs; either a separation of between 4 and 5 list items or between 4 and 5 seconds of intervening irrelevant auditory input.

Results

The cued recall and free association data are presented in Table 1. The pattern is again very similar to that obtained in Experiment 1. The initial analysis indicated that the overall difference between target recall under cued recall and target recall under free association was reliable, F (1,38) = 5.85, MSE = .04. The facilitative effect of the presence of PSWs in the auditory stream was significant, F (1,38) = 7.61, MSE = .03, and the interaction was reliable, F (1,38) = 5.58, MSE = .03. The planned comparisons indicated that the presence of the PSWs among the irrelevant speech facilitated target recall in the cued recall condition, t (19) = 3.36, but not under free association, t (19) = .29.

A Wilcoxon test indicated that the difference between target recall in the control and PSW conditions was significant in the cued recall task, Z = 2.94.

The running memory span data are presented in Table 2. This time there was a significant difference favoring free association, F (1,38) = 9.62, MSE = .08. None of the other main effects or interactions was significant.

Discussion

The cued recall and free association results are consistent with the assumptions that we have been working with. The use of irrelevant speech and

distributing the phonologically similar items across a five out of 20 items on each trial, makes it highly unlikely that the effect of the PSW and the false memory effect can be explained in terms of participants becoming aware of the structure of the lists and producing the response they think the experimenter wanted.

The running memory span results were surprising but we think that they are potentially important. It appears that the use of irrelevant speech has fundamentally altered the results from those obtained in previous experiments in which running memory span was better following cued recall than following free association. One possibility is that participants were using a generate-recognize strategy in this experiment when they clearly had not in the previous experiments. This, however, seems unlikely. First, the cued recall and free association results were very similar to the results from the earlier experiments suggesting that there had been no strategy change. Furthermore, we can think of no reason for such a dramatic strategy change because the time pressure was at least as great in this experiment as it had been in the previous experiments.

It is also not clear which of the two running memory span results is aberrant. The short-term retention literature on irrelevant speech effects speaks to this issue. Perhaps the most well developed model of irrelevant speech effects is that developed by Jones and his colleagues (Jones, 1993; Jones & Macken, 1995). Their research has indicated that irrelevant speech effects have minimal effects upon tasks that do rely upon the use of order information. However, disruption is always observed in tasks were recall in serial order is required. From this perspective, the expectation would be that free association and cued recall should be largely unaffected by irrelevant speech because neither of these tasks rely upon serial order. However, the running memory span task should be severely disrupted because participants must use serial order

information to do the task. In looking at the cross experiment comparisons, the absence of a substantial decrement in cued recall and free association performance is consistent with expectations. Moreover, the large decrement observed in running memory span after cued recall is also entirely consistent with predictions. The one data point that is inconsistent with the Jones assumptions is serial recall after free association. In this condition, the expected decrement has not emerged. We would argue that it is this data point that is aberrant, not the RMS data after cued recall.

If our speculation about the maintenance of context versus the reinstatement of context is correct, it would appear that as long as context is maintained throughout study, cued recall and running memory span, the items in the irrelevant stream remain active and influence recall. However, it seems that when context has to be reinstated, items in the irrelevant stream are no longer or minimally involved in the intersection process. It is quite possible that these items are not re-activated when the context cue is presented, or they are inhibited during the intersection process. What ever the explanation, the results are important because it is the first time that irrelevant speech appears to have minimal impact upon a serial recall task.

General Discussion

The effect of having the PSW in the lists was highly consistent in cued recall. All five comparisons between the combined PSW and Target plus PSW conditions and the combined Control and Target conditions were significant. In contrast in free association none of the five comparisons was significant. There was also evidence that the effect of the PSW was significantly larger in cued recall than in free association. That is, in the analysis of type of test (Cued Recall vs Free Association) by Presence of the PSW (PSW and Target plus PSW vs. Control and Target) interaction was significant in four out of the five experiments and narrowly missed

significance in the fifth (p = .059). It seems reasonable, however, to suppose that because Target effects (the effect of having the target present) were smaller in free association than in cued recall, PSW effects should also have been smaller. To check on this possibility for each experiment we divided the PSW effect (PSW - Control + Target plus PSW - Target) by the Target effect (Target - Control + Target plus PSW - PSW). The values for each of the five experiments for the Cued Recall and Free Association conditions are given in Table 3. Even after scaling, the effect is over three times larger in cued recall than in free association. The difference between these ratios was also significant, t (4) = 3.37, p.< .05. In short the effects of the PSW in cued recall are robust and reliable.

Evaluation of the Models

In the introduction we indicated that extralist cued recall produced three challenges to current memory theory: The need to explain the similarities and differences between direct and indirect tasks; the need to explain how semantic and episodic memory could be combined in cued recall; and the need to explain how pre-existing semantic networks associated with the cues and the targets would influence memory. The PAI approach does provide an answer to these challenges.

According to the PAI approach, direct memory tasks like cued recall and indirect tasks like free association are similar in that the experimental cue will elicit or activate the pre-existing semantic network associated with that cue. What differs between the two tasks is the use of a context cue. The context cue provides the episodic information which is used in direct tasks but not in indirect tasks. In cued recall the parallel activation of the networks associated with the experimental cue and the context cue provide the starting point for the combination of these two sources of information. The proposed intersection process is where these two sources of

information are actually combined and determines what is recalled. Because the model makes a distinction between association and similarity, item interactions involving pre-existing semantic information and episodic information are possible. This shows up in either enhanced target recall or increased likelihood of constructing a false memory. We would contend that like the PIER-2 model, the PAI approach does provide answers to the three challenges that were specified at the start of this article.

Is the PAI approach superior to PIER-2? To the extent that the target interactions that we have examined require the distinction between similarity of representation and association, then PIER-2 will have trouble accounting for the effect that a rhyme has on target recall because no such distinction is made in the model. That is, if subjects are explicitly instructed to produce rhymes of *dog* they may produce *log,* but they will not produce it spontaneously when asked to free associate to *dog*. Without specific instruction to think of rhymes PIER-2 would not be able to predict that *log* was activated when *dog* was present or that *dog* was activated when *log* was presented. Furthermore, *log* should not be activated when the cue ANIMAL is presented. Thus PIER-2 should not be able to predict that the presentation of *log* will have any effect on the recall of *dog* given ANIMAL as a cue. Secondly, PIER-2 is not based upon distributed representations. Any model based upon local representations would have particular troubles in dealing with Experiment 4 where the phonemes of the PSW were distributed across items in the irrelevant stream. Thirdly, PIER-2 also does not make the distinction between long-lasting semantic codes and transient phonological codes. This distinction is crucial to the item interaction effects that we have observed. However, the reliance upon short-lasting phonological codes

in the PAI approach does have the drawback that such item interaction effects may well be more difficult to observe in more traditional LTM cued recall tasks.

There are areas where PIER-2 is certainly more developed than the PAI approach. As just one example, the PAI approach focuses upon the networks associated with the cues. As yet, the PAI approach has not formally addressed the issue of the networks associated with the target item. Whereas, the PAI approach has the potential to account for cue set effects in cued recall, target set size effects would be more problematic. This is the case because the lexical aspects of the Chappell and Humphreys (1994) model have not been explored or developed to the same extent as the cuing aspects. Cue and target set size effects are the bread and butter of the PIER-2 model.

Context as a Retrieval Cue

The results clearly indicate that list members with no direct relationship with the cue play a substantially larger role in cued recall than in free association. We think that the most parsimonious explanation is that in cued recall a contextual cue activates all of the items in the list and that this contextual cue is not used or only rarely used in free association. This explanation would not be parsimonious if all we had was the results from the short-term cued recall paradigm. That is, all we would be doing is postulating that an essentially unobservable process or concept was responsible for the empirical observation that the other list items matter in cued recall but not free association. There are, however, several other phenomena that are also explained by the assumption that context is used as a retrieval cue and several predictions that can be made.

Proactive interference: We have already discussed the immunity to PI found on an immediate test with a category cue. A prediction that immediately follows from

the current argument is that such immunity would not be observed in a free association test.

The cue-dominance effect: The model also accounts for item interaction effects involving a list item and pre-existing associates of the cue that are not presented in the list. Tehan and Humphreys (1996) explored the cue-dominance effect in the short-term cued recall task. The cue-dominance effect refers to the finding that recall is better when the target is more strongly associated with the cue. Tehan & Humphreys (1996) used a single 6-word list containing a single target and no foils. They showed that with category cues high dominant and low dominant instances of the category were equally likely to be recalled on an immediate test but on a delayed test the strong items were better recalled than the weaker items. However, with ending cues the dominant items in the ending category were better recalled that the weaker items on both an immediate test and a delayed test. Their explanation for this was essentially the same as their explanation for the parallel finding with PI. That is, on an immediate test the presence of a short-lasting phonological code protected the target from interference from the other associates of the category cue. However, this would not work with the ending cue because the other associates of the ending cue were by definition phonologically similar to the target. In this instance the contextually derived phonological information did not constrain recall in any way and the pre-existing relationship amongst members of the category remained apparent. A prediction that follows is that the cue dominance effect should be present in free association for both taxonomic and ending cues.

List-length effects in LTM tasks: The assumption that context is used as a retrieval cue also provides a way of thinking about list-length effects in LTM tasks (Dennis & Humphreys, 2001; Humphreys, 2001). If a context cue is activating the all

items in the list there, the longer the list is, the greater the possibility for spurious items/features to survive intersection. That is, there is increased chance for cross talk between these items and the items that are elicited by the other cue(s) in the retrieval process and the chances of the correct target being produced from an increasingly noisy background are thus reduced. A prediction that follows is that the list-length effect should be much stronger in cued recall than in free association.

Long-term Recency in Free Recall: Glenberg and Swanson (1986) proposed that the long-term-recency effect could be explained by a rapidly changing contextual cue. More recently, Howard and Kahana (1999, 2002) have expanded on this suggestion by formalizing it and extending it to a new phenomenon. That is, their formulation not only accounts for the long-term-recency effect it can also account for the lag functions (how far apart on average in the study list are two words which are recalled in adjacent output positions).

There appears to be no impediment to producing an integrated theory that would account for our target interaction effects, list length and long term recency/lag effects. Such a theory would be more parsimonious than the corresponding sets of empirical generalizations about the conditions under which these different effects manifest themselves.

False Memories

In all five experiments, in the cued recall condition, the probability of recalling the target when it was not actually present in the list was significantly greater in the PSW than in the Control condition. This is a false memory created out of the semantic information about the cue and the episodic information about the list. This finding supports view that memories are constructed. As such it is an explicit demonstration of an idea that goes back to Bartlett (1932; also see Tulving, 1983).

Namely that it is inappropriate to talk about finding a memory or retrieving a memory. Instead one needs to think of memory as a process in which both memory traces and cues contribute to what is produced (also see Toth & Hunt, 1999).

The current results along with the results of Tehan and Humphreys (1998), Tolan and Tehan (2002) and Humphreys, Burt, and Lawrence (2001) also provide support for the assumption that words are represented as a pattern of features that can blend with other words to create new memories. Admittedly these blends have only been observed under rather special circumstances. Nevertheless this insight into the nature of the underlying representations provides some direction for future research into false memories.

Moreover our results are relevant to other more general issues concerning human memory. Our finding supports the use of distributed representations and the view that memories are constructed. Moreover thinking about what cues are used and how information is combined is for us, a far better starting point for thinking about false memories than traditional ideas about symbolic representations, separate storage and sequential search processes.

Summary and Conclusions

In the current series of experiments we have argued that target interactions in memory stem from the combination of pre-existing semantic information with episodic information that is elicited by a context cue. We predicted and confirmed that the presence of a PSW in the study list enhances target recall and produces false memories in cued recall but not free association.

Taken together these finding provide strong support for the theory proposed by Humphreys and his colleagues. Namely, words have distributed representations and that in cued recall a contextual cue activates the list items and the cue activates its

associates whereas the contextual cue is not used or only rarely used in free association.

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Table 1

Mean probability (and standard deviation) of recalling the target item as a function of type of memory task and the presence of phonologically similar words (PSW) in the list.

	Control	PSW Only	Target Only	Target plus PSW
Experiment 1				
Free Association	.03 (.05)	.04 (.05)	.08 (.09)	.10 (.10)
Cued Recall	.00 (.02)	.04 (.06)	.18 (.11)	.29 (.17)
Experiment 2				
Free Association	.10 (.07)	.17 (.11)	.25 (.12)	.22 (.10)
Cued Recall	.04 (.06)	.15 (.17)	.40 (.18)	.50 (.22)
Experiment 3A				
Free Association	.13 (.12)	.09 (.10)	.21 (.15)	.27 (.15)
Cued Recall	.02 (.05)	.09 (.10)	.25 (.14)	.41 (.25)
Experiment 3B				
Free Association	.11 (.09)	.11 (.10)	.21 (.14)	.23 (.11)
Cued Recall	.04 (.06)	.22 (.15)	.37 (.17)	.54 (.22)
Experiment 4				
Free Association	.03 (.04)	.06 (.08)	.17 (.15)	.16 (.14)
Cued Recall	.02 (.04)	.10 (.09)	.19 (.16)	.32 (.18)

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Table 2

Mean probability (and standard deviation) of recalling an item during the Running memory span phase, as a function of the type of memory task, the presence of a target item and a phonologically similar word (PSW) in the list.

	Control	PSW Only	Target Only	Target plus PSW
Experiment 1				
Free Association	.25 (.16)	.24 (.14)	.26 (.13)	.25 (.14)
Cued Recall	.30 (.12)	.29 (.12)	.34 (.16)	.31 (.17)
Experiment 2				
Free Association	.63 (.16)	.59 (.15)	.61 (.15)	.57 (.12)
Cued Recall	.67 (.13)	.61 (.14)	.70 (.12)	.63 (.12)
Experiment 3A				
Free Association	.56 (.18)	.59 (.15)	.62 (.23)	.59 (.12)
Cued Recall	.61 (.18)	.61 (.15)	.60 (.16)	.60 (.16)
Experiment 3B				
Free Association	.53 (.18)	.53 (.18)	.57 (.18)	.58 (.20)
Cued Recall	.69 (.16)	.64 (.17)	.70 (.13)	.69 (.13)
Experiment 4				
Free Association	.52 (.18)	.50 (.19)	.46 (.14)	.50 (.19)
Cued Recall	.33 (.14)	.35 (.17)	.38 (.12)	.37 (.15)

Table 3

Rescaling the phonological similarity effect by the target effect as a function of type of test.

Experiment	Cued Recall	Free Association
1	.367	.219
2	.291	.220
3A	.418	.077
3B	.538	.143