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Perceptual Enhancement: Persistent Effects of an Experience

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Presenting a word enhances its later perceptual identification. This article focuses on the relation between this effect on perception and recognition memory. Prior experiments have revealed that perceptual enhancement is independent of recognition memory and have led to the two types of task being identified with separate memory systems. In contrast, the present experiments reveal parallel effects on the two types of task. Perceptual enhancement persists over days but, like recognition memory, is influenced by manipulations of retrieval conditions. I conclude that both perceptual and memory tasks rely on the retrieval of memory for whole prior processing episodes but can differ in terms of the number and nature of retrieval cues that they provide. I describe perception and memory within a common framework.

Presenting a word enhances performance on a number of later perceptual tasks, including tachistoscopic identification (e.g., Jacoby & Dallas, 1981), completing word fragments (Tulving, Schacter, & Stark, 1982), solving anagrams (Jacoby & Dallas, 1981), reading inverted text (Kolers, 1976), and making lexical decisions (Scarborough, Cortese, & Scarborough, 1977). This enhancement shows that memory for a single prior presentation of a word affects its later perception. An important question is what the relation is between this perceptual test of memory and the more conventional recall or recognition tests of memory for prior events. One possibility is that the perceptual tasks differ from other tests of memory only in the sensitivity of the measures that they provide. This view would be consistent with traditional "strength" or "threshold" views of the relation between different tests of memory. Evidence against this possibility is the demonstration of independence of perceptual enhancement and recognition memory (Jacoby & Witherspoon, 1982; Tulving et al., 1982). Such independence shows that perception is not just a more sensitive measure of memory of a prior event than is a recognition memory task. Another possibility emphasizes the independence of performance on perceptual and recognition memory tasks by identifying the two types of task with separate memory systems. By this second possibility, the memory system that underlies perceptual enhancement is separate from the episodic memory system that is responsible for recognition memory (Tulving et al., 1982).

A third possibility, supported in this article, is that perceptual and recognition memory tasks depend on different aspects of memory for whole prior processing episodes. A perceptual task provides retrieval cues that make closest contact with the perceptual processing aspects of the prior event; a recognition memory test provides a different type and number of cues that make contact with different aspects of memory for the prior event. Whether performance on these tasks will be correlated or independent depends on details of the original processing and how it interacts with the particular cues provided by the retention test. The relation between perceptual and recognition memory tasks, then, is treated in the same way as is the relation between recognition memory and recall (e.g., Mandler, 1980; Tulving, 1976). Independence between perceptual enhancement and recognition memory has been demonstrated previously. In the current article, the contrasting case of parallel effects of manipulations on the two types of task are presented. The variable relation between perceptual enhancement and recognition memory shown by the combination of these two sets of results is awkward for a theory that identifies the tasks with different memory systems. Other

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aspects of the data in this article provide additional difficulty for the currently popular approach that treats the memory system underlying perception as a system very different from the one responsible for recognition memory. Performance on tests of recognition memory are typically described as relying on memory for particular episodes (e.g., Tulving, 1976). In contrast, perception is seen as using more general, abstract representations of knowledge such as schema or logogens (Friedman, 1979; Morton, 1979). These abstract representations do not preserve information about individual episodes and change very slowly, although temporary priming is possible. By Morton's (1969, 1979) model of word perception, for example, prior presentation of a word can temporarily lower the threshold of its corresponding logogen and thereby reduce the amount of visual information that is required for the word to be identified.

According to the logogen view, an important difference between the memory system underlying perception and the episodic memory responsible for recognition memory is the magnitude and persistence of effects that can be gained from a single presentation of a word. Large and persistent effects of a single presentation are predicted for a test of recognition memory but not for a test of perception. For recognition memory, the focus of research has been on factors influencing retrieval of memory for the relevant prior episode rather than on time-dependent factors such as decay. Among the factors that are considered important for retrieval is the similarity between the context in which an item is studied and the context in which the item is presented at test (e.g., Tulving, 1976). In contrast, permanent effects on perception are supposedly gained only through a large number of repetitions of a word. The repetitions of a word combine to determine permanent differences in the threshold of logogens so that logogens representing words that occur with a high frequency in the language have a lower threshold than do those representing low-frequency words (Morton, 1979). This pooling of repetitions does not preserve information that is unique to an episode that corresponds to any single presentation of a word. Consequently, variables that are important for retrieval of episodes and that therefore influence recognition memory should have no effect on perception. The effect of a single presentation of a word on its later perception should be short-lived and uninfluenced by manipulations of context and other variables meant to affect retrieval.

In contrast to the above view, recent results have shown that perceptual identification is too sensitive to a single prior presentation of a word to be totally reliant on an abstract representation such as a logogen. First, the effect of a prior presentation is larger than could be expected. The effects of frequency in the language can be greatly diminished by a single presentation of words prior to their test of perceptual identification (e.g., Jacoby & Dallas, 1981). That is, a single presentation of a low-frequency word is sufficient to overturn, to a large extent, a disadvantage that has accrued over a long history of differential exposure to high- and low-frequency words. Second, effects on perceptual identification are too long lasting to be caused by an influence on the threshold of a logogen. The prior presentation of words is said to lower temporarily the threshold of their corresponding logogens. However, the effects of a prior presentation persist over at least 24 hr. in visual perceptual identification (Jacoby & Dallas, 1981) and have been shown to last for a year in an investigation of reading inverted text (Kolers, 1976). It cannot simply be assumed that a single presentation of a word is sufficient to permanently lower the threshold of its corresponding logogen. The notion of a threshold becomes meaningless when used to account for large and persistent effects of a single presentation of a word on its later perception.

The persistence of perceptual enhancement encourages the view that perception relies on memory for prior episodes. To provide further support for this view, experiments are needed to show that variables that are thought to influence retrieval from episodic memory are important for perceptual enhancement as well as for recall and recognition memory. The present experiments investigated the effects on perceptual enhancement of several variables of this sort. In a first experiment, the proportion of items in the perceptual identification test list that had been previously presented for study was varied as a means of manipulating list context. In later experiments, the effects of retention interval, environmental context, and the number of prior and interpolated lists was investigated. When these variables were manipulated in a fashion that was unfavorable for retrieval of memory for the prior presentation of a word, perceptual enhancement was diminished. Effects found in perceptual identification generally parallel those found for the same variables in recognition memory.

Finding parallel effects on recognition memory and on perceptual identification corresponds to a correlation between performance on the two types of task and brings with it all of the problems of interpreting a correlation. On the one hand, effects on perception might be mediated by effects on recognition memory. Subjects might be biased toward reporting words on a perceptual task that they recognize as having been previously studied. On the other hand, effects on perception might mediate recognition memory. Prior presentation of a word may cause the subject to perceive the word more readily, and this increase in relative perceptual fluency might serve as one basis for a subject judging that he or she has previously studied the word (Jacoby & Dallas, 1981). I favor the latter alternative. Under the former alternative, increases in recognition memory performance should invariably be accompanied by an increased effect of a prior presentation of a word on its perception. In contrast, independence in performance of the two types of tasks is often observed. The variable relation between performance on the tasks is understandable if perceptual enhancement serves as only one basis for recognition memory (Jacoby & Witherspoon, 1982).

However, perceptual enhancement may be due to a perceptual bias. In their discussion of the effect of frequency in the language on word perception, Broadbent and Broadbent (1975) attributed the advantage of high-frequency over low-frequency words to a bias in responding that combines in a multiplicative rather than an additive fashion with information gained from the stimulus. A multiplicative relation was postulated because the advantage of high-frequency words in correct perception is greater than could be predicted by using intrusion errors to calculate differences in the probability of giving high- versus low-frequency words as guesses and by then claiming that this guessing bias added to "true" perception. In the present experiments, analyses of intrusion errors reveal that perceptual enhancement is not caused by an additive effect in which previously presented words will more likely be given as guesses. However, the importance of bias is indicated by a finding that the perceptual enhancement of previously presented words is often offset by poorer identification of "new" words so that no overall advantage in perceptual identification is gained from prior study. To account for these results, I suggest a view that is similar to current theories of perception (Broadbent & Broadbent, 1975; McClelland & Rumelhart, 1981) in that information gained from a stimulus combines with a memory bias toward some items. However, bias relies on retrieval of memory for prior episodes rather than reflects the threshold of an abstract representation. The resultant model is appropriate for describing effects on recognition memory or recall as well as effects on perception.

General Method

Because one basic paradigm is used throughout the series of experiments, the method is described in detail at this point. Variations in the general method will be indicated as each experiment is described.

The subjects were volunteers from an introductory psychology course at McMaster University who served in the experiment for course credit. Subjects were randomly assigned to conditions and were tested individually.

Each experiment included a study phase and a test phase. During the test phase, words that had been studied and "new" words were intermixed and presented for a perceptual identification test. Stimuli were presented by means of a PDP-8A computer. The video screen of this system measures 26.5 × 18.5 cm. The screen was covered by a black construction-paper mask that contained a centered window that was 8.5-cm long and 1-cm tall; words were presented in this window. Character size was approximately 2.8 × 5.1 mm. Words were presented in all capital letters. Subjects were seated such that their viewing distance was approximately 60 cm.

The study phase was introduced to subjects as a test of reading. Words were presented at a 1-sec rate, and subjects were instructed to read each word aloud as it was shown. Subjects were informed that their reading latency for each word was being recorded and were instructed to read the presented words as rapidly as possible. These instructions served to provide a cover task; reading latencies were not recorded. Subjects were not told of the impending test of perceptual identification.

Prior to the test of perceptual identification, subjects were told that words would be flashed on the screen and that they were to report each word immediately after its presentation. They were encouraged to respond to each test item, guessing if necessary. The sequence of events accompanying presentation of a word were as follows: First the message, "Press when ready," appeared on the screen and remained there until the subjects pressed a button mounted in a box that they held on their lap. After the button was pressed, the original message left the screen, and a set of markers (two short horizontal lines) appeared on the screen for 500 msec, surrounding the location in which the word would be presented. Immediately after presentation of the word, a mask (a series of ampersands of the same length as the word) appeared in the same location as had the word and remained on the screen for 2 sec. This sequence of events was then repeated until the entire test list had been presented. For the main test list, words were presented for 35 msec prior to replacement by the mask. Before the main test list was presented, a practice list was presented to shape perceptual identification performance. This practice list contained 10 words that did not appear either in the study phase of the experiment or in the main test list. The first of these 10 words was presented for 135 msec, a duration that allowed nearly all subjects to report the presented word. The presentation duration of each successive word in the practice list was then decreased by 10 msec so that the last word appeared for 45 msec, a duration near that for which items in the main test list were presented.

Experiment 1

Prior experiments have used procedures that were likely to produce awareness of the relation between study and the perceptual identification test. The procedures used by Murrell and Morton (1974) ensured awareness by presenting a short list of words for study and instructing subjects to keep those words in mind during the later test of perceptual identification. Jacoby and Dallas (1981) used much longer lists of words, but a relatively high proportion of those words appeared in the test of perceptual identification. The proportion of the words that were common to study and to the test was manipulated in the present experiment. Either 90% or 10% of the words appearing in the test of perceptual identification had been previously studied. In the condition in which 90% of the tested words had been previously studied, subjects were informed that a large majority of the words that would be tested had been previously studied. In contrast, subjects in the 10% condition were not informed that any of the words that were to be tested had been previously studied. Obscuring the relation between study and test was expected to decrease the probability of retrieving memory for the prior presentation of a word and thereby to reduce later perceptual enhancement of that word.

Method

Subjects. A total of 36 volunteers served in a 1-hr. session.

Design and materials. A list of 90 words was presented for study, and a list of 100 words were presented in a test of perceptual identification. In one condition, the test list included the 90 words that had been previously studied plus 10 new words so that 90% of the tested words had been previously studied. In a second condition, only 10% of the tested words had been previously studied; the test list used in that condition consisted of 10 old words and 90 new words.

All words were five-letter nouns. A pool of 180 words was selected from the Thorndike-Lorge (1944) wordbook; 60 of the selected words were low frequency (1 to 5 per million), 60 were medium frequency (10 to 49 per million), and 60 were high frequency (A and AA) as scaled by Thorndike and Lorge. Words from this pool were used in the construction of two 90-word study lists. Each list contained 30 words from each of the three levels of frequency in the language. With the exception of a set of 10 critical low-frequency words, these two study lists were nonoverlapping with regard to the words that they contained. A test list was constructed by adding the 10 remaining low-frequency words to one of the two study lists. It was arranged that when the test list was preceded by the study list from which it was constructed, 90% of the tested items had been previously studied, whereas if preceded by the other study list, only 10% of the tested items would have been previously studied. This arrangement generated one set of 10 words that was critical in that the words were old and a second set of 10 words that was critical in that the words were new in the test of perceptual identification, regardless of the study list (and the proportion overlap condition defined by it) that was used. For presentation, there were three random orders of words for each of the study lists and two random orders for the test list. Within each experimental condition, determined by the study list given, each of the six combinations of study order and test order was received by three subjects.

Procedure. Subjects in the 90% overlap condition were informed that the perceptual identification test would consist of words that they had just read, whereas subjects in the 10% overlap condition were not informed of the relation between study and test. Subjects in this latter group were told that a new list of words was to be presented for the perceptual identification test. Except for the time devoted to instructions, the perceptual identification test immediately followed study.

Results and Discussion

Perceptual identification of critical old test words that were common to the two proportion overlap conditions and the critical new test words that had not been previously presented for either of these two conditions was of primary interest. The probability of perceptual identification of those critical old and new words is displayed separately for each of the proportion overlap conditions in Table 1. Analysis of those data revealed both a significant effect of prior study, $F(1, 34) = 104.87, p < .05, MS_e = .001$, and a significant interaction of prior study with the proportion of test words that had been previously studied, $F(1, 34) = 10.24$, $p < .05$, $MS_e = .001$. Presenting a word during study had a larger effect on its subsequent perceptual identification when 90% rather than 10% of the words that were tested had been previously studied. Even when only 10% of the test words had been previously studied, however, prior study still had a substantial effect on perceptual identification. Decreasing the proportion of words that had been previously studied not only decreased the probability of perceptually identifying old words but also increased the probability of perceptually identifying new words.

An analysis of intrusion errors did not reveal any difference between the two proportion overlap conditions regarding the bias of giving a previously studied word as a response. The probability of giving a critical old word as an intrusion error was .003 in each of the proportion overlap conditions. To compute an estimate of the probability of correctly guessing an old word, the probability of an intrusion error can be multiplied by 1/100 (1/the number of words tested). This multiplication is necessary because the guessed word must coincide with its presentation in the test list for the guess to be counted as correct. The resulting probabilities are so low as to make it clear that differences in pure guessing played little role in producing either the perceptual enhancement of old words or the dependence of perceptual enhancement on the proportion of tested words that had been previously studied.

Table 1
Perceptual Identification of Critical Words in Experiment 1

Word type	Proportion overlap	
	90%	10%
Old	.66	.55
New	.31	.37
Difference	.35	.18

An additional analysis involved words that were not shared by the two study lists. For the 90% overlap condition, all of these nonshared words had been presented during study, whereas for the 10% overlap condition, none of these words had been previously presented. The comparison across conditions, then, corresponds to a between-subjects comparison of the effect of prior study, and the interaction of that effect with frequency in the language. The probability of correct perceptual identification for each combination of conditions is displayed in Table 2. Analysis of these data revealed a significant effect of condition (old vs. new), $F(1, 34) = 8.27$, $p < .05$, $MS_e = .145$, a significant effect of frequency in the language, $F(2, 68) = 72.71$, $p < .05$, $MS_e = .006$, and a significant interaction between those two variables, $F(2, 68) = 5.07$, $p < .05$, $MS_e = .006$. Regardless of the level of frequency in the language, presentation of a word during study enhanced its subsequent perceptual identification; however, this effect of prior study was greater for low- and medium-frequency words than for high-frequency words. The pattern of results obtained in the present experiment is identical to that obtained in experiments that have manipulated prior study and frequency in the language within subjects (e.g., Jacoby & Dallas, 1981).

Table 2
Probability of Perceptual Identification of Noncritical Words in Experiment 1

Proportion overlap	Frequency		
	High	Medium	Low
90% (old)	.78	.74	.63
10% (new)	.61	.55	.35

The most important finding in the present experiment was that obscuring the relation between study and test reduces perceptual enhancement. The manipulation of the proportion of the tested words that had been previously studied and the manipulation of instructions were confounded, so it is not possible to assess their differential contribution to producing the results. However, it is likely that the manipulation of proportion overlap was at least partially responsible for the observed effects. That manipulation produces variation in the similarity of the study and test list context. The results of later experiments further implicate that similarity in list context is important for producing perceptual enhancement. Similar effects of list context have been found in investigations of recognition memory and attributed to an influence of context on retrieval (e.g., Jacoby, 1972; Todres & Watkins, 1981).

Experiment 2

The effect of retention interval was investigated in a second experiment. As in the small proportion overlap condition of the prior experiment, only 10% of the words presented for perceptual identification had been previously studied. The test of perceptual identification either immediately followed presentation of the study list or was delayed for 24 hr. Jacoby and Dallas (1981) did not find a significant reduction in perceptual enhancement across a 24-hr. retention interval. However, in their experiment, a relatively large proportion of the words that were tested had been previously studied. The effect of retention interval might be more pronounced when the relation between study and test is obscured as in the present experiment.

Method

Subjects. A total of 32 students enrolled in an introductory psychology class served as subjects.

Design and materials. Only 10% of the words presented for perceptual identification had been previously studied. The test of perceptual identification either immediately followed presentation of the study list or was delayed by 24 hr. Retention interval was manipulated between subjects.

The construction of the study and the test lists was identical to that for the 10% condition in the prior experiment. Ninety words comprised the study list whereas 100 words were presented for perceptual identification. Each of three levels of frequency in the language were represented by 30 words in the study list and by a different set of 30 words in the test list. Ten low-frequency words in the test list were critical in that they had been previously studied. A second set of 10 low-frequency words served as critical new items. Unlike the prior experiment, two lists formats were constructed such that words that served as critical old items in one format served as critical new items in the other and vice versa. Although this change in materials makes comparisons across experiments difficult, the use of two list formats serves to unconfound the comparison of perceptual identification of old and new items with the particular words that were presented. Two random orders of study words and two random orders of test words were used. Each of the eight combinations of list format, study order, and test order was received by two subjects in each of the two retention interval conditions.

Procedure. Subjects were intentionally misinformed that the perceptual identification test was being given to allow examination of the relation between speed of reading (measured in the study phase of the experiment) and ability to identify the briefly presented words. Subjects were not informed that words presented in the study phase would appear in the test of perceptual identification.

Results and Discussion

A first analysis involved the noncritical words, all of which were new in the test of perceptual identification. The only significant effect revealed by that analysis was an effect of frequency in the language, $F(2, 60) = 120.67$, $p < .05$, $MS_e = .008$. The probability of perceptually identifying high-frequency words (.68) was greater than that of identifying medium-frequency words (.57), which, in turn, was greater than that of identifying low-frequency words (.33).

The probability of perceptually identifying critical words for the two retention interval conditions is displayed in Table 3. An analysis of those probabilities revealed a significant effect of prior study (old vs. new), $F(1, 30) = 50.46$, $p < .05$, $MS_e = .02$, and a significant

Table 3
Probability of Perceptual Identification as a Function of Prior Study and Test Delay

	Test delay	
Word type	Immediate	24 hr.
Old	.67	.58
New	.30	.39
Difference	.37	.19

interaction of prior study with retention interval, $F(1, 30) = 5.86, p < .05, MS_e = .02$. The effect of prior study was larger when the test of perceptual identification was immediate, but it was still substantial even when 24 hr. intervened between study and the perceptual identification test. As was true for the proportion overlap manipulation in the prior experiment, the manipulation of retention interval only influenced the perceptual identification of old words relative to that of new words. The perceptual identification of old words was higher at the immediate than at the delayed test whereas the opposite was true for that of new words. Collapsed across old and new words, the probability of perceptual identification was not influenced by the manipulation of retention interval.

Presumably due to the change in materials, the advantage of old over new items in the immediate test of perceptual identification was substantially larger in the present experiment than in Experiment 1. Indeed, the size of the advantage of old words after a 24-hr. retention interval is near to that observed at the immediate test in the first experiment. It is not possible to make comparisons across experiments to see how the effects of the manipulation of proportion of test words previously studied combine with those of the manipulation of retention interval. However, it is clear that the effect of a single prior presentation of a word persists over a 24-hr. interval even when subjects do not expect that words presented for perceptual identification have been previously studied.

Effects of test list position were examined for evidence of any increase in perceptual enhancement across test positions. An effect of prior study was found for the first word tested even after a 24-hr. retention interval. In that condition, the probability of correctly identifying the first old test word was .56, whereas that of correctly identifying the same word when it was new was .38. These probabilities closely approximate the corresponding probabilities of perceptual identification collapsed across test positions.

An analysis of intrusion errors revealed that there was a slightly higher probability of giving a critical old word as an intrusion error on the immediate test (.007) than on the delayed test (.002). However, when the probability of an intrusion error is multiplied by the probability of a guessed word coinciding with its test presentation, the resulting probability of a correct guess is extremely small for both conditions. It seems certain that differences in guessing biases were not responsible for the results.

Experiment 3

In an attempt to further reduce perceptual enhancement, environmental context was manipulated in the present experiment. For all conditions, only 10% of the tested words had been previously studied, and the test of perceptual identification was separated from study by a 24-hr. interval. In a context-change condition, study and test took place in different experimental rooms, used different computers, and were supervised by different experimenters. The computer, the room, and the experimenter were held constant across study and test in a context-same condition. If retrieval of memory for an individual prior presentation of a word is responsible for its perceptual enhancement, a change in environmental context between study and test might reduce the accessibility of the memory for that prior presentation and, thereby, reduce perceptual enhancement. Against this possibility, effects of changing environmental context were not found when a test of recognition memory was used (Smith, Glenberg, & Bjork, 1978). Recognition memory necessarily relies on memory for a prior episode, so the lack of an effect of environmental context is surprising. To check the reliability of prior findings, a test of recognition memory as well as a test of perceptual identification was used in the present experiment.

Method

Subjects. Serving as subjects were 24 students enrolled in an introductory psychology class; 12 subjects were randomly assigned to each of two between-subjects conditions.

Design, materials, and apparatus. A list of 90 words was presented to be read followed by a list of 100 words presented for a test of perceptual identification. The test of perceptual identification occurred 24 hr. after presentation of the list to be read, and only 10% of the tested words had been previously read. After the test of perceptual identification, a test of recognition memory was given. Environmental context was varied between subjects. Study and the perceptual identification test involved either the same or different room, computer, and experimenter. The study and test lists were the same as used in the prior experiment. The two list formats were used so that across formats, the same words served as critical old words and as critical new words on the perceptual identification test. Three random orders of the study words and two random orders of words in the test list were used.

The design of the experiment required two experimental rooms, two experimenters, and two computers. The two experimental rooms were similar in dimensions and in appearance. The two experimenters were both females in their mid-30s who had had substantial experience testing subjects. An Apple computer, connected to a television set with a 14-in. screen, served as the second system to the PDP-8A computer. Character size produced on the television screen was approximately 5.7 × 6.6 mm; words were presented in all capital letters. Subjects were seated such that their viewing distance was 70 to 75 cm.

The sequence of events in the test of perceptual identification controlled by the Apple computer was nearly identical to that described earlier for the PDP-8A computer. First, the message, "Press return when ready," appeared on the screen and remained there until the subject pressed the "return" button on the computer terminal keyboard. After the subject pressed the return button, the original message left the screen, and a set of markers (two short horizontal lines) appeared on the screen for 500 msec, surrounding the location in which the word would be presented. Immediately after presentation of the word, a mask (a series of ampersands of the same length as the word) appeared in the same location as had the word and remained on the screen for 1 sec. This sequence of events then repeated until the entire test list had been presented. For the main test list, words were presented for approximately 35 msec prior to replacement by the mask. The presentation duration and other intervals were only approximate because the screen was not directly controlled by the computer, making the refresh cycle of the screen a source of error. As a result of this source of error, the large majority of events was near the intended duration, but the true duration of some events was a maximum of ±17 msec from the intended duration. This variability in presentation duration was random across words and does not compromise the results because it was the probability of correctly reporting a word during the perceptual identification test, rather than a calculated threshold duration, that served as a dependent variable. As with the other computer, a practice list that presented each successive word at a shorter duration preceded the main test of perceptual identification.

The test of recognition memory consisted of the 90 words that had appeared in the study list, 80 of which had not been presented for the perceptual identification test, the 90 new words from the perceptual identification test list, and 20 new words that had not been presented either during study or in the perceptual identification test. These last 20 new words were of a mixed level of frequency in the language. These words were typed on a sheet of paper in a random order to be presented in the test of recognition memory.

The manipulation of experimenter, experimental room, and computer were confounded to define two levels of environmental context. This manipulation was further confounded with study list format, study order, and test order. Although the combinations differed in the frequency with which they were used across conditions, each environmental context, study list format, study order, and test order was used equally often within and between the context-same and the context-different conditions. The same recognition memory test list was used for all subjects, but the words on this test that were old depended on the particular study list the subject had received.

Procedure. After having read the list of study words, subjects were told to return the next day for a further test. Subjects were not informed prior to the test of perceptual identification that it would include words that had been previously read. The details of the procedure used for presentation of the study list and the identification test were as described earlier. The test of recognition memory immediately followed that of identification. Subjects were instructed to circle words that they had read during the first phase of the experiment. The test of recognition memory was subject-paced.

Results and Discussion

The probability of perceptual identification for the critical old and the critical new words is displayed separately for the context-same and the context-different conditions in Table 4. An analysis of those results revealed only a significant effect of prior study; old words were more readily perceptually identified than were new words, $F(1, 22) = 18.25$, $p < .05$, $MS_e = .027$. The main effect of study context also approached significance, $F(1, 22) = 4.10$, $p < .05$, $MS_e = .005$. There was a tendency for both old and new words to be more readily identified when the test was in the same context as that in which the words had been studied. The displays may have been different enough that prior experience with the display, gained during study in the context-same condition, was a source of nonspecific transfer. However, an analysis of the probability of identifying noncritical words,

Table 4
Probability of Perceptual Identification as a Function of Prior Study and Environmental Context

	Context	
Word type	Same	Different
Old	.74	.59
New	.53	.40
Difference	.21	.19

all of which were new at test, failed to reveal a significant effect of changing context and, consequently, of displays between study and test. The only significant effect revealed by the analysis of the perceptual identification of the noncritical words was one of frequency in the language, $F(2, 44) = 104.38, p < .05, MS_e = .009$. As in prior experiments, high-frequency words were more likely to be identified (.77) than were medium-frequency words (.66), which, in turn, were more likely to be identified than were low-frequency words (.38).

The analysis of recognition memory performance involved only the 80 words that had been presented for study but not presented for perceptual identification. The recognition of words that had served as new words in the test of perceptual identification was of no real interest because there was no manipulation of environmental context between the study and test of those words. For the words that had been previously presented only during study, the probability of correctly recognizing a word as old is presented (separately for the three levels of frequency in the language and for the context-same and context-different conditions) in Table 5. An analysis of those data revealed a significant effect of frequency in the language, $F(2, 44) = 14.76, p < .05, MS_e = .01$. Low-frequency words were more likely to be correctly recognized than were middle-frequency words, which were, in turn, more likely to be correctly recognized than were high-frequency words. Further, there was a significant interaction of experimental context with frequency in the language, $F(2, 44) = 3.93, p < .05, MS_e = .01$. Low-frequency words were more likely to be correctly recognized if they were tested in the same context as they had been studied. For middle- and high-frequency words, there was a slight advantage when the study and test were in different contexts. The probabilities of a false alarm, calculated using the words that were presented for the first time in the test of recognition memory, were .17 and .16 for the context-same and context-different conditions, respectively.

The recognition memory results of the present experiment generally replicate those reported by others. The finding of an effect of frequency in the language on recognition memory is a common one (e.g., Gregg, 1976). Others have failed to find an effect of environmental context on recognition memory, although substantial effects are found when a recall test is used (Eich, 1980; Smith et al., 1978). The finding in the present experiment of an interaction of frequency in the language with environmental context contradicts a finding reported by Smith et al. (1978) and is probably a spurious result. Smith et al. found no effect of environmental context regardless of the frequency in the language of the test words.

Table 5
Probability of Recognition Memory as a Function of Frequency and Environmental Context

Context	Frequency		
	High	Medium	Low
Same	.21	.27	.44
Different	.27	.30	.35

Perhaps more extreme manipulations of environmental context would be sufficient to produce effects on both perceptual identification and recognition memory. In a later experiment, we added music as an additional manipulation of environmental context in an attempt to further differentiate study and test. The results of that experiment largely paralleled those of the present experiment. There was no effect of environmental context on either recognition memory or perceptual identification. The results of yet another experiment are more encouraging. In a pilot experiment that was conducted in collaboration with D. Nelson, words were projected to be read and then presented in a different room by means of a three-channel tachistoscope for the test of perceptual identification. Results from a few subjects revealed no effect of prior study under these conditions, although perceptual enhancement was observed when words were presented by means of the tachistoscope for both study and test.

The lack of an effect of environmental context is problematic for theories of recognition memory because recognition memory seems to rely necessarily on memory for prior episodes. Smith et al. (1978) suggested that the lack of effects is due to the relative unimportance of environmental context caused by the large number of alternative cues for retrieval that are provided by a test of recognition memory. A similar account can be applied to the lack of an effect of environmental context on perceptual identification. However, it is difficult to remove alternative cues in order to show an effect. In the pilot experiment conducted with Nelson, a substantial change in the visual appearance of a word was confounded with the manipulation of environmental context. It may have been the change in visual appearance that was responsible for the observed reduction in perceptual enhancement (e..g, Jacoby & Witherspoon, 1982). The means by which stimuli are displayed is a part of the environmental context, so extreme manipulations seem necessarily to produce confounding with factors such as the visual appearance of the stimuli.

Experiment 4

Experiment 4 was designed to investigate further the influence of retention interval on the effects of prior study. The interval between the reading of a word and its subsequent identification was extended up to a maximum of 4 days. Conditions were made even more unfavorable for showing an effect of prior study by presenting and testing an additional list of words on each of the days intervening between study and the perceptual identification test of the original list. The design of the experiment was such that both effects of proactive and effects of retroactive inhibition could be assessed.

Subjects were presented a new list of 50 words to be read on each of 5 consecutive days. On each day, a subset of the words from the list that had just been presented were intermixed with new words and presented for an immediate test of perceptual identification. A second subset of the words from each list was intermixed with new words and presented for perceptual identification at the beginning of the experimental session on the following day so that 24 hr. intervened between the presentation of those words and their perceptual identification test. Any decline across days in the effect of a prior presentation on either the immediate or the 24-hr. delayed tests can be attributed to proactive inhibition, the effect of presenting and testing words on preceding days. Following the presentation and immediate test of words on the fifth day, a final test was given. From each day, a third subset of words that had been presented but not previously tested were selected and intermixed with new words to be presented for perceptual identification. Differences in identification between the words presented on the various days can be attributed to retroactive inhibition caused by the presentation and test of words on days intervening between presentation of a particular word and its test. If it is memory for the presentation of the word in the study context that is responsible for perceptual enhancement, it seems reasonable for long-lasting effects of prior study to be found, and questions about proactive and retroactive inhibition become of interest.

Method

Subjects. In all, 10 students enrolled in an introductory psychology course were paid at a rate of $3 per hour to serve as subjects.

Design and materials. On the first day of testing, a list of 50 words was presented, as five blocks of 10 words each, for perceptual identification. Words in the first block were presented for a duration of 40 msec, whereas words in later blocks were presented at either shorter or longer durations in an attempt to find a presentation duration for each subject that would yield an approximate .40 probability of correctly identifying a presented word. Next, a list of 50 words was presented to be read aloud followed by a test of identification of 20 of those words intermixed with 20 new words. The presentation duration determined in the initial phase of the experiment was used for this first and for all subsequent tests of perceptual identification. Each subject returned 24 hr. later for a second experimental session. At the beginning of that session, 15 words from the list presented on the preceding day were intermixed with 15 new words and presented for identification. Next, a new list of 50 words was presented to be read. Twenty words from that list were then intermixed with 20 new words and presented for test. The procedure followed on the second day was repeated each day through the fifth day of the experiment. Each experimental session began with a perceptual identification test of words presented on the preceding day, followed by presentation of a new list of words and a test of a subset of those words that had been presented immediately prior to the test. At the end of the fifth experimental session, a final test of identification was given. The list used for this final test consisted of 90 words: the remaining 15 words that had not yet been tested from each of the five lists that had been presented on one of the preceding days and 15 new words.

A pool of 490 low-frequency words (1 to 5 per million) was selected from the Thorndike-Lorge (1944) norms and used to construct lists. All words in this pool were nouns of four to six letters in length. Study and test lists were constructed as required by the design described above. Five list formats were constructed by rotating study lists through days so that across formats, each list was presented equally often on each of the days. An additional two list formats were constructed by interchanging new and old words so that effects of prior study were not confounded with words and by interchanging old words that were to be tested after a 24-hr. interval with those that were to be tested on the final test. The combination of these two types of list format resulted in 10 different sets of lists; each of these sets of lists was received by one subject.

Procedure. The presentation of study and test lists was controlled by means of an Apple computer following the procedure described for Experiment 3. Study lists were presented at a rate of 1 sec per word to be read aloud. Words in the perceptual identification test were presented at a rate determined individually for each subject in an initial phase of the experiment. For each subject, the first experimental session occurred on a Monday and was followed by an experimental session at the same time each succeeding day through Friday of that week. Prior to each test, subjects were informed that the test would contain items that had been previously presented; the list origin of the previous presentation was specified. In contrast to prior experiments, subjects were required to give some response to each test item. All errors in identification, then, were intrusion errors.

Results

The average presentation duration used for the tests of perceptual identification was 22.3 msec and ranged from 15 to 35 msec. As indicated earlier, the system used for presenting stimuli was such that variation in the actual presentation duration was produced, but it was the probability of correct report that was of interest rather than the calculation of a critical duration.

The probability of perceptual identification of old and new words as well as the difference between those two probabilities are presented in Table 6, separated for each day of the experiment and each level of delay of testing.

A first set of analyses assessed the effect of previously presenting a word on its later identification and the susceptibility of that effect to proactive inhibition. The data involved in those analyses came from the immediate and the 24-hr. delayed tests. Analysis of performance on the immediate tests revealed that old words were more likely to be identified than were new words, $F(1, 9) = 78.38$, $p < .05$, $MS_e = .034$, and that identification of both old and new words increased as a function of days in the experiment, $F(4, 36) = 6.09$, $p < .05$, $MS_e = .015$. The increase across days in the probability of perceptual identification reflects nonspecific practice effects. Analysis of the identification of words tested 24 hr. after their study revealed that old words were more likely to be identified than were new words, $F(1, 9) = 39.67$, $p < .05$, $MS_e = .019$. The effects of days in the experiment was not significant when 24 hr. intervened between study and test.

Proactive inhibition would be reflected as a decrease in the difference between the perceptual identification of old and new words as a function of number of days in the experiment. Effects of proactive inhibition were not significant on either the immediate or the

Table 6
Probability of Perceptual Identification as a Function of Prior Study, Delay of Test, and Day in the Experiment

	Test								
	Immediate study			24-hr. delay study			Final study		
Day	Old	New	D	Old	New	D	Old	New	D
1	.79	.40	.39	.69	.43	.26	.73	.61	.12
2	.83	.46	.37	.69	.47	.22	.76	—	.15
3	.90	.61	.29	.66	.51	.15	.79	—	.18
4	.89	.60	.29	.73	.53	.20	.73	—	.12
5	.86	.56	.30	—	—	—	.78	—	.17
M	.85	.52	.33	.69	.48	.21	.76	.61	.15

Note. D = the difference between the perceptual identification of old and new words.

24-hr. delayed test. Despite the numerical decline in the difference between old and new words as a function of days in the experiment, the corresponding interaction was not significant in either of the two analyses. In an attempt to reduce the variance, data from the immediate and the 24-hr. delayed tests was combined, and the effects of proactive inhibition were assessed. This analysis also failed to reveal a significant effect. The failure to find significance may be due to insufficient statistical power in the present experiment. However, it should be noted that the apparent reduction in the difference between identification of old and new words as a function of days reflects an increase in identification of new words rather than a decrease in identification of old words. Nonspecific practice effects make it difficult to disentangle any effect of proactive inhibition.

Further analyses assessed the effect of increasing the delay between study and test and sought evidence of retroactive inhibition. A first analysis involved only words that had been presented on one of the first 4 days of the experiment and compared performance on the immediate tests with that on the corresponding tests that were delayed by 24 hr. As evidenced by a greater difference between the probabilities of identifying old and new words, the effect of a prior presentation was greater when the test was immediate rather than delayed by 24 hr., $F(1, 9) = 7.53$, $p < .05$, $MS_e = .042$. This effect of increasing delay appears to have been largely due to a decrease in the probability of identifying old words. The difference between the probabilities of identifying old and new words was lower still on the final test. However, this further decline in the effectiveness of prior study was not statistically significant. An analysis of difference-scores that included 24-hr. delay versus final test and Days 1–4 in the experiment as factors failed to reveal any significant main effects or interactions.

To provide evidence of retroactive inhibition, it is differences between the probabilities of identifying old words on the final test as a function of the day in the experiment on which those words were presented for study that is important. An analysis of those probabilities failed to provide any evidence of retroactive inhibition. Increasing the number of days and study lists intervening between the study and the final test of a word did not produce a significant effect. In the most extreme condition, 4 days intervened between the study presentation of a word and its final test. Even in this most extreme condition, perceptual identification of old words was significantly more likely than of words that were new on the final test, $t(9) = 3.157$, $p < .05$, $SE_M = .038$.

List context appears to have played some role in producing the decline in performance from the immediate to the final test. For items presented for study on the fifth day of the experiment, the final test was given promptly after the immediate test of identification so there was little difference in retention interval. More important, perhaps, the tests differed in that all old words on the immediate tests originated from the list that had just been studied, whereas old words on the final test came from all of the previously studied lists. The difference in the probability of identifying old and new words on the fifth day was significantly larger on the immediate test (.30) than on the final test (.17), $t(9) = 2.24$, $p < .05$, $SE_M = .06$. This decline in perceptual enhancement is as large as that observed across 24 hr. but is probably due to the difference in composition of the test lists rather than to an effect of retention interval. The manipulation of list composition here is in some ways similar to that in Experiment 1 and produces parallel results.

An analysis of intrusion errors revealed that the bias toward giving words from the most recently studied list was more pronounced on the immediate than on the 24-hr. delayed tests. Collapsed across days, the probability of an intrusion error from the most recently studied list was .054 on the immediate test and .020 on the delayed test. This decline in bias across retention interval parallels results reported in Experiment 2. Taking into account the probability of a guessed word coinciding with its test list presentation, the probability of a correct guess on the immediate test was .0014, whereas that on the delayed test was .0007. These probabilities are so low that it appears that correct guessing contributed little to the results.

The pattern of results obtained in the present investigation of perceptual identification is similar to that obtained in investigations of recognition memory and investigations of verbal discriminations. In contrast to effects observed in recall, investigations of verbal discrimination have failed to reveal an effect of proactive inhibition (Postman & Keppel, 1977; Underwood, Broder, & Zimmerman, 1973). Further, tests of recognition memory reveal less drop in retention performance across time than do recall tests. When a word is presented only once for study, there is a large drop in recognition memory performance when the retention interval is increased from an immediate test to a test that is delayed 24 hr. but less additional drop in performance when the test is further delayed for 7 days (Underwood, Zimmerman, & Freund, 1971). This pattern in recognition memory corresponds to that observed for perceptual identification in the present experiment.

General Discussion

In agreement with the results of prior experiments (e.g., Jacoby & Dallas, 1981; Kolers, 1976; Tulving et al., 1982), the present experiments revealed perceptual enhancement that is too persistent to be attributed to the temporary priming of a logogen. Whereas prior experiments have revealed independence of perceptual enhancement and recognition memory, the present experiments revealed parallel effects on the two types of task. Tulving et al. (1982) noted that its persistence does not encourage the view that perceptual enhancement is a result of temporary priming of an abstract representation. Their solution to this problem was to suggest that in addition to the semantic memory in which temporary priming supposedly occurs and the episodic memory that underlies recognition memory, there is a third memory system that is responsible for persistent perceptual enhancement. As an alternative, I suggest that both perceptual enhancement and recognition memory rely on retrieval of memory for episodes. I describe the variable relation between perceptual enhancement and recognition memory as having a basis that is similar to that of the relation between recall and recognition tests of memory. If both perception and recognition memory rely on retrieval of memory for episodes, perception and memory can be described within a common framework. I describe similarities between theories of perception and theories of memory and propose a means of reconciling differences between the two types of theories. Describing both perception and recognition memory as relying on retrieval of memory for prior episodes is useful for accounting for the results of the present experiments and has substantial heuristic value.

The results of the present experiments reveal a number of parallels between perceptual enhancement and recognition memory and are consistent with the claim that perceptual enhancement, like recognition memory, relies on retrieval of memory for prior episodes. A single presentation of a word is sufficient to produce perceptual enhancement even when a long retention interval separates a word's prior presentation and test. The persistence of perceptual enhancement seems to be subject to the same variables as is recognition memory. For both types of task, variables that influence retrieval are important. Similarity between study and test list context are important for both types of task. Although effects of environmental context were not obtained, it seems that such persistent effects must be specific to some of the details of the prior presentation of the word. If details of an encounter are not preserved but effects are long term, eventually all words should be primed so there would be no advantage for words presented in the laboratory. For both types of task, the difficulty of obtaining effects might be due to the large number of retrieval cues that remain when environmental context is changed. Both perceptual enhancement and recognition memory decline as retention interval is increased. However, proactive inhibition apparently plays little role in producing losses in either perceptual enhancement or recognition memory.

Although effects on retrieval were investigated in the present experiments, other experiments have investigated effects on encoding and also revealed parallels between recognition memory and perceptual enhancement (Jacoby, in press). If perception relies on an abstract representation that is consistently used to identify a word, perceptual enhancement should not reflect variability in the processing of a word during its prior presentation. Contrary to this prediction, effects of manipulations that influence the processing of a word were found in later perceptual identification as well as in recognition memory. Manipulations that increased data-driven processing of a word, such as reading the word without context, facilitated later identification of that word. Conversely, a greater degree of conceptually driven processing of a word, such as having the subject generate the word from a conceptual clue, resulted in better recognition memory and no facilitation of perceptual identification. Effects on perceptual identification and recognition memory, then, were totally independent of one another. However, performance on both types of task reflected differences in the processing of a word on its prior presentation, so effects must have relied on memory for that prior processing episode.

The problem of specifying the relation between perceptual enhancement and recognition memory is similar to that of specifying the relation between recall and recognition tests of memory. Like the variable relation between perceptual enhancement and recognition memory, some variables have parallel effects on recall and recognition whereas other variables differentially influence performance on the two types of task. This variable relation between tasks is accounted for by assuming that recognition and recall differ in terms of the number and type of cues that they provide (e.g., Tulving, 1976) as well as the type of information on which they can rely (e.g., Mandler, 1980). For recall, relations between items are important because they provide the primary basis for retrieval. Interitem relations can also be used as a means of retrieval during a test of recognition memory, so some variables have parallel effects on recall and recognition. However, there is also a second basis for recognition memory. Unlike recall, recognition memory can rely on the perceptual characteristics of the test item. The re-presentation of an item on the recognition test provides a "copy" cue for retrieval (Tulving, 1976). It is the possibility of this second basis for recognition memory that allows recognition and recall to sometimes be independent of one another.

The variable relation between perceptual enhancement and recognition memory can also be accounted for in terms of differences in retrieval and types of information used. As in comparisons of recall and recognition, it is assumed that recognition memory can rely on either interitem organization (meaning) or on perceptual characteristics of the test word (Jacoby & Dallas, 1981). Perceptual enhancement is identified with the perceptual basis for recognition memory. The notion is that subjects can note that they are relatively fluent in their perception of some words, and they correctly attribute their relative perceptual fluency to the prior presentation of those words in the experimental setting. That is, relative perceptual fluency can be used as a basis for recognition memory. Manipulations such as those in the present experiments that influence retrieval of memory for a relevant prior episode effect perceptual enhancement and will have a parallel effect on recognition memory when relative perceptual fluency serves as the basis for recognition memory. The prior finding that both recognition memory and perceptual enhancement are greater when modality of presentation is held constant between study and test can be given a similar interpretation (Jacoby & Dallas, 1981). Independence of performance on the two types of task arises when subjects use meaning as a basis for recognition memory—a form of information that is not available when words are presented without context for a test of perceptual identification. For a test of recognition memory, the subject begins with a copy cue and can use meaning to attempt to reconstruct the study context in which the word appeared. For perceptual identification, the visual information that is provided is impoverished, and perceptual identification of the word at some minimal level is necessary before information about the meaning of the word can be gained. That is, independence of performance on the two types of task can arise from differences in the cues that they provide for retrieval and the type of information on which they rely.

By this view, tests of recognition memory are intermediate to tests of recall and tests of perception in terms of the retrieval cues that they *typically* provide. Recall relies on the relation between words as a basis for retrieval whereas perceptual identification of words tested without context relies on the sensory information provided by a word. Recognition memory can use either of the two types of retrieval cues and so holds a variable relation with each of the other two types of task. The relations between tasks is seen as dependent on the type of information that they use rather than as resultant of inherent differences between those tasks. For example, when a word is tested in the context in which it has been studied, perceptual identification relies on meaning (Franks, Plybon, & Auble, 1982); such testing may remove the independence of recall and perceptual enhancement. Factors influencing the relation between perceptual enhancement and recognition memory are further discussed elsewhere (Jacoby, in press; Jacoby & Witherspoon, 1982). The variable relation between tasks discourages the identification of tasks with separate memory stores but is consistent with the view that recall, recognition memory, and perceptual enhancement rely on retrieval of memory for episodes. Differences between the tasks arise from differences in the retrieval cues that they provide and differences in the type of information that they typically use.

There is a great deal of unexploited similarity between theories of episodic memory and theories of perception. For episodic memory, Tulving (1976) describes performance as a joint product of retrieval cues and information contained in the memory trace of a prior episode. The two types of information are seen as holding a compensatory relation in that, within limits, a reduction in one type of information can be offset by an increase in the other type of information. Theories of perception, although more completely developed, take the same general form as does Tulving's view of episodic memory. Perception is described as a joint product of information gained from a stimulus and biases in responding that reflect conceptually driven processing. A reduction in the information or constraint gained from one source can be offset by an incresae in that gained from the other source (e.g., Broadbent & Broadbent, 1975; McClelland & Rumelhart, 1981; Morton, 1979). The primary difference between episodic and perceptual theories is the generality or abstractness of the memory that is assumed to underly performance. For episodic memory, it is the trace of a single episode that is relevant. For perception, prior presentations of a word are pooled to determine the threshold of an abstract representation such as a logogen.

There is also a great deal of similarity between the procedures used and the results obtained in investigations of memory and of perception. In this vein, word fragments have been used in a variety of tasks. Nelson and McEvoy (1979) used "ending cues" (word fragments) in a study of episodic memory to investigate differential loss of sensory as compared with semantic information. Subjects were given word endings and instructed to restore missing letters by recalling previously studied target words. Nelson and McEvoy found that the effectiveness of visually presented ending cues was diminished when words were presented auditorily rather than visually during study. This result parallels the finding in perceptual identification that hearing a word does less to enhance its later visual identification than does reading the word (e.g., Jacoby & Dallas, 1981; Morton, 1979). In other experiments, ending cues were shown to be more effective when the previously studied word was a preexperimentally dominant response and one of few possible completions of the ending cue (Nelson & McEvoy, 1979). Tulving et al. (1982) also presented words to be studied and then required subjects to restore the missing letters of word fragments derived from those previously studied words. Unlike Nelson and McEvoy, Tulving et al. did not explicitly instruct their subjects to use the word fragments as cues for recall. Word fragments derived from new words were intermixed with those derived from old words; for both types of fragment, there was only one possible solution word. Tulving et al. did not hold the view that fragment completion relies on either episodic memory or semantic memory but, rather, concluded that a separate, third memory system underlies the persistent effect of prior study on fragment completion. Broadbent and Broadbent (1975) did not present a list of words to be studied but presented word fragments that were to be completed; all fragments were derived from new words. Broadbent and Broadbent viewed their investigation as essentially one of semantic memory.

They were concerned with stable biases based on knowledge about the general structure of words that come into play when word fragments are being completed.

I want to emphasize the continuity in procedures rather than to identify variations in a task with separate memory stores. The 90% condition in Experiment 1 could be described as almost an investigation of episodic memory whereas the 10% condition in that experiment could be described as almost a study of semantic memory. A description of this sort could be reconciled with a distinction between "controlled" and "automatic" search or processing (e.g., Posner & Snyder, 1975; Shiffrin & Schneider, 1977) and used to explain the superiority of the condition in which 90% of the tested words had been previously studied. However, I prefer to conclude that both memory and perception are determined by the joint product of constraints provided by the stimulus (cues provided by the test) and those coming from memory for prior episodes. The primary difference between tasks is likely to be in the type and amount of constraint imposed by the cues provided at test. In Experiment 1, the advantage of the condition in which 90% rather than 10% of the tested words had been studied was probably largely due to list context being more nearly constant between study and test. Furthermore, the manipulation of instruction may have resulted in subjects in the 90% condition being more likely to intentionally use memory for the previously studied words. For intentional use of memory, subjects may use self-generated context as a source of constraint that is in addition to that explicitly provided by the experimenter so that fewer prior episodes are retrieved or heavily weighted. In this vein, the effects of a change in environmental context on recall can be offset by instructing subjects to recall the original study context prior to the test (Smith, 1979). However, it is not clear that the process of generating context is dichotomous or restricted to tests of episodic memory. Generating context may involve processes that are common to those involved in conceptually driven processing in a semantic memory task. As discussed earlier, tasks can also differ in terms of the type of information on which they primarily rely, but these differences in type of information do not clearly separate perceptual tasks from tests of memory.

The difference between theories of perception and those of memory is largely removed if it is assumed that both types of task involve parallel access to a large population of memories for prior episodes. If both perception and memory rely on retrieval of prior whole episodes, the two types of task can be described in a common framework (Jacoby, in press; Jacoby & Witherspoon, 1982). By this episodic view of perception, the level of activation that has been postulated as a property of an abstract representation of a word can be seen as a summary statistic that reflects the number and the similarity of memories for prior whole episodes during which a particular word was read and whose retrieval has been occasioned by presentation of the test stimulus. The general notion is the same as that underlying relative judgment theories such as Ratcliff's (1978) random walk model of memory. The probability of giving a particular word as a response reflects the amount of evidence in favor of that word gained from retrieved memory for prior episodes relative to the evidence gained in the same fashion for other words. The important point is that evidence relies on retrieval of memory for whole episodes rather than on criterial or defining features of a word that remain invariant across situations.

In contrast to the logogen view, the episodic view of perception predicts persistent perceptual enhancement of the sort observed in the present experiments and response biases that are less stable across situations. By the logogen view, the threshold of logogens corresponding to high-frequency words are permanently lowered so there is a bias toward responding with those words that is stable across situations (e.g., Broadbent & Broadbent, 1975; Morton, 1979). In the present experiments, perceptual enhancement can be described as a result of a bias toward giving "old" words as a response. However, this bias in responding was not stable across situations but, rather, dependent on factors that influence retrieval of memory for prior episodes. Perceptual enhancement was reduced by factors such as increases in retention interval and changes in list context. In line with the interpretation that perceptual enhancement is due to a response bias, manipulations that increased identification of old words decreased that of new words so that there was sometimes no change in overall identification performance. Relativity of this sort is expected if bias reflects differences in retrieval of prior episodes but is awkward for a theory in which bias reflects stable differences in the thresholds of logogens.

In contrast to the inhibition of "new" words that accompanied the enhanced perceptual identification of "old" words, neither effects of retroactive nor effects of proactive inhibition were obtained in the present experiments. McClelland and Rumelhart (1981) postulate abstract representations of words, such as logogens, and account for word perception in terms of the number of "friends" and "enemies" that are recruited on the basis of similarity when a particular word is presented. Enemies inhibit identification of a word whereas friends facilitate its identification. The present view is similar to that of McClelland and Rumelhart but adds the complexity that it is memory for whole prior episodes rather than abstract representations that are retrieved. By the episodic view of perception, similarity must be defined in terms of the similarity of processing episodes rather than in terms of the similarity of literal representations of words. This added complexity seems necessary to account for the effects of differences in processing of a word on its later perception (Jacoby, in press) and the effects of variables influencing retrieval, observed in the present experiments. With these modifications, McClelland and Rumelhart's theory is as applicable to memory as it is to perception. Tasks vary with regard to the cues they provide for retrieval and, consequently, with regard to the number and type of prior episodes whose memory will be recruited on the basis of similarity. Concerns that have motivated investigation of the effects of retroactive and proactive inhibition on memory become equally relevant to perception.

An interesting implication of this view is that either facilitation or inhibition of perception can be produced by prior study of words that share letters with a tested word, dependent on the balance of "friends" and "enemies." I have conducted preliminary experiments along these lines in collaboration with D. Witherspoon. In those experiments, inhibitory effects turned out to be surprisingly hard to obtain; facilitation from the presentation of a word that shares letters with the target word was the dominant finding. We have not yet found a situation that produces a convincing amount of either retroactive or proactive inhibition in perception.

The strategy of postulating different memory stores or dichotomies in processing is in many ways a tempting one. The apparent complexity of problems can, thereby, be reduced along with the portion of the voluminous literature on human memory and performance that one is held responsible for knowing. However, these gains carry the price of ignoring similarities between problems and theoretical developments in different areas. The specificity of effects of prior experience is one such theme that has recently developed in a number of areas. A person's success in solving a problem is often dependent on details of the presentation of the problem that could be considered superficial rather than just the person's knowledge of some abstract rule; factors influencing retrieval of relevant prior experiences are crucial (e.g., Wason & Johnson-Laird, 1972). Concept formation may use memory for particular instances of the concept rather than a representation that is at a higher level of abstraction and that encompasses all of the instances of that concept (Brooks, 1978; Medin & Schaffer, 1978). Recall and recognition memory depend on the similarity of the study encoding of a word and the cues provided at test rather than the strength of an association involving some abstract representation of the word (e.g., Tulving & Thomson, 1973). The results of the present experiment along with those from other experiments (e.g., Jacoby, in press; Kolers, 1976) point toward the conclusion that perception relies on the retrieval of memory of whole episodes rather than on an abstract representation such as a logogen. A number of important theoretical and applied implications can be gained by exploiting the commonality of effects between tasks. A general feeling that abstraction has been overrated seems to be emerging. Episodic perception takes its place next to episodic memory, episodic concept formation, and episodic thought.

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