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Item versus associative information: A comparison of forgetting rates with and without recollective experience

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ITEM VERSUS ASSOCIATIVE INFORMATION: A COMPARISON OF FORGETTING RATES WITH AND WITHOUT RECOLLECTIVE EXPERIENCE

By

Angela Consoli

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ABSTRACT

Past experiments examining the relationship between recognition memory and the recollective experience has consistently focused on single word stimuli. The present study was designed to assess the nature of this relationship with associative information in addition to item information. Two experiments are reported in which participants studied a list of random word pairs, and were subsequently given a recognition memory test for both item and associative information. Of those recognized events, participants were asked to indicate which words or word pairs they could and could not recollect from the study phase. Participants returned either 2 and 7 days later (Experiment 1) or 30 minutes and 1 day later (Experiment 2) to take a delayed memory test. The findings showed that across a 1-week delay, item and associative information did not differ with respect to forgetting rates. The two types of stimuli did differ with respect to recollective experience, with associative information eliciting a greater proportion of "remember" responses than did item information. These findings provide further evidence for the distinction between item and associative recognition memory, as well as extending previous research on recollective experience.

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Recognition memory has been the focal point of numerous studies in contemporary cognitive psychology. Recognition memory, the instance wherein an individual remembers having previously experienced an item or event, is believed to be associated with, or based on, two different types of memory. Essentially, recognition memory has been documented as either being accompanied by conscious awareness (conscious recollection) of specific aspects of a previously encountered event, or based solely upon feelings of familiarity or knowing for a previously encountered stimulus or event.

Mandler, Pearlstone, and Koopmans (1969) were the first to propose that the act of recognizing a previously seen stimulus or event may involve one of two processes. This view, known as Dual Process theory, postulates that an individual may recognize an event on the basis of familiarity for that event. In this instance, the recognition judgement is made in the absence of contextual information pertaining to the event. This familiarity process is believed to be fuelled by perceptual processing. Alternatively, Mandler et al. suggested that recognition could also be based on a second, slower process. In this instance, an individual uses a search and retrieval process in an attempt to retrieve stored contextual information about the event in question. This process requires conceptual processing. In Dual Process theory, it is assumed that these two types of processes are inherent within a single memory system, and work together to produce the recognition of a previously experienced event.

Tulving (1985) suggested that an individual may recognize a previously encountered stimulus because he/she can clearly and distinctly remember seeing the stimulus. He defined this type of recognition memory as that accompanied by conscious recollection. Tulving labelled this type of response a "remember" response, a decision made when an individual can consciously recollect the context in which the event was experienced (e.g., the stimulus from the previous study list). Alternatively, Tulving proposed that an individual's recognition of a previously encountered stimulus may be fuelled by a sense of familiarity or feeling of knowing for the stimulus. In this instance, there is no specific conscious recollection of having seen the stimulus previously. Tulving labelled this type of response a "know" response, a decision made when the individual cannot consciously recollect having seen the stimulus in question, but feels or senses that he/she may have encountered it before.

Unlike Mandler et al., Tulving believed that these two types of recognition memory reflect a distinction between two different memory systems; episodic and semantic memory. Essentially, Tulving maintained that recognition memory with recollective experience was a characteristic feature of one's episodic memory. Episodic memory is defined as one's autobiographical memory (i.e., one's memory for the past events of one's life). In contrast, recognition memory without recollective experience is believed to be characteristic of one's semantic memory (i.e., one's knowledge of the world).

This association of "remember" responses with episodic memory, and "know" responses with semantic memory is problematic for some. One may reason that a participant's assignment of a "know" response to a recognized item reflects the testing of that individual's episodic rather than semantic memory. Richardson-Klavehn, Gardiner, and Java (1996) suggest that although an individual may feel that a particular person, object, or place elicits feelings of familiarity, one may sometimes fail to recollect the instance wherein the person, object, or place was encountered in the past. In such an instance, Richardson-Klavehn and his colleagues suggest that this memory does indeed possess a sense of personal experience, but is not episodic because there is only that feeling of familiarity or knowing which signals a prior encounter.

In contrast to Tulving, experimenters such as Gardiner (1988) have argued that the two types of recognition memory mirror implicit and explicit memory. Implicit memory is presumed to involve the retrieval of stored information without any conscious awareness that the information is being retrieved from the prior study phase; however, explicit memory is believed to be accompanied by a conscious awareness of recollecting a prior event (Roediger, Weldon, & Challis, 1989). It is believed that recognition memory with recollective experience is a product of the explicit memory system, a system that makes use of conceptual processing. In contrast, recognition memory without recollective experience is believed to arise from the implicit memory system where processing is more perceptual or data-driven in nature.

Many may disagree with such an operationalization of "remember" and "know" responses, especially with the linking of "know" responses to implicit memory. One may reason that the instance wherein a participant assigns a "know" response to a recognized item is, in effect, an indication of an awareness of the item on some level. A more accurate qualification would be to consider both "remember" and "know" responses as two types of conscious awareness differing solely with respect to the presence or absence of recollective experience (Richardson-Klavehn et al., 1996).

The two bases of recognition memory have been examined in several studies in which participants study a list of verbal stimuli, and subsequently are given a recognition memory test. For each item recognized on the memory test, participants are requested to make a "remember" or a "know" judgement. A "remember" response is defined as a response made when one not only recognizes a given item from the study session, but can also clearly recollect the instance in which the item was studied. A "know" response is defined as a response made when one feels he/she encountered the stimulus in the previous study session, but cannot specifically recollect the instance wherein it was studied (Gardiner & Parkin, 1990). The differential effects of various independent variables on "remember" and "know" responses suggest the existence of two distinct types of recognition memory.

One such study was that of Gardiner (1988, Experiment 1) in which a level of processing manipulation was implemented in the "remember/know" paradigm. Some participants were instructed to provide a semantic associate for each word on a study list, while other participants were instructed to provide a phonemic associate for each word. Participants were subsequently given a recognition memory test, and were asked to make "remember" and "know" judgements for those items recognized from the study list. Gardiner obtained a level of processing effect for "remember" responses, where the proportion of "remember" responses was much greater for the semantic group than for the phonemic group. In contrast, the proportion of "know" responses yielded by the semantic and phonemic groups did not differ. This differential effect suggests a distinction between recognition memory accompanied by conscious recollection and recognition memory in the absence of conscious recollection.

Gardiner (1988, Experiment 2) found similar results with the use of a generate task. One group of participants was instructed to generate the target words whereas the other group of participants was asked to simply read the target words aloud. Performance on a recognition memory test indicated that the proportion of "remember" responses was greater for the "generate" condition than for the "read" condition. The "read" and "generate" conditions yielded comparable proportions of "know" responses, thus providing additional evidence for a functional distinction between the two bases of recognition memory.

Gardiner and Parkin (1990) attempted to provide further evidence for the distinction between recognition memory with and without conscious awareness. In their experiment, the attention of some participants was divided during study while others' attention during study remained uninterrupted. Gardiner and Parkin expected that participants in the divided attention condition would have less time, or fewer resources, to devote to conscious processing of the study items. As a result, Gardiner and Parkin expected that the information in the divided attention condition would not be consciously or explicitly encoded as well, or as deeply, as in the full attention condition. Consequently, they hypothesized that the divided attention condition would yield a much smaller proportion of "remember" responses compared to the full attention condition, whereas recognition performance measured by "know" responses would remain relatively unaffected by the attention manipulation. The results indicated that participants in the divided attention condition showed a significant decrease in the number of correct "remember" responses, whereas the number of correct "know" responses was unaffected. Gardiner and Parkin concluded that these results provided further evidence for the distinction between the two bases of recognition memory, one requiring conscious awareness and influenced by the amount of conscious processing resources available at encoding, the other without conscious awareness and less dependent on such resources.

Gardiner and Java (1990, Experiment 1) attempted to provide additional evidence for the existence of two bases of recognition judgements. In this study, natural language word frequency was examined as a possible factor that might differentiate between the two bases for recognition. A previous study by Jacoby and Dallas (1981) showed that low-frequency words produce greater priming effects in a perceptual identification task. Gardiner and Java reasoned that if low-frequency words produce greater perceptual fluency, then low-frequency words should elicit a greater proportion of "know" responses than "remember" responses. The results provided evidence to the contrary. The proportion of "know" responses generated for low and high-frequency words did not differ. Instead, the word-frequency effect manifested itself in the proportion of "remember" responses, where a greater proportion of "remember" responses were made for low-frequency words than for high-frequency words. Gardiner and Java interpreted these findings as evidence that perceptual fluency does not lead to superior recognition of low-frequency words. Instead, it appears that low-frequency words elicit the recollective experience more so than do high-frequency words.

Gardiner and Java (1991) examined the rate of forgetting for recognition memory with and without conscious awareness. Participants studied a list of words, and were tested either 10 minutes, 1 hour, 1 day, or 1 week later. The proportion of correct "remember" responses was similar for the 10 minutes and 1 hour retention interval conditions. This proportion markedly decreased over the 1 day and 1 week conditions. The proportion of correct "know" responses, however, remained relatively constant over retention interval.

These findings further distinguish between the two types of recognition memory and indicate that recognition memory with conscious recollection decreases over a 1 week period whereas recognition memory without recollection undergoes very little forgetting over the same time frame.

In Experiment 2, Gardiner and Java examined a greater range of retention intervals. In this instance, participants were given a memory test either 1 week, 4 weeks, or 6 months after the study session. Results indicated that the two types of recognition memory yielded comparable, gradual forgetting rates over these extended retention intervals. As a result of these findings, Gardiner and Java concluded that recognition with and without recollective experience exhibits the greatest difference in forgetting within the first 24 hours, with recognition with recollective experience having the greater forgetting rate. Once this initial 24 hour period has passed, the two types of recognition memory slowly deteriorate at comparable rates, and both persist for at least 6 months.

These studies have collectively provided evidence for the existence of two bases for recognition memory. They demonstrate that a variety of factors influence recognition memory with recollection, but do not affect recognition memory without recollection. In addition, these studies consistently yielded proportions of "know" responses that were smaller than the proportions of "remember" responses. Thus, it is also possible that the differences in the proportions of "remember" and "know" responses may simply be due to differences in memory strength where "remember" responses reflect stronger memory traces and "know" responses are indicative of weaker memory traces. In an attempt to refute this explanation, some researchers sought to find a variable that would influence the proportion of "know" responses while leaving the proportion of "remember" responses relatively unaffected.

Rajaram (Experiment 3, 1993) examined how perceptual fluency in the processing of items is manifested in the proportion of "remember" and "know" responses on a recognition memory test. Perceptual fluency, or perceptual learning, is the result of a previous encounter with experimental stimuli. This prior encounter subsequently results in superior perceptual recognition performance for previously encountered items (Jacoby & Dallas, 1981). In this study, Rajaram implemented a masked repetition manipulation into the "remember/know" paradigm. Participants were required to study a list of words. At test, the studied words appeared either in a masked repetition condition or in an unrelated prime condition. A mask of ampersands appeared, and was followed briefly by a prime word (either the target item or an unrelated word) presented in lowercase letters. This presentation was followed by the unmasked presentation of the test probe in uppercase letters (either a previously studied word or an unstudied word). Rajaram argued that when the prime word was identical to the test probe (masked repetition condition), perceptual fluency would be enhanced, and subsequent recognition would be greater than when the prime word was not the same as the test probe (unrelated prime condition). As a result, it was hypothesized that the proportion of "remember" responses, which are assumed to be uninfluenced by perceptual processing, would remain relatively unchanged with this manipulation. The proportion of "know" responses, which are believed to be the result of perceptual processing, would change with the perceptual fluency manipulation.

The results indicated that for both target and lure items, a greater proportion of "know" responses were generated for items in the masked repetition condition than for items in the unrelated prime condition. The proportion of "remember" responses for both target and lure items remained unaffected by the masked repetition manipulation.

Gardiner and Java (1990, Experiment 2) compared word and nonword recognition. They predicted that nonwords would elicit a greater proportion of "know" responses than would words. This prediction was based on previous findings that there is enhanced perceptual fluency in nonword recognition (Johnston, Dark, & Jacoby, 1985). As a result, Gardiner and Java hypothesized that this enhanced perceptual fluency should produce a greater proportion of "know" responses in nonword recognition than in word recognition. Results indicated that nonwords did indeed show a greater number of "know" responses than "remember" responses whereas words elicited a greater number of "remember" responses than "know" responses. These results refute the notion that "remember" and "know" judgements are simply indicative of memory trace strength. Rather, they support the view that these responses are based on different components of recognition memory.

The findings obtained in these two studies are important because they provide additional instances of a clear distinction between recognition memory with recollective experience, and recognition memory without recollective experience. In addition, these findings are also of key importance because they demonstrate variables that solely affect "know" responses, but do not affect "remember" responses.

Despite the findings obtained with Gardiner and Java's word/nonword manipulation, it may be argued that the memorial trace strength of nonword stimuli are generally weaker than the memory strength for words. Essentially, if nonword stimuli are associated with weaker memory traces, and nonword stimuli are found to elicit a greater proportion of "know" responses than "remember" responses, than one can still argue that "know" judgements are due to weaker memory traces than "remember" judgements. As a result, the "remember/know" distinction may indeed reflect varying memory trace strengths.

The results of a subsequent study by Gardiner and Java (1990, Experiment 3) provide evidence which challenges this argument. In this study, Gardiner and Java addressed the issue of the relationship between "remember/know" responses and confidence levels at the time of responding. Instead of giving "remember" and "know" responses, participants were asked to give a confidence rating for those items recognized from the study list using a 2-point scale with "sure" and "unsure" as the two possible responses. Tulving's study (1985, Experiment 2) served as the basis for this experiment. Tulving examined the confidence with which participants made "remember" and "know" responses at test. Tulving asked participants to study a list of words, and subsequently take a recognition memory test and make "remember" and "know" responses for items recognized from the study session. Participants were also asked to return seven days later to take a second recognition memory test identical in task and format. In addition, Tulving also asked participants to make confidence judgements. The results indicated greater confidence for those recognized items given "remember" responses compared to those given "know" responses. As a result, Tulving concluded that one's confidence level in responding and "remember" responses were positively correlated. This result raises the question of whether "remember/know" decisions are essentially equivalent to "sure/unsure" confidence judgements.

In their study, Gardiner and Java (1990) examined whether a greater proportion of "unsure" ratings would be obtained with nonwords than with words. The findings suggested that "unsure" judgements were not equivalent to judgements made in the absence of recollection. It was noted that nonwords (which yielded a greater proportion of "know" responses) did not yield a greater proportion of "unsure" confidence ratings. As a result, Gardiner and Java concluded that although one's confidence ratings may be somewhat correlated with the presence of conscious recollection, the two are not necessarily equivalent to each other. They reasoned that, in certain instances, one may be very confident in recognizing an item from a study list; however, one may not be successful in recollecting the instance wherein the item was encountered. Gardiner and Java suspected that this was the case with their confidence data pertaining to the nonword stimuli. In contrast, they reasoned that the word stimuli led to the encoding of more contextual information which subsequently allowed participants to recollect the actual instance wherein they encountered the stimulus.

Based on Tulving's (1985) findings, Gardiner and Java

(1990) state that "as a general rule, stronger memories will be positively correlated with sharper recollective experiences and higher levels of confidence" (p.28). As a result, if the memorial representation of nonword stimuli is weaker than that of word stimuli, and "know" responses (absence of recollection) are indicative of weaker memory traces than "remember" responses, then these weaker memory traces should have led to lower confidence levels, and ultimately, to a greater proportion of "unsure" responses for the nonword stimuli in Gardiner and Java's study. Instead, nonword recognition was associated with a greater proportion of "sure" responses. These findings provide further evidence that the "remember/know" distinction is not due to varying degrees of memorial strength, but instead to the existence of two bases of recognition memory.

Rajaram (1993, Experiment 4) also examined the relationship between "remember/know" responses and confidence judgements. In a replication of her masked repetition study, Rajaram also asked participants to make "sure" and "not sure" responses instead of "remember" and "know" responses. The purpose of this study was to determine if the masked repetition effect would be manifested solely in the proportion of "not sure" responses, or in the proportions of both "sure" and "not sure" responses. Rajaram hypothesized that if the "not sure" proportion of responses alone exhibits an increase, one can conclude that the "know" judgements reflect responses that are accompanied by low confidence in participant responding. In contrast, if an increase in the proportions of both "sure" and "not sure" responses occurs, then the proportion of "know" responses cannot be interpreted as such. The results indicated that both targets and lures in the masked repetition condition received more "sure" and "not sure" responses than did those targets and lures in an unrelated prime condition. Since the proportions of both types of responses were enhanced, Rajaram concluded that one's confidence level does not serve as the underlying basis for making "remember" and "know" judgements. These findings, together with those of Gardiner and Java's (1990), indicate that "remember" and "know" judgements are not equivalent to "sure" and "unsure" confidence judgements.

The literature reviewed thus far provides a clear distinction between two functionally different bases for recognition memory. Variables such as levels of processing, word generation, and degree of attention affect the proportion of "remember" responses, but have little effect on the proportion of "know" judgements. Such a pattern of responding is believed to reflect recognition memory with recollective experience, recognition that is supported by conceptually-driven processing. On the other hand, manipulations such as masked repetition affect the proportion of "know" responses, but not "remember" responses. This pattern of responding reflects perceptually-driven processing which is assumed to underlie recognition memory without recollective experience. These findings have been interpreted as evidence for two separate memory systems: episodic memory and semantic memory (Tulving, 1985). The differing proportions of "remember" and "know" judgements have also been related to the distinction between conceptually-driven processing and data-driven processing (Gardiner, 1988). Parallels between the two types of judgements and the distinction between explicit and implicit memory have also been drawn (Gardiner, 1988). Recent research, however, suggests that this comparison of the "remember/know" distinction to the explicit/implicit distinction is not as clear and distinct as previously believed.

The linking of "remember" responses with explicit memory, and "know" responses with implicit memory may be a point of contention for those who propose that "know" responses may not be "unconscious". Some may argue that performance on tests supposedly testing implicit memory (such as word stem completion) reflects automatic, unconscious processing to a large extent. However, it is suggested that a "know" response (believed to reflect instances wherein one cannot consciously recollect the study context of an experiment) is made on the basis of awareness that the item in question actually appeared during the study phase.

This issue was addressed by Richardson-Klavehn, Gardiner, and Java (1994) in a study in which they implemented a variation of the "method of opposition" procedure (cf. Jacoby, Woloshyn, & Kelley, 1989). In this study, Richardson-Klavehn et al. gave participants a list of verbal stimuli. For each study item, participants were asked to either generate a related word (associate condition) or asked to count the number of letters containing enclosed spaces (enclosure condition). Participants were also placed into one of three test conditions. The direct test condition involved instructing participants to use the word stems occurring on the subsequent memory test as retrieval cues for previously studied items. The indirect test condition required participants to use the first word that came to mind to complete each word stem on the test. The third condition was the opposition test condition in which participants were instructed to complete each word stem on the test with the first word that came to mind; however, in the event that this word was recognized as having appeared on the study list, participants were instructed to try and complete the word stem with an alternate word.

It was predicted that participants in the opposition test condition would complete the word stems with previously studied words only when they had no conscious memory of the item. Alternatively, if the first word which came to mind was consciously recognized from the study phase, it would not be used to complete the word stem. In terms of the encoding manipulation, it was hypothesized that those items provided with a semantic associate would lead to more instances of conscious recollection than would those items for which an enclosure response was generated. In turn, more enclosure items were expected to be used by opposition participants to complete the word stems. This line of reasoning stems from previous research suggesting that providing a semantic associate for study items leads to greater recollection for those items than does performing a graphemic task (Gardiner, 1988) as in the enclosure condition.

Results showed that a greater proportion of word stems were completed for associate targets in the indirect testing condition compared to the opposition condition. The same pattern of performance was obtained for enclosure targets, but not as large of a difference was found. The fact that the indirect condition yielded a much greater proportion of completed word stems for associate targets than did the opposition condition suggests that where the indirect condition involved automatic or involuntary processing, it may have also involved conscious awareness of the previous study event. In fact, post-experiment interviews were performed, and all participants in the indirect condition indicated that they were aware that some of the word stems on the test could be completed with some of the items encountered during the study phase. These participants indicated that despite their test awareness, they completed the test items with the first word that came to mind.

The very small proportion of word stems completed with associate targets in the opposition group suggests that these participants used automatic processing that was truly unaccompanied by conscious awareness. This was also noted on a subsequent recognition test of their completed word stems where these participants failed to recognize any of the word stems completed with previously studied items. Participants in the indirect condition, however, exhibited very accurate recognition of stems that had been completed with associate targets presented during the study phase.

These findings collectively suggest that performance on tests supposedly measuring implicit memory is in fact accompanied by conscious awareness of the study event. As a result, findings such as these should caution the association of implicit memory with unconscious memory, and ultimately, with the proportion of "know" responses generated on a recognition memory test.

The findings of the studies presented thus far and their subsequent interpretations have served as a springboard for other studies on recollective experience. The issues raised in these studies have attempted to provide explanations for the existence of two bases of recognition memory. Although these studies are of importance for the distinction between recognition memory with and without recollective experience, some of the interpretations raised are beyond the scope of the present research, and thus, will not be used to interpret the obtained findings.

Although these studies have focused upon different independent variables and their effects upon recognition memory performance, they have consistently utilized a similar experimental paradigm. One of the common filaments of this collection of experiments is the type of stimulus used. In the majority of cases, participants were instructed to study a list of verbal stimuli consisting solely of single words (item information). No attention has been given to word pairs (associative information) in studies of recognition memory and conscious recollection.

Item information represents the occurrence of a single event whereas associative information represents a relationship between two or more single events (Murdock, 1974). Recognition memory for both item and associative information can be examined. For example, Hockley (1991, 1992) used a procedure in which participants were presented with pairs of words, and were subsequently tested for their recognition memory for both single words and word pairs. When presented with an item information test probe, participants must determine whether the test probe is a new item or a previously studied item. When presented with an associative information test probe, participants must indicate whether the word pair was previously studied (i.e., the two words appeared together on the previous study list) or whether the word pair is a new or rearranged word pair (i.e., two words that did not appear together as a word pair on the previous study list, but were presented in the study list as members of other word pairs). This procedure is considered to be a relatively pure test of associative recognition memory because participants can only use their memory for the studied word pair to aid them in distinguishing between old and new word pairs.

As previously stated, all research pertaining to the recollective experience has used item information as the experimental stimuli. The findings of these studies have consistently provided evidence for the existence of two bases of recognition. No study, however, has determined if the same two bases for recognition underlie associative recognition decisions. The use of the "remember/know" paradigm could provide an extension of research done in the domain of recollective experience as well as that of item/associative information.

The "remember/know" paradigm could also extend previous research on the forgetting rates of item and associative information. Hockley (1991, 1992) consistently found that the two types of information differed with respect to forgetting rates. For example, Hockley (1992, Experiment 4) used a study - test paradigm in which participants studied lists of word pairs, and were then immediately given a recognition memory test. After ten study - test lists, participants were given a final recognition memory test at the end of the session. Hockley found that the proportion of correct responses for item and associative information did not differ on the immediate tests. In contrast, the proportion of correct responses for item and associative information as a function of study list on the final test did indeed differ, with greater forgetting for item information compared to associative information. Associative information yielded recognition performance that remained relatively constant over study lists.

Consoli (1995) examined the forgetting rates of both item and associative information by measuring the proportion of "remember" and "know" responses made 1 day and 1 week following the study session in a between groups comparison. It was hypothesized that the forgetting rates of both "remember" and "know" responses would be slower for associative information than for item information based on the assumption that associative information is a more distinct and durable memorial representation than is item information.

Hunt and Einstein (1981) proposed that the processing of single item stimuli involves encoding information specific to that stimulus. This type of encoding allows for the use of discriminative processes at test. Alternatively, it is maintained that the processing of word pairs (relational learning) emphasizes the encoding of similarities or shared information between the two members of the word pair. This association between two members of a word pair subsequently gives way to enhanced retrieval processing at test.

This difference in encoding processes between item and associative information is believed to be an underlying cause of observed memory performance in many studies. For example, Marschark and Hunt (1989) found a concrete word advantage over abstract words with relational learning. This advantage was not noted when each word pair member was learned separately. Given these findings, is was assumed that associative information is more elaborately processed and encoded than item information, and therefore, would be more readily recollected.

It was also predicted that associative information would yield a greater proportion of "remember" responses than would item information, and that item information would yield a greater proportion of "know" responses than would associative information.

In Consoli's (1995) study, the performance of the 1 day and 1 week groups could not be directly compared because their initial levels of recognition performance on the immediate recognition test were significantly different. As a result, statistical analyses were restricted to a within-subjects analysis of performance. It was found that item and associative information yielded comparable proportions of "remember" and "know" responses in both the 1 day and 1 week delay conditions. In terms of recognition performance accuracy, mean d' values for item and associative information did not differ on the immediate or delayed test for either condition. The two types of information yielded comparable forgetting rates in both the 1 day and 1 week delay conditions.

The Present Research. The present study will also focus upon the forgetting rates of both item and associative information as measured by the proportion of "remember" and "know" responses. In this study, however, two major alterations will be made to the experimental paradigm of Consoli (1995). First, retention interval will be manipulated within-subjects in order to obtain a more direct and sensitive measure of forgetting rates. Second, a practice trial will also be included in the initial session in order to help participants become accustomed to the study and test tasks (i.e., forming associations and making "remember" and "know" responses). Response latency data will also be collected in an attempt to replicate past findings obtained by Dewhurst and Conway (1994).

In a series of studies, Dewhurst and Conway found that correct "remember" responses were made more quickly than correct "know" responses. In interpreting these findings, they suggested that, during the process of remembering, various contextual attributes pertaining to the event in question trigger the recollective experience, and a "remember" judgement is subsequently quickly made. In the event that the recollective experience is not activated first, recognition may be accomplished on the basis of familiarity. Thus, only when the attribution of a "remember" judgement cannot be made does a response based on familiarity occur. As a result, Dewhurst and Conway suggested that the extra time taken to switch to and assess familiarity accounts for the slower response times for "know" judgements. If Dewhurst and Conway's findings are replicated in the present study, it would provide additional support for the distinction between recognition memory with recollective experience, and recognition memory without recollective experience.

Consoli (1995) found that the forgetting rates of item and associative information were comparable in the 1 day and 1 week delay conditions. This finding is not consistent with previous studies that have provided evidence for different forgetting rates for item and associative information (Hockley 1991, 1992). In keeping with previous research, it is hypothesized that the forgetting rate of associative information will be much slower than that of item information (as indexed by the proportion of "remember" responses as retention interval increases). Alternatively, the proportion of "know" responses for both item and associative information is expected to remain relatively unchanged across delays based on the findings of Gardiner and Java (1991). If the forgetting rates obtained in this study mirror those obtained by Consoli, it is possible that longer retention intervals yield more comparable forgetting rates for item and associative information, whereas shorter retention intervals yield different rates of forgetting for item and associative information.

It is also predicted that associative information will yield a greater proportion of "remember" responses than will item information, and that item information will yield a greater proportion of "know" responses than will associative information. Since associative information may involve deeper or more elaborate processing than does item information, a greater proportion of "remember" responses for associative information will provide additional evidence for past findings which suggest that "remember" responses occur due to conceptual processing, while "know" responses are more indicative of data-driven processing (Gardiner, 1988). Consoli, however, obtained results indicating that the proportions of "remember" and "know" judgements were very similar. If Consoli's findings are replicated in the present study, this would imply that the two types of information may be processed in a similar fashion and have common bases of recognition.

Finally, it is hypothesized that the response time required for "remember" and "know" judgements will differ, with shorter response latencies occurring for "remember" responses than for "know" responses (as found by Dewhurst & Conway, 1994).

Two experiments are reported. In Experiment 1, recognition memory for single words and word pairs was tested on an immediate, 2-day, and 7-day delayed memory test. In Experiment 2, recognition memory was tested on an immediate, 30-minute, and 24-hour delayed memory test.

Experiment 1

Method

Participants. The participants were 50 undergraduate students at Wilfrid Laurier University who were either paid for their participation or received bonus credit. All participants were asked to return on a series of days, and were tested individually.

Apparatus and Stimuli. IBM-compatible personal computers were used to control the generation and display of study lists, and the recording of responses in both

Experiments 1 and 2. The keyboards were fitted with opaque plastic covers which exposed only the three keys used for responding.

The stimuli consisted of a pool of 480 concrete nouns derived from Paivio, Yuille, and Madigan (1968). On a scale from 1 to 7 measuring concreteness and imagery values, all 480 words used in this experiment possessed concreteness and imagery values greater than 5.0. The natural language word frequency of these nouns varied from 1 to AA (AA indicates a frequency of greater than 50 counts per million).

Design and Procedure. The experimental design consisted of a 2 x 3 within-subject factorial design, where type of information (item and associative) and retention interval (immediate, 2 days, and 7 days) were the independent variables. The experiment involved three separate sessions. The first session consisted of a practice phase and the initial experimental phase. The practice phase was implemented to allow participants to become accustomed to making "remember" and "know" responses while the second part of the session served as a study phase and an immediate test phase. The second and third sessions served as delayed and final test sessions.

In the practice phase in the first session, the study list consisted of 24 random word pairs plus 3 primacy buffer pairs and 3 recency buffer pairs for a total of 30 word pairs. Participants initiated the presentation of the study list. Each study pair appeared on one line in the centre of the computer screen for a total of 4.5 s. A blank interval of 0.5 s separated each word pair presentation. Participants were instructed to try and remember as many of the study pairs as possible, and that they would be given a memory test immediately after all word pairs were presented. Specifically, participants were instructed to create a visual image or generate a sentence involving both words of the word pair in order to aid in subsequent memory of the pair.

Once the entire list of word pairs was presented, all participants were given a practice immediate memory test. This test consisted of a total of 24 test probes with 12 item recognition test probes (6 old items and 6 new items) and 12 associative recognition test probes (6 old pairs and 6 new pairs). An old item was a single word that appeared in the previous study list, whereas a new item was a single word that did not appear anywhere in the previous study list. An old pair was a word pair that appeared in the study list. A new pair was a pair of old words that did not appear together in the study list (i.e., two words that appeared in the study list, but had not been paired together).

Old items were randomly selected from both left and right members of word pairs presented in the study list. New word pairs were randomly created by combining the left member of one pair with the right member of another pair. This method of creating new word pairs was used in order to maintain the study position of the words in each test pair. The order of test probes was completely random, and each participant received a different random sequence. The immediate test was participant-paced. Each test probe appeared on one line in the middle of the computer screen and remained until a response was made. Participants were asked to enter their responses as quickly and as accurately as possible, but that response accuracy was more important than speed. The subsequent test probe appeared 1 s after a response was entered.

The experimental instructions were based on those of Gardiner and Parkin (1990), and were given to the participants once the practice study list had been presented (i.e., just prior to the practice recognition memory test). Essentially, for each single word and word pair that appeared on the screen, participants were asked to indicate whether or not they recognized the test probe from the previous study list. If the participant believed that the single word or word pair did not appear on the study list, he/she was instructed to press the "T" key ("new" response). If a single word or word pair was recognized from the study list, the participant was asked to make one of two judgements. If the word or word pair could be clearly and distinctly recollected from the study list, the participant was instructed to press the "U" key ("remember" response). If the single word or word pair could not be clearly recollected, but instead, seemed familiar, the participant was instructed to press the "O" key ("know" response). These instructions were given to participants to read (see Appendix A). After participants read the instructions, the experimenter paraphrased the instructions to the participants and provided clarification. Examples of old and new single words and word pairs, and examples clarifying the distinction between "remember" and "know" responses were also provided.

Once participants completed the practice recognition memory test, they were asked to provide the experimenter with an example of a "remember" and a "know" response he/she made during the test portion of the practice session, and why he/she made such responses. This provided the experimenter with an opportunity to clarify any misunderstandings that arose concerning the instructions.

Once participants understood all instructions, they were asked to begin the study phase of the session. The study and test phases were identical in format to those of the practice portion of this session; however, the study list word pairs, and the item and associative test probes on the immediate test were not previously seen in the practice session. In addition, the actual study list consisted of 120 word pairs plus 3 primacy buffer pairs and 3 recency buffer pairs for a total of 126 random word pairs. Each participant received a different random sequence of word pairs.

Once all word pairs were presented, participants began the immediate test phase of the session. Participants were given a recognition memory test consisting of 40 test probes with 20 item recognition test probes (10 old items and 10 new items) and 20 associative recognition test probes (10 old pairs and 10 new pairs). Response latency was measured from the time the test probe appeared until a response was entered. The study list was divided into 5 blocks consisting of 24 word pairs each. For the immediate test and both delayed memory tests, 2 old items, 2 old pairs, and 2 new (rearranged) pairs were randomly selected from each block to ensure that list position was not confounded with tests. All test probes were selected in the same fashion for the immediate test and both delayed memory tests, and different test probes were presented on each test. Upon completion of the immediate recognition test, participants were thanked for their participation and were reminded of their next session. A second session was arranged for a time of mutual convenience 2 days later. Most often, this second session was arranged at the same time of day as that of the first session.

Upon arrival at the second session, participants were given the identical instructions and examples as given in the previous session. Once participants understood all instructions, they were asked to begin the delayed recognition test. As with the immediate test, the delayed test was also participant-paced and initiated by the participant. The delayed test was identical in format and presentation to the immediate memory test (40 old and new single words and word pairs). Participants were then asked to return for another delayed test session 5 days later (i.e., 7 days after the initial study session). This third and final session was identical in format to the second session. Upon completion of all three sessions, participants were thanked for their participation and debriefed.

Results and Discussion

Three participants were excluded from the data analysis because they failed to participate in the third session of the experiment. A 0.05 level of significance was adopted for all statistical analyses.

Recognition Accuracy. Mean d′ values were calculated to determine overall recognition accuracy for both item and associative recognition performance on the immediate, 2-day delayed, and 7-day delayed memory tests (day 0, 2, and 7, respectively). These values are presented in Figure 1. This figure shows that recognition performance greatly decreases from the immediate memory test to the 2-day delayed test, and then subsequently decreases at a slower rate from the 2-day delayed memory test to the 7-day delayed memory test. An analysis of variance (ANOVA) revealed that the main effect due to retention interval was highly significant, F (2, 92) = 60.22, MSe = 1.09. The main effect due to type of information (item versus associative) was not significant, F (1, 46) = 2.47, MSe = 0.89. The interaction between retention interval and type of information, F (2, 92) < 1, did not approach significance. Thus, these findings indicate that overall recognition performance and the decline in recognition accuracy for both item and associative information did not differ. This is evident in the comparable decline of item and associative recognition performance across each retention interval. This finding fails to replicate those of Hockley (1991, 1992) where item and associative information differed in terms of rate of forgetting, but replicates those of Consoli (1995).

Insert Figure 1 about here

Remember Versus Know Responses. Hits and false alarms for the proportions of "remember" and "know" responses were analyzed separately using a 2 X 3 (information type X retention interval) repeated measures analysis of variance. The mean proportions of responses are presented in Figure 2. For hits assigned a "remember" response, the main effect of information type was reliable, $\underline{F}$ (1, 46) = 12.24, $\underline{MSe}$ = 0.05. The main effect of retention interval was highly significant, $\underline{F}$ (2, 92) = 134.96, $\underline{MSe}$ = 0.03. The information type X retention interval interaction for "remember" responses assigned to target items was also significant, $\underline{F}$ (2, 92) = 4.39, $\underline{MSe}$ = 0.02.

Insert Figure 2 about here

To explore the source of this interaction, the proportion of "remember" responses assigned to recognized test probes was compared for single word and word pair stimuli using separate paired comparison t-tests. These tests indicated that a significantly greater proportion of hits were assigned a "remember" response for word pairs (0.66) than for single words (0.53)[t(46) = 2.95, SE = 0.05] on the immediate test. Performance on the 2-day delayed memory test exhibited the same pattern of performance, with a significantly greater proportion of hits assigned a "remember" response for word pairs (0.34) than for single words (0.22)[t(46) = 4.16, SE = 0.03]. The 7-day test, however, failed to yield a significant difference in hits assigned a "remember" response (0.22 and 0.21 for word pairs and single words, respectively)[t(46) = 0.38, SE = 0.03].

As can be seen in Figure 2, a significantly greater proportion of "remember" responses was generated for associative than for item information test probes on both the immediate and the 2-day test. However, on the 7-day delayed test, comparable proportions of "remember" responses were made for item and associative test probes. The observed decrease in the proportion of "remember" responses within the initial 2 days of the retention interval mirrors findings obtained by Gardiner and Java (1991).

The mean proportions of "know" responses generated on each memory test are also presented in Figure 2. For recognized test probes assigned a "know" response, the main effect of information type was significant, $\underline{F}$ (1, 46) = 4.67, $\underline{MSe}$ = 0.05. The main effect of retention interval was also reliable, $\underline{F}$ (2, 92) = 15.35, $\underline{MSe}$ = 0.02. The information type X retention interval interaction for "know" responses assigned to target items was not significant, $\underline{F}$ (2, 92) < 1. Thus, the proportion of "know" responses generated for item test probes was consistently greater than the proportion of "know" responses for associative test probes. Proportions for both types of information increased and subsequently remained relatively constant across longer retention intervals. The constant proportion of "know" responses generated from the 2-day test to the 7-day test replicate findings obtained by Gardiner and Java (1991).

Remember Versus Know Responses to Lures. The mean proportions of "remember" and "know" false alarms for item and associative recognition are presented in Figure 3. For lure probes assigned a "remember" response, the main effect of information type was found to be significant, $\underline{F}$ (1, 46) = 4.29, $\underline{MSe}$ = 0.09. The main effect of retention interval was also reliable, $\underline{F}$ (2, 92) = 5.79, $\underline{MSe}$ = 0.05. The information type X retention interval interaction was not significant, $\underline{F}$ (2, 92) = 1.63, $\underline{MSe}$ = 0.01. Thus, item information lure probes yielded a greater proportion of incorrect "remember" responses than did associative lure probes. These proportions increased over retention interval.

Insert Figure 3 about here

For lure probes assigned a "know" response, the main effect of information type failed to reach significance, F (1, 46) = 0.81, MSe = 0.04. The main effect due to retention interval was reliable, F (2, 92) = 9.03, MSe = 0.25. The information type X retention interval interaction was also significant, F (2, 92) = 4.44, MSe = 0.08. Thus, as retention interval elapsed, the proportions of incorrect "know" responses increased. This increase was greater for item recognition than for associative recognition.

Response Latency. Response times longer than 30 seconds were not collected. Due to a computer program error, response latency data were only correctly collected on the immediate memory test. No statistical analyses were conducted on these data because there were no observations in some of the conditions for some participants. The mean response times for correct "remember" and "know" responses for item and associative targets are presented in Figure 4. On average, "remember" responses were made more rapidly than were "know" responses for both single word and word pair stimuli.[1] This difference in response latency between "remember" and "know" responses replicates results obtained by Dewhurst and Conway (1994).

Insert Figure 4 about here

As shown in Figure 1, the findings of Experiment 1 suggest that item and associative information did not significantly differ in terms of overall recognition performance or rate of forgetting. The two types of stimuli, however, did reliably differ with respect to recollective memory. Associative recognition yielded a greater proportion of "remember" responses compared to item recognition on both the immediate and 2-day tests. This difference dissipated by the 7-day test where item and associative information elicited comparable proportions of "remember" responses.

Item information test probes generated greater proportions of "know" responses than did associative information. The proportion of "know" responses for both item and associative information increased from the immediate to the 2-day test, but remained largely unchanged from the 2-day test to the 7-day test. Although Gardiner and Java (1991) did not observe an increase in the proportion of "know" responses, they did find that this proportion was relatively constant over retention periods of 10 minutes, 1 hour, 1 day, and 1 week. In terms of response latencies, "remember" responses consistently elicited faster response times than did "know" responses (as found by Dewhurst & Conway, 1994).

The patterns of forgetting obtained in Experiment 1 clearly indicate a significant decrease in the proportion of "remember" responses generated from the immediate memory test to the 2-day test. Both item and associative information yielded a marked decrease in memory performance within this 48 hour time interval. In addition, associative information yielded a greater proportion of "remember" responses than did item information. The purpose of Experiment 2 was to replicate these findings. In addition, Experiment 2 was designed to obtain a clearer pattern of item and associative recognition memory performance with and without recollective experience within this initial 2-day time frame where the majority of forgetting appeared to be occurring. Specifically, Experiment 2 was designed to reconcile the findings of the present study with those of Hockley (1991, 1992) where item and associative information were found to reliably differ in terms of rate of forgetting. As a result, shorter retention intervals were implemented in Experiment 2. The use of shorter retention intervals than those used in Experiment 1 may indicate the instance wherein item and associative information actually begin to elicit differences in forgetting rates. Participants in Experiment 2 were tested on an immediate test, a 30-minute delayed test, and a 1-day delayed test.

Experiment 2

Method

Participants. The participants were 51 undergraduate students at Wilfrid Laurier University who were either paid for their participation or received course bonus credit. All participants were asked to return the following day after the initial session and were tested individually.

Materials. The stimuli used were identical to those used in Experiment 1. In addition, a face recognition task was also implemented to serve as a distracter during a one half hour retention interval. This task is described in Appendix B.

Design and Procedure. The procedure was identical to that of Experiment 1 with the exception of the retention interval manipulation and the inclusion of the face recognition distracter task. The experimental design consisted of a 2 x 3 factorial design, where type of information (item and associative) and retention interval (immediate, 30-minutes, and 1 day) were the independent variables. The present experiment consisted of two separate sessions. The first session consisted of the practice phase, the first two experimental sessions (immediate and 30-minutes retention interval), and the face recognition distracter task. The second session occurred on the subsequent day, and served as a final delayed test session.

The face recognition distracter task was implemented between the immediate memory test and the 30-minute delayed memory test of the actual experiment in order to provide participants with a distracter task while the one half hour retention interval elapsed (see Appendix B). Upon completing the distracter task, the participants were asked to take a delayed memory test for the word pair list they learned one half hour earlier. This delayed memory test was also identical in format and procedure to the delayed memory tests of Experiment 1 (i.e., 40 old and new single words and word pairs). Participants were then asked to return for another session the subsequent day. As in Experiment 1, this final session was identical in format to the previous delayed test session. Upon completion of both sessions, participants were thanked for their participation and debriefed.

Results and Discussion

Five participants were omitted from the statistical analyses due to very poor recognition performance on the immediate memory test. These participants were excluded from the statistical analyses because their average overall recognition of item and associative information was below 0.5 (i.e., below chance performance).[2] As in Experiment 1, a 0.05 level of significance was adopted for all statistical analyses.

Recognition Accuracy. Mean d′ values for both item and associative recognition performance on the immediate, 30-minute delayed, and 1-day delayed memory tests are presented in Figure 5. This figure shows that recognition accuracy decreased slightly from the immediate test to the 30-minute delayed test, and then dramatically decreased from the 30-minute test to the 1-day delayed test. An ANOVA revealed that the main effects of information type, F (1, 45) = 8.98, MSe = 1.34, and retention interval, F (2, 90) = 57.28, MSe = 0.79, were highly significant. As in Experiment 1, the information type X retention interval interaction did not approach significance, F (2, 90) < 1.

Insert Figure 5 about here

Remember Versus Know Responses. As in Experiment 1, separate 2 X 3 (information type X retention interval) repeated measures ANOVAs were performed on the proportions of "remember" and "know" responses generated for hits. These values are presented in Figure 6. For recognized target test probes assigned a "remember" judgement, the main effect of information type was found to be significant, F (1, 45) = 24.70, MSe = 0.07. The main effect of retention interval was also reliable, F (2, 90) = 72.92, MSe = 0.03. The information type X retention interval interaction was not significant, F (2, 90) = 2.63, MSe = 0.02. As can be seen in Figure 6, associative information yields a significantly greater proportion of "remember" responses than does item information. This difference in performance can be noted on all three memory tests. The decrease in the proportion of "remember" responses once again replicates the findings obtained by Gardiner and Java (1991).

Insert Figure 6 about here

For those recognized target test probes assigned a "know" judgement, the main effect of information type was significant, F (1, 45) = 10.12, MSe = 0.04. The main effect of retention interval was also reliable, F (2, 90) = 10.26, MSe = 0.02. The information type X retention interval interaction was not significant, F (2, 90) = 1.51, MSe = 0.02. Thus, the proportion of "know" responses to recognized item targets was consistently greater than that yielded by associative targets. These proportions slowly increased with retention interval. This small increase in the proportion of "know" responses was not observed in Gardiner and Java (1991), but was observed in Experiment 1 of the present study.

Remember Versus Know Responses to Lures. The mean proportions of "remember" and "know" responses assigned to item and associative lure test probes are presented in Figure 7. For lure probes assigned a "remember" response, the main effects of information type, F (1, 45) = 4.39, MSe = 0.01, and retention interval, F (2, 90) = 7.13, MSe = 0.01, were significant. The information type X retention interval interaction was not significant, F (2, 90) = 1.22, MSe = 0.01. Thus, the proportion of incorrect "remember" responses increased over retention interval, with a greater proportion of incorrect "remember" responses being made for item information than for associative information.

Insert Figure 7 about here

For "know" responses assigned to item and associative lure probes, the main effect of information type was not significant, $\underline{F}$ (1, 45) < 1. The main effect of retention interval was significant, $\underline{F}$ (2, 90) = 7.74, $\underline{MSe}$ = 0.02. The interaction between these variables was not reliable, $\underline{F}$ (2, 90) < 1. Thus, item and associative information generated comparable proportions of incorrect "know" responses, and these proportions of incorrect responses increased over retention interval.

Response Latency. Response latency data were collected on the immediate and 1-day tests. Due to a computer programming error, response latency data were not collected for the 30-minute delayed test. As in Experiment 1, the data were not statistically analyzed due to too few observations in some conditions. However, in examining response latency means, it is clearly evident that correct "remember" responses maintain their response speed advantage over correct "know" responses for both types of stimuli. These means are presented in Figure 8. On the immediate test, "remember" responses were made more quickly than "know" responses for single words, and also for word pair stimuli. The 1-day delayed test elicited the same response latency advantage where "remember" responses yielded faster mean responses than did "know" responses for both item and associative recognition. These findings replicate those of Dewhurst and Conway (1994).

Insert Figure 8 about here

In contrast to Experiment 1, the main findings of Experiment 2 suggest that item and associative information differed with respect to overall recognition performance, with greater recognition accuracy for associative information than for item information. In terms of recollective memory, associative recognition yielded a significantly greater proportion of "remember" responses than did item recognition. Furthermore, these proportions were found to decrease over retention interval (as in Gardiner & Java, 1991).

In terms of "know" responses, both item and associative information once again yielded a small increase in the proportion of "know" responses generated from the immediate test to the 1-day delayed test. It was also found that a greater proportion of "know" responses were assigned to single word test probes than to word pairs on each memory test.

Finally, mean response latencies for "remember" and "know" responses clearly demonstrated a response speed advantage for "remember" responses over "know" responses (as observed in Experiment 1).

GENERAL DISCUSSION

The present research had three goals. The first goal was to further examine the forgetting rates of item and associative information. This was done by measuring overall recognition performance at various retention intervals. Secondly, the present studies attempted to provide further distinctions between item and associative information, as well as "remember" and "know" responses, by examining which type of stimuli generated more "remember" and "know" responses. The third and final goal of the research was to examine the response latencies of "remember" and "know" responses in order to replicate past findings which indicate a distinct response speed advantage for "remember" responses over "know" responses.

The findings of Experiment 1 and Experiment 2 were quite consistent. Both studies yielded similar rates of forgetting for both item and associative information. In terms of recollective memory, both studies showed that associative information elicited a significantly greater proportion of "remember" responses than did item information. Furthermore, in both experiments, "remember" responses decreased as retention interval elapsed, a finding that is consistent with that reported by Gardiner and Java (1991). Additionally, a modest increase in the proportion of "know" responses was also noted in each study occurring within the initial 2 days of the 7-day retention period. Finally, both studies showed that correct "remember" responses were consistently made faster than were correct "know" responses.

The results obtained in both Experiment 1 and Experiment 2 are rather straightforward. The forgetting rates of item and associative information did not significantly differ. This finding fails to replicate those obtained by Hockley (1991, 1992) where slower forgetting rates were noted for associative information than for item information. Specifically, Hockley (1992, Experiment 4) found that the proportion of correct responses for item and associative information was comparable on an immediate memory test, but greater for associative information on a final delayed test. Instead, the present research replicates the results obtained by Consoli (1995) where item and associative recognition yielded comparable forgetting rates over a 1-week delay condition.

One must not, however, overlook the fact that Hockley's studies were designed to test the forgetting rates of item and associative information in a study-test paradigm via an immediate versus end-of-session final recognition memory test. As a result, Hockley's findings provide a clear pattern of different forgetting rates for single words and word pairs across a short interval of time (i.e., the duration of the experimental session). Alternatively, the present research presents quite a different pattern of performance. Across a 1-week time period, the forgetting rates of item and associative information did not reliably differ. Given the findings of Experiment 1, differences in forgetting rates do not extend to retention intervals that span a 1-week time frame. Hockley's results suggest that the differences in forgetting for the two types of stimuli are manifested in very short-term (within-session) periods of time. However, this pattern of performance was not obtained on the 30-minute delayed test of Experiment 2. Across this comparable time interval, a difference between item and associative forgetting was not clearly observed from the immediate test to the 30-minute delayed test.

In Hockley's study, participants underwent multiple study-test trials prior to taking a final delayed recognition memory test. The studying of these multiple word lists may have created a build-up of interference which subsequently affected item recognition performance more so than associative recognition performance on the final test.

Given the results of Experiment 2 of the present research, one can only conclude that the face recognition distracter task did not create a similar level of interference with the verbal stimuli presented during the study phase. As a result, item and associative recognition performance did not differ from the immediate test to the 30-minute delayed test.

In terms of recollective memory, a significantly greater proportion of "remember" responses were generated for associative than for item information test probes. This performance was noted on both the immediate and 2-day test of Experiment 1 as well as on the immediate, 30-minute, and 1-day tests of Experiment 2. However, the proportions of correct "remember" responses generated for item and associative information on the 7-day delayed test of Experiment 1 were clearly comparable.

The proportion of "remember" responses generated on the immediate and 2-day test of Experiment 1 suggest that, within a 48 hour time period, recollection does indeed decrease for both single word and word pair stimuli. In using the proportion of "remember" responses as an index of recollective forgetting, the fact that word pairs yielded a significantly greater proportion of "remember" responses on both tests than did single word stimuli suggests that word pairs were subject to less forgetting than individual words. These findings may be explained by Hockley's (1992) proposal that the memorial representation of a word pair is more durable and resistant to factors such as interference or memory decay than is the memorial representation of an individual word.

This line of reasoning, however, becomes more difficult to reconcile with the recognition performance observed from the 2-day test to the 7-day test in Experiment 1. During this period of time, it appears that associative recognition underwent a further decrease in the proportion of correct "remember" responses while there was no change in the proportion of correct "remember" responses generated for item information. On the 7-day memory test, there appears to be no difference in the proportion of "remember" responses generated for single words and word pair stimuli.

Given the nature of these observations, it is possible that the memorial representation of the word pair becomes increasingly susceptible to factors such as interference and decay of memory. The results obtained in these studies suggest that the initial greater proportion of "remember" responses for word pairs is a short-lived advantage persisting solely for a period of 2 days. By 7 days, this advantage no longer exists.

In an attempt to explain the differences in forgetting rates between item and associative information, Hockley (1992) suggested that the obtained differences stem from the manner in which the two types of stimuli are represented in memory. Hockley proposed that item recognition involves the discrimination of old (previously studied) words from an array of new words. Associative recognition requires the discrimination of old (intact) word pairs from new (rearranged) word pairs.

It is maintained that the pairing of two random words during such an experiment causes the associative information to be a very unique or distinctive event, specific solely to the present experimental context. It is very unlikely that a participant encountered the identical random pairing of words prior to the experiment. Alternatively, the item information used in such an experimental setting is not entirely specific to the study at hand. Instead, these same single words were encountered many times prior to the study. This makes the item information less unique, and as a result, a participant must determine if these single item events were encountered pre-experimentally or during the experiment.

As a result of these different memorial representations, associative information leads to a superior, and more durable memory. In addition, the difference in encoding processes between item and associative information and the advantage of relational learning over item-specific learning (Hunt & Einstein, 1981; Marschark & Hunt, 1989) suggest that associative information should elicit slower forgetting rates than does item information.

This reasoning can also be applied as an explanation for the different levels of recollection observed for item and associative information. The distinctiveness or uniqueness of the word pair stimuli led to a greater proportion of "remember" responses on both the immediate and 2-day tests. As previously mentioned, this superior level of recollection turns out to be a short-lived advantage. By 7 days, the proportion of "remember" responses generated for item and associative information targets are comparable. In all likelihood, this is due to the loss or irretrievability of information that leads to the recollective experience.

The results of the present study successfully replicate previous findings in the domain of the recollective experience. Essentially, the results of Experiments 1 and 2 largely mirror the forgetting patterns of recollective memory obtained by Gardiner and Java (1991). These researchers found that the response probability of "remember" responses markedly decreased from a 10-minute delayed test to a 1-day test. On a 1-week delayed test, the "remember" response probability remained relatively unchanged from that of the 1-day test.

This pattern of performance reflects that obtained in the present studies. Within the initial 2 days of the 7-day retention interval, a sharp decline in the proportion of "remember" responses generated by single word stimuli was clearly noted. Performance decreased dramatically from the immediate test to the 2-day test. The proportion of "remember" responses assigned to recognized single word targets remained relatively unchanged from the 2-day test to the 7-day test.

In terms of "know" responses, the results of the present studies replicate Gardiner and Java's findings towards the latter end of the retention interval, but present quite a different pattern of performance within the initial 48 hours. In Gardiner and Java's study, the mean proportion of "know" responses assigned to target items changed very little as the retention interval elapsed. This stability in responding was also obtained in the present study from the 2-day test to the 7-day test. The initial 2 days of the retention interval, however, yielded an increase in the proportion of "know" responses assigned to target items from the immediate test to the 2-day test. In light of this increase, one may explain this pattern of responding as an instance wherein some of the "remember" responses made on the immediate test became "know" responses on the 2-day test. This issue was raised and addressed by Gardiner and Java in an additional experiment they performed. This experiment implemented a test-retest design where participants were given a delayed test one week following the initial testing session. Results from this study indicated that of those items assigned a "remember" response on the initial test, only a small proportion were assigned a "know" response on the subsequent test.

However, in the present research, it is quite possible that some "remember" responses did indeed become "know" responses. Different test probes appeared on each of the three memory tests. It is quite possible that some of the target probes not appearing on the immediate test may have elicited a "remember" response had they been tested on the immediate test. Since these probes did not appear on the immediate test, any recollection associated with these items may have readily decreased. When finally appearing on the delayed test, it is possible that recollection for these probes could not be triggered, and a recognition judgement based on familiarity was made instead. This could account for the increase in the proportion of "know" responses from the immediate test to the 2-day test.

The present study also extends research in the domain of recollective experience by including word pairs as the experimental stimuli in addition to the use of single word stimuli. Within the initial 2 days of the 7-day retention period, it was found that word pair stimuli elicited a greater proportion of "remember" responses to targets on the immediate test than on the 2-day test. This sharp decline in the proportion of "remember" responses mirrors that observed with single words. Performance on the 7-day test indicated that the word pairs continued to experience a decrease in the proportion of "remember" responses between Day 2 and Day 7. This decrease, however, was much less of a sharp decrease than that observed from the immediate test to the 2-day delayed test. The pattern of forgetting also contrasts with the forgetting associated with single words from the 2-day test to the 7-day test where the proportion of "remember" responses generated during this time frame remained relatively unchanged.

Collectively, these results not only replicate, but also unite these prior findings, and thus, provide further distinctions not only between item and associative information, but also between "remember" and "know" responses. The present results clearly demonstrate that associative information differs from item information in that a greater proportion of "remember" responses were generated for word pairs than for individual words. Perhaps the deeper or more elaborate processing known to be involved in processing of word pairs leads to this pattern of responding. Alternatively, item information which involves less elaborate processing gives rise to a greater proportion of "know" responses on a memory test. Essentially, recognition of item information appears to rely upon recognition without recollective experience whereas recognition of associative information relies upon the presence of recollective experience. This distinction, however, becomes less well-defined when performance on the 7-day delayed memory test is examined. The comparable proportions of "remember" responses may suggest that at the end of a 1-week retention interval, both item and associative information rely upon common bases of recognition memory.

In terms of the response latency data, the results are consistent with Dewhurst and Conway's (1994) findings. "Remember" responses were consistently made much more rapidly than were "know" responses. This speed in responding was clearly noted for responses assigned to both single word and word pair targets and lures. The results of the present research reinforce the hypothesis proposed by Dewhurst and Conway that the act of remembering is the result of the retrieval of various attributes of the original memorial representation of an event. These retrieved attributes subsequently lead to the recollective experience, and ultimately, to the assignment of a "remember" response for the recognized item. In the event that a recognition response based on the recollective experience cannot be made, it is proposed that one may proceed in making a recognition response ("know" response) based upon the familiarity of the item. Dewhurst and Conway suggest that this shift in processing requires additional time by an individual, and as a result, accounts for the consistent, faster response latencies for "remember" responses than for "know" responses.

The issue of "remember/know" responses and their relation to confidence levels at the time of responding has been the focal point of a series of studies (Gardiner & Java, 1990; Rajaram, 1993). These experiments have collectively provided evidence against the notion that "remember" and "know" responses reflect nothing other than "sure" and "unsure" confidence responses based on the strength of the memorial trace of previously encountered stimuli. As a result, these studies provide further evidence that "remember/know" judgements represent two very distinct types of recognition memory where one type is accompanied by recollective experience, and the other type is not.

Despite such findings, the view that "remember/know" responses are fuelled by one's level of confidence at the time of responding is still maintained by many. Donaldson (1996) argues that one's memory of a previously encountered stimulus exists as a solitary continuum upon which, at the time of testing, a participant establishes a recognition criterion. This criterion is utilized in distinguishing "old" (previously studied) items from "new" (never studied) items. Donaldson proposes that in "remember/know" experiments, a second criterion is subsequently established. This second criterion is used to divide the previously made "old" (yes) responses into "remember" and "know" responses. At this point in responding, Donaldson proposes that those items located above this second criterion are labelled "remember", whereas those items falling beneath the upper criterion and above the "old" criterion are assigned a "know" response. It is the establishment of this second criterion and the assignment of "remember/know" responses that Donaldson maintains is a reflection of a participant's confidence level. He argues that "remember" responses are assigned to strong "old" (yes) responses, and weaker "yes" responses are, in turn, assigned "know" judgements.

Donaldson proposes that the location of these criteria upon the unitary continuum of memory strength depends upon the type of responding occurring at test. A participant may adopt a very conservative manner of responding, a neutral type of responding, or responding may indeed be quite liberal. The use of a stringent criterion ultimately leads to very few items being given a "yes" response which in turn leads to an equally small number of these "yes" items labelled as "remember" judgements. As a result, Donaldson reasons that in this instance, a "remember" response clearly represents an extremely conservative and confident "yes" response.

To support this claim, Donaldson performed a meta-analysis of the data obtained from 28 recognition memory experiments which implemented the "remember/know" paradigm, many of which have been reviewed in this paper. His analysis consisted of calculating the values of A′ and d′, statistics used in the measurement of recognition memory performance and accuracy. The A′ statistic measures memory on a range from zero to one, where a value of 0.50 reflects performance at chance levels. The d′ statistic measures memory on a range from zero to approximately four, and represents the difference between the mean of the distribution of "no" (new) responses and the mean of the distribution of "yes" (old) responses. Although he presented both measures in his meta-analysis, Donaldson preferred the use of A′ rather than d′. His preference is based on findings (Donaldson, 1993) that A′ may be a more accurate measure of memory performance when criterion changes are believed to be occurring (as in his theory of "remember/know" responding). d′, however, was found to be a more accurate measure of memory performance when such a shift in response criteria does not occur.

Donaldson hypothesized that regardless of which statistic (A′ or d′) was calculated, A′(recog) = A′(rem), and d′(recog) = d′(rem), or in other words, the overall recognition hit rate would be equivalent to the hit rate for "remember" responses. He made this prediction by reasoning that wherever the second response criterion is established on the familiarity continuum (i.e., conservative, neutral, or liberal responding), A′ and d′ are independent of the placement of this criterion. Consequently, the pattern of hit rates for "remember" responses would parallel the hit rates for overall recognition for "yes" and "no" responses. As a result, Donaldson proposed that if a given variable affects the overall recognition performance to some extent, the same magnitude of effect would be noted in the hit rate for "remember" responses.

Results obtained from the meta-analysis fulfilled his predictions. Overall recognition performance was equivalent to performance for "remember" responses as calculated by A' (A'(recog) = 0.86 and A'(rem) = 0.83). Using the d' statistic elicited the same pattern, where d'(recog) = 1.71 and d'(rem) = 1.80.

As a result of these analyses, Donaldson firmly maintains that "remember" and "know" responses reflect levels of confidence based on a continuum of familiarity for previously encountered stimuli. He rejects the notion that "remember" and "know" responses are two different types of responses, each representing a different component or basis of recognition memory.

To evaluate Donaldson's theory, the data from the present studies were re-analyzed. As in Donaldson's meta-analysis, overall recognition responses and "remember" recognition responses were compared. Separate 2 X 3 X 2 (information type X retention interval X recognition type) repeated measures ANOVAs for A' and d' were performed. The findings for Experiment 1 for A' and d' are presented in Figures 9 and 10, respectively.

For the A′ analysis, the main effects of information type, F (1, 46) = 14.15, MSe = 0.024, and retention interval, F (2, 92) = 83.34, MSe = 0.033, were significant, while the main effect of recognition type (overall versus "remember") was not reliable, F (1, 46) = 3.48, MSe = 0.015. The information type X recognition type interaction was significant, F (1, 46) = 7.93, MSe = 0.016, while the information type X retention interval, F (2, 92) = 2.53, MSe = 0.028, and the retention interval X recognition type, F (2, 92) < 1, were not reliable. Finally, the information type X retention interval X recognition type interaction did not approach significance, F (2, 92) < 1. The same analyses performed for d′ yielded the same pattern of effects. Essentially, the significant information type X recognition type interaction indicates that overall recognition accuracy and "remember" recognition accuracy did indeed differ, and this difference was greater for associative recognition than for item recognition.

Insert Figures 9 and 10 about here

The findings for Experiment 2 for A′ and d′ are presented in Figures 11 and 12, respectively. The analyses indicated a very similar pattern of results to those of

Experiment 1, where the main effects of information type, $F_{(1, 45)} = 13.32$, MSe = 0.031, and retention interval, $F_{(2, 90)} = 70.60$, MSe = 0.018, were significant. The main effect of recognition type was also reliable for these data, $F_{(1, 45)} = 9.40$, MSe = 0.009. As in Experiment 1, the information type X recognition type interaction was reliable, $F_{(1, 45)} = 7.56$, MSe = 0.008, whereas the information type X retention interval, $F_{(2, 90)} < 1$, and the retention interval X recognition type interaction, $F_{(2, 90)} < 1$, did not approach significance. The information type X retention interval X recognition type interaction also failed to approach significance, $F_{(2, 90)} < 1$. As in Experiment 1, the analyses for d′ exhibited the same pattern of effects as those obtained in the A′ analyses. Once again, the significant information type X recognition type interaction suggests that overall recognition accuracy and "remember" recognition accuracy did differ, and this difference was once again greater for associative recognition than for item recognition.

Insert Figures 11 and 12 about here

The results of these analyses are quite straightforward. For both sets of data, A′ and d′ for overall recognition and "remember" recognition for item information did not significantly differ. This finding replicates those obtained by Donaldson's meta-analysis, and thus, provides additional evidence for his theory of "remember" and "know" responses. It appears that "remember" and "know" responses for item information may reflect one's level of confidence at time of testing.

The A' and d' analyses for associative information, however, present a very different pattern of results. For associative information, A' and d' analyses both yielded greater recognition performance for "remember" recognition than for overall recognition. This finding does not support Donaldson's theory. Although his theory is supported by the recognition performance for single word stimuli in the present studies, his theory does not appear to hold true when the experimental stimuli consist of word pairs. Recognition performance for associative information clearly indicated a difference between overall recognition memory and recognition for "remember" responses. As a result of these analyses, one is left to conclude that the distinction between "remember" and "know" responses is not based solely on confidence where associative information is concerned.

The fact that the A' and d' analyses for associative information did not mirror those for item information poses a problem for Donaldson's interpretation of "remember" and "know" judgements. As stated previously, Donaldson proposes that "remember" and "know" responses are the result of one's level of confidence based on a familiarity continuum for previously encountered events. He maintains that the assignment of a "remember" response represents a conservative and confident "yes" response.

In the present research, associative information consistently elicited a greater proportion of "remember" responses than did item information. If Donaldson's theory is correct, one must interpret these findings as greater confidence associated with word pairs than with single word stimuli. If Donaldson's theory is accurate, and a greater level of confidence was indeed associated with word pairs in the present research, then the A' and d' analyses should have generated overall recognition hit rates that were equivalent to "remember" hit rates (as they did for item information). Instead, these analyses failed to provide such statistical outcomes. If Donaldson's theory is applied to these data, one is left to conclude that confidence level affected recognition of single word stimuli, but did not play a role in the recognition of word pairs. This seems unlikely.

In light of these results, Donaldson's theory of "remember" and "know" responses may not serve as an accurate explanation for the "remember/know" dissociations consistently noted in the literature. Instead, it is possible that the two types of responses represent different bases of recognition memory.

In summary, the present findings extend previous research in both the areas of item and associative recognition, and recollective memory. In terms of forgetting rates, no significant difference was observed between item and associative information across a 1-week retention interval. This finding suggests that the different rates of forgetting for the two types of stimuli, noted in earlier studies, may be limited to shorter retention intervals, and are not exhibited when longer retention intervals are implemented. In terms of recollective experience, this study extends previous research in this area of cognitive psychology by including word pairs as the experimental stimuli in addition to single words. In doing so, associative information was found to elicit a significantly greater proportion of "remember" responses than did item information. In turn, a greater proportion of "know" responses was generated for item information than for associative information. It is believed that the encoding of associative information leads to a more distinct memorial representation than does the encoding of item information. As a result, greater recollection accompanies recognition of associative information than the recognition of item information. This clear pattern of performance provides further evidence for two distinct bases of recognition memory. The reaction time data also further establish this distinction, where "remember" responses were made more rapidly than "know" responses.

Finally, the present findings also provide additional evidence against the notion that the apparent "remember/know" distinction manifests itself solely as a result of one's confidence level at the time of responding.

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Footnotes

1. To address the possibility of outliers in the mean response time data, all response times greater than 10 seconds were also excluded. Upon doing so, it was noted that "remember" responses were still made more rapidly than were "know" responses. As a result, this response time advantage for "remember" responses over "know" responses is not attributable to extremely long response times.

2. Statistical analyses were performed both prior to and following the exclusion of these data from the data set. The two sets of analyses yielded identical patterns of main effects and interaction effects.

It is believed that participants in Experiment 2 showed poorer recognition performance than those participants of Experiment 1 due to the time of year that the experiment was conducted. Experiment 1 was conducted at the start of the academic year whereas Experiment 2 was conducted midway through the latter part of the academic year. It is possible that the participants in Experiment 2 were more fatigued than those of Experiment 1, and this fatigue subsequently led to very poor recognition performance on the immediate test. It is also possible that participants simply chose not to participate fully or to comply with instructions.

Figure Caption

Figure 1. Mean d′ values for item and associative recognition performance as a function of retention interval (Experiment 1).

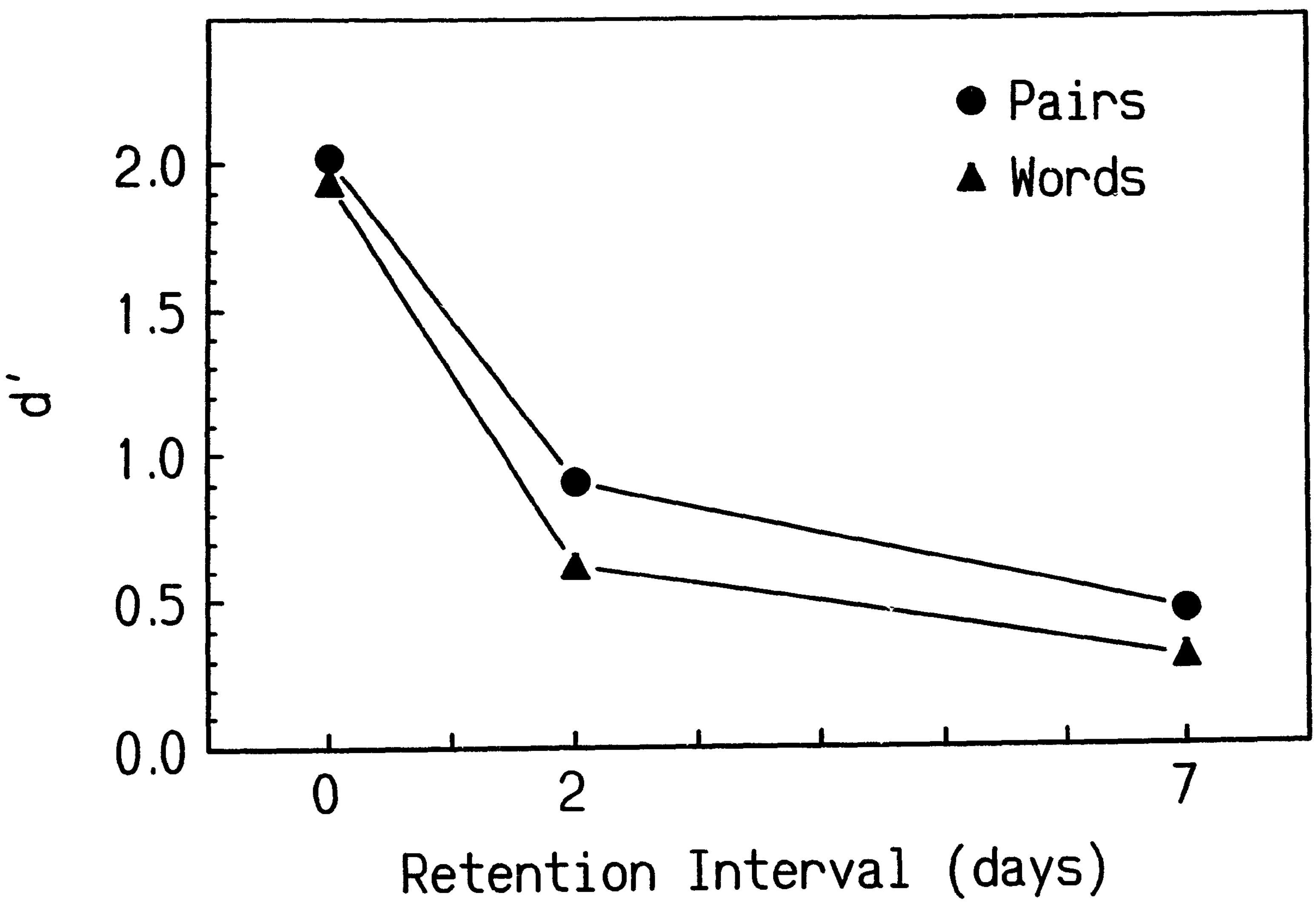

Pairs
Words
d′
2.0
1.5
1.0
0.5
0.0
0
2
7
Retention Interval (days)

Figure Caption

Figure 2. Mean proportion of "remember" and "know" responses assigned to recognized item and associative targets (Experiment 1).

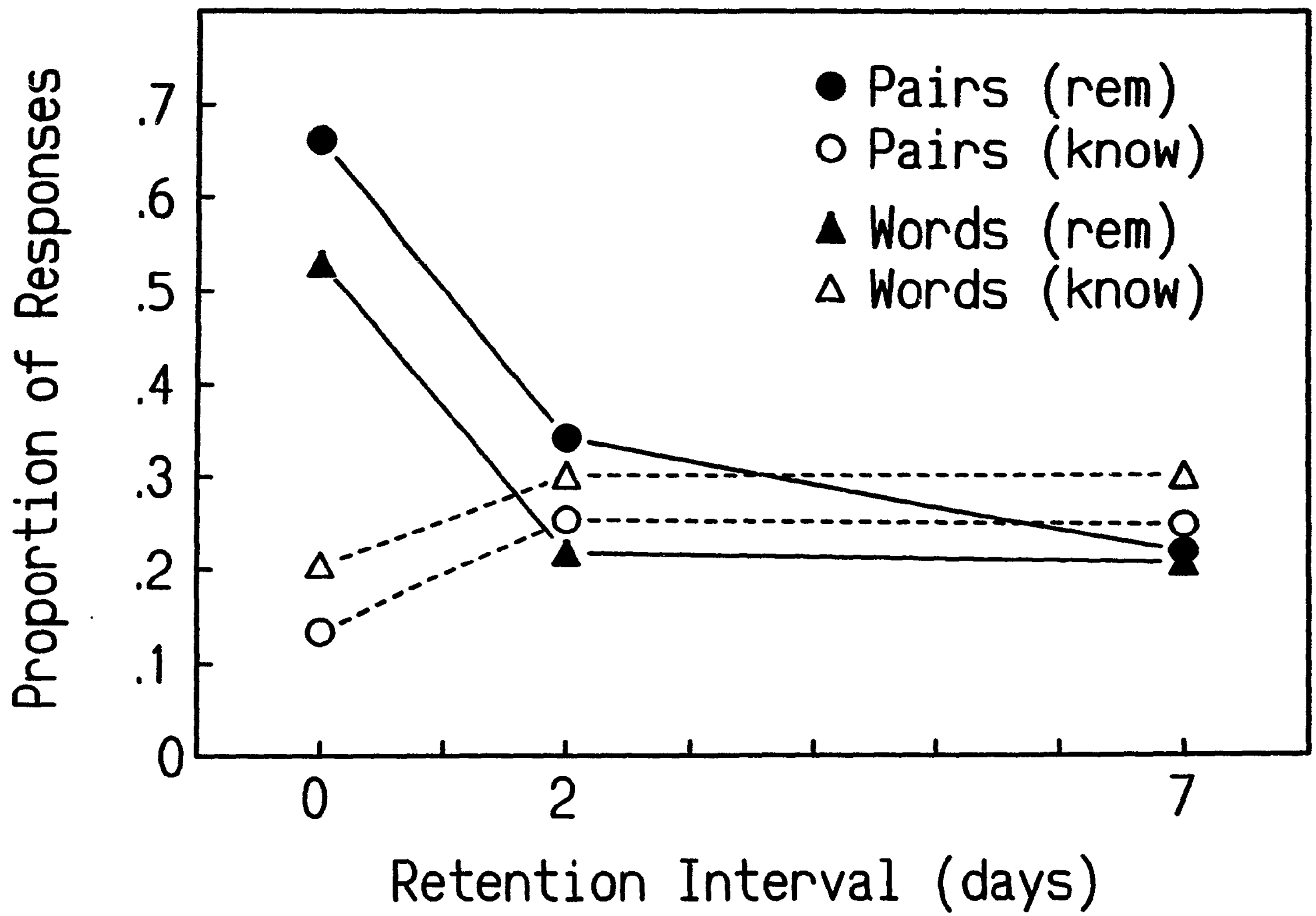

Pairs (rem)
Pairs (know)
Words (rem)
Words (know)
Proportion of Responses
0
.1
.2
.3
.4
.5
.6
.7
0
2
7
Retention Interval (days)

Figure Caption

Figure 3. Mean proportion of "remember" and "know" responses assigned to "recognized" item and associative lures (Experiment 1).

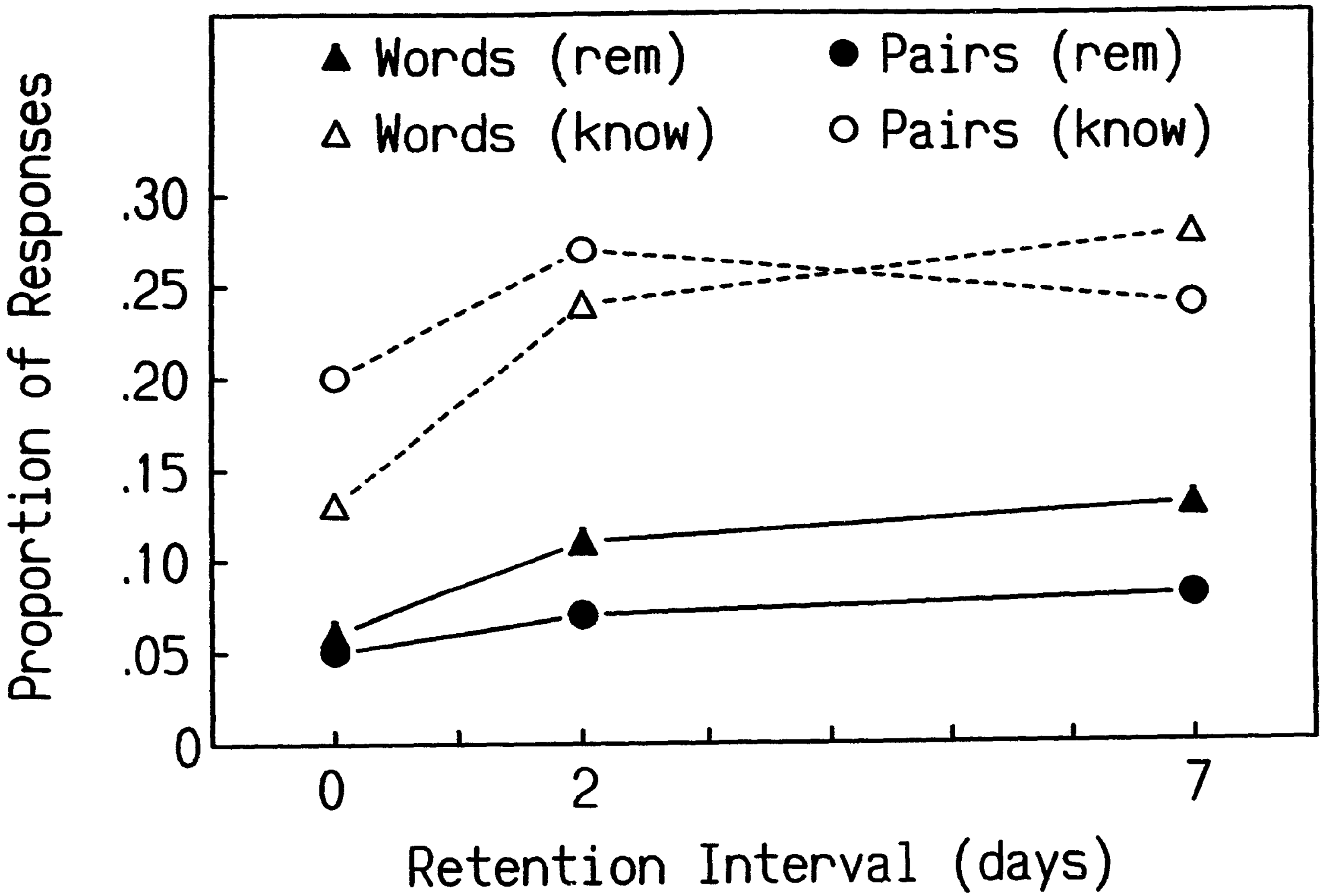

Words (rem)
Words (know)
Pairs (rem)
Pairs (know)
Proportion of Responses
.30
.25
.20
.15
.10
.05
0
0
2
7
Retention Interval (days)

Figure Caption

Figure 4. Mean response latencies for correct "remember" and "know" responses for item and associative targets (Experiment 1).

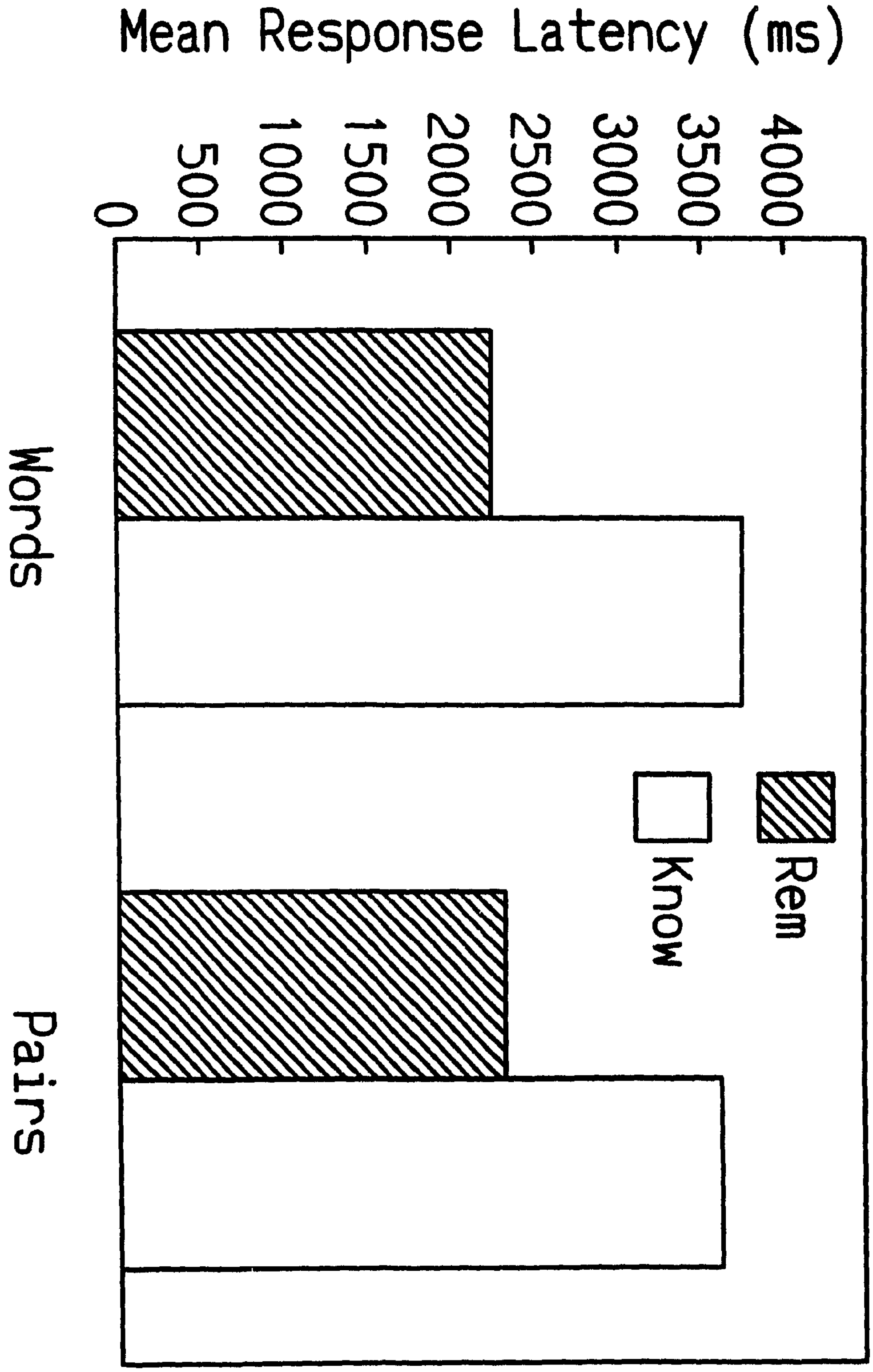
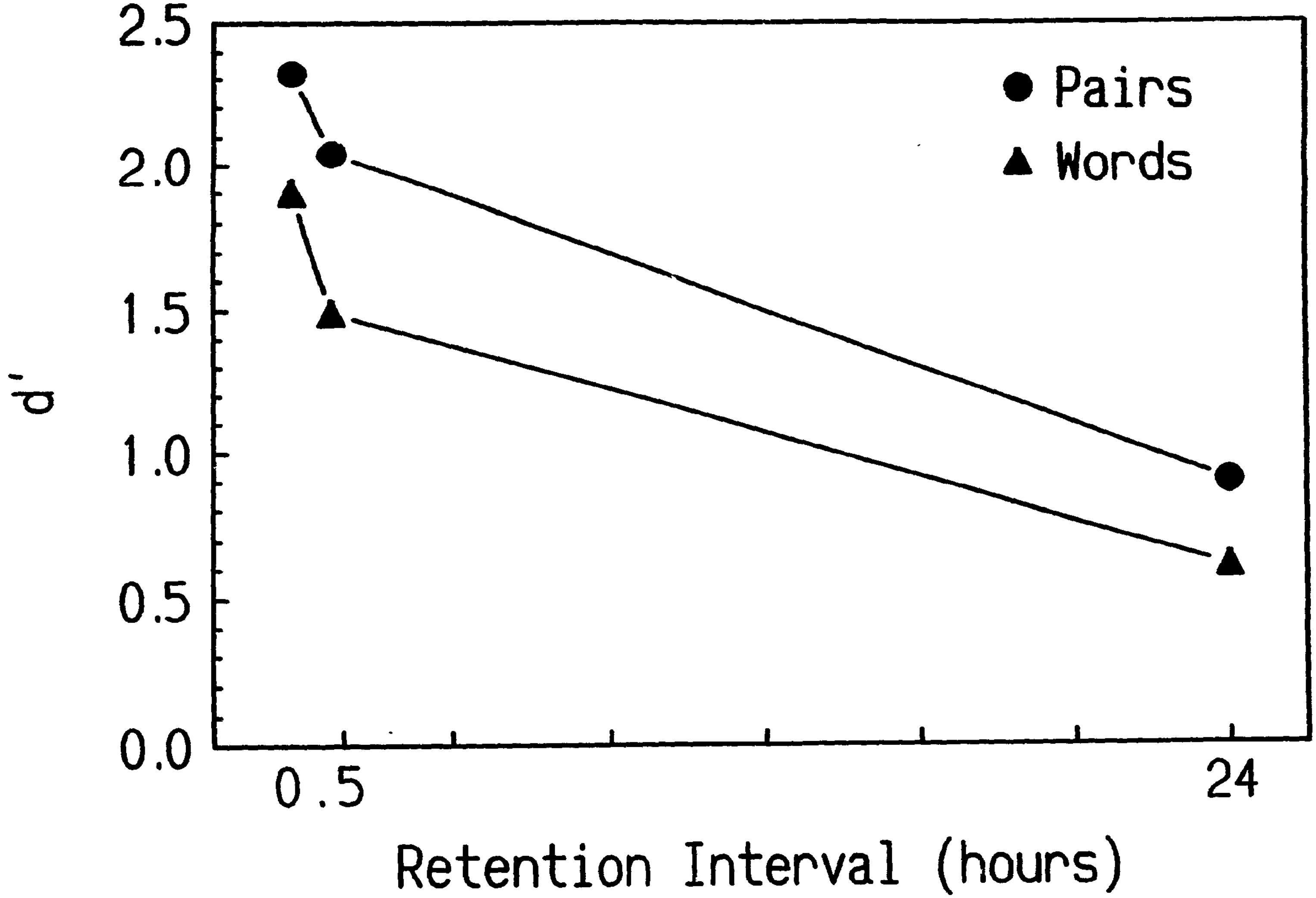

Mean Response Latency (ms)
0
500
1000
1500
2000
2500
3000
3500
4000
Words
Pairs
Rem
Know

Figure Caption

Figure 5. Mean d' values for item and associative recognition performance as a function of retention interval (Experiment 2).



d'
2.5
2.0
1.5
1.0
0.5
0.0
0.5
24
Retention Interval (hours)
Pairs
Words

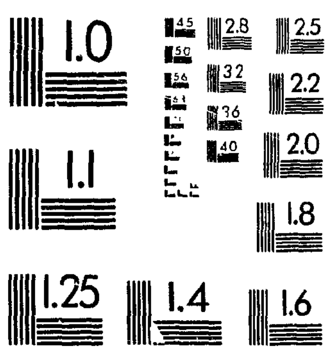

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6

Figure Caption

Figure 6. Mean proportion of "remember" and "know" responses assigned to recognized item and associative targets (Experiment 2).

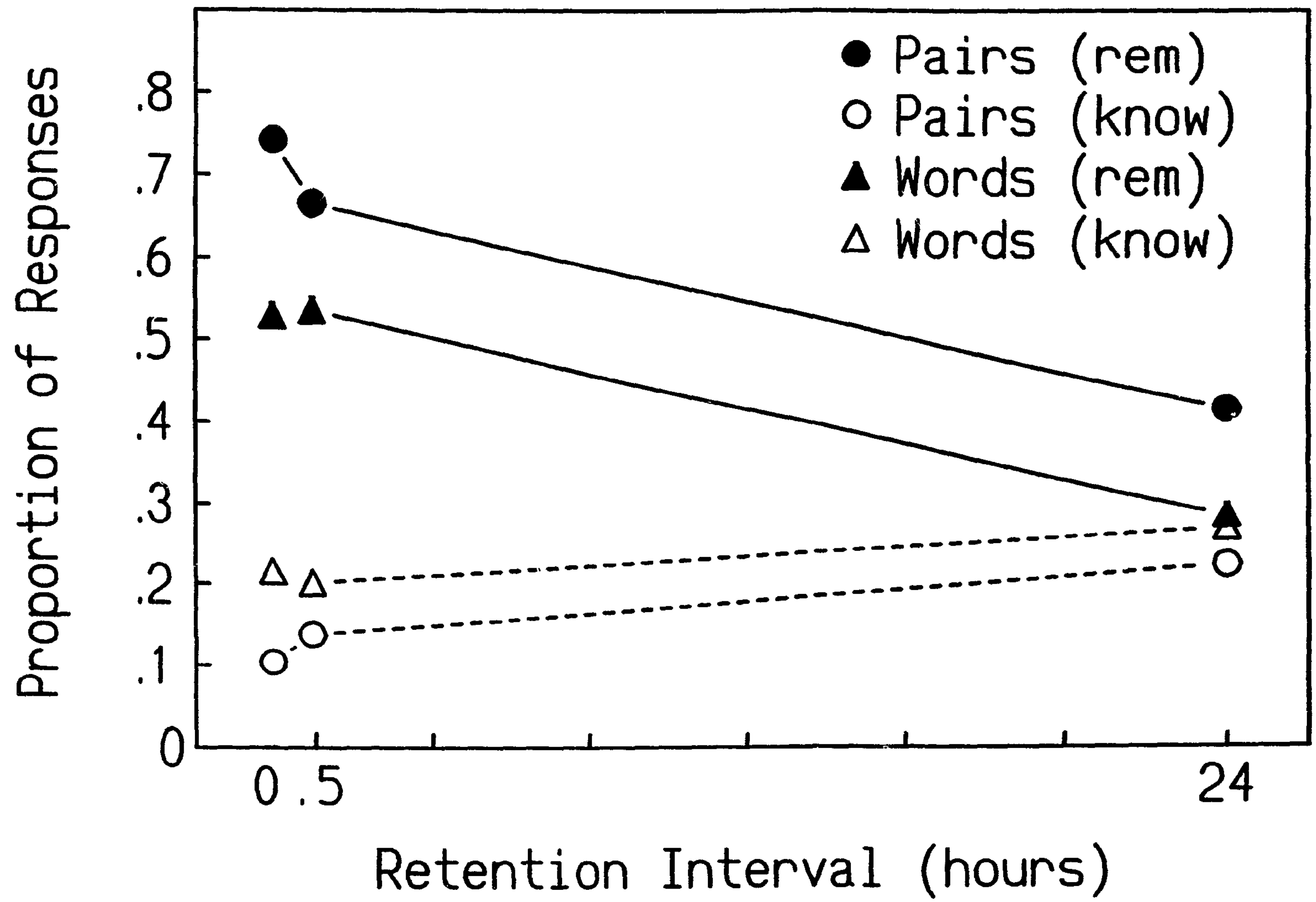

Proportion of Responses
0
.1
.2
.3
.4
.5
.6
.7
.8
0.5
24
Retention Interval (hours)
Pairs (rem)
Pairs (know)
Words (rem)
Words (know)

Figure Caption

Figure 7. Mean proportion of "remember" and "know" responses assigned to "recognized" item and associative lures (Experiment 2).

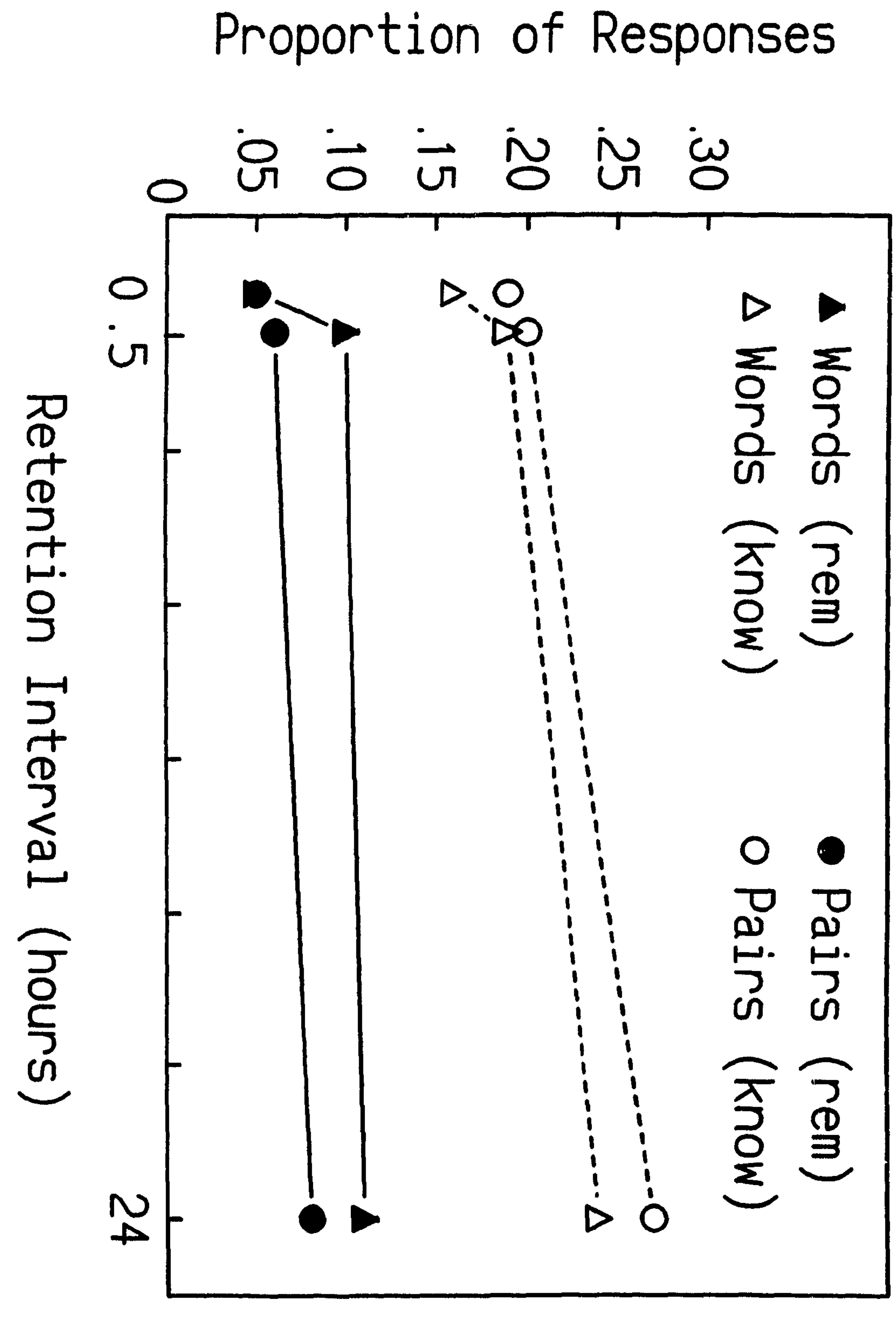

Proportion of Responses
0
.05
.10
.15
.20
.25
.30
Retention Interval (hours)
0.5
24
▲ Words (rem)
△ Words (know)
● Pairs (rem)
○ Pairs (know)

Figure Caption

Figure 8. Mean response latencies for correct "remember" and "know" responses for item and associative targets (Experiment 2).

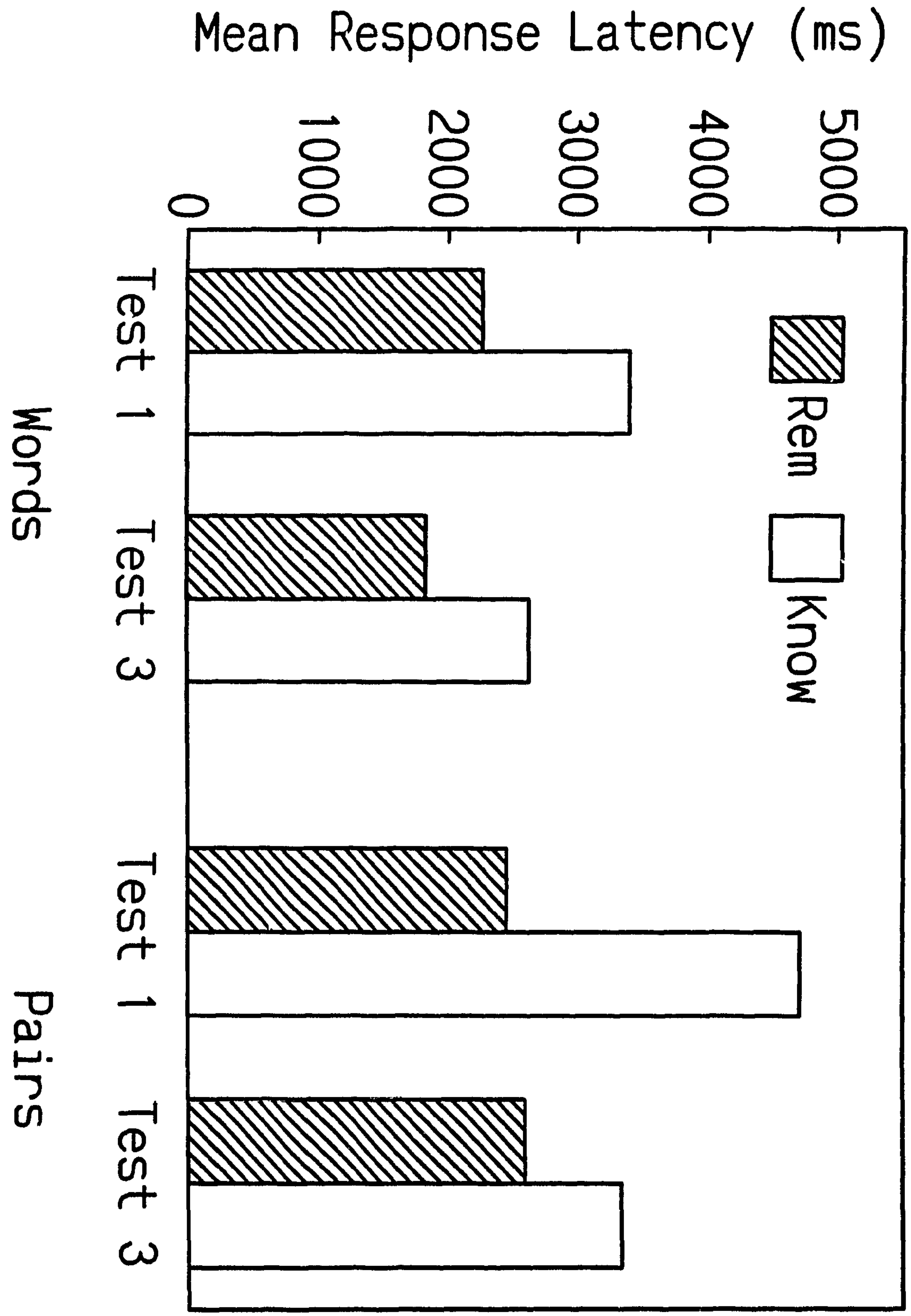
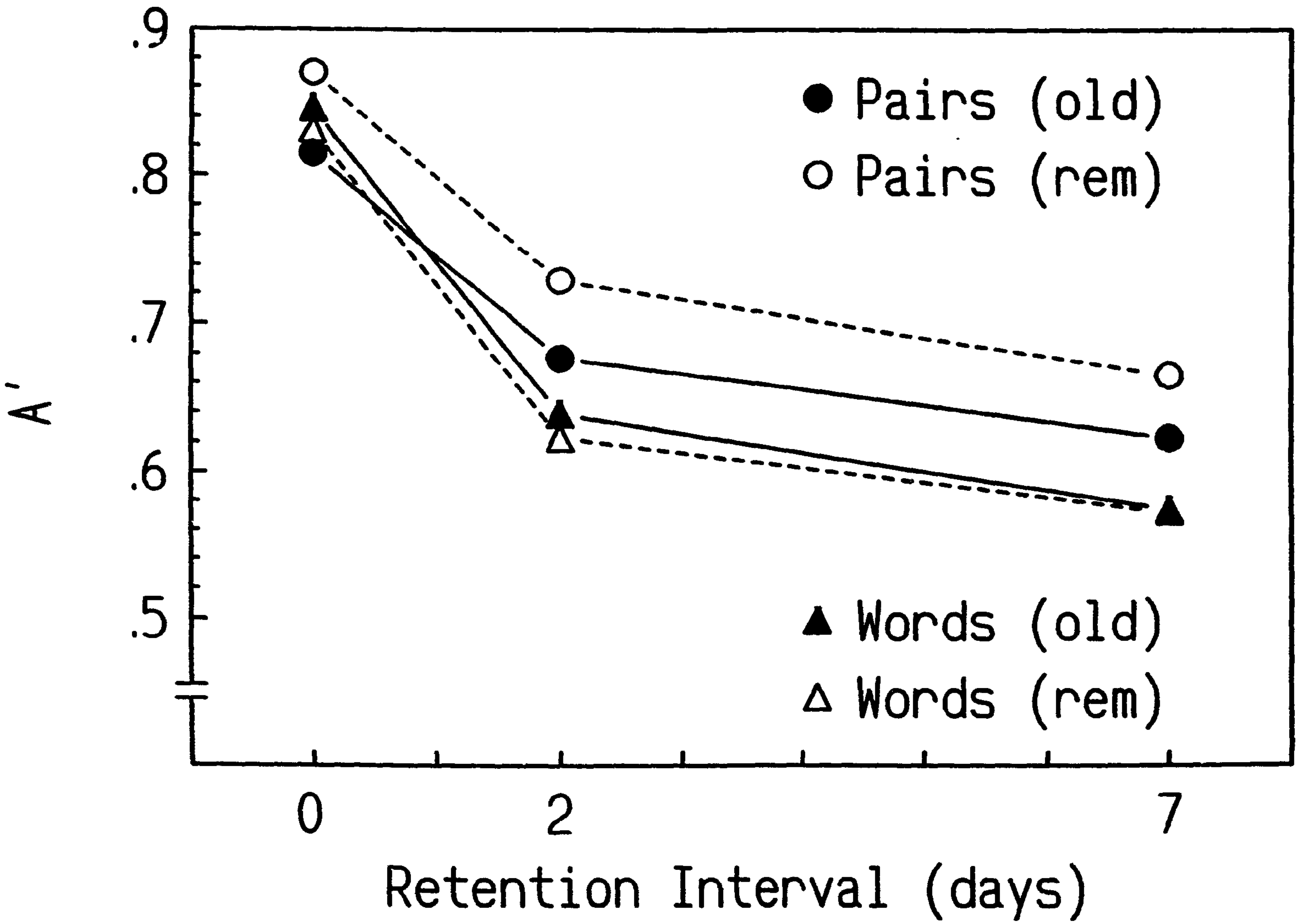

Mean Response Latency (ms)
0
1000
2000
3000
4000
5000
Rem
Know
Test 1
Test 3
Test 1
Test 3
Words
Pairs

Figure Caption

Figure 9. Mean A′ values for "old" (overall recognition) and "remember" responses ("remember" recognition) for item and associative information (Experiment 1).



A'
.9
.8
.7
.6
.5
0
2
7
Retention Interval (days)
Pairs (old)
Pairs (rem)
Words (old)
Words (rem)

Figure Caption

Figure 10. Mean d′ values for "old" (overall recognition) and "remember" responses ("remember" recognition) for item and associative information (Experiment 1).

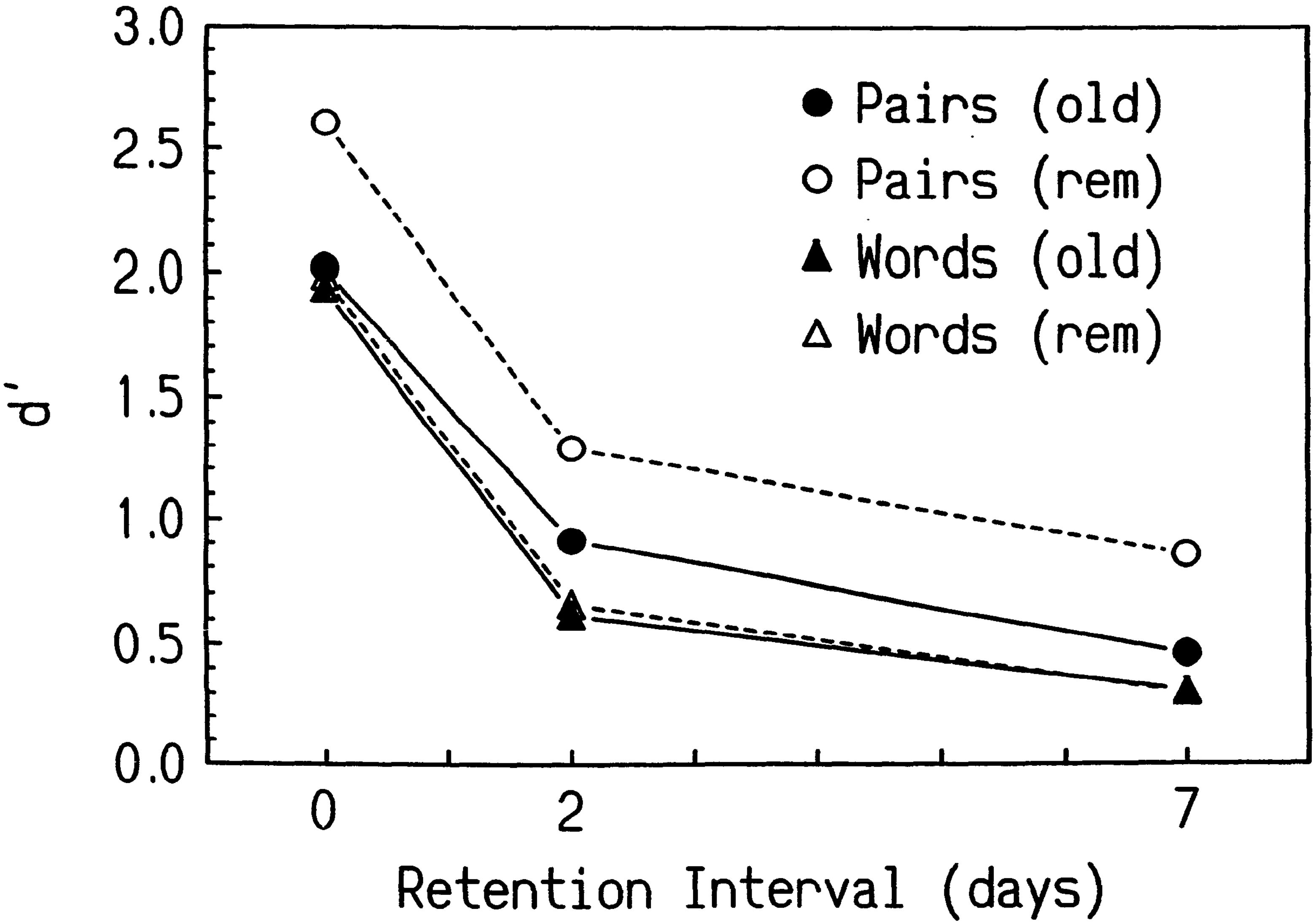

Pairs (old)
Pairs (rem)
Words (old)
Words (rem)
d′
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
7
Retention Interval (days)

Figure Caption

Figure 11. Mean A′ values for "old" (overall recognition) and "remember" responses ("remember" recognition) for item and associative information (Experiment 2).

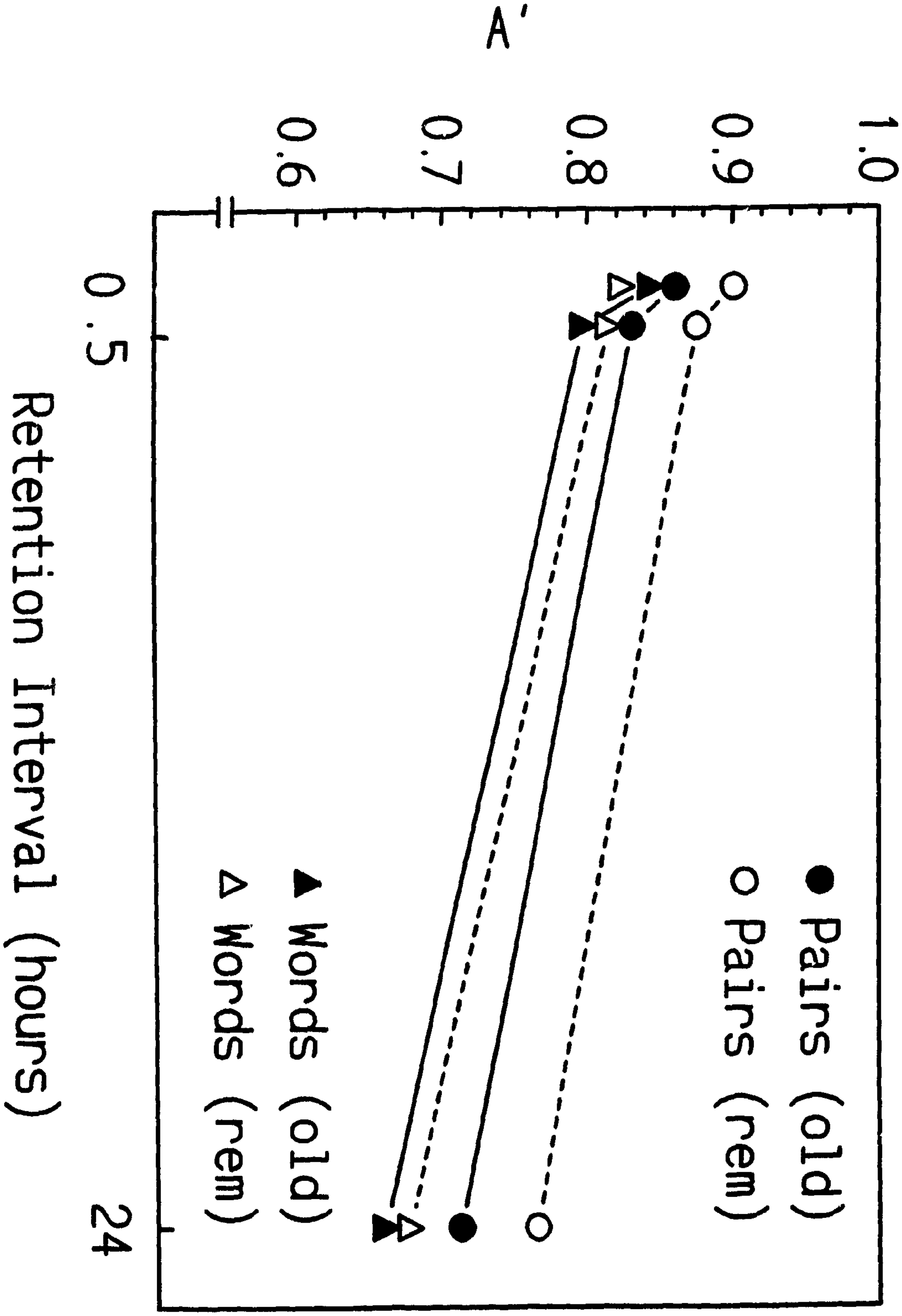
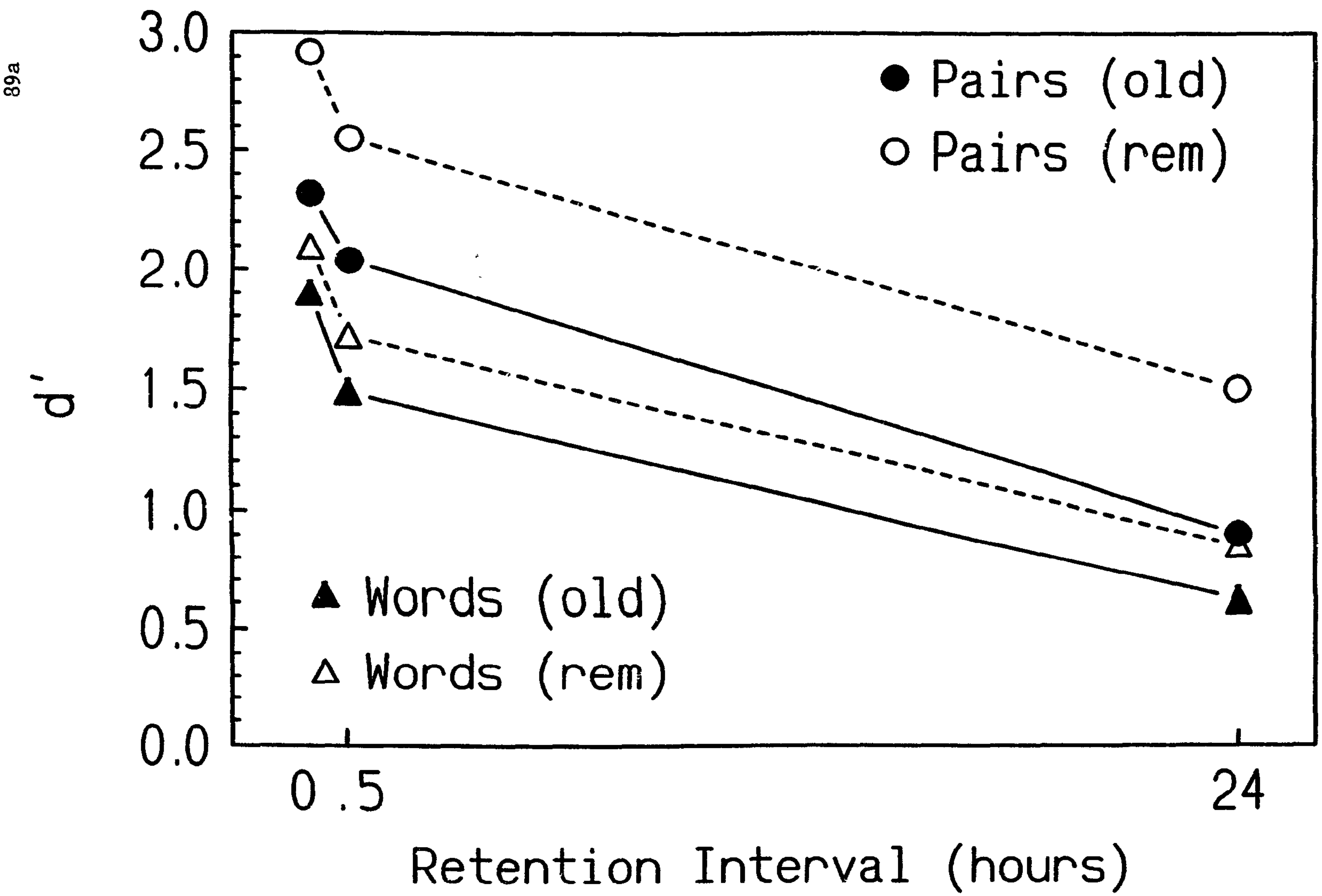

A′
1.0
0.9
0.8
0.7
0.6
0.5
24
Retention Interval (hours)
● Pairs (old)
○ Pairs (rem)
▲ Words (old)
△ Words (rem)

Figure Caption

Figure 12. Mean d′ values for "old" (overall recognition) and "remember" responses ("remember" recognition) for item and associative information (Experiment 2).


3.0
2.5
2.0
1.5
1.0
0.5
0.0
d'
Pairs (old)
Pairs (rem)
Words (old)
Words (rem)
0.5
24
Retention Interval (hours)

Appendix A

Experimental Instructions:

The present study focuses upon recognition memory. In the first session of this study, you will undergo a practice phase in which you will be asked to study a list of word pairs, and subsequently take a memory test. This practice phase has been included in the study in order to answer any questions you may have or resolve any misunderstandings that may arise pertaining to the study and the instructions.

For each single word and word pair that appears on the test, you are asked to indicate whether or not you recognize the item from the study list.

If you believe that the single word or word pair did not appear on the study list, please press the "T" key ("new" response). If you believe that the single word or word pair did appear on the study list, you are asked to make one of two judgements. If you can clearly remember the word or word pair from the study list, you are asked to press the "U" key ("remember" response). If you cannot specifically remember the single word or word pair, but instead, it seems familiar to you, you are asked to press the "O" key ("know" response).

You are asked to make a "remember" response to recognized single words and word pairs that evoke some specific recollection from the study phase. For example, remembering a word or word pair because it evokes a particular association, image, or some other more personal experience, or because something about its appearance or position can be recalled. A "remember" response would be like recognizing someone on the street, and remembering who he/she is, where you know them from, etc.

You are asked to make a "know" response to recognized single words and word pairs that you feel confident in recognizing but which fail to evoke any specific conscious recollection from the study phase. A "know" response would be like recognizing someone on the bus, but you do not remember who the individual is, or anything specific about the individual.

Once you have finished this portion of the study, you will be asked to provide the experimenter with an example of a "remember" response and a "know" response that you made during the practice test, and your reasons for making these judgements. Once you have completed the practice session, you are asked to begin the initial experimental session of the study. This session will be identical to the practice session in terms of instructions and format.

Appendix B

Face Recognition Distracter Task:

The distracter study was a variation of the present study, where instead of word pairs, participants were asked to study a collection of slides portraying faces. Faces were used in order to provide participants with stimuli that would not be confused with the verbal stimuli of the actual experiment. The experimental instructions and tasks, however, were identical to those of the actual experiment. This ensured that participants would not confuse instructions of the actual experiment and those of the face recognition distracter study. The distracter study phase consisted of the presentation of 21 colour slides of male and female faces. Each slide was presented for a total of 1 s with an interval of 0.5 s between each slide presentation. Participants were instructed to study each face, and that they would be given a memory test once all slides were presented.

Once the entire collection of slides had been presented, participants underwent a 15 minute delay, and were subsequently given a face recognition memory test. This test consisted of a total of 32 face test probes with 16 sunglasses test probes (8 old faces and 8 new faces) and 16 normal (no sunglasses) test probes (8 old faces and 8 new faces). An old face was a face that appeared in the previous study presentation, whereas a new face was a face that did not appear anywhere in the previous slide presentation. Each test probe remained in the centre of the screen for 5 s. The subsequent test probe appeared 1 s later.

The experimental instructions were based on those used in Experiment 1 (see Appendix A), and were given to participants immediately after the study phase. Participants were given a sheet of paper and asked to make either a "new", "remember" or "know" response for each slide that appeared in the test slide presentation. For each sunglasses and normal test slide, participants were asked to circle "new" if they believed the face did not appear during the study phase. If the face was recognized from the study phase and could be clearly and distinctly recollected from the study phase, participants were instructed to circle the "remember" response. If the face could not be clearly recollected, but instead, seemed familiar, the participants were instructed to make a "know" response.

Once participants understood all instructions, and a delay of 15 minutes had elapsed, the participants were instructed to begin the test phase of the distracter experiment.