# **Remembering Without Awareness\***

#### Larry L. Jacoby and Dawn Witherspoon McMaster University

**ABSTRACT** Amnesics reveal savings in their objective performance of a task even though they are not aware of remembering. Experiments that are described reveal a dissociation of memory and awareness for normals as well as amnesics. The episodic-semanitc memory distinction has been employed by others as an account of the dissociation of memory and awareness. An account of this sort leads one to expect remembering without awareness to be relatively context free. In contrast, several experiments are reviewed to show that remembering without awareness can be specific to memory for a particular episode.

**RÉSUMÉ** Même s'ils ne prennent pas conscience du fait qu'ils se souviennent, les amnésiques démontrent néanmoins une économie dans leur rendement objectif à une tâche donnée. Les expériences décrites font état d'une dissociation entre mémoire et conscience autant chez les sujets normaux que chez les sujets amnésiques. La distinction entre mémoire sémantique et épisodique a été utilisée pour rendre compte de cette dissociation entre mémoire et conscience. Si tel était le cas, les souvenirs sans conscience devraient être relativement libres de tout effet contextuel. Au contraire, la revue de plusieurs expériences permet de montrer que le souvenir sans conscience peut être spécifique à la mémoire d'un épisode particulier.

Webster's New World Dictionary defines the word 'remember' as meaning: 'to bring back to mind by an effort.' In line with this definition, the majority of research on human memory has employed tasks that require remembering to be deliberate. In an experiment in which a person is asked to recall a previously studied list of words, for example, remembering is intentional so that the person is necessarily aware that he is remembering. Although deliberate remembering obviously does occur, many functions of memory may operate without intention or awareness. Memory for a prior event may influence the interpretation and encoding of a later event without a person being aware of remembering the prior event. It is this remembering without awareness that has served as a focus for our research program. In this paper, we explore the relationship between memory and awareness for normal people as well as for amnesics.

The amnesic, by definition, is less able to reflect on memory for prior episodes or to recognize items as being familiar. By several reports, however,

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amnesics preserve a nearly normal ability to employ memory for recent events to aid their interpretation of an ambiguous display or as a source of savings revealed in their objective performance. As an example, exposure to an intact picture allows amnesics to identify more readily a fragmented version of that picture presented later (Milner, Corkin, & Teuber, 1968). This effect on identification occurs, although amnesics deny any sense of subjective familiarity when confronted with the picture. We further establish this dissociation of memory and awareness for amnesics and provide evidence of a parallel dissociation for normals.

The hallmark of situations showing remembering without awareness is that the instructions stress some perceptual or motor task rather than the remembering of a prior experience. For example, when subjects are given a perceptual identification test in which they are asked to report briefly presented words, prior exposure to those words in the experimental situation enhances subsequent perceptual identification performance (e.g., Murrell & Morton, 1974). This effect in perceptual identification is obviously produced by the subject 'remembering' the words in some sense. However, subjects in the perceptual identification situation are instructed to report the word that has been flashed without any reference being made to whether or not the flashed word was studied previously. The instructions focus on the task at hand rather than requiring subjects to reflect on their prior study. The influence of previously presenting a word on its subsequent perceptual identification may be independent of the subject's awareness that the word is one that was presented previously.

Jacoby and Dallas (1981) reported a series of experiments investigating the effects of study on perceptual identification performance. The results of those experiments are suggestive of a dissociation between memory and awareness in normals that parallels that reported for amnesics. A single presentation of a word during study was sometimes sufficient to double the probability of that word being correctly reported when it was subsequently presented for perceptual identification, even when 24 hours intervened between study and the perceptual identification test. This enhanced perceptual identification of 'old' words was apparently independent of the subject's awareness that the words had been presented previously. Variables such as the level-of-processing of words during study influenced recognition. Prior presentation of a word had as much effect on its later perceptual identification when recognition memory performance was very poor as it did when recognition memory performance was almost perfect.

Moscovitch (1981) reviews several accounts of the dissociation of memory and awareness shown by amnesics. Common to most of these accounts is the claim that there are two memory systems that differ in the extent that they preserve information about the context in which an event occurred. For example, the episodic-semantic theory claims that personal reference and information about context are represented in episodic memory, and that it is episodic memory that is disrupted by amnesia (Kinsbourne & Wood, 1975). Following Tulving's (1972) distinction between episodic and semantic memory, episodic memory is defined as comprising memory for specific events whereas semantic memory is concerned with general knowledge.

An account that is essentially identical to the episodic-semantic theory can be used to interpret the dissociation of perceptual identification performance and recognition memory shown by normals. Recognition memory may depend on a memory trace of an individual presentation of a word, while enhanced perceptual identification reflects the 'priming' of a more abstract semantic memory representation of that word. This distinction can be conceptualized using the logogen theory of word recognition (Morton, 1969) by claiming that presentation of a word results in the establishment of a memory trace that preserves the context of that presentation, and serves to lower the threshold of a logogen. It is the lowering of the threshold of a logogen or the priming of information in semantic memory that would be responsible for remembering without awareness. Critical to the above account is the claim that remembering without awareness reflects the operation of a memory that is relatively context-free.

In the present paper, we provide an overview of a research program that is ongoing in our laboratory. First, we report data that further establishes the existence of a dissociation between awareness and memory for normals, as well as for amnesics. Accounts of this dissociation are then considered. It is argued that most prior accounts adopt a particular theory of concept formation by postulating the existence of memory systems that correspond to different levels of abstraction. A prediction of these accounts is that remembering without awareness should be relatively context free. Experiments designed to test this prediction are reviewed.

### THE DISSOCIATION OF MEMORY AND AWARENESS

Experiments interpreted as showing a dissociation of memory and awareness have typically taken the form of demonstrations that amnesics reveal a relatively normal level of savings in their objective performance of a task, even though they deny any sense of subjective familiarity or memory for having practiced the task. Among the first reports of this sort was the demonstration of improvement due to practicing a pursuit-rotor task (Corkin, 1968). The variety of situations that reveal normal savings is important for specifying the nature of the memory system that is spared by amnesia. For example, it might be that only motor learning is preserved and that this form of memory does not allow awareness of remembering. A normal level of savings, however, has been found employing a wide variety of tasks, including verbal as well as motor and perceptual tasks. Among the tasks that have revealed savings are: completion of a word fragment (e.g., Warrington & Weiskrantz, 1970), identifying Gollin figures (Milner, Corkin, & Teuber, 1968), reading inverted text (Cohen & Squire, 1980), assembling a jigsaw puzzle (Brooks & Baddeley, 1976), and applying a new mathematical rule (Kinsbourne & Wood, 1975).

An experiment of our own sought to demonstrate that amnesics can employ memory for a recent event when asked to interpret a verbal communication. When engaged in a conversation, the interpretation given an ambiguous word by normals is influenced by the prior use of the word in the conversation. It is of interest to determine whether or not amnesics reveal normal memory in their use of prior context to restrict their interpretation of words. As is true for savings in objective performances, using memory for recent events as a basis for interpretation may not require that one be aware that he is remembering.

A second purpose of our experiment was to establish further the existence of the dissociation of memory and awareness. Prior experiments interpreted as showing a dissociation are open to the criticism that the savings method of measuring retention is simply more sensitive than are recall and recognition memory tests. Consistent with this interpretation, Nelson (1978) has suggested that the savings measure has a lower threshold than does recognition memory. The problem here is similar to that faced when comparing recognition and recall; many of the arguments and procedures employed to show the independence of recognition memory and recall (e.g., Flexser & Tulving, 1978) are applicable. If only a difference in threshold is involved, passing a more difficult test should insure that the easier test will be passed. To support the claim of a dissociation, it must be shown that performance of a memory task that requires awareness and performance on a test that does not require awareness are independent of one another, so that performance on the one type of test will not allow prediction of performance on the other type of test.

## Spelling Experiment

This experiment made use of a procedure that is similar to one employed by Britton (1976), and that relies on the subject's spelling of a homophone to index the influence of memory for a prior presentation of that homophone on its later interpretation. The procedure for the experiment is outlined in Table I. The interpretation of a homophone was biased in the first phase of the experiment by the subject hearing the homophone in the context of a question that was to be answered. This bias was always towards the interpretation of the homophone that is least frequent, as indexed by norms (Galbraith & Taschman, 1969), when the homophone is heard in isolation. The spelling of homophones required in the second phase of the experiment provides a measure of the effect of the prior presentation of the homophone on its later interpretation. If the prior presentation is remembered and influences later interpretation, a spelling in line with the low frequency interpretation of a homophone should be more probable for homophones that appeared in the context of questions and were, thereby, biased towards that interpretation than for homophones that were not previously presented. An influence of memory on the spelling of a word does not necessarily require awareness of remembering; but such awareness, in contrast, *is* required by the recognition memory test given in the third phase of the experiment. Assessing the independence of the effects of memory in spelling performance and in recognition memory provides a test of the dissociation of memory and awareness.

Subjects in the experiment were five Korsakoff patients classified as amnesic on the basis of their performance on standardized tests, and five university students.<sup>1</sup> The university students were not matched with the patients in terms of age or any of a number of other relevant factors; however, their performance does provide an interesting contrast to that of the amnesics.

#### TABLE I

#### Procedure for spelling experiment

#### Phase 1: Questions

Homophone — Name a musical instrument that employs a *reed*. Nonhomophone — What is your favorite *sport*?

#### Phase 2: Spelling

reed (biased homophone)	read (unbiased spelling)
sport (old nonhomophone)	
grate ('new' homophone)	great (unbiased spelling)
train ('new' nonhomophone)	

#### Phase 3: Recognition Memory

reed (old homophone) sport (old nonhomophone) steal (new homophone) cabin (new nonhomophone)

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Neither university students nor Korsakoff patients experienced any great difficulty answering the questions asked in the first phase of the experiment. Results from the spelling phase of the experiment are displayed in the left portion of Table II. For both Korsakoff patients and normals those results reveal a large effect of previously presenting a homophone on its later interpretation and spelling. Korsakoff patients actually revealed more evidence of memory in their spelling performance than did normals. That is, the probability of spelling a homophone in line with the interpretation biased during the question phase was higher for Korsakoff patients than for normals. This greater effect of prior presentation may be a result of the perseveration that is characteristic of the Korsakoff syndrome and that has been attributed to frontal lobe damage (Moscovitch, 1981). Perseveration in the interpretation of a word is interesting in that it might present a difficulty that the Korsakoff patient encounters when he attempts to comprehend a message. In any case, the important point is that Korsakoff patients did reveal at least a normal level of memory in their spelling performance.

As would be expected, the memory performance of the Korsakoff patients was very poor when tested by means of a procedure that required them to be aware that they were remembering – the recognition memory test given in the third phase of the experiment. As shown in the third column of Table II, the probability of a correct recognition (hit) was substantially lower for Korsakoff patients than for normals. Neither Korsakoff patients nor normals made any false recognition responses to homophones that had not been presented in the first phase of the experiment. For new nonhomophones, the probability of a false recognition response was .09 for Korsakoff patients and .08 for normals.

It is not necessary that a person be aware of remembering for past experience to influence his/her interpretation of a word. Indeed, in the present experiment, it was common for the Korsafkoff patients to greet the spelling task with an expression of relief that they were being asked to engage in a task that they could accomplish, rather than being given a test of memory. Despite the substantial influence of memory on their spelling performance, Korsakoff patients seemed to be unaware that they were remembering. Further analyses revealed evidence of this dissociation of memory and awareness for normals as well as for amnesics. For homophones that had been presented in the question phase of the experiment, 2 X 2 contingency tables were constructed with the factors being biased (low frequency) vs. unbiased (high frequency) spelling of the homophone in the second phase and recognition vs. failure to recognize the homophone in the third phase of the experiment. Chi-square tests were employed to test the independence of recognition memory and bias in spelling separately for amnesics and for normals. The obtained chi-square values were well below those required for significance. As an additional test of independence, the probability of

correct recognition in the third phase of the experiment was conditionalized on spelling being biased by memory in the second phase of the experiment [p(Rn/Sp)]. These conditional probabilities are presented in the last column of Table II. The conditionalized probability of a correct recognition did not differ significantly from the unconditionalized probability for either Korsakoff patients or normals.

#### TABLE II

Probabilities of a low frequency spelling, recognition memory, and recognition memory ( $R_{_{N}}$ ) conditionalized on low frequency spelling (Sp)

	Spelling		Measure Recognition	p (RN/Sp)
	old homophone	new homophone		
Normals	.49	.20	.76	.82
Amnesics	.63	.21	.25	.29

The dissociation of memory and awareness found in the present experiment cannot be accounted for by postulating a simple difference in threshold for the two forms of test. Performance on each type of test was independent of that of the other so recognition memory was not a prerequisite for showing an effect on interpretation or vice versa. Both normals and Korsakoff patients revealed an influence of recent experience on their interpretation of homophones, and a dissociation between this effect and recognition memory. The disadvantage of the Korsakoff patients was restricted to recognition memory, a form of test that requires deliberate remembering.

## Perceptual Identification

Further evidence for the dissociation of memory and awareness in normal subjects has been gained by means of a variety of procedures. In a study of reading transformed text, Kolers (1976) found a very low correlation between memory as measured by an increase in the speed of reading a repeated sentence, and memory as measured by a test of recognition memory. Sentences that had been read a year earlier were read more rapidly than were new sentences taken from the same source, and this increase in reading speed appeared to be independent of the subject recognizing the sentence as one he had read earlier.

Scarborough, Cortese, and Scarborough (1977) found that in a lexical decision task the effect of previously presenting an item remains constant across conditions that influence recognition memory. When asked to discriminate between words and nonwords presented in a list, subjects respond-

ed more quickly and accurately to repetitions of previously presented words. This effect of repetition on lexical decisions remained essentially unchanged when the second presentation of a word was widely separated from its prior presentation, even though the increase in separation did result in a reduction in recognition memory performance. Jacoby and Dallas (1981) argued that effects of previously presenting an item on perceptual identification do not require awareness, whereas awareness is required for recognition memory. Their argument was based on the finding of differential effects of some variables on the two forms of test. For example, level-of-processing influenced recognition memory performance while having no effect in perceptual identification.

A recent experiment of our own was conducted to provide more direct evidence of the dissociation of effects in perceptual identification and recognition memory. The procedure employed to assess the independence of these two measures of memory was similar to that employed by others to assess the independence of recognition and recall (e.g., Flexser & Tulving, 1978). In the first phase of the experiment, a long list of words was visually presented for study. A test of recognition memory for the studied words was given in the second phase of the experiment. A perceptual identification test, given in the final phase of the experiment, included 'new' words as well as words that had been studied and presented in the test of recognition memory. For the test of perceptual identification, words were flashed for 35 msec followed by a mask, and subjects were instructed to report the word that had been flashed.

The purpose of the experiment was to determine the extent to which the influence of prior study on perceptual identification is dependent on recognition memory. To assess this dependence, the probability of perceptual identification was computed separately for items that had been recognized as being old during the second phase of the experiment. If effects in perceptual identification do depend on recognition memory, the probability of perceptual identification conditionalized on recognition memory in this way should exceed the unconditionalized probability.

Included in the experiment were several manipulations intended to influence the levels of perceptual identification and recognition memory performance. First, words were either high or low frequency with regard to their occurrence in the natural language (Thorndike & Lorge, 1944). Second, the tests of recognition and perceptual identification followed the original presentation session either immediately, or after a 20 minute delay during which subjects solved math problems. Third, the recognition memory test was presented by the computer on a video screen as was the study presentation of words, prepared as a typed sheet of paper, or presented auditorily.

For each of the twelve combination of conditions, Figure 1 shows the probability of perceptual identification conditionalized on recognition

memory plotted against the unconditionalized probability of perceptual identification. The diagonal at 45° plotted in Figure 1 represents the results that would be expected if there was complete independence so that conditionalized and unconditionalized probabilities were equal. All points fell either on or very close to that diagonal. As a further indication of independence, chi-square tests computed separately for each combination of conditions all failed to reveal any evidence of dependence.



Figure 1 Perceptual identification of recognized words as a function of perceptual identification.

A single presentation of a word is sufficient to enhance subsequent perceptual identification of that word. This effect of memory on perceptual identification does not depend on recognition memory nor is enhanced perceptual identification a necessary prerequisite for recognition memory. The variables manipulated in the present study were effective in producing a relatively broad range of levels of recognition memory and perceptual identification performance. In all instances, however, performance of the two types of test were independent of one another.

The results of other experiments suggest that the effects of study in perceptual identification appear to subjects as being immediate and perceptual in nature. Previously presented words are not only detected more accurately but also with a shorter latency than are new words. More impressively, when asked to make judgments concerning the duration of the presentation of words that are briefly flashed, subjects judge old words as appearing on the screen longer than new words even though words of the two classes are presented for the same objective period of time. This effect of prior presentation parallels an effect of frequency in the language on judged duration (Warm & McCray, 1969). The important point is that the effect of prior study in perceptual identification appears to be 'perceptual' in nature, rather than being produced by subjects deliberately giving previously studied words as guesses during the perceptual identification tests.

The foregoing is to argue that recognition memory is not a prerequisite for an effect of prior experience on perceptual identification. In contrast, Jacoby and Dallas (1981) suggested that ease of perceptual identification can serve as one basis for recognition memory. If an item is readily perceived so that it seems to 'jump out' or to stay on the screen longer, a person is likely to judge that he has seen the item before in the experimental situation. The notion is that subjects become aware of the relative perceptual fluency of their identification of some items and correctly attribute that fluency to the prior presentation of those items in the study session. If relative perceptual fluency can serve as a basis for recognition memory, it should be possible to find situations in which recognition depends on perceptual identification rather than the total independence of the two tests reported earlier. Following Mandler (1980) and others, Jacoby and Dallas suggested that there are two forms of recognition memory. As an alternative to judging relative perceptual fluency, subjects can base their recognition memory decisions on the success of their attempt to retrieve the study context of an item. This retrieval of study context is seen as primarily involving the meaning of an item rather than its perceptual characteristics, and as depending on factors such as level of processing during study - factors that are not important for perceptual identification of isolated words. That recognition memory and perceptual identification can rely on different types of information or different mechanisms is consistent with the reported independence of performance on the two types of test.

By the above analysis of recognition memory, one would expect dependence of recognition and perceptual identification if the role of meaning as a basis for recognition memory was minimized. To check this possibility, a later experiment employed a procedure similar to that described earlier but used pronounceable pseudowords rather than words as stimuli. The notion was that recognition memory of pseudowords should be based largely on their perceptual characteristics. A prior presentation of a pseudoword was found to be sufficient to enhance its subsequent perceptual identification with the magnitude of the effect being comparable to that found previously for low frequency words. Recognition memory of pseudowords was also found to be reasonably accurate. In contrast to results obtained for words, however, performance on the two types of test were dependent on one another. Pseudowords that were later perceptually identified were more likely to be recognized as having been presented during study (.80) than were pseudowords that were not later perceptually identified (.70). Chi-square tests produced statistically significant results, revealing evidence of dependence.

## THEORIES OF CONCEPT FORMATION AND REMEMBERING WITHOUT AWARENESS

Several accounts of the dissociation of memory and awareness have postulated two memory systems that differ with regard to their level of abstraction (Hupert & Piercy, 1976; Kinsbourne & Wood, 1975; O'Keefe & Nadel, 1978; Wickelgren, 1979). By these accounts, both memory systems are intact in normal people, and it is primarily one of the memory systems that is disrupted by amnesia. Although these theories differ in their description of the two memory systems, they do agree that one memory system preserves more information about context than does the other. The one memory system preserves context in memory for events while the other memory system represents information in a more abstract form that is relatively context free. The distinction between episodic and semantic memory (Kinsbourne & Wood, 1975; Tulving, 1972) is currently popular; consequently, discussion will centre around that distinction, although the points to be made apply equally well to any other theory that postulates two memory systems that differ in terms of their level of abstraction.

The distinction between episodic and semantic memory is in line with an abstractionist view of concept formation. By this view, individual experiences serve as the basis for abstraction of more general rules or concepts that are then represented separately from the individual experiences from which they were abstracted. Semantic memory is memory for these concepts and rules, whereas episodic memory is memory for the individual experiences. Viewed in this way, questions about the nature of transfer between episodic and semantic memory translate into questions about concept formation. With regard to semantic memory, the occurrence of an event can contribute to the formation of a concept or act to prime an existing concept. With regard to prime and the occurrence of an event are preserved to form a memory trace of the individual episode.

An alternative view of concept formation is at odds with the distinction between episodic and semantic memory. By this alternative view, concept formation makes use of memory for individual instances as a source of generalization or analogies rather than a separate concept being abstracted (Brooks, 1978; Medin & Schaffer, 1978). The suggestion is that a concept does not exist independently from the instances of that concept, so no distinction can be drawn between memory for instances and memory for a concept. Only episodes or individual instances are stored in memory, and a new item is categorized on the basis of its similarity to these remembered individual instances. This view of concept formation differs from the abstractionist view in terms of the specificity of effects in memory performance that it predicts. By the semantic vs. episodic memory distinction, the priming of an existing concept provides a form of memory that is relatively context free. By the individual instance view, in contrast, it is always an episode or a specific instance of a concept that is being remembered, so memory is always tied to context.

The contrast between an individual instances view and an abstractionist view of concept formation can be clarified by considering accounts of the effect of repetition of a word in a list learning experiment. A strength theory provides what is essentially an abstractionist account of repetition effects. As pointed out by Hintzman (1976), a strength theory of memory assumes that the traces formed by repetition of an item pool to determine the overall strength of an association involving that item, and that the identity of traces of individual presentations of an item is lost in this pooling. Hintzman goes on to demonstrate that subjects do remember the individual presentations of a repeated word, and takes this finding as evidence for the superiority of a multiple-trace view over a strength view of memory. The multiple-trace view corresponds to an individual instances view of concept formation. However, a distinction of the same form as that between semantic and episodic memory could have been applied to account for Hintzman's results. The strengthening of an association by repetition would correspond to an influence on semantic memory, whereas memory for individual presentations of a repeated word would correspond to episodic memory. A theory of this form was employed by Huppert and Piercy (1976) to account for the memory performance of amnesics.

Most theorists, however, have not found it necessary to postulate differences in memory strength as well as differences in the number of traces to account for repetition effects. The finding of extensive effects of context in list-learning experiments has led to an emphasis on the specificity of encoding (e.g., Tulving & Thomson, 1973), and to accounts of repetition effects that are similar in form to an individual instances view of concept formation. Repetition has been described as having its effect through the formation of multiple traces (Bernbach, 1970; Hintzman, 1976) or by increasing encoding variability (e.g., Madigan, 1969). By these models the effect of repetition relies on memory for the individual presentations of an item rather than the strength of some abstract representation. Increasing the number of presentations makes it more likely that a trace representing a particular item will be retrieved by increasing the number of traces representing the particular item or by increasing the probability that there is an encoded version of the item that is similar to the cues provided at the time of the test. The random walk model proposed by Ratcliff (1978) provides another model that could be used to describe repetition effects in terms of individual traces.

The problem of accounting for the effects of frequency in the language on word recognition is identical to that of accounting for the effects of repetition in a list-learning experiment, with the exception that the boundaries within which frequency is cumulated have been broadened. Morton's logogen model for word recognition (Morton, 1969) is in some ways similar to versions of strength theory applied to repetition effects in list-learning experiments. A logogen is an abstract representation responsible for producing a phonological code whenever it is appropriate. The notion is that words are represented by logogens that differ in threshold - the amount of information that must be collected for the subject to decide that the particular word has occurred. Logogens corresponding to words that appear with a high frequency in the natural language are said to have a lower threshold than logogens corresponding to low frequency words. This claim that frequency of encountering a word influences its threshold, parallels the claim that repetition of a word strengthens some abstract representation. In addition to lowering the threshold of a logogen, presentation of a word also presumably results in the formation of a memory trace that represents that individual presentation.

As with strength theory, the effects of context are important for evaluating the logogen model of word recognition. The effect of prior presentation on a word's later perceptual identification may depend heavily on recreating the context of that prior presentation. If so, it is again tempting to account for the effect in terms of memory for the particular prior presentation of the word, as opposed to postulating that that presentation has served to lower the threshold of a logogen.

To summarize, the dissociation of memory and awareness can be interpreted as being due to the existence of two memory systems that differ in terms of their level of abstraction. Presentation of a word may serve to prime an abstract representation of that word without a trace of the individual presentation being preserved, so that effects in perceptual identification are found in the absence of recognition memory. The memory system that represents events at a more abstract level may be intact in amnesics, although amnesics are incapable of representing individual events. Interpretations of this form are most compatible with an abstractionist view of concept formation, and predict that the effects of prior experience can be relatively context-free. In contrast, an individual instances view of concept formation does not allow a distinction between semantic and episodic memory, and predicts that the effects of prior experience are always context specific. Evidence that is to be reported is in line with the individual instances view, and discourages an episodic-semantic distinction as an account of the dissociation of memory and awareness.

### THE SPECIFICITY OF REMEMBERING WITHOUT AWARENESS

It has been claimed that amnesics are incapable of remembering unique events. Effects of recent experience that are observed in the performance of amnesics have been attributed to the activation of existing concepts (e.g., Milner, 1970; Wickelgren, 1979) or to the development of skills that do not rely on memory for individual events (Cohen & Squire, 1980; Moscovitch, 1981). The experiments that have been conducted, however, do not rule out the possibility that amnesics have relatively normal memory for events but are incapable of aware forms of remembering.

Effects on performance revealed by amnesics may be more specific than has been credited. In the spelling experiment reported earlier in this paper, it seems at least possible that the influence of memory on the interpretation of homophones was specific to the experimental situation. Milner (1970) reported that prior exposure to an intact picture allowed the famous amnesic H.M. to identify incomplete versions of that picture more readily. This effect of prior training was attributed to the activation of existing knowledge rather than to the acquisition of new information. It would be useful, however, to systematically vary the relationship between the studied picture and the incomplete picture that is to be identified. Rather than a general memory being activated, the amnesic may remember the specific picture that he studied so that, for example, changing the orientation of the object portrayed between the studied and incomplete version of the picture would reduce the effect of prior study. Cohen and Squire (1980) found that amnesics acquired the skill of reading inverted text as readily as did normals. Amnesics also revealed some memory for the specific words that had been read by reading repeated inverted words faster than new ones. Cohen and Squire interpret these results as revealing normal skill learning by amnesics but an impaired declarative form of memory, memory for the specific words that were read. In studies of reading inverted text employing normal subjects, however, Kolers and his colleagues (e.g., Kolers & Magee, 1978) have shown that the effects of training are specific to the orientation of the text, the words read, type font, order of approximation to English, and the spacing of letters. In contrast to the position taken by Cohen and Squire, the skill of reading inverted text does not seem to be abstract in the sense of being divorced from the specific material that has been the object of prior practice.

It was suggested earlier that the effect of study on subsequent perceptual identification may be due to the priming of an abstract representation such as a logogen, and that the dissociation of effects in perceptual identification and recognition memory can be accounted for in terms of this priming. Memory for a single presentation of an item, however, can influence perceptual identification performance. In our laboratory, Paul Gabel has found effects of a single presentation of a nonword on later perceptual identification of that nonword; also, Gordon Hayman has found large effects of repeating nonwords in a lexical decision task (see also McKoon & Ratcliff, 1979). These effects cannot be accounted for in terms of logogens unless a single presentation is sufficient to establish a logogen.

It seems likely that the effect of presenting a word on its later perceptual identification relies, at least partially, on memory for the individual presentation. Morton (1969) accounts for the perceptual identification advantage of high-frequency over low-frequency words by postulating that the threshold of a logogen reflects the frequency in the language of the word that it represents. Morton goes on to suggest that a threshold can be temporarily lowered by presentation of a word, but will recover to a level that reflects the words's frequency in the language. However, Jacoby and Dallas (1981) found that a single presentation of a word during study was sufficient to largely eliminate the advantage of high-frequency words in subsequent perceptual identification, and that the effect of a study presentation was not significantly diminished over a 24-hour interval. Similarly, Scarborough, Cortese, and Scarborough (1977) have employed a lexical decision task to show that a prior presentation of a word in the experimental setting has long-lasting effects and largely eliminates the effect of frequency in the language. Results of this sort are problematic for the logogen model, in that if the effects of presentation persist over the long term, thresholds of all logogens should eventually be permanently lowered, and high-frequency words will have no selective advantage. Word recognition seems too sensitive to the effects of a single prior presentation to be due totally to the involvement of a context-free abstract representation.

Morton (1969) allows for context effects by postulating that input from a cognitive system can act to lower the threshold of a logogen. However, an important question concerns the specificity of the information about context that is preserved and that acts to influence perceptual identification. If one assumes that contextual information that is specific to a single presentation of an item is preserved and is employed through the cognitive system, the model becomes equivalent to an individual instance model of word recognition. If effects in perceptual identification, like recognition memory, depend on memory for an individual presentation, the dissociation of the types of memory performance cannot be accounted for in terms of different memory systems. We now present a description of research investigating the effects of different types of change between word presentation and a subsequent test of perceptual identification. By the semantic-episodic dis-

tinction, recognition memory reflects episodic memory while effects on perceptual identification reflect semantic memory. Results that are to be reported, however, reveal that effects in perceptual identification are as context specific as is recognition memory.

## Modality Specificity

The effects of previously studying an item on its subsequent perceptual identification can be largely eliminated by changing the modality of presentation between study and test (Jacoby & Dallas, 1981; Morton, 1979; Postman & Rosenzweig, 1956). In a study reported by Jacoby and Dallas (1981), a subject having previously heard a word in the experimental situation did not significantly enhance later visual perceptual identification of that word, although having previously read the word was sufficient to more than double the probability of its later correct perceptual identification. Morton (1979) interprets the modality specificity of the effects of prior training as evidence of the existence of two logogen systems – one system that deals with visual input, and a second system that deals with auditory input. This increase in the number of logogen systems that is postulated reduces the level of abstraction that is still well above that of memory for individual presentations of a word.

The specificity that is important for obtaining effects in perceptual identification may be the specific way in which a person deals with an item during study rather than the particular modality in which an item is presented. An experiment conducted in our laboratory presented words auditorily but required subjects to spell the words prior to a later test of visual perceptual identification. Previously spelling a word did almost as much to increase the probability of later perceptual identification (.63) as did previously reading a word (.72). The probability of perceptual identification of words that had not been previously presented was .42. One possibility is that spelling a word can make use of a remembered visual representation of that word, and imagining a word may be functionally equivalent to perceiving the word (Finke, 1980). In this vein, transfer from visual study to auditory perceptual recognition has been found (Postman & Rosenzweig, 1956), and may result from the subject saying the visually presented words to himself during study. Although reasonable, the above interpretation makes the task of assessing specificity effects a more difficult one. Specificity becomes subjective rather than objective, in that it must be defined in terms of a person's processing of an event rather than in terms of the objective circumstances.

## Effects of Changes in Visual Similarity

Postulating the existence of two logogen systems in reaction to the modality-specificity of the effects of prior training amounts to a relatively

minor modification of the logogen system. The representation that is said to be involved in word recognition is still a very abstract one. Much more drastic modification of the logogen model would be required if transfer within a modality was found to depend on the physical similarity of the study and test versions of a stimulus. As an extreme example, it might be necessary to postulate a separate logogen system for every typescript or handwriting in which a word could appear.

Morton (1979) reports that perceptual identification of words presented in a typewritten format was enhanced equally by prior study of those words presented in a handwritten format as by prior study of the words presented in a typewritten format. Other experiments, however, have employed different procedures and found an effect of changing the visual appearance of items. A change in typeface reduces the amount of transfer gained from prior practice in reading inverted text (Kolers & Perkins, 1975; Kolers, Palef, & Stelmach, 1980). As a second example, a change between words presented in alternating upper and lower case and words presented in uniform lower case reduces transfer in a scanning task (Brooks, 1977).

The effects on perceptual identification of changing the case of the type in which an item is presented have been investigated in a series of experiments conducted in our laboratory. These experiments have revealed an effect of change in case between study and test, but the effect has been consistently small. For low-frequency words tested in lower case, for example, the probability of perceptual identification of words presented in lower case for study was .76 while that for words presented for study in upper case was .70. In that experiment, the probability of perceptual identification of words that were tested in lower case but not previously studied was .53.

There is some specificity but still a good deal of transfer across changes in case found in studies of perceptual identification. This pattern of results could be accounted for by claiming that in addition to influencing the threshold of a logogen, presentation of a word results in a memory trace of that individual presentation being formed. Effects of changing the appearance of an item between study and test could then be attributed to the involvement of these memory traces in word recognition. However, traces of individual episodes are then allowed to be involved in perceptual identification, so the dissociation of perceptual identification and recognition memory is no longer accounted for. Further, recognition memory is not fully specific to the case in which a word is presented (Kirsner, 1974), so some less specific representation is also required to account for recognition memory performance. As is true for perceptual identification, the effects of change in case are small in recognition memory.

### List Context

Maintaining list context between study and test may be important for finding effects of prior study in perceptual identification. One way this variable could operate is to influence the subject's awareness of the relationship between study and test. The subject may have to be aware of the relationship before he employs his memory for the studied items during the perceptual identification test. Murrell and Morton (1974) used procedures that insured awareness by presenting a short list of words for study and instructing the subjects to keep those words in mind during the later test of perceptual identification. Jacoby and Dallas (1981) employed much longer lists of words, but a relatively high proportion of the studied words appeared in the test of perceptual identification. The proportion of the items that are common to study and test may be important for finding effects in perceptual identification. To check this possibility, an experiment was conducted in which either 90% or 10% of the words appearing in the test of perceptual identification had been previously studied. The results of that experiment are displayed in Table III.

#### TABLE III

Probability of perceptual identification as a function of the proportion of items studied

	Proportion Studied			
Item Type	90%	10%		
Old	.66	.55		
New	.31	.37		

Perceptual identification of previously studied words was more probable when the bulk of the tested words had been studied previously. However, even when only 10% of the tested words had been previously studied there was still a large effect of prior study on later perceptual identification. If this effect of prior study depended on awareness of the relationship between study and test, one would expect the effect of prior study to increase across the serial position of old items in the perceptual identification test as subjects 'caught-on' to the relationship. However, even the first old item in that test showed enhanced perceptual identification, and there was no evidence of the amount of facilitation increasing across the serial position of old test items.

Increasing the proportion of words in the perceptual identification test that had been previously studied not only increased the probability of perceptually identifying those old words, but also decreased the probability of identifying words that had not been previously studied, (new words). This pattern of results has also appeared in other studies that we have done, and is in some ways similar to effects of frequency in the language found in perceptual identification. As shown by analyses of errors, the advantage of high frequency words in perceptual identification is a result of subjects' bias towards responding with high rather than low frequency words (Broadbent & Broadbent, 1975). Similarly, reductions in the probability of perceptually identifying new words can be interpreted as being due to an increase in bias towards responding with an old word.

To interpret the effects of list context, one might be tempted to argue that the criterion a subject employs involves an implicit test of recognition memory. A person may be more willing to output an item as a response during the test of perceptual identification if he recognizes that item as having been studied. The problem with this account is that it attributes the effects of prior study on perceptual identification to an influence on recognition memory; and perceptual recognition and recognition memory have previously been shown to be independent of one another. The effects of prior study are larger when list context is preserved, but recognition memory of an item is not required for its enhanced perceptual identification.

### Environmental Context

Perhaps the effect in perceptual identification of previously studying an item depends on the environmental context remaining constant between study and test. An experiment conducted in our laboratory was designed to check this possibility. In that experiment, only 10% of the items tested had been studied previously, and those items had been presented only once during study. The perceptual identification test was given 24 hours after study and subjects were neither forewarned of this test nor told about the relation between study and test. To manipulate environmental context, the room, the experimenter, the presence vs. absence of background music, and the computer used for stimulus presentation was either changed or held constant between study and test. This manipulation of environmental context had no significant influence on perceptual identification performance. The probability of perceptually identifying an item that had been previously studied (.76) was still substantially higher than that of perceptually identifying new items (.57), even in the condition that employed an extremely changed test context.

The manipulation of environmental context in the above experiment may not have been sufficiently extreme to produce an effect. In the changed environment condition, the perceptual identification test was still in the context of a psychology experiment and items were presented by means of a computer. There is some evidence that a more extreme manipulation does have an effect. Douglas Nelson at the University of South Florida, in collaboration with the first author of the present article, recently ran a few pilot subjects for an investigation of effects in perceptual identification. Not being a slave to computers, Nelson presented words by means of a slide projector for study and used a tachistoscope situated in another room to present items for the perceptual identification test. Under these conditions, no effect of previously presenting an item was found in subsequent perceptual identification performance. For the main experiment, the procedure was changed so that items were presented by means of the tachistoscope for both study and test, and a substantial effect of prior study was obtained. A difficulty with more extreme manipulations of context of the sort used by Nelson is that a change in environmental context is confounded with a change in the visual appearance of items between study and test. A word looks very different when presented by means of a slide projector than when presented in a tachistoscope, and the effective manipulation may have been this change in appearance rather than the change in room and viewing conditions.

Others have investigated the influence of changes in environmental context on deliberate forms of remembering (see Craik, 1981 for a review). Although effects are consistently found when recall tests are employed, recognition memory appears to be insensitive to changes in environmental context. In our experiment a test of recognition memory, like the perceptual identification test, failed to reveal an effect of environmental context. Perhaps list context and similarities in the physical characteristics of the study and test versions of an item overwhelm the effect of environmental context in tests of perceptual identification and recognition memory. In any case, there is no evidence that recognition memory is any more dependent on environmental context than are effects of prior study in perceptual identification. A difference in dependency would be expected if recognition memory is based on memory for a particular event, whereas effects in perceptual identification reflect the operation of a more abstract form of memory.

### CONCLUDING COMMENTS

The obtained specificity of effects encourages the view that the influence of prior training on perceptual identification relies partially, at least, on memory for the individual prior presentations of items rather than on the lowering of the threshold of a logogen. Memory for individual instances is involved in perceptual identification performance as well as in recognition memory. Recognition memory is reduced by changes in modality or type font between study and test (Kirsner, 1974, 1973). Similar effects are found in perceptual identification. Neither perceptual identification nor recognition memory are easily influenced by changes in environmental context. Further, in some cases, it appears that enhanced perceptual fluency can serve as a basis for recognition memory. It does not appear, then, that the dissociation of effects in recognition memory and perceptual identification can be accounted for in terms of the one employing a more abstract memory representation than does the other. In general, the specificity of the effects of prior training may be too great to allow the distinction between episodic and semantic memory to account for the dissociation of memory and awareness.

Others (Anderson & Ross, 1980; McCloskey & Santee, 1981; McKoon & Ratcliff, 1979) have not identified the semantic vs. episodic distinction with theories of concept formation, but have questioned its utility on different grounds. If one accepts an abstractionist view of concept formation so that a distinction is drawn between memory for concepts and memory for instances of those concepts, questions about the interrelatedness of the two forms of memory remain. A strong version of the episodic-semantic distinction would claim that concepts are represented totally separately from instances and in a different format so that there are two completely independent memory systems. It is this version of the semantic-episodic distinction that has been attacked most often (e.g., Anderson & Ross, 1980). The attack has been that semantic and episodic memory do not operate as separate systems since similar effects can be found in 'episodic' and 'semantic' memory tasks. In contrast, we have found a clear dissociation of performance on a semantic memory task (perceptual identification) and performance of an episodic memory task (recognition memory), but are still uneasy about accepting the distinction between episodic and semantic memory. Again, the source of our uneasiness is the specificity of the effects of prior experience found in the perceptual identification task. Although recognition memory and effects in perceptual identification can be independent of one another, both seem to rely on memory for individual prior presentations of an item. We prefer to view the semantic-episodic distinction in terms of theories of concept formation because such a view makes contact with problems that have been well-worked (e.g., repetition effects) and because of the directions in which it points future research. The choice among theories of concept formation is basic to the distinction between episodic and semantic memory.

The semantic-episodic distinction provides only for the two extremes of context specificity. The information represented in semantic memory is said to be largely context-free while episodic memory preserves information about the context in which an event occurred. It seems likely that degrees of context specificity, in addition to the two extremes, exist. Garner (1976) distinguishes among separable, configural, and integral dimensions in his description of perception. Similar distinctions applied to the relationship between memory for an event and its context may be useful (see Baddeley & Woodhead, this issue). In any case, a more precise definition of context and a greater differentiation of forms of context seems necessary.

In contrast to the account in terms of differences in representation offered by the semantic-episodic memory distinction, the dissociation of memory and awareness could be accounted for in terms of differences in retrieval. Interpretations of the independence of recognition and recall have emphasized differences in retrieval (e.g., Begg, 1979; Flexser & Tulving, 1978), and a similar account might be applied to the independence of recognition memory and perceptual identification, or any other tests that produce results that are taken as evidence of a dissociation of memory and awareness. Instructions to subjects and the cues provided by the test situation are certainly different for a perceptual identification test and a recognition memory test, and it seems reasonable that these differences might influence retrieval. As pointed out by McClosky and Santee (1981) in their discussion of the distinction between episodic and semantic memory, effects interpreted as evidence for separate memory systems can be reinterpreted as evidence of differences in retrieval.

Deliberate forms of remembering may require conscious analysis on the part of a subject whereas remembering without awareness does not. Remembering without awareness may operate in an early passive phase of processing that is involved in a variety of tasks. Theories directed at several areas of cognition postulate a passive phase of processing that precedes a second more active phase. In problem solving, hypothesis generation is sometimes described as being relatively passive and as preceding an eval-uative phase. Broadbent and Broadbent (1980) account for word recognition in terms of a passive/active or perceptual cycle model. Similarly, Neisser (1967) distinguishes between preattentive processing and focal attention. For present purposes, the key notion is that a first phase involves pas-sive access to memory for prior events to provide an initial interpretation of a later event; in a second phase, more active analytic processing serves to evaluate and possibly modify that initial interpretation. By this view, awareness that one is remembering can be seen as a result of active processing and as following passive access to memory; that is, the judgment that one has remembered comes after a passive form of remembering. Jacoby and Dallas (1981) relate the problem of judging that one is remembering to the more general problem of the relationship between effects in performance and introspective reports (Nisbett & Wilson, 1977). It is the active phase of processing that Korsakoff patients are seen as being unable to carry out, and that underlies their deficit. The distinction between forms of processing cuts across interpetations in terms of storage and retrieval in that a deficiency in more active processing has consequences for both storage and retrieval (Jacoby, 1981).

Regardless of the eventual interpretation of the dissociation of memory and awareness, procedures designed to investigate memory without awareness are likely to be useful for understanding the memory processes of normal subjects as well as those of amnesics. It seems to us that research on memory has concentrated too heavily on deliberate forms of remembering. Memory for a prior experience can play an important role in

the interpretation of later events even if one is not consciously aware of remembering. Effects of this sort may be important in complex tasks as well as the simple ones discussed here. As an example, consider the amnesic's ability to comprehend text. A subtest in the Wechsler Memory Scale consists of a paragraph that is to be heard and then recalled. Very poor recall is among the criteria employed to classify a patient as being amnesic. Although the patient cannot recall the paragraph, he may be able to use information gained from that paragraph as a context for the interpretation of later presented material. We plan to check this possibility by using a listening through noise task (Hannigan, Shelton, Franks, & Bransford, 1980) to see if having heard a relevant prior paragraph will provide a context that allows the amnesic to identify words better when played through white noise. Manipulations of the structure of the paragraph and comparisons with normals may be useful for gaining information about the processes involved in comprehension and the disruption of those processes by amnesia. Some parts of the comprehension process may involve deliberate remembering while others involve memory without awareness and are not disrupted by amnesia.

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