Episodic and Lexical Contributions to the Repetition Effect in Word Identification

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SUMMARY

The repetition effect refers to the finding that the speed and accuracy of naming a visually presented word is enhanced by a single prior presentation of the word. A new technique was developed to study this phenomenon: The visual signal-to-noise ratio of a printed item in a field of masks was slowly increased. When accuracy was of interest, the increase ceased at a predetermined time; when latency was of interest, the increase continued until the printed item could be named. Experiment 1 tested the validity of the new accuracy technique against a more traditional threshold measure of ease of identification, in which the item is presented for a single brief exposure, followed by a mask. When performance levels at the first presentation were equated for the two techniques and for both words and nonwords, the repetition effect was equal for the techniques and slightly stronger for words than for nonwords. In Experiment 1a psychometric functions for first presentations were obtained, giving accuracy as a function of final exposure duration. A large interaction was seen with the traditional technique yielding superior performance for words than the new technique, but the reverse was true for nonwords. In Experiment 2 the latency version of the new technique was used: The difference in the latencies necessary for word and nonword identification was found to be additive to the difference due to repeated presentations. Taken together, the results of the experiments suggest separate contributions of lexical status and presentations to the repetition effect. Experiment 2 used separate groups for words and nonwords, but the word–nonword difference was, if anything, increased when mixed lists of words and nonwords were used in Experiment 3. This result rules out certain guessing bias interpretations of the word–nonword differences. In Experiments 1, 2, and 5, lag between repetitions had at most a small and nonsignificant effect on identification accuracy and latency. However, in Experiment 5, lag between repetitions had a large effect on recognition performance. In Experiments 1 and 3, shifting case between presentations of identical items produced a very small decrease in the repetition effect, suggesting a minimal role for low-level physical features in the repetition effect. In Experiments 2 and 4, orthographic similarity (i.e., spelling overlap) of new items to previously presented items not sharing a common morpheme was studied. A small (sometimes significant) facilitation of identification of such new items was observed. This result suggests that letter-name clusters play some role in the repetition effect.

A model was developed that outlines the relative contributions of episodic traces for particular events, and of unitized representations of words in semantic memory, to the repetition effect in word and nonword identification. The unitization that characterizes identification of words and that is missing for nonwords plays a prominent role in the model. Specifically, the repetition effect is attributed to the presence of episodic memory traces that are assumed to increase uniformly the speed and accuracy of both word
In this article we attempt to study some factors that produce the “repetition effect” in identification, decision, and recognition tasks. In the present context the repetition effect refers to the enhancing effect of a single presentation of an item on a subsequent test of that same item. The enhancement is usually substantial and has been demonstrated in a variety of different paradigms. For example, the probability of correct identification of a briefly presented word is much higher for words that have been presented earlier (Carroll & Kirsner, 1982; Jacoby, 1983, in press; Jacoby & Dallas, 1981; Jacoby & Witherspoon, 1982; Morton, 1979b; Murrell & Morton, 1974). In lexical decision, in which subjects are asked to decide whether a presented letter string is a word, a single prior experience with a given word decreases both the latencies and errors for subsequent tests with the same word (Forbach, Stanners, & Hochhaus, 1974; Scarborough, Cortese, & Scarborough, 1977; Scarborough, Gerard, & Cortese, 1979). Similar effects have been found in a wide variety of tasks, including word fragment completion (Tulving, Schacter, & Stark, 1982), reading inverted text (Kolers, 1976), spelling homophones (Jacoby & Witherspoon, 1982), solving anagrams (Jacoby & Dallas, 1981), and free association (Kihlstrom, 1980). In some instances, the effects of a single presentation of a stimulus could be observed hours, or even days, later (Jacoby, 1983; Jacoby & Dallas, 1981; Tulving et al., 1982).

The repetition effect is important because it lies at the empirical and theoretical interface between what have come to be known as episodic and semantic memory (Tulving, 1972). The distinction was motivated by an emergent body of literature that dealt with memory for abstract knowledge—knowledge about words, linguistic structure, facts, relations among concepts, categorical relations, and the like. The study of this abstract, or “semantic,” memory was contrasted with the study of episodic memory: the study of the ability to remember individual events that occurred within the confines of a specific temporal–contextual environment. In effect, the dichotomy distinguishes between memory for specific instances, or episodes, and memory of a more general character.

Two largely distinct areas of research may be defined according to this distinction, each employing different tasks, concepts, and models. The study of episodic memory has become identified with tasks such as list recall or recognition memory, in which a subject is asked to decide, say, whether a word has been presented on an earlier list of words. Semantic memory, on the other hand, has been studied with tasks such as word identification or lexical decision, in which subjects are asked about the identity of a word or whether a string of letters constitutes a word. These tasks do not logically require access to memory for individual events. Only limited contact has been made between these two fields of endeavor. However, item repetition is an important exception; it has been studied extensively in both types of task, sometimes in the same experiment.

Theoretically, repetition effects have been attributed to semantic factors by some researchers and to episodic factors by others. In one type of “semantic” account, repetition effects are attributed to residual activations of abstract memory representations, or “logogens,” which are responsible for pro-
duplicating phonological codes for words (Morton, 1969, 1979a, 1979b). The idea is that each time a logogen is activated, its threshold is temporarily lowered so that on subsequent presentations, reactivation is more rapid. One of the important properties of the logogens is that they are assumed to be abstract representations that do not retain information about individual instantiations of their referents. In effect, the logogen system, as defined by Morton, is a component of semantic memory.

Much of the research with semantic memory tasks has been consistent with the logogen model. For example, in threshold identification tasks, large repetition effects are observed with repeated words that differ in physical appearance, as in upper- versus lowercase (Jacoby & Witherspoon, 1982) or hand- versus typewritten (Morton, 1979b). The transfer of facilitation between items that differ in case has also been found in lexical decision (Scarborough et al., 1977). These results have been taken as evidence for the abstract character of logogens. Similarly, in lexical decision, although repeated words enjoy persistent repetition effects, repeated nonwords are only slightly facilitated (Scarborough et al., 1977). Findings such as these are consistent with the logogen model because nonwords are not represented in the system, and thus there is no logogen, or "node," for maintaining activations.

Perhaps the most ubiquitous evidence that the repetition effect is tapping semantic, rather than episodic, memory is the finding that repeating an item has a much different effect on recognition memory, an episodic task, than on semantic tasks. Although the repetition effect may persist essentially without change for days in semantic tasks, recognition performance for the same materials deteriorates over comparatively short periods of time (Jacoby & Dallas, 1981; Jacoby & Witherspoon, 1982; Scarborough et al., 1977; Scarborough et al., 1979; Tulving et al., 1982). In fact, Jacoby and Witherspoon have offered evidence that the size of the repetition effect in identification does not depend on the response given to that item on an earlier test of recognition memory. Similarly, Tulving and his associates (Tulving et al., 1982) have provided evidence of stochastic independence between performance on a recognition memory task and a fragment completion task. These findings have prompted many investigators to suggest that two independent memory systems are tapped by the two types of task; that is, episodic and semantic memory. Unfortunately, there are empirical and methodological problems with this interpretation.

First, the facilitation observed between physically different instantiations of the same word in the visual domain does not generalize very strongly to repetitions across the auditory and visual modalities (Jacoby & Dallas, 1981; Morton, 1979b; Winnick & Daniel, 1970). In fact, even within the visual domain, there is no transfer between a printed word and a picture of its referent (Scarborough et al., 1979). Thus, if the logogens are responsible for the repetition effect, there must be different logogen systems for the different modalities. Morton (1979b) adopted this solution to account for transfer failure between vision and audition. Of course, the picture results would require a similar solution for pictoral versus written stimuli. Clearly, this proliferation of logogen systems violates the spirit of parsimony.

The second problem with the conclusion that the repetition effect resides in semantic memory is the finding that when changes are induced in the size of the effect in identification tasks, parallel changes are sometimes observed in recognition memory performance. For example, Jacoby (1983) found that as he increased the proportion of words that were common to both the study and test lists, the repetition effect was larger. Thus, as is true for recognition memory (e.g., Jacoby, 1972), list context can affect identification performance. Similarly, although repetition effects in semantic tasks appear to be very persistent, both identification and lexical decision do yield observable performance decreases over retention intervals that also produce decreases in recognition memory performance (Jacoby, 1983; Scarborough et al., 1977).

Another difficulty revolves around the question of independence in performance between identification and recognition mem-
ory tasks, and the implication that this independence reflects different memory systems (Tulving et al., 1982). The finding in question is that the probability that a word is correctly identified in a threshold task is independent of whether a correct recognition judgment had been made on that same word in an earlier test of recognition memory (Jacoby & Witherspoon, 1982). This result does not preclude the possibility that the two tasks share some common mechanisms that are not involved in the process whereby a recognition decision is made. For example, if a word must be identified before a recognition judgment about it can be made (not an unreasonable assumption), then the identification process would be completely embedded within the recognition process, with recognition requiring an additional decision stage. Thus, the independence observed between recognition responses and identification facilitation bears on the type of processing necessary for performing the two tasks and should not be interpreted as reflecting the operation of two different memory systems.

In fact, recently Jacoby (1983, in press) has suggested that the identification process is intimately involved in recognition memory performance. His idea is that the ease or fluency with which a word is identified constitutes the feeling of "familiarity" that has been proposed by some experimenters as an important component of the recognition process (e.g., Atkinson & Juola, 1973, 1974; Mandler, 1980). That is, the more rapidly an item is identified, the more familiar it seems and, consequently, the more likely that it will be judged as having occurred earlier. Unfortunately, the single-trial threshold identification technique is not ideally suited for investigating this possibility because it does not yield a measure of the relative fluency of identification of an item: A word is either identified or it is not.

Finally, the finding in lexical decision that repetition effects are not observed with nonwords is suspect for methodological reasons: Whether or not an item is a word is confounded with the response. That is, the subject must always respond "yes" to a word and "no" to a nonword. For first presentations of words and nonwords this is not a problem. The first time a nonword is presented there is (presumably) no memory representation, and the subjects can base their negative responses on the failure to contact a memory trace. But what about repeated presentations? If the episodic trace from the previous presentation is accessed, it might be expected to inhibit a no response because the nonword has now gained wordlike qualities: It seems familiar. Thus, even if the episodic trace from the prior presentation facilitates the analysis of a nonword letter string, the facilitation could be offset by the requirement of an incongruous response. In fact, McKoon and Ratcliff (1979) obtained results supporting this hypothesis: Repeated nonwords were rejected more slowly and less accurately than new nonwords in their lexical decision task.

This response confound is particularly disturbing because, in other respects, lexical decision is ideally suited for exploring the independence question for repetition effects. That is, because lexical decision provides a reaction time measure, the method of additive factors (Sternberg, 1966, 1969a, 1969b) could be used to determine whether the effects of repetition are additive to the effects of the lexicality of an item. Unfortunately, any interpretation of the Word-Nonword × Repetition interaction in lexical decision is complicated by the inherent response confound in the task.

In light of this array of seemingly inconsistent results and interpretations, it is not too surprising that some contention exists with respect to the locus of the repetition effect. For example, Morton (1979b) and Scarborough et al. (1979) have posited semantic memory as the locus of the repetition effect. In contrast, Jacoby (1983, in press) has suggested that the effect derives from memory for specific temporal-contextual episodes. Tulving et al. (1982) have proposed yet a third memory system, neither episodic nor semantic, to account for repetition effects in their fragment completion task.

In the present article, we propose a model that we believe reconciles some of these disparate views of the repetition effect. The model is based on the results of several experiments conducted with a new task. The task we developed combines some of the features of other tasks, such as lexical decision and threshold identification, that have pre-
Previously been used to investigate repetition effects. First, the task yields unconfounded processing time data for the identification of words and nonwords. This not only provides an (unambiguous) test of additive factors, but also confers the advantage of a relative measure of the amount of facilitation for items in an identification task. Thus, the probability of a correct recognition memory response can be conditionalized on the relative ease of identification for the same item on a single trial. Any correlation would indicate some interdependency between the two processes.

Second, the task is modifiable to allow tests of accuracy of identification at threshold. This modification, then, can be compared with the single-trial threshold identification technique. Thus, our new task and its modification allow direct comparisons with both the lexical decision and identification results in the literature and provide a basis for comparison between the two types of tasks with respect to performance changes due to repetitions.

In the General Method section below, the new tasks are described. Essentially, they involve a slow "fading in" (i.e., increasing the visual signal-to-noise ratio) of a word or nonword embedded in a field of masks. If the display is terminated when the item in the field of masks is not readily discernable, the task yields a probability of correct identification. On the other hand, the display can be terminated by the subject when the item becomes clear enough to be identified unambiguously. In this case, a latency, or processing-time measure, results.

In Experiment 1, the probability of correct identification of repeated words and nonwords was investigated using both the accuracy version of the new task and the traditional threshold identification task. Experiments 2 and 3 used the latency version of the new task to address the issue of the relationship between lexicality and the effect of repetitions. Finally, Experiments 4 and 5 extended the results of the earlier experiments and investigated the relationship between ease of identification and recognition memory using the latency version of the task.

In addition, several of the experiments include manipulations of similarity between items on the list. With these manipulations we aimed to determine the level of processing at which repetitions exert their influence: How closely related do items need to be in order to obtain facilitative effects between presentations of related items? For example, large repetition, or priming, effects between items that have several letters in common would suggest a mechanism for the effect based solely on overlap of physical features. Conversely, large facilitatory effects between items that are physically disparate but retain a high degree of conceptual identity (e.g., upper- vs. lowercase instantiations of the same word) would suggest the involvement of a higher level of abstraction in the repetition effect.

General Method

Because the experiments are similar, this General Method section describes the common procedure, apparatus, and stimulus-generation techniques. Any deviations from the general procedure, and the specific design and stimuli for individual experiments, are described separately before each experiment.

Subjects

All the subjects were undergraduate psychology students at Indiana University. They were either paid or were participating in partial fulfillment of an introductory psychology course requirement. All subjects reported normal or corrected-to-normal vision and were native speakers of English.

Stimuli and Apparatus

The subjects were tested individually. They were seated in a small testing booth in a dimly lit (002 fl.) room. All stimuli and prompts were presented on a Tektronix Type 602 fast phosphor (P-15) display scope. The screen was situated about 60 cm in front of the subject just below eye level. In addition to the display scope, the booth contained a 16-button response box, a small display unit for visual feedback, and a microphone. Stimulus presentation and response collection were controlled by a PDP 11/34 computer located in an adjacent room.

The display consisted of a row of eight characters (letters and/or random dot masks) presented horizontally across the center of the screen. The letter characters were upper- and lowercase roman letters. Both the letters and the masks were formed by specifying the coordinates of dots in a rectangular grid 48 dots high × 32 dots wide. The mean number of dots needed to form a single letter

1 The idea for the tasks we used grew out of discussions with William A. Johnston, who developed a similar task for his research on attention.
was 43. Although they were formed from discrete dots, the line segments in the letters appeared continuous. The masks were formed by randomly positioning 43 dots in the grid. Five different masks were constructed in this fashion.

When displayed on the scope, the individual characters subtended about .33° of visual angle horizontally and .49° vertically. The spacing between the centers of the characters was .94°. Thus, for an eight-character display (the maximum size used) the total angle subtended was 6.91°. The estimated luminance directional energy for each dot constituting the characters was about .5 candle-microsecond (see Sperling, 1971). The background luminance of the screen was .0004 FL.

Procedure

A single experimental trial consisted of three phases: identification, self-scoring, and in some experiments, recognition. The trials were embedded in a long continuous list. Depending on the individual experiments, the identification phase of a trial could consist of any one of three different display configurations. The first type of display configuration was the traditional task, which consisted of a single brief presentation of a target item immediately followed by a mask. This technique will subsequently be referred to as discrete threshold identification (DTI). The second type of display consisted of a series of DTI display configurations presented in very rapid succession with the duration of the stimulus item relative to the mask increasing by a small amount with each successive presentation. The sequence of displays was terminated when the ratio of the item duration to the mask duration was such that the item could only be identified some proportion of the time (20% to 80%). This technique will be called continuous threshold identification (CTI). The third type of display configuration allowed the collection of latency data. This technique was identical to the CTI technique except that the display sequence was allowed to continue until the subjects indicated that they knew what the item was. Thus, the dependent measure was the length of time the subjects allowed the display sequence to continue before they made their identification responses—a latency measure. This technique will subsequently be called continuous threshold latency identification (CTL). The CTL task will be described first.

Each individual presentation of a word and mask during one portion of one trial of CTL is called a frame. The frames were of a fixed duration of 100 msec. The maximum number of frames in a series was 50. This is illustrated across the top of Figure 1. The manner in which the content of the display varied with successive frames is shown in the bottom of the figure. The first frame consisted entirely of eight masks and served as a temporal and spatial warning signal. At the beginning of the second frame the word was presented for 2 msec and was immediately followed by masks that stayed on for the remaining 98 msec in the frame. In the third frame the word was displayed for 4 msec before it was masked, in the fourth, 6 msec, and so on until in the last frame only the word was presented.

Depending on the individual experiments, the items were either left-justified or centered in the row of masks. Item lengths varied from three to eight letters. When the item was fewer than eight letters long, the remaining letter positions were filled with masks as shown in Figure 1. Within the portion of the frame that was occupied only by masks, the five different masks were randomly placed in the available (nonletter) positions with the restriction that any single mask was never used more than twice. Between frames these masks were randomly repositioned. The phenomenological appearance of the display was one of a rapidly flickering row of constantly changing dot masks out of which a word would gradually emerge.

![Figure 1](image-url)
The subjects' task was to push a button on the response box as soon as they could identify the word and simultaneously to say the word aloud. The verbal responses were not recorded. However, the subjects were told that they were being recorded and that the recordings would be checked for accuracy at a later time. This procedure was adopted to ensure that the subsequent self-scoring of the identification errors would be accurate. In addition, subjects were monitored to ensure that they were responding according to instructions. The subjects used the index finger of their preferred hand to make this initial identification response.

As soon as the response was made, the display was terminated. After a blank interval of 500 msec, the item that had actually been presented under the mask was displayed for 500 msec. This allowed the subjects to verify whether they had correctly identified the item. Immediately following the offset of the item, the prompt CORRECT appeared on the screen. The subjects then indicated whether they had made a correct identification by pushing one of two buttons labeled yes and no. Any other response was ignored. On trials for which the subjects made no identification response, an error was recorded and the scoring prompt was omitted. These trials were eliminated from all subsequent identification time analyses. The identification time recorded for each trial was taken to be the duration of the word in the frame during which the identification response was made.

Because the CTI and DTI tasks were designed to yield a probability, rather than a latency, measure, the procedure was somewhat different for these trials. For both types of trials the display began with the prompt READY presented across the center of the screen. When the ready signal was displayed, pushing either the yes or no button would start the trial. When the button was pushed, the ready signal was erased and the screen remained blank for 500 msec. If the trial was a CTI trial, the blank interval was immediately followed by the same display sequence described above except that the display was terminated at a predetermined frame. If the trial was a DTI trial, the blank interval was followed by a single presentation of the stimulus item and mask. The total display duration of the stimulus and the mask for the DTI trials was 100 msec.

In both the DTI and CTI trials, the display of item and mask was immediately followed by the appearance of a small question mark in the center of the screen. When the question mark appeared, the subjects attempted to identify the item that had been presented by saying it aloud. Once they made their identification response, or if they had no guess as to what the item was, they again pushed either of the response buttons. This button press terminated the question mark, and, 500 msec later, the item that had been presented was displayed for 500 msec so that the subjects could verify whether they had responded correctly. The screen then prompted the subjects with the word CORRECT, and they scored themselves by pushing the appropriate response button. Immediately after the scoring response, the ready signal for the next trial was displayed.

In the experiments for which recognition responses were required, the computer responded to the button press with the prompt ON LIST. Here the subjects were asked to indicate, by pushing the appropriate button, whether the presented item had appeared on an earlier trial on the list. For these recognition judgments, feedback was provided: A green light flashed for 100 msec for a correct response, and a red light for an incorrect response. The screen was then erased, and 1 sec later the next trial began.

For the experiments in which the CTLI task was used, the instructions emphasized the speed of identification but also encouraged the subjects to make as few identification errors as possible. An arbitrary criterion of a minimum 85% correct identification, over all trials, was adopted. Subjects who failed to satisfy the criterion were replaced.

Experiment 1

The CTI and DTI tasks yield the probability of correct identification given a fixed amount of information under discrete or continuous presentation procedures. CTI yields a latency measure and is not directly comparable to the other two tasks. The first experiment was designed primarily to ascertain whether the CTI and DTI tasks are tapping the same underlying mechanisms. Later studies look into the relationship between these two tasks and the CTLI approach.

Aside from the repetition effect itself, the CTI and DTI paradigms were compared with respect to their sensitivity to changes in the physical appearance of repeated items. Jacoby and Witherspoon (1982), using case changes, and Morton (1979b), using hand-versus typewritten words, found that although some differences were observed, the repetition effect persisted across such changes. As a check on the validity of the new technique, changes in case were incorporated into the design of the experiment. In addition, because data on nonword repetition effects have been inconclusive and few, a between-group manipulation of lexicality (i.e., word vs. nonword) was made. Thus, the experiment provided several variables across which the two techniques could be compared.

Method

One group of subjects was tested on a list of words, and another group was tested with nonwords. The words and nonwords were presented either two or four times, with the last presentation of any given item always in the opposite case from the earlier presentation(s). Half of the tested items were presented using the continuous (CTI) technique and half were presented with the discrete (DTI) technique.

Subjects The subjects were 69 students drawn from the population described in the General Method section. Five subjects were replaced for failing to meet an iden-
Stimuli and procedure. Two groups of subjects were tested: a word group and a nonword group. The nonwords were derived from the words by replacing a single pseudo-randomly chosen letter with a letter of similar frequency to form a pronounceable letter string, as judged by three independent observers. In all other respects, the list-generation procedure was identical for the two groups. For this reason, only the construction of the word list is described in detail.

In addition to the word–nonword condition, which was between subjects, three other variables were manipulated within subjects: number of presentations (two vs. four) of the same items, changes in the case (uppercase vs. lowercase) of the items between repetitions, and the two test types (CTI vs. DTI). For these conditions, 16 high-frequency (A or AA) words from the Thorndike and Lorge (1944) frequency counts were chosen.

The CTI and DTI trials were randomly intermixed on the experimental lists. For any given subject, 8 of the 16 words were presented using the CTI task, and 8 were presented with the DTI task. Of these 8, 4 were presented twice and 4 were presented four times. At both presentation levels, the last occurrence of the words was in the opposite case from the earlier presentations. Thus, for the words presented twice, if the first presentation was in uppercase letters, the second was in lowercase letters and vice versa. Similarly, in the four-presentation condition, the fourth occurrence of a given word was in the opposite case from all of the previous occurrences. Two of the 4 words at each Presentation X Test-Type combination changed from upper- to lowercase and 2 changed from lowercase to uppercase.

The number of words intervening between repetition of the same words (lag) was controlled for the critical items. Repetitions of 1 of the 2 words at each of the eight combinations of conditions were presented at a short lag of 1 to 5 intervening words. Repetitions of the other word were separated by a longer lag of 21 to 25 intervening words. The actual number of intervening words was varied pseudo-randomly within the specified intervals so that the mean lag fell at or near the center of the interval.

A master list was constructed, which specified the list positions occupied by each of the 16 words and their repetitions. The same master list was used for all the subjects. Between subjects, the 16 words were rotated through the 16 sets of list positions. Thus, across subjects, each of the 16 words occurred an equal number of times in each of the combinations of conditions.

The critical words were embedded in a long list of 152 total items. The first presentations of the critical words were spread as evenly as possible throughout the list in an attempt to minimize any confounding between the effects of repetitions and list position. In addition, none of the critical items occurred within the first 20 list positions. This was done to minimize any possible primacy effects. The primacy buffer and remaining list positions were filled with 60 high-frequency filler words. The case, number of presentations, and test type of the fillers were counterbalanced. The lag between repeated fillers was not controlled.

An additional set of 32 items was used for the practice list. The practice list served two purposes. First, it allowed the subjects to become familiar with the apparatus and procedure. Second, it served to give an estimate of the identification thresholds for the individual subjects. For the words, the practice exposure time for both the CTI and DTI trials was 36 msec. For the nonword practice list, the exposure duration for both tasks was set at 48 msec.) These times were chosen because they were near the average threshold for most individuals tested in a pilot experiment.

Recall that for the DTI trials, an exposure duration of 36 msec means that the word was flashed on the screen for 36 msec and was immediately covered by masks for 64 msec. For a CTI trial, however, an exposure duration of 36 msec means that the continuous display terminated in the frame where the duration of the word was 36 msec. Thus, the total exposure time of the word was longer in the CTI task (i.e., 36 + 34 + 32 + ... + 2 msec) than in the DTI task (i.e., 36 msec).

The performance of the subjects on the practice list was used to estimate their thresholds via an algorithm based on pilot work. For each subject, separate estimates were made for the DTI and CTI trials. These (admittedly rough) estimates were then used as the exposure times on the experimental list. In spite of the individual threshold adjustments, performance on the experimental list varied substantially between subjects. In order to avoid any ceiling or floor effects, five subjects who failed to fall within a range of 20% to 80% correct identification for the first presentations of items on the experimental list were replaced. Recognition responses were not collected in this experiment.

During the instructions, the subjects were told that the experimental list would contain repetitions of items and that some items would be presented in uppercase letters and some would be lowercase. They were not, however, told that repeated items might be presented in different cases. In addition, the subjects in the nonword group were told that they would be seeing pronounceable nonwords and that they should treat these nonwords as real English words that they had never before seen. None of the subjects had any difficulty pronouncing the nonwords during the practice list.

Results and Discussion

Unless otherwise noted, the significance level adopted for all statistical tests was .01. An overall analysis indicated that the lag manipulation had no effect on the identification probabilities of repeated items, $F(1, 62) = 2.79$, $p > .10$. For CTI, short lags resulted in correct response probabilities for repeated items that were .08 higher than at long lags. The comparable difference for DTI was .024. For this reason, the data were collapsed across the two lags for all subsequent analyses. The collapsed means are shown in Figure 2. The top figure shows the probability of correct identification of words as a func-
tion of the number of presentations. The left and right panels are for the two-presentation (P2) and four-presentation (P4) conditions. The filled symbols are the results for the DTI task, and the open symbols are for the CTI task. Recall that for both the P2 and P4 conditions, the last presentation was always in the opposite case from the earlier presentations. The bottom of the figure shows the results for the nonword group.

Separate analyses were conducted on the P2 and P4 conditions. The P2 analysis revealed a main effect of presentations, $F(1, 62) = 22.17$. Repeated items were more accurately identified than first presentations of those same items. This was true in spite of the fact that the second presentation was in the opposite case from the first presentation. In fact, for the words tested with CTI and the nonwords for both tasks, there was a small trend for the second presentations to be identified more accurately than the second presentations of unshifted words in the P4 condition. The effects of test type (CTI vs. DTI) and lexicality (word vs. nonword) were not significant (both $F$s < 1.0). None of the interactions were significant.

Thus, both test types yielded similar results, and the identification probabilities for the words were not different from those of the nonwords. The failure to find any differences for at least the first presentations across lexicality and test type was not unexpected because the exposure durations were adjusted for each subject so that performance would be roughly equivalent across these variables. (However, the differences in the adjusted times are, in themselves, of interest, and are discussed in detail below.)

The analysis for the P4 condition also showed a repetition effect, $F(3, 186) = 47.99$. Repeated items were more accurately identified than new items. Again, the effects of lexicality and test type were not significant, $F(1, 62) = 1.72, p > .19$, and $F(1, 62) < 1.0$, respectively. However, there was a significant interaction between lexicality and presentations for this condition, $F(3, 186) = 3.50, p < .02$. This interaction is apparent in Figure 2 from the fact that the identification accuracy rose more rapidly with increasing presentations for the words than for the non-words. None of the other interactions were significant.

Because the Lexicality X Presentation interaction was significant, post hoc analyses were done for the four presentations in the two groups. The analyses confirmed that the repetition effect was significant for both the words and the nonwords, $F(3, 93) = 32.49$ and $F(3, 93) = 16.40$, respectively. There were no differences between the tasks in either group (both $F$s < 1.0). Thus, there were reliable repetition effects for both words and nonwords, and the repetition effect was not differentially affected by the two tasks (CTI and DTI).

The small decrease in accuracy at the fourth presentation for both test types in the word group and for the CTI task in the non-
word group indicates that there may be a small decrement in the repetition effect when the repeated items are not physically identical. Unfortunately, unlike the P2 condition, there were no items on the lists that were presented four times without a shift in case. Thus, it was not possible to determine whether changing the case caused a significant decrease in the repetition effect relative to unshifted items at the same presentation level. The apparent decreases observed between the third, unshifted presentation and the fourth, shifted presentation were not significant (all Fs < 1.0). Although it could not be determined whether the change in case caused a significant decrease in the repetition effect relative to unshifted items, it was nevertheless true that the change did not eliminate the effects of the prior presentations of the items. Scheffé's paired comparisons showed that the shifted words were identified with greater accuracy than first-presented words for both the CTI and DTI tests, \( F(3, 29) = 21.34, p < .02 \), and \( F(3, 29) = 33.68 \), respectively. This was also true for the nonwords, \( F(3, 29) = 19.53 \), \( p < .03 \), and \( F(3, 29) = 25.80 \), for the CTI and DTI tests, respectively. This result is in agreement with the results of other investigators who varied the display characteristics of repeated words (e.g., Jacoby & Witherpoon, 1982; Morton, 1979b).

In summary, the two techniques yield strikingly similar results for both words and nonwords when the exposure durations are adjusted to equate performance. In addition, although it was found that the magnitude of the repetition effect was greater for words than nonwords, there was still a substantial increase in the probability of identification of repeated nonwords. Changing the case of both the words and nonwords between repetitions had at most a small effect on the facilitation due to repetitions.²

The lack of a substantial effect of changing the physical appearance of items between presentations suggests that the memory representation being contacted is more abstract than a single episodic trace consisting of a "physical copy" of the item. However, the fact that a repetition effect was observed for the nonwords is problematic for certain theories that posit abstract memory representations (e.g., logogens or semantic "nodes") as the sole locus of the repetition effect. In order for theories of this sort to account for these results, a single presentation of a novel stimulus (e.g., a nonword) must be sufficient to establish the representation. If this is true, there seems little point in making a strong distinction between episodic and semantic memory representations. Thus, the repetition effect for the nonwords, coupled with the case change results, starts to call into question the semantic node, or logogen, view of the repetition effect.

Except for the repetition effect, the data discussed so far do not allow any comparisons to be made between words and nonwords. This, of course, is because the exposure durations of the items were adjusted individually for the subjects in the two groups so that performance was roughly equated at 50%. However, any large differences between the groups should be manifested in the differences in the amount of time that the subjects needed in order to identify the words and nonwords with equal accuracy. In order to see whether any differences were apparent for the duration adjustments, the mean adjusted times and resulting correct identification probabilities of first presentations of list items for the two groups were calculated. These data are shown in Table 1 for both the DTI and CTI tasks.

Note, first, that the performance on both the DTI and CTI tasks was very close to 50% in all cases, as designed. Second, given the almost equal identification probabilities, there were large differences in the adjusted times between the words and nonwords for both the DTI and CTI tasks, \( t(62) = 12.14 \) and \( t(62) = 9.51 \), respectively. Much more time was needed to attain 50% accuracy for the nonwords than for the words. This difference, of course, was not unexpected: Many factors could be contributing to the enhanced identification of words relative to nonwords. For example, the identification of constituent elements of words may be perceptually en-

² In this and subsequent experiments, the performance on lowercase items was somewhat lower than on uppercase items, presumably because the internal details of the lowercase letters were more severely masked. However, although absolute performance levels were lower, the magnitude of the repetition effect did not differ appreciably.
hanced by excitatory interaction with preexisting lexical nodes. This is a “top-down” view of identification. Another possibility is that the subjects’ frequent past experience with words has resulted in highly unitized memory representations that allow automatic responses to words without recourse to analyses of the individual letters (e.g., Drewnowski & Healy, 1982). The more interesting and unexpected finding was that the two tasks seemed to require very different amounts of time for identification of words relative to the nonwords. For the words, the adjusted frame times were shorter for the DTI task than for the CTI task, \( t(31) = 9.41 \). For the nonwords the opposite was true: The CTI task required significantly less time, \( t(31) = 7.14 \). This effect was very consistent across subjects. Out of 32 subjects in the word group, 30 had lower adjusted times for the DTI task. For the nonwords, 28 out of 32 had lower adjusted times for the CTI task. Furthermore, the differences in the adjusted times were paralleled by opposite (although small) differences in the identification probabilities. That is, for the words, the DTI task resulted in greater accuracy at shorter times and the CTI task yielded lower accuracy at longer times. Precisely the opposite was true for the nonwords.

Of course, it could be argued that the adjusted times shown in Table 1 are not meaningful—that within this range of times, frame time would not affect accuracy. If so, no conclusions from these data would be possible. To test this possibility, additional subjects were tested with words and nonwords that varied in exposure duration within the two lists. This was done to ensure that changes in the exposure times would result in changes in the identification probabilities over the range of times used in the experiment. Additionally, and more important, the results will be used to generate a model for the effects presented throughout this article.

Experiment 1a

Method

The exposure duration of first-presented items was varied within subjects. One group of subjects was tested with words, and one was tested with nonwords. For each group, half the items were tested with the CTI and half with the DTI technique.

### Table 1

<table>
<thead>
<tr>
<th>Task type</th>
<th>CTI</th>
<th>DTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word</td>
<td>M</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>37.75</td>
<td>.45</td>
</tr>
<tr>
<td>Nonword</td>
<td>42.44</td>
<td>.54</td>
</tr>
</tbody>
</table>

Note. \( P = \) probability of correct identification for first presentations of items on the lists; CTI = continuous threshold identification; DTI = discrete threshold identification.

Stimuli and procedure. Four subjects were tested on a list of 180 words, and four were tested on a list of 180 nonwords. The first 20 list positions in both lists served as a primacy buffer. Within each list, half of the remaining 160 words were tested with the DTI task, and half with the CTI task. Four different exposure durations were tested for each task. In the word group, the exposure durations for the DTI task were 24, 28, 32, and 36 msec. The CTI durations were 30, 34, 38, and 42 msec. For the nonword group, the DTI durations were 44, 52, 60, and 68 msec, and the CTI durations were 36, 44, 52, and 60 msec. Twenty items were tested at each exposure duration. The range was chosen to be wider for the nonwords because between-subject variability tended to be greater than for the words. A larger range was necessary to get a reasonably accurate estimate of the psychometric function.

The items tested in the two tasks were exclusive. That is, an item that was assigned to the DTI test was never used as a CTI item. However, across subjects, the items were used equally often (once) at each duration within each task. The items were always presented in lowercase letters. In all other respects, the procedure was the same as in the previous experiment.

Results and Discussion

Figure 3 shows the resulting psychometric functions for the two tasks in the two groups. The figure shows the probability of correct identification as a function of exposure duration. The curves drawn through the points are the best fitting logistic response functions for the data shown.\(^3\) The logistic fits will be used later for model development.\(^3\)

\[^3\]The logistic response function is commonly used for psychometric data. It closely approximates the cumulative normal distribution but is computationally much simpler. It is given by

\[
p_i = \frac{\exp(b_0 + b_2x_i)}{1 + \exp(b_0 + b_2x_i)}
\]

---

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The psychometric functions confirm and clarify the findings from the adjustment data. First, the words were identified more accurately with shorter exposure durations than the nonwords for both DTI and CTI trials. Second, the CTI task was more difficult than the DTI task for the words, whereas the converse was true for the nonwords. Third, it is apparent from the figure that the performance on the DTI task was affected by the word–nonword manipulation to a much greater extent than was performance on the CTI task. This was true not only for absolute performance differences between words and nonwords but also for the difference in the rate of change of performance with increasing exposure duration. The slopes of the word and nonword functions are more similar for the CTI than DTI task.

Can both the word and nonword effects be accounted for by a model positing increments in activation of abstract semantic representations (e.g., logogens) as the sole basis for repetition effects? We think this would be difficult. In order to account for the nonword repetition effect, logogens would have to be established on the first presentation of a nonword. However, these new logogens must necessarily be weaker than those for words to account for the large word advantage: Words are always more readily identified than nonwords. Furthermore, repetitions of nonwords must cause less of an increment in activation of these new logogens, because the repetition effect is smaller for the nonwords. If this were true, there would then be no obvious way to explain the Lexicality × Task interaction seen in the exposure durations needed to reach threshold. We therefore prefer an explanation in which the repetition effect is due to support from episodic memory images, and the lexical difference is due to the availability of a unitized code for words that can produce automatic, rapid identification on the basis of a brief sample of near-threshold infor-
mation. In one sense, this interpretation is like a logogen model, except that the newly created nonword logogens are not capable of producing a unitized identification response. This argument is described in more detail below and again in broad theoretical context in the General Discussion section.

Given that the above analysis is correct, some explanation must be made as to why the CTI and DTI tasks interact so strongly with the lexicality of the tested items. Any explanation must take into account the difference in the masking characteristics of the DTI and CTI procedures. The DTI task has no masks prior to the single display. On the other hand, the masks at the end of each frame in the CTI task are forward masks for the letter strings at the start of the succeeding frame. Forward visual masking causes degradation of the displays and hence should cause an overall increase in difficulty for the CTI task relative to the DTI task.

The possibility that masking differences between the two tasks may be largely responsible for the Task × Lexicality interaction is suggested by related findings in research on the "word superiority effect." The word superiority effect refers to the finding that letters are more easily identified when they occur in a word context than when they are presented alone or in a nonword (e.g., Reicher, 1969). This advantage, however, seems to be largely dependent on the visual characteristics of the display (Johnston & McClelland, 1973; Massaro & Klitzke, 1979). With high-contrast displays and a patterned, backward mask, the effect is quite large. On the other hand, the advantage is largely eliminated when the displays are low in contrast or the targets are otherwise indistinct.

In light of these findings, we suggest that the Task × Lexicality interaction is due to masking differences between CTI and DTI. In the CTI task it might be expected that performance is limited by the quality of the available information in the display. That is, the fact that the presented item is a word is not helpful if the constituent letters cannot be discerned because of forward masking. In the DTI task, however, the letters are sharply (although briefly) presented. Here the limiting factor is not the quality of the display but rather the time available in which to identify or label the presented string before the sensory impressions of the constituent elements have faded. Thus, the advantage for words may be due to an automatic code generated from a unitized memory representation, an advantage greatly accentuated when only a single brief stimulus display is available. In the CTI task, although the quality of the display is poorer, the items are presented again and again for longer periods of time so memory limitations are less of a contributing factor: Features forgotten after one frame can be reinstated in the next. What becomes important, then, is the discriminability of the individual letters in the display. Thus, for the CTI task, the word–nonword difference is much smaller.

Whether or not the above analysis is correct, the Task × Lexicality interaction suggests intriguing possibilities for use as a research tool. That is, it should be possible to determine whether a tested item is contacting an integrated, unitized memory representation (i.e., a node or logogen) by determining whether threshold identification of the item is more likely under DTI or CTI conditions. As exciting as this possibility is, it is peripheral to the present purposes and is not pursued in this article.

In summary, four important conclusions can be drawn from the results discussed above. First, given appropriate adjustments in overall exposure duration, the CTI and DTI tasks produce similar results as a function of repetitions and lexicality. Therefore, the factors producing the sharp differences between CTI and DTI (presumably the rapid forgetting of features in DTI) probably do not interact strongly with factors producing the repetition effects. Second, changes in the physical appearance (case) of repeated items had only a small effect on identification facilitation, precluding any process based solely on the physical identity of repetitions as the locus of the effect. Third, large repetition effects were found with repeated nonwords, and

4 Suppose, for example, that one wished to determine how many presentations of a novel item, under what kind of presentation schedule, were necessary to establish a unitized trace that can respond quickly and readily. By presenting the items in question and testing equivalent items under CTI and DTI procedures, one could determine the answer to this question.
there was also a large interaction between lexicality and the CTI and DTI tasks (in terms of the exposure durations required for equivalent performance). These results are difficult to reconcile with the idea that the action of the repetition effect is on the activation of a lexical memory representation, independent of contributions from individual episodic memory images. Fourth, even though both words and nonwords showed repetition effects, the words were always identified more easily than the nonwords, suggesting the possibility of a unitized identification response for the words.

The fact that words are identified more easily than nonwords, although both show repetition effects, suggests that these two effects result from the operation of different processes. The CTLI task may be well suited for exploring this possibility because it yields a measure indicative of processing time. Thus, it should be possible to determine if the effects of lexicality and repetitions are additive. As Sternberg (1966, 1969a, 1969b) has pointed out, additivity of processing times suggests the involvement of different contributory stages or processes.

Another important and related question concerns the stage of processing at which repetitions have their effect. We have already argued that increments to logogens by themselves do not explain the effect. On the other hand, the small effects of case shifts seem to rule out facilitation due to residual activations only at the physical feature level. If the locus of the repetition effect is not at the level of physical features or logogens, where is it?

One possibility is that the facilitation occurs at the level of individual letters or configurations of letters. However, because the exact shape of the letters (i.e., upper- vs. lowercase) is of little consequence to the repetition effect, it is perhaps better to adopt the phrases letter name and letter cluster when referring to these levels of analysis. The phrase letter name is used here to indicate that the distinction between individual letters is preserved, whereas the exact physical shape of the letters is not.

Some evidence for an encoding level with these characteristics has already been found. Jacoby and Witherspoon (1982) have reported that although switching the presentation modality of words from auditory to visual virtually eliminates any identification facilitation, the repetition effect is reinstated if the subjects are required to spell the auditorily presented words aloud. It seems as if it is enough to make the subjects aware of the letters that constitute a word in order to demonstrate a repetition effect.

In another experiment, using a discrete presentation technique, Murrell and Morton (1974) found partial identification facilitation for words that were similar in spelling to previously presented words but only when the spelling overlap was accompanied by a common base morpheme (e.g., “bored” and “boring”). When there was no morphemic overlap (e.g., “bored” and “born”), there was a trend toward facilitation, but it was not significant. In that experiment, the overlap in spelling was always at the beginning of the words, and nonwords were not tested. Experiment 2 was therefore designed, in part, to elaborate on these results. An overlap condition similar to that of Murrell and Morton’s was included to investigate the possibility of identification facilitation at the letter-name or letter-cluster level.

**Experiment 2**

Experiment 2 used words and nonwords that were different but shared letter clusters to study the role of spelling similarity on the repetition effect in word identification. The CTLI task was used and identical repetitions of words and nonwords were included, so that the question of additivity between the repetition effect and lexicality could be pursued.

**Method**

Two groups of subjects, a word group and a nonword group, were tested using the CTLI technique. For both groups, some of the items presented differed by one or two letters from items that had been presented twice in earlier list positions. The locus of the different letters was either at the beginning or ending of the items. The identification times of these “overlapping” items were compared with those for items that were unrelated to any earlier presentations and to those for third presentations of identical items.

**Subjects.** The subjects were 42 students from the same population described earlier. Of these, 19 were tested in the word condition and 23 were tested in the nonword condition. Three of the subjects tested with
words were replaced for failing to reach the 85% criterion for correct identification. For the nonword condition, 7 such subjects were replaced.

*Stimuli and procedure.* For the word condition, 32 pairs of related words between three and seven letters long were generated. Of these 32 pairs, there were 8 in each of four conditions: B1, B2, E1, and E2 (B for beginning; E for ending). In the B1 condition, one letter was added to or deleted from the beginning of one of the pair members to form another, semantically distinct, word (e.g., SHIP and HIP). In the B2 condition, the two words from the pairs differed by two letters at their beginnings (e.g., TROUT and OUT). In conditions E1 and E2, similar manipulations were performed at the ends of the words. These four conditions will subsequently be called the *overlap conditions.*

In all cases the word pairs were carefully chosen so that they did not share a common morpheme. Thus, none of the pairs differed only by the addition or deletion of a prefix or suffix. This was done so that any identification facilitation that might occur between the word pairs could be attributed to their physical or orthographic similarity rather than to semantic relatedness.

The same overlap conditions were used in the nonword list. The nonwords were generated from the words by changing one letter that was common to both members of an overlap pair. All of the nonwords generated in this fashion were judged pronounceable by three independent observers. The shorter of the pair members for both the words and nonwords varied between three and five letters.

The word–nonword variable was tested between subjects. The lists used in the word and nonword groups were generated identically. Within each list, four of the pair members for each letter-overlap level were used as control and four were used as experimental items. For the control items one member of each pair appeared three times on the list. Of the four control items, two were the shorter member of the pair and two were the longer member. One of these two was randomly assigned to a short lag of 10 to 15 intervening items between repetitions and one was assigned to a long lag of 40 to 50 items.

The experimental items were treated identically to the controls except that on the third presentation the other, related member of the pair of items was presented. For convenience, the item from a given related pair that was presented first on the list will subsequently be called the *initial item.* The other pair member, which was presented later in the list, will be called the *derived item.* The word from the pair that was used as the initial word was counterbalanced across subjects. Between subjects the pairs were rotated through the experimental and control conditions.

An additional 60 filler items, presented once or twice, were used. The total list length was 216 items, and the first 20 list positions included none of the experimental or control items. A practice list of 20 items was given prior to the experimental list. For the subjects in the word group, the practice list consisted of 20 proper nouns (country names). The nonword subjects received a practice list of pronounceable nonwords derived from the country names.

All the items were presented in uppercase letters. Because the overlap between the initial and derived items occurred both at the beginnings and ends of the words, the items were centered in the field of eight masks. In all other respects, the procedure was identical to that of Experiment 1.

*Results and Discussion.*

For the word group, the identification results for correct responses in the four overlap conditions are shown in Figure 4. The top figure shows the identification times for the experimental and control words. The four panels are for the four different overlap conditions. In the figure the two presentations of the initial items from the experimental pairs have been pooled together with the first two presentations of the control items for clarity. The derived items and the third presentation of the control items are shown separately. The bottom figure shows the error rates for these same words. The comparable data for the nonword group is shown in Figure 5.

A preliminary analysis showed no effect for the lag manipulation, $F(1, 30) = 3.64, p > .07$. On the average, the repetition effect for words repeated at long lags was slightly larger (1.13 sec) than for repetitions at short lags. For the nonwords, short lags resulted in a larger (1.38 sec) effect than long lags. Therefore, the data were collapsed across the lag variable for subsequent analyses.

The control data were analyzed first. In this and all subsequent analyses, only the identification times for the correct responses were included. Because the overlap variable was irrelevant for the controls (they were identical repetitions of the items), the control data were collapsed across the overlap conditions. In the overall analysis for the identification times, there were main effects of repetition, $F(2, 60) = 99.85$, and lexical status, $F(1, 30) = 5.14, p < .04$. The effect of repetitions was due to the fact that the identification time decreased with successive presentations of identical items. Post hoc analyses confirmed that this was true for both the words, $F(2, 30) = 36.47$, and nonwords, $F(2, 30) = 67.19$. The main effect of lexical status reflects the finding that the words were more rapidly identified than the nonwords. There was no interaction between repetitions and lexical status, $F(2, 60) = 1.22, p > .30$. A similar analysis for the control error rates
showed no effect of repetitions, $F(2, 60) = 2.01, p > .14$. The effect of lexical status and the interaction were also not significant for the errors (both $F$s < 1.0). Thus, the repetition effects found in Experiment 1 were replicated for both the words and nonwords using the CTLI task.

Next, the identification times for the experimental items were analyzed. Of course, the interesting comparison here is between the first presentation of the initial item and the single presentation of the derived item. For this reason, the second presentations of the initial items were not included in any of the analyses for the experimental condition.

The analysis showed that there were no significant differences between the four overlap conditions for the identification times, $F(3, 90) < 1.0$. Thus, whether the initial and derived items differed by one or two letters and the location of the intact letter clusters that they shared did not affect the facilitation in identification time. Further, no differences were found between derived items that consisted of additions or deletions of their initial items, $F(1, 30) < 1.0$. However, the derived items were identified significantly faster than the initial items overall, $F(1, 30) = 9.96$, and, as with the control items, the words were more rapidly identified than the nonwords, $F(1, 30) = 4.69, p < .04$.

Because the effect of lexicality was significant, separate post hoc analyses were conducted on the word and nonword data to determine whether the facilitation found in the overall tests was present for both the words and nonwords. These analyses showed that the derived nonwords were identified more rapidly than the initial nonwords, $F(1, 15) = 7.18, p < .02$. However, the same comparison for the words fell short of significance, $F(1, 15) = 2.99, p > .09$. This result is very similar to Murrell and Morton's (1974) finding for words that did not share a common base morpheme. That is, for the words, spelling overlap produced only a non-

![Figure 4. Identification results for the words in Experiment 2. Top: The four panels show the identification times for the four overlap conditions. (In this and all subsequent figures, identification time refers to the amount of time [in msec] the stimulus item occupied in the frame during which the identification response was made. Within each panel, the closed symbols include the identical repetitions of the control words and the first two [identical] presentations of the experimental words. The open symbol is for the derived [experimental] word. The error bars are one standard error of the mean.) Bottom: Error probabilities associated with the identification times.](image-url)
significant trend toward facilitation for the derived items.

Although the facilitation for the words failed to reach significance, in all cases the trend was for the derived words to be identified more rapidly than the initial words (Murrell & Morton, 1974, have also found a trend in this direction). This pattern of results suggests that the kind of similarity that exists between words that share letter clusters may play some part in the large facilitation that is typically found between repetitions of identical items. However, it is also apparent that the shared letter clusters cannot entirely account for the repetition effect. Similar results and conclusions apply to the nonword data.\(^5\)

The error analyses revealed more errors for the derived items relative to the first presentation of the initial items for both words and nonwords, \(F(1, 15) = 6.64, p < .03\), and \(F(1, 15) = 5.28, p < .04\), respectively. As was true for the identification times, the error rates for both the words and nonwords were unaffected by the overlap manipulation, \(F < 1.0\) and \(F(3, 45) = 1.42, p > .25\), respectively.

Thus, although the derived items that were correctly identified enjoyed some facilitation, there was a concurrent elevation in the probability of an identification error. This was probably due to a tendency for the subjects to identify incorrectly the derived items as the previously presented initial item. Unfortunately, because the responses were not recorded, the only basis for this hypothesis is anecdotal. However, if this interpretation is correct, then the rise in errors for the derived items is further evidence that the identification process is contacting the episodic traces left by the prior presentations of the initial items.

\(^5\) If the slight difference in facilitation for the words and nonwords is real, it could be argued that the difference is due to inhibition between words that does not exist for nonwords. Although the present data are too weak to draw any strong conclusions concerning this point, such inhibitory connections between words are probably fairly weak.
items. This is especially true for the derived nonwords, because the initial nonwords presumably are less likely to have a stored semantic representation.

Although the overall error analysis showed no differences between the four overlap conditions, it is apparent from Figure 5 that the rise in errors for the derived nonwords was due entirely to the two conditions in which the nonoverlapping portion of the items was at the ends. In fact, for the E1 condition, the rise in errors was significant, $F(3, 12) = 6.56, p < .05$, and for the E2 nonwords, it approached significance, $F(3, 12) = 3.44, p < .06$. There were no significant differences for the B1 and B2 conditions (both $Fs < 1.0$). This differential effect on errors, which was not observed for the words, is probably due to the way in which the subjects were analyzing the nonwords. That is, if the subjects were analyzing the nonwords from left to right, in a letter-by-letter fashion, more errors would be expected for items that differed from earlier items only in the later letter positions. Presumably, for the nonwords that differed at initial letter positions, the first letters analyzed could be used to eliminate the earlier presented similar item from the set of possible responses. By the same reasoning, the lack of a similar differential effect for the words suggests that they are processed in a unitized fashion rather than serially from left to right (see Drewnowski & Healy, 1982, for a similar interpretation of frequency effects in identification).

In summary, there were large repetition effects for both words and nonwords. In addition, partial facilitation of (derived) nonwords was observed when they were preceded on the list by (initial) nonwords that shared a common letter cluster, suggesting that at least some of the facilitation is occurring at the level of letters or letter clusters. A similar trend was found for the words, although it failed to reach significance. Concurrently with the partial facilitation of identification times, there was a rise in identification errors for the derived words and nonwords in most conditions, suggesting that the episodic traces of the prior occurrences of the initial items contributed to the identification of the derived items. This interpretation is especially convincing for nonwords, where no preex-

Figure 6. Identification times for the control words and nonwords in Experiment 2. (The data have been collapsed across the four overlap conditions. The error bars are one standard error of the mean.)

Of course, the rise in errors makes the interpretation of the latency results problematical. The possibility of a speed-accuracy trade-off cannot be discounted. However, in an analysis of only those subjects with very low error rates (less than 3%), no change was observed in the facilitation effect for derived items. Furthermore, in Experiment 4, no rise in errors was found under similar conditions (see Figure 8).
ditivity suggests that different processing stages are involved in the two effects.

Why were the effects of repetition and lexicality additive in this experiment and interactive in Experiment 1? The answer may lie in the differences between the tasks in the two experiments. In Experiment 1 the exposure durations were held constant, and the probability of correct identification was the dependent variable of interest. Thus, the subjects' responses were based on only the partial information available in a very brief display. In the present experiment, however, the subjects were holding their identification probabilities relatively constant near 100%, and identification time was the dependent variable of interest. Thus, their responses were based not on partial information but on sufficient information to allow positive identification. The implication of the difference in the tasks will be discussed more fully in the General Discussion section, where a model of word–nonword repetition effects is elaborated.

Experiment 3

The results discussed so far provide evidence that the effects of repetition and lexicality are derived from the operation of two different processes. However, one issue especially needs further consideration. In the introduction, it was argued that the failure to find repetition effects for nonwords in lexical decision tasks (Forbach et al., 1974; Scarborough et al., 1977, 1979) was probably due to a confounding between lexicality and the different responses required for words and nonwords in a lexical decision task (e.g., McKoon & Ratcliff, 1979). There is, however, another difference between the CTLI task used here and the lexical decision task. That is, lexical decision necessarily involves the use of mixed lists of words and nonwords.

In Experiments 1 and 2 the lexicality manipulation was between groups using separate, unmixed lists. It is possible that the use of unmixed lists might have allowed the subjects to adopt special strategies for identification of words and nonwords that were not available when the lists were mixed. For example, the subjects in the word group in Experiment 2 knew that only a word response was acceptable. They could have “guessed” appropriate words on the basis of partial information. However, this strategy would not be possible in a mixed list because partial information about presented items would not be sufficient to specify a single item or even a set of items: Subjects would have to wait until every letter was clearly visible before they could decide that an item was a word or a nonword. Thus, the word–nonword difference might be eliminated in a mixed list. On the other hand, a model based on readily available, unitized responses for words would predict that mixed lists would yield results similar to those in the unmixed lists. Experiment 3 tested these possibilities. In addition to the mixing of words and nonwords, changes in case between repetitions were included in the design of Experiment 3 to ensure that the results obtained for case shifts in the CTI task of Experiment 1 would generalize to the CTLI task here.

Method

Mixed lists of words and nonwords were used in a CTLI procedure. Each of the words and nonwords were presented four times. For half the items, the last presentation always displayed letters that were in the opposite case from the earlier presentations.

Subjects. The subjects were 18 students from the same population used in the previous experiments. Two subjects were replaced for failing to reach the 85% criterion for correct identification.

Stimuli and procedure. From the stimuli used in Experiment 2, 32 nonwords, together with the words from which they were derived, were chosen. These 32 pairs were divided into two exclusive sets of 16. The nonwords from one group of 16 and the words from the other group served as critical items in the two lexicality conditions. Of the 16 items in each group, half served as experimental items and half were used as controls. Both the control and experimental items were presented a total of four times on the list. For the experimental words and nonwords, the fourth presentation of any given item was always in the opposite case from the previous three presentations, as in the P4 condition in Experiment 1. Four of the eight experimental items (chosen randomly) switched from upper- to lowercase, and four switched from lowercase to uppercase. For the controls, all four presentations were in uppercase letters for half of the items and in lowercase letters for the remaining half. The item pairs were rotated through the conditions between subjects so that each pair contributed to the word and nonword conditions an equal number of times. The items also served equally as experimental and control items.

As in the earlier experiments, a master list specifying the list positions of the items in the various conditions was constructed and the same master list was used for
all subjects. The lag between presentations of critical items was varied pseudo-randomly within an interval of 10–30 intervening items. An additional 24 pairs of words and nonwords were used as filler items. The case and number of presentations of the fillers were counterbalanced. The lag between fillers was not controlled.

The resulting list length was 168 items with the first 20 items constituting a primacy buffer. The proportions of words to nonwords and critical to filler items were the same in the first and second halves of the list. In addition, the critical items used in the various combinations of conditions were evenly distributed between the two list halves. A 20-item practice list, using the same words and nonwords as the practice lists in Experiment 2, was given at the beginning of each session. The instructions were the same as in Experiment 2 except, of course, that the subjects were made aware of the fact that both words and nonwords would be presented.

Results and Discussion

The identification times and error rates as a function of presentations are shown in Figure 7. In the figure the first three presentations of the experimental items (which did not change case) are pooled with the control items. On the fourth presentation, the (experimental) items that changed case are shown separately from the control items that did not.

Analysis of variance revealed significant effects of both lexicality, $F(1, 15) = 64.17$, and presentations, $F(3, 45) = 162.53$. The words were identified more rapidly than the nonwords, and identification became faster with repetitions. Thus, the major results of Experiment 2 were replicated. In addition, however, there was a significant interaction between lexicality and presentations, $F(3, 45) = 25.53$, which was not found in Experiment 2. This interaction is apparent in the figure from the fact that the decrease in identification time with repetitions was larger for the nonwords than for the words. This difference is especially obvious between the first and second presentations. If anything, the mixing of words and nonwords has increased rather than decreased the difference in performance between them.

The other comparison of interest is that between the shifted (experimental) and unshifted (control) fourth presentations for the words and nonwords. Any differences between these points would indicate an effect of changing the physical appearance of the items between repetitions. Planned comparisons indicated that there was a significant decrement in the repetition effect with case shift only for the nonwords, $F(3, 12) = 4.94$, $p < .05$. A similar trend for the words fell short of significance, $F(3, 12) = 2.37$, $p > .10$. There were no other significant effects.

Although highly variable, the errors par-

Figure 7. Top: Identification times for the experimental and control words and nonwords in Experiment 3. (The filled symbols include the control items and the first three [identical] presentations of the experimental items. The open symbol is for the fourth presentation of the experimental items that were in the opposite case from the earlier items. The error bars are one standard error of the mean.) Bottom: Error probabilities associated with the identification times.
alleled the identification times to a large extent. There were more errors for nonwords than for words, \( F(1, 15) = 10.79 \). Similarly, fewer errors were made, in general, as the number of presentations increased, \( F(3, 45) = 8.79 \). There were no other significant effects for the errors.

These results confirm much of what was found in the first two experiments. First, although there is some indication that the physical appearance of the item is affecting its ease of identification, it is obvious that the identification of the case-shifted items is still greatly facilitated relative to the first presentations of items on the list. Second, mixing the list did not eliminate the difference between words and nonwords. In fact, if anything, the nonwords enjoyed an even larger facilitation, due to mixing, than did the words. Thus, the repetition effects themselves and the word–nonword differences cannot be attributed to the use of unmixed lists.

One new result is the finding that the repetition and lexicality effects were not additive for the mixed lists. The interaction is due primarily to the elevated identification times for the first presentations of the nonwords and the low identification times for the fourth presentation of the nonwords, relative to the words. In other respects, the identification times are quite comparable to those found in Experiment 2. The effect of the fourth presentation may well be due to a floor effect for the words. The reason for the elevated nonword identification times at the first presentation is somewhat more difficult to explain. Because words and nonwords were mixed, the set of possible candidates available (in memory) for the first presentations of nonwords would include any words that they resembled. The activation of similar words might compete with the mechanism responsible for producing a response to the nonword. On the second presentation, however, an episodic trace of the first presentation has been established. Because this trace exactly resembles the test item, a nonword response is now available, and competition from similar words might be less severe. In conditions such as Experiment 2, such competition might not occur for the nonwords because any similar word candidates could be eliminated from consideration on an a priori basis: The subjects know that there are no words on the list. Of course, the notion that a nonword response is available from an episodic trace does not imply that this response occurs automatically in a unitized fashion. Psychometric functions would have to be examined using CTI and DTI techniques at presentations beyond the first to test this possibility.\(^7\)

In summary, the results from the first three experiments suggest that episodic representations of items play a large part in the repetition effect observed in identification. The interaction observed in Experiment 3 somewhat weakens the force of the conclusions reached from the data of Experiment 2 because additivity was not observed. Nonetheless, the weight of evidence in all the studies supports the notion that somewhat different factors produce the word–nonword difference and the repetition effects. We hypothesize that an automatic generation of a unitized code is responsible for much of the word–nonword difference, whereas contributions from episodic traces are responsible for much of the repetition effect.

**Experiment 4**

The word–nonword results from the first three experiments provide evidence that memory for individual events plays a role in the identification process. However, this is not the only method of addressing the issue of episodic involvement in word identification. Recently, Jacoby (1983, in press) has provided corroborative evidence of a different sort. As was mentioned in the introduction, his approach has been to look for effects on identification accuracy of variables that have known effects on recognition memory. If the identification process involves memory for individual events, then changes in identification performance for repeated items should be accompanied by parallel changes in recognition memory, a task that necessarily involves access to single episodes.

\(^7\)In subsequent work we have collected such psychometric functions comparable to Figure 3, for presentations after the first. At least for the first three presentations, the strong Task × Lexicality interaction remains, suggesting that a strongly unitized response to the nonwords in DTI and CTI tasks takes longer than three presentations to develop.
The present experiment investigated the possibility of parallel effects on the two tasks for the overlap condition of Experiment 2. If the partial facilitation for the derived items in Experiment 2 was due to the prior episodic occurrences of the initial items, then it might be expected that the derived items would also tend to elicit more false alarms in a test of recognition memory. Furthermore, if episodic memory is important for both tasks, then both the partial facilitation effect in identification and any tendency to make false alarms to the derived items in recognition should change in a similar fashion as the number of prior occurrences of the initial item changes. For this reason, the number of presentations of the initial item before the derived item was varied in Experiment 4.

Method

Subjects viewed a long list of words presented with a CTLI procedure. Immediately following the identification response for each word, the subjects made recognition judgments as to whether the word had been presented on an earlier trial on the list. Embedded in the list of words were initial-derived pairs as in Experiment 2. The number of presentations of the initial word prior to the presentation of the derived word varied between one and four.

Subjects. The subjects were 35 students from the same population as the earlier experiments. Three subjects were replaced because they failed to reach 85\% accuracy in their identification responses.

Stimuli and procedure. As described in the General Method section, a continuous-identification/recognition paradigm was used in this experiment. Thus, both recognition accuracy and identification times were the dependent variables of interest. The stimuli were 32 pairs of words with the same relationship as the word pairs in the 11 condition of Experiment 2. That is, the two members of the pair overlapped in spelling except for a single final letter (e.g., HUG, HUGE). The length of the shorter word in the pair was always three letters. From these 32 pairs, 16 were selected pseudo-randomly for each subject with the restriction that, across subjects, all 32 pairs were used an equal number of times.

The overlap condition was similar to the overlap condition of Experiment 2, except that the number of repetitions of the initial word was varied between one and four before the derived word was introduced. Thus, the total number of presentations of either member from a given pair varied between two and five with the last presentation switching to the derived pair member. Four of the 16 pairs were assigned to each of these four presentation levels. Within a given pair, the case in which the two words were presented was always the same. However, in each presentation level, 2 pairs were presented in uppercase and 2 in lowercase letters. The presentation order of the pair members was counterbalanced as in Experiment 2. The lag between pair members in both conditions was held constant within an interval of 20 to 25 intervening items.

An additional 36 words, counterbalanced for case and number of presentations, were used as fillers. The length of the resulting experimental list was 136 items. The first 20 positions on the list included only filler items. The subjects were given a practice list of 15 proper nouns (men's names). During the instructions the subjects were told that half of the words would be in uppercase letters and half in lowercase letters. In all other respects the procedure was identical to that of Experiments 2 and 3.

Results and Discussion

Identification. The identification times and error rates for the overlap condition are displayed in Figure 8. The four panels in each figure are for the four presentation levels: 2, 3, 4, and 5 total presentations of either of the words from the pair. In each panel the last presentation is of the derived word.

As in Experiment 2, the critical comparison for these means is between the first presentations of the initial and the counterpart derived words. The analysis of these times showed that there was an overall difference between the identification times for the initial and derived words, $F(1, 31) = 4.77, p < .04,$ as well as a significant difference between the presentation levels, $F(3, 93) = 3.41, p < .03.$ More important, however, the interaction was also significant, $F(3, 93) = 6.02.$ That is, the number of prior presentations of the initial word had a differential effect on the identification facilitation seen with the derived word. In general, relatively more facilitation occurred for the derived word as the number of presentations of the initial increased. However, the difference between the identification times for the first presentation of the initial word and the derived word was significant only when the initial word was presented three, $F(1, 30) = 7.16, p < .04,$ or four times, $F(1, 30) = 6.56, p < .05,$ prior to the occurrence of the derived word.

The error data are shown in the bottom panel of Figure 8. The analysis comparing the errors for the first presentation of the initial words and the derived words showed no effect between the pair members and no effect for the presentation level (both $F$s < 1.0). The interaction was also not significant, $F(3, 93) = 1.34, p > .26.$

Thus, there was no elevation in the error rates for the derived word relative to the first
presentation of the initial word. This was true even for the three and four presentation levels where significant facilitation was found for identification of the derived words: Unlike Experiment 2, there was no indication of a speed–accuracy trade-off for these data.

The fact that the identification times were not significantly facilitated for the derived words when the initial word had been presented one or two times (or for the words in Experiment 2) indicates that the facilitation between visually similar words may be somewhat fragile. Nevertheless, it is clear that the effect is real and that as the number of repetitions of the initial word increases, the identification of the derived word becomes faster.

In summary, the results replicate the finding from Experiment 2 that the partial facilitation of the derived words stems from the prior presentations of orthographically similar (initial) words. Of course, the partial facilitation observed with these related words is always much smaller than that observed with repetitions of identical items, presumably because the initial and derived words are, after all, not identical.

Recognition. The false alarm probabilities for the words in the overlap condition are shown in Table 2. Only the false alarms for the first presentation of the initial word and the presentation of the derived word, at each level, are tabulated. These data include the words for which identification errors were made, because the recognition judgments were always made for a clearly presented item. The mean hit rates for identical repetitions of the initial words were .862, .977, and .945 for the second, third, and fourth presentations, respectively. An analysis performed on these false alarms yielded a significant effect on recognition between the initial and derived words, $F(1, 31) = 22.81$. Neither the presentation level nor the interaction was significant, $F(3, 93) < 1.0$ and $F(3, 93) = 1.07$, $p > .36$, respectively. Thus, the subjects were much more likely to say, incorrectly, that the derived word had been previously presented than they were to say,
Table 2
Recognition Probabilities for the Overlap Condition of Experiment 4

<table>
<thead>
<tr>
<th>Pair member</th>
<th>Presentation of initial words</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Initial</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>.700</td>
</tr>
<tr>
<td></td>
<td>.039</td>
</tr>
<tr>
<td>Derived</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>.140</td>
</tr>
<tr>
<td></td>
<td>.188</td>
</tr>
</tbody>
</table>

Note. Shown are the false-alarm rates for the first presentation of the initial word and the derived word for the four presentation levels of the initial word.

incorrectly, that the initial word had occurred before.

As was true for the identification times, recognition performance was significantly affected by the overlap in spelling between the initial and derived words. This result is consistent with several findings in the literature that show that recognition responses are very sensitive to a variety of types of relatedness between words. These findings include such variables as associativeness (Underwood, 1965), antonymity (Fillenbaum, 1969), synonymity (Anisfeld & Knapp, 1968), and modality changes (Hintzman, Block, & Summers, 1973). More directly related to the present findings are those of Wallace (1968) who found elevated false-alarm rates to words that were orthographically related to earlier presented words. Thus, the effect of the initial-derived manipulation on recognition was not unexpected.

The relationship between identification times and false alarms is also of interest. Several investigators (e.g., Atkinson & Juola, 1973, 1974; Mandler, 1980) have suggested that recognition responses are based jointly on the outcomes of a search process and a (usually ill-defined) "familiarity" evaluation process. That is, to the extent that tested items seem familiar, they are judged as having been previously presented. Recently, Jacoby (1983; Jacoby & Dallas, 1981) has suggested that the familiarity mechanism in recognition is derived directly from the ease with which an item is identified. That is, if an item is more easily or rapidly identified, it "seems" more familiar, and consequently, a positive recognition decision is more likely.

This interpretation predicts that as the identification times for the derived words become faster (as a function of increasing presentations of the initial word), the false alarms to the derived words should rise monotonically. The data in Table 2 do not support this interpretation. However, the power in this experiment was low. Nevertheless, the fact that the derived words exhibit both higher false-alarm rates and lower identification times than the first presentations of the initial items ($r = -0.43$) suggests that recognition and identification share at least some common mechanisms. The nature and extent of the commonality between the two tasks is discussed in more detail in Experiment 5.

Experiment 5

The results from the previous experiments suggest that the repetition effect in identification is supported by stored episodic events. However, there is a puzzle. Episodic support is generally thought to give rise to lag effects or memory loss, yet one of the reasons that the repetition effect has received so much attention is that it tends to persevere over extended retention intervals (e.g., Jacoby, 1983; Jacoby & Dallas, 1981; Scarborough et al., 1977, 1979). Similarly, we also failed to find significant loss in the magnitude of the repetition effect over lag. Specifically in Experiment 1, using CTI and DTI, no difference in the identification probabilities for repeated items was found between lags of 1–5 and 21–25 intervening items. In Experiment 2, using CTLI, lags of 10–15 and 40–45 also failed to produce a difference in identification times. However, in those experiments, lag was not the primary variable, and consequently, the tests lacked power. The present experiment was aimed at comparing the effects of lag on recognition and identification time using the CTLI/recognition paradigm. This comparison should also allow evaluation of Jacoby's hypothesis (e.g., Jacoby & Dallas, 1981) that ease of identification is a contributory factor to recognition. Any relationship between identification time and recognition accuracy might
provide insight into the possible role of episodic traces in the repetition effect in identification.

**Method**

A list of words was presented that contained items that were repeated after lags of 1–5, 10–15, 45–55, or 120–130 intervening items. There were three total presentations of the items in the three shorter lag conditions. The words at the longest lags were presented only twice. As in Experiment 4, each word on the list was tested with CTLI for identification fluency and for recognition accuracy.

**Subjects.** The subjects were 34 students drawn from the same pool as the previous experiments. Two subjects were replaced for failure to reach 85% accuracy on the identification task.

**Stimuli and procedure.** The lag between repetitions of words on the list was the independent variable. The words used in the lag condition were 24 high-frequency (A or AA) nouns from the Thorndike and Lorge (1944) word counts. The lengths of the words varied between four and six letters. For each subject, the 24 words were randomly divided into four groups of 6 words each. These four groups were assigned to four levels of lag: 1–5, 10–15, 45–55, and 120–130 items intervening between successive presentations of the same word. For lags 1–5, 10–15, and 45–55 there were three presentations of each of the 6 words within the levels. In the 120–130 lag, however, each word was presented only twice so that the list would not be excessively long. Between subjects the words were rotated through the conditions. The items in the lag condition were distributed as evenly as possible throughout the list. However, for obvious reasons, it was not possible to present first occurrences of items in the long lag conditions (45–55 and 120–130) in positions near the end of the list. An additional 94 words were used as fillers. The number of presentations of the fillers was chosen so that the number (120) of newly presented items equaled the number of items presented earlier. This was done to minimize the possibility of response bias for the recognition judgments. The lag for the filler items was not controlled. The first 10 words on the list constituted a primacy buffer. The subjects saw the same 15-word practice list that was used in Experiment 4. For both the practice and experimental lists, all the words were presented in uppercase letters.

**Results and Discussion**

**Identification.** The top panel in Figure 9 shows the mean correct identification times as a function of the four lag conditions. The three curves are for the first, second, and third presentations of identical items. The bottom panel shows the error probabilities associated with the identification responses. Because there was a different number of presentations in the 120–130 lag condition than in the other lag conditions, two separate analyses were performed on both the identification times and error probabilities. The first was for the first and second presentations at all four lags, and the second was for all three presentations at the three shorter lags. The analyses confirmed the large effect of repetitions on identification times evident in the figure, \(F(1, 31) = 165.02\) and \(F(2, 62) = 132.77\) for the four-lag and three-lag analyses, respectively. There were significant effects of lag for the four-lag, \(F(3, 93) = 4.16\), and three-lag analyses, \(F(2, 62) = 5.00\). Analyses of the simple main effects showed that the lag effect was due primarily to the rise in identification time across lags for the second presentations, \(F(3, 93) = 3.79\). There were no significant lag differences for first, \(F(3, 93) = 2.33, p > .07\), or third, \(F(2, 62) < 1.0\), presentations. Although the change in identification time with lag for second presentations suggests that there was some decrement in the repetition effect over time, the presentation \(\times\) lag interaction for the first two presentations failed to reach significance, \(F(3, 93) = 1.97, p > .12\). That is, the identification time difference between the first and second presentations did not differ significantly over lag. Thus, there is, at best, only weak evidence for an effect of lag.

The results for the error rates closely parallel those for the identification times. Because the error rates for the second and third presentations were essentially zero at all lags, statistical analyses will not be reported.

**Recognition.** The results for the recognition judgments are shown in Table 3. Shown in the table are the miss rates for the second and third presentations of repeated items as a function of lag. There was a large effect of lag for the second presentation, \(F(3, 93) = 14.58\), as well as a significant interaction between presentation and lag over the three shorter lags, \(F(2, 62) = 24.27\). The miss rates for the third presentations are all near zero (a floor effect). For the first presentations of critical items, the correct rejection rates were .91, .94, .97, and .96 for words in the 1–5, 10–15, 45–55, and 120–130 lag conditions, respectively. These results show that as lag increases, the probability that a previously presented word will be recognized falls dra-
Figure 9. Top: Mean identification time as a function of lag between presentations in Experiment 5. (The three curves are for the first, second, and third presentations of identical words. The error bars are one standard error of the mean.) Bottom: The probabilities of identification errors associated with the identification time results.

This is not an unexpected finding. The fact that forgetting occurs over time in recognition tasks is a well-documented phenomenon. The fact that the miss rates seem to be close in value at the two short lags and close in value at the two long lags is certainly unexpected, and we have no compelling explanation to account for such a finding.

In summary, a large decrement with lag was found in recognition performance, and if there was a diminution with lag for the

Table 3

<table>
<thead>
<tr>
<th>Lag (intervening items)</th>
<th>Presentation 1-5</th>
<th>10-15</th>
<th>45-55</th>
<th>120-130</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second</td>
<td>M</td>
<td>.042</td>
<td>.047</td>
<td>.188</td>
</tr>
<tr>
<td></td>
<td>SE</td>
<td>.012</td>
<td>.015</td>
<td>.029</td>
</tr>
<tr>
<td>Third</td>
<td>M</td>
<td>.031</td>
<td>.026</td>
<td>.022</td>
</tr>
<tr>
<td></td>
<td>SE</td>
<td>.015</td>
<td>.013</td>
<td>.013</td>
</tr>
</tbody>
</table>

Note. There were no third presentations at the longest lag.

8 One possible problem in analyzing the lag effects for both recognition and identification is the inherent confound between lag and serial position: Repeated items must necessarily be presented in later list positions than first presentations of the same items. However, an inspection of the identification times and recognition probabilities for only those items that occurred within a restricted range of serial positions (80-120) yielded a pattern of results not appreciably different from that found in the overall analysis. Thus, relative serial position seems not to have been a contributory factor to the results shown in Figure 9.
repetition effect in identification, it was very small. This pattern of results is similar to those found by other investigators using different tasks (e.g., Jacoby, 1983; Jacoby & Dallas, 1981; Scarborough et al., 1977).

The failure to find a large lag effect for repeated items in identification apparently poses a problem for the idea that the effect derives from access to episodic traces during the identification process. Recognition memory (logically) requires access to episodic traces, and recognition shows large effects of retention interval. If identification also relies on access to individual episodes, then why are comparable performance decrements not observed for the repetition effect in identification?

Jacoby (1983) has proposed one possible solution. He has suggested that the differences observed between recognition and identification are due to differences in the kind of information required for accurate performance in the two tasks. For example, recognition memory is commonly thought to rely jointly on two processes: an evaluation of the “familiarity” of a tested item plus an extended memory search (Atkinson & Juola, 1973, 1974; Mandler, 1980). Mandler (1980) has suggested that the familiarity stage of recognition relies on “intra-item integration,” a quality derived from characteristics of the item itself. Identification also relies on information inherent in the item (e.g., pronunciation, letters, letter clusters). The similarity between identification and recognition may therefore be based on similarities between the identification process and the familiarity (nonsearch) phase of recognition.

The search phase of recognition, on the other hand, may rely on information that is not integral to the tested item. Recognition requires that contextual information associated with an item be retrieved. To do this, subjects must use information about the original list context as a retrieval cue. Thus, recognition failure over time may result from a progressive mismatch between the test and storage contexts (e.g., Anderson & Bower, 1972; Bower, 1972). If identification does not rely on these search processes, then no greater lag effect in identification would be predicted than would be predicted in recognition due to the familiarity phase. Thus, if the familiarity phase in recognition does not show lag effects, then lag effects would not be seen in identification either. Such an explanation has a number of problems, however. If this were true, for example, a long delay would ensure that recognition performance would depend mainly on familiarity (which does not decay) rather than search (which does). Not much evidence supports the view that search processes and associated effects disappear at long lags in recognition tests. In fact, Mandler (1980) has presented arguments and evidence that exactly the opposite is the case—that search processes become predominant at long test delays.

We next consider an explanation that relies on different types of retrieval cues and information used in identification and recognition. According to this hypothesis, the episodic traces stored in memory can be accessed by several types of cues. In recognition, contextual cues are used that change over time, so lag effects are observed. In identification, however, the cues that give access to the episodic images are not temporally variable. They include such features as the physical characteristics of the test stimulus, relationships among those features, and information at the letter level of analysis. Because these types of cues do not change much over time, only small lag effects would be predicted. It might then be asked, Why do subjects not use these same cues in recognition and eliminate lag effects? The answer seems clear: Such cues are used and they succeed in part. The tested items in recognition are identified, and identification is probably more rapid for target items than for distractors. However, identification is not the goal in a recognition task. Rather, access to temporal-contextual information is needed for accurate performance, and temporal-contextual cues are needed to gain access to this kind of information (e.g., Bower, 1972).

The above analysis does not preclude the possibility that the information used in identification plays some role in recognition, as Jacoby and his associates (Jacoby, 1983, in press; Jacoby & Dallas, 1981) have suggested. In order to probe this issue, a correlational analysis between recognition accuracy and identification time was done on all of the items on the list that were presented three
times. Both the critical lag items and the filler items were included in this analysis.

The relationships are shown in Figure 10. The top panel shows the relationship between the probability of a correct rejection of first presentations of the words and their identification times. The identification times were pooled across blocks of five consecutive frames. Extreme frame times, in which few responses were obtained, were not included in the analysis. The numbers in brackets below each point are the number of observations that constitute the point.

Notice that the correct rejection rate rose with the time required to identify the word. That is, when the word took more time to identify, the probability of a no response for the recognition judgment increased. The

![Figure 10. Top: The correlation between the probability of correct rejection of first occurrences of words and the identification time for the words in Experiment 5. Bottom: The correlation between hit rates and identification time for repeated items on the list (second and third presentations). (The number in brackets below each point is the number of observations that constituted the point.)](image-url)
Pearson product-moment correlation between the weighted means was +.78. The bottom panel shows the correlations between the hit rates and identification times for second and third presentations of the words. The same trend is present here as for the first presentations. As identification took longer, a no response (which for a repeated item is an incorrect response) was more likely. Because the recognition responses are plotted in terms of hit rates, the slope is in the opposite direction than for correct rejections of first presentations. The correlations were —.84 and —.21 for the second and third presentations, respectively. Thus, it is clear that as identification became faster, the subjects tended to report that they had seen the item previously, regardless of whether that was true.

Although the evidence is correlational and does not imply any causality, this result is consistent with Jacoby’s proposal that the identification ease or fluency for an item contributes to the recognition judgment made about that item. That is, the subjects could be using the ease of identification as one source of evidence that the word had occurred on a recent list. For several reasons, however, it seems unlikely that this is a major factor. First, large differences in identification times were accompanied by changes of only a few percentage points in recognition accuracy. Second, identification times vary idiosyncratically for different words. Thus, relative “perceptual fluency” is an unreliable cue to list membership. Finally, the small increase in identification time with increasing lag hardly seems adequate to account for the large decrease in recognition accuracy. Although identification fluency may play some role in recognition, it seems likely that the retrieval of the context associated with episodic events is the more important determinant of recognition performance.

General Discussion

The experiments discussed above raise the possibility that the repetition effect in word identification is derived largely from memory for individual episodes. First, large repetition effects were observed from nonwords in the first three experiments. Unless it is assumed that a single experience with a nonword is sufficient to establish an abstract memory representation, it is difficult to reconcile this result with models that posit activations of abstract unitized memory traces (i.e., logogens) as the sole locus of the repetition effect. Even if a single presentation is assumed sufficient to establish a logogen, the additive result in Experiment 2 and the Task X Lexicality interaction for exposure durations in Experiment 1 remain unexplained. These results suggest that the repetition effect is derived from the operation of a process that has little to do with general knowledge about what constitutes a word.

Second, the elevated errors and faster identification time for derived items in Experiments 2 and 4 suggest that memory for the prior occurrences of the initial items was accessed by the identification process. This argument is particularly convincing for the nonwords, because any explanation based on “spreading activation” between orthographically related lexical nodes is unlikely for nonword stimuli.

Our emphasis on episodic contributions to the repetition effect should not be taken as support for a model positing a sharp structural distinction between episodic and semantic memory or a model in which semantic knowledge does not play a role in word identification. We would be quite comfortable with a model like Jacoby’s (1983, in press) in which semantic knowledge is an emergent property of amalgamations of individual episodic traces. Furthermore, word identification may well be the result of a combination of system response to semantic and episodic images even if these are thought of as different. The response could result from a race between episodic traces and semantic traces or from some synergistic interaction between the two.

We do wish to make a sharp distinction between one characteristic of semantic codes for words (or logogens) and another characteristic of episodic codes for nonwords: the presence versus absence of a unitized response. The results of Experiment 1a, particularly, provide evidence that the word–nonword differences may be due to an (automatic) generation of a unitized code for words that is not available for (unfamiliar) nonwords. We suggest that it is the avail-
ability of a unitized code that appears largely independent of the factors producing repetition effects.\(^9\)

Our emphasis on the importance of the unitization factor leads us to a model that differs in certain respects from a model of identification and repetition recently proposed by Jacoby (1983, in press). In his account, the episodic–semantic distinction is obviated, and differences observed between identification and recognition are attributed to differences in the requirements of the two tasks. In many respects the model elaborated below is consistent with Jacoby’s approach, but we retain part of the distinction between episodic and semantic memory. As already indicated, we argue that lexical codes and episodic representations each contribute to identification facilitation in separate ways. This seems necessary not only to account for the large differences in the identification times of words and nonwords (particularly in Experiment 3 where the mixed list results preclude any response bias explanation of the word–nonword difference) but also the Lexicality $\times$ Task interaction found in Experiment 1 (which suggests a qualitative difference between the identification of words and nonwords).

The discussion of the model is divided into two parts. In the first part, it is shown that with appropriate assumptions the additivity of the effects of lexicality and repetitions that was found in Experiment 2 using CTLI, but was not found in Experiment 1 using CTI and DTI, can be predicted from the psychometric functions obtained in Experiment 1a (Figure 3). This analysis, in turn, provides a basis for isolating the relative contributions of information of a lexical nature (i.e., unitization, automatic response) from information specific to temporal–contextual episodes. In the second part, a general framework for repetition effects in identification is proposed, which illustrates the role of various component mechanisms in the identification process.

The Model

Lexicality and repetitions. In the model, we assume that when an item is presented, evidence about the identity of the item begins to accumulate in the perceptual system. When a sufficient amount of evidence has accrued to specify a single item, an identification response ensues. This “information growth” assumption is similar to proposals made by other investigators to account for findings in recognition memory (e.g., Ratcliff, 1978) and letter perception (e.g., McClelland & Rumelhart, 1981; Rumelhart & McClelland, 1981).

Once this framework has been adopted, it is possible to generate an explanation of the additivity of the effects of lexicality and repetitions under CTLI in Experiment 2 and the nonadditivity of these factors under DTI and CTI in Experiment 1. Consider first the results from Experiment 1. Recall that with the techniques used in that experiment, the stimuli (i.e., words and nonwords) were all presented at, or near, threshold. That is, the display was terminated at some point when only partial information about the stimulus was available to the subjects. The responses were, of course, based on the extent and quality of the available information. If we assume that the probability of identifying a given item at a given time is proportional to the amount of information that has accrued about the item at that time, then the rate at which the information accrues is proportional to the slopes of the psychometric functions that were obtained (Figure 3). Once this assumption is made, then the time course of information growth can be depicted graphically as in the top panel of Figure 11. The functions in Figure 11 are the best fitting logistic response functions that are shown in Figure 3.

Figure 11 also shows how the relationship between performance and exposure duration would be obtained given the information growth functions. Interrupting the display at a time that would yield about 50% accuracy (as was attempted in Experiment 1) is represented in the figure by the horizontal line

\(^9\) However, unitization is only one characteristic of lexical codes—there are many others as well. Thus it may be possible to present nonwords sufficiently many times that the letter strings become unitized and act like words in the CTI and DTI paradigms, but it would not be appropriate to conclude that a lexical code has been generated.
drawn through the growth functions at the 50% crossover point. The projections onto the abscissa of the intersections of this line with the growth functions would then represent the times needed in the two tasks to obtain 50% accuracy for the words and nonwords.

What, then, is the effect of repetitions on the growth functions? Consider the possibility that each presentation of an item results in the storage of a complex memory trace consisting of the item and the presentation context in which it is embedded (Raaijmakers & Shiffrin, 1981). Suppose further that the next time that item is presented the rate of accrual of information is uniformly increased by a constant amount of time because of the presence of episodic image(s).

The resulting growth functions are illustrated in the bottom panel of Figure 11. Here the curves are shifted to the left by a constant to represent the increased processing efficiency due to the episodic trace. Because of the shift, relatively more information will accrue at a given exposure duration than for a first presentation. This additional information is represented in the figure by the differences between the intersections of the (constant) times with the functions at the first (i.e., 50% line) and second presentations. The extent of the information increase is thus a joint function of the amount of the shift and the slopes of the growth functions. Thus, to the extent that the slopes of the functions differ, the amount of available information will increase differen-

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**Figure 11.** Top: Schematic representation of the growth of information over time for first presentations of words and nonwords in the continuous threshold identification (CTI) and discrete threshold identification (DTI) tasks. (The curves are the best-fitting logistic functions from Figure 3. The projections onto the abscissa of the intersections of the 50% line with the functions indicate the amount of time necessary to obtain 50% accuracy for the two tasks.) Bottom: Shift of the functions to the left for repeated items (i.e., the decrease in processing time as a result of contributions from the episodic trace established at the first presentation). (The deltas [Δ] indicate the gain, between presentations, in the amount of information available at the constant exposure durations.)
tially with repetitions for the words and non-words in the two different tasks.

The difference in the amount of additional information made available by repeating the items is, in turn, reflected in the identification probabilities from Experiment 1 (see Figure 2). The probability of identification increases more rapidly with repetitions under conditions that yield a steeper growth function. In fact, to a large extent, the differences in the Identification \times Presentation functions in Figure 2 mirror the slope differences in the psychometric functions in Figures 3 and 11.

The above analysis carries with it the implicit assumption that the lexicality of an item has at least one effect on its identification that is independent of the effects of repetition. That is, as has already been suggested, the presence of an episodic image speeds the identification process more or less uniformly, whereas the fact that an item is a word tends to increase the ease with which it is encoded into a form more resistant to decay. The difference in encoding ease is reflected in the difference in the shapes and levels of the functions, and the change in the speed of the identification process due to repetitions is represented by the temporal shift of the functions. This hypothesis is bolstered by the results from the control conditions of Experiment 2 (Figure 6), suggesting that the effects of lexicality are additive to the effects of repetition, at least for three presentations.

As mentioned earlier, the reason why additivity was present in the results from Experiment 2, although lexicality and repetitions clearly interacted in Experiment 1, has to do with the differences between the tasks used in the two experiments. In Experiment 1 the exposure durations were held constant for a given subject, and the probability of identification was the dependent variable. Thus, the error rates changed, so the slopes of the functions became crucial. In Experiment 2, as well as in the other experiments, the subjects were encouraged to keep their error rates fixed. (Actually, they were kept quite low, but the level at which the errors are kept is not crucial to the argument.) Thus, the identification performance was being held relatively constant, at a high level, and identification time was varying. This is manifested as a constant time difference, when repetitions cause all the curves to shift (left in Figure 12) by a constant amount of time. This is illustrated in Figure 12 for the first and second presentations of word and non-word items. Notice that the difference between the two functions is unaffected by the shift to the left: The identification time difference between the words and nonwords will stay constant between repetitions even though

![Figure 12](image_url)

*Figure 12. The growth functions for the first and second presentations of words and nonwords in the continuous threshold identification task. (The projections onto the abscissa show the identification times at asymptotic performance levels. Under the assumption that the presence of an episodic trace uniformly increases the speed of analysis for both the words and nonwords, the difference in response times between the two stimulus types remains constant across repetitions.)*
both are more rapidly identified. Note that the constant time shift would be found even if performance were not at asymptote—any horizontal line (constant accuracy) drawn through Figure 12 would result in such a constancy. (Of course, it is possible that the subjects find it easier to maintain equal accuracy under “low error” instructions that produce asymptotic performance.)

Thus, we have a tenable hypothesis about the differences between the effects of lexicality and repetitions on identification. In the next section, we propose a general framework for the repetition effect in identification that outlines some probable components of the process and the way in which these components might interact with unitized lexical codes and episodic memory representations of the target items.

**A framework for the repetition effect.** The data discussed above, together with results from other experiments, suggest a model of the identification process that would operate as follows: First, assume that there is a mechanism that analyzes the features of a letter string through a hierarchically organized series of levels. At each successive level, a more complex organizational structure is imposed on the incoming stimulus. The end result of this analysis is a name or label for the letter string—the identification response. The notion that word identification is accomplished through a hierarchically organized information-processing system is not original. Several existing models make similar assumptions (e.g., Adams, 1979; Johnston & McClelland, 1980; McClelland, 1976; McClelland & Rumelhart, 1981; Rumelhart & McClelland, 1981, 1982). What is unique, however, is the type of information stored in memory that is accessed when the items are presented for identification.

As the identification process progresses, it begins recruiting information in memory that is associated to the particular featural and contextual elements of the stimulus item. This information includes both general semantic or lexical knowledge about words, transitional probabilities between letters, and so on, and information that is associated with specific temporal-contextual episodes. The degree to which the stored information is recruited or activated is a function of its association to the particular stimulus and context that are presented for test.

For words, the operation of this analytic mechanism is depicted schematically in Figure 13. When the word is presented, it begins to ascend an analytic path represented by the central column of the figure. At each level episodic memory representations that are consistent with the presented word are activated. Simultaneously, contextual features of the test situation begin to activate stored episodic images that contain contextual elements common to the test context. Thus, the activation of the episodic information is sensitive to both the item being tested and the context in which the test occurs.

The distinction between episodic and semantic memory, represented in the figure by the dashed vertical line, is not intended to imply two separate, noninteracting memory systems. That is, the memory traces of episodic occurrences of the items include infor-
mation about those occurrences generally assumed to be semantic in nature: pronunciation, spelling, meaning, and so on. Thus, in this regard our model is similar to that proposed by Jacoby (1983, in press). The distinction is intended to be of significance only in that it makes clear the separate contributions of a unitized code for words and episodic and contextual information generated by the experimental presentations.

Similarly, the levels represented in the analytic path are not intended to be inclusive of the kinds of knowledge brought to bear on the stimulus word. Other sources of information not examined in our paper, for example, word shape, pronunciation regularity, and so forth, may well be involved in the identification process. However, the represented levels do seem to constitute a minimum requirement in light of the results reported here and elsewhere. Thus, the inclusion of a "letter name" level, as distinct from a "physical letter" level, reflects the finding that changes in case or type font have little effect on the magnitude of the repetition effect. Similarly, the "letter cluster" level is included because of the repetition effect observed between items that share common literal configurations. The "word name" level reflects our belief that one important component in the identification task is the decision that a string of letters composes the entire stimulus word.

The levels in the analytic path make contact with the episodic traces that are consistent with the activations within the levels. The interaction between the images and the levels is similar to the kind of interaction suggested by McClelland and Rumelhart (1981). (It may prove necessary to assume that the connections are much more strongly excitatory than inhibitory, because words that overlap in orthography sometimes facilitate but never inhibit each other in our work.) To the extent that an episodic image is consistent with the activations at any given level, it will itself become active. This activation, in turn, feeds back to the perceptual level, increasing the excitation of consistent features within the level and, consequently, speeding the analysis. This interactive quality is represented in the figure by the double-headed arrows interconnecting the various components. Dashed connections reflect interactions for which empirical evidence is weak or nonexistent. Thus, for example, the connection between episodic memory and the "physical letter" level reflects the finding that case changes have only a slight effect on the repetition effect, and the connection between episodic memory and word pronunciation signifies that no link exists before the first presentation during the session.

The excitation of the episodic images is also influenced by the overlap between the test context and the context stored with the episodic trace. The ability of the test context to influence the identification process is necessary for any model of repetition effects. The small effect of lag, as well as the effect of list context on the identification process reported by Jacoby and his associates (Jacoby, 1983; Jacoby & Witherspoon, 1982), demonstrates the influence of contextual factors at the time of test.

The analytic process also interacts with the preexperimental traces, including codes like "logogens" and lexical codes in the case of words. These contain unitized representations that are responsible for automatically producing a phonological code and/or name code when appropriate.

How does the model handle repetition effects for nonwords? Logically, at least, the difference between words and nonwords is that the words have preexisting lexical representations and the nonwords do not. In other respects, the analytic system elaborated above will process an incoming nonword letter string in the same fashion as a word letter string. The major contribution of the semantic store is that it provides the identification system with a readily available unitized response. For pronounceable nonwords, this readily available response is nonexistent and must be constructed analytically from the subjects' knowledge of orthography and letter-to-sound rules.

The differences are illustrated in Figure 14. The primary change is a mechanism that produces a phonological response analytically. (The phrase letter-to-sound rules is used here more for convenience than as an endorsement of any particular model of phonological encoding.) Because the synthesis of a phonological representation presumably
takes time, it is the absence of a readily available response based on preexperimental unitized codes that causes the constant difference between the identification times of words and nonwords observed in Experiment 2. Although the present data do not bear on the automatism of these processes, the word–nonword difference could be construed as a manifestation of the difference between an automatic versus controlled process (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). The poor performance of the subjects on nonwords in the DTI task could reflect a capacity limitation for the (controlled) process responsible for constructing a phonological representation of the nonwords. The words, then, would not be subject to this limitation.

Notice that, in the figure, the semantic store is still contacted for the nonword stimuli. This, of course, is because the spread of activations through the hierarchy is largely automatic, and the system has no a priori way of “knowing” that the incoming letter string is a nonword. Thus, the representations of words that are similar to the nonwords are partially activated. The partial activations may contribute (by analogy) to the process of constructing a pronunciation of the nonword. Mechanisms that allow knowledge about the pronunciation of words to contribute to the construction of a pronunciation for nonwords have been suggested by other investigators (Glushko, 1979, 1981; McClelland & Rumelhart, 1981). However, such an assumption can also account for the tendency, reported by some subjects, to respond to nonword stimuli with word responses.

It is important to note that the difference between episodic and semantic memory (represented by the difference between the two sides of Figures 13 and 14) is not relevant to the position that we are adopting with respect to the repetition effect for words and nonwords. Note that both semantic and episodic memory components are contacted during the identification of nonwords as well as of words. What is important is the manner in which an identification response is produced for word and nonword stimuli. For words, a unitized response code is available, whereas for nonwords, an additional phonological construction process is required to produce a response. It is this additional analytic process (letter-to-sound rules) that is responsible for the (additive) difference in the identification of words and nonwords. We are suggesting that repetitions affect processing along the analytic pathways in both Figures 13 and 14, whereas lexicality is manifested in the difference between the two figures—the phonological receding stage for nonwords and the availability of a relatively “automatic” and unitized response for words.

How can the model resolve the contradictory results that have sometimes been reported for the repetition effects? For example, why should there be facilitation between visually presented items that differ substantially in physical appearance (e.g., case) but

![Figure 14. Schematic representation of the analytic path leading to an identification response for nonwords. (It deviates from the path for words depicted in Figure 13 by the inclusion of an additional process responsible for constructing a pronunciation of nonwords and the exclusion of a unitized response from the semantic store.)](image-url)
no facilitation between auditory and visual presentations of items (e.g., Jacoby & Dallas, 1981; Morton, 1979b)? The answer probably lies in the type of information that is preserved between successive presentations of items. For example, with visual presentations, it could be argued that the important cues for access to episodic traces are such things as the visual characteristics of the display and the configuration of letters in the item. When the first presentation is auditory, information of this sort is not present (and, hence, not stored), and consequently, the episodic trace is not contacted by the second, visual presentation. In support of this explanation, it is interesting to note that when subjects are required to spell auditory presentations of words, subsequent visual identification of those words is facilitated (Jacoby & Witherspoon, 1982).

In lexical decision, the failure to find facilitation for repeated nonwords (e.g., Forbach et al., 1974; Scarborough et al., 1977) is probably due to a somewhat different, but related, problem. It seems likely that this finding is derived from the facility with which repeated nonwords contact episodic memory representations rather than the failure to access lexical or semantic representations. Suppose, for example, that the decision about the lexicality of a letter string is based partially on the failure to access a memory trace. If the episodic trace from the first presentation of a nonword is accessed the second time the nonword is presented, then one reliable source of evidence about the item’s lexical status is no longer effective. The subjects must resort to other, perhaps less efficient, means of determining whether the item is a word. McKoon and Ratcliff’s (1979) finding that repeated nonwords are rejected more slowly and less accurately than first occurrences of nonwords in lexical decision is consistent with this interpretation. Thus, the failure to find enhancing repetition effects for nonwords in lexical decision can be taken as evidence for, rather than against, the idea that the repetition effect involves access to memory for single prior events.

If it is accepted that memory for episodic events plays a large role in word identification, then what account can be given in the model of the independence that is sometimes observed between identification and recognition memory (e.g., Jacoby & Witherspoon, 1982)? As was discussed in Experiment 5, such independence can be accounted for by differences in the kind of information required for performance on the different tasks and the retrieval cues used to access that information. One hypothesis would posit that recognition requires access to temporal–contextual information associated with a repeated item and that identification requires access to information about structural aspects of the item. Thus, the decision in recognition is based on the use of different cues to access different aspects of the memory representation than those accessed in identification. The differential effects of lag on the two tasks (e.g., Jacoby, 1983, in press; Jacoby & Dallas, 1981) probably results from such differences in the important cues. The cues that are effective in identification may not be subject to the deleterious effects of temporal delay. The important recognition cues, however, could be subject to such effects.

In summary, we suggest that both recognition memory and the repetition effect in word identification are manifestations of the presence of a stored episodic image. Thus, recognition should not be adopted as the only task diagnostic of memory for specific episodes. Tasks such as word identification, which do not logically require the retrieval of the context in which an event occurred, can nevertheless reveal the influence of that event. Jacoby and Witherspoon (1982) have characterized the difference between these two manifestations of episodic memory as the difference between memory “with awareness” and memory “without awareness.”

In our model, repetitions produce episodic traces that support the identification process, thereby speeding the analysis of both words and nonwords. Whether this process operates as a retrieval phenomenon or as a result of activation of stored episodic traces is not yet clear. Although word and nonword identifications are similarly facilitated by repetitions in our model, the perceptual processing pathways resulting in correct pronunciation and identification responses to words and nonwords differ vastly. Words have integrated representations in semantic memory that allow identification to be made relatively
quickly, on what may be an automatic basis:
A unitized code can be provided for a per-
ceived set of features before the features are
forgotten. The nonwords are dealt with by
some sort of phonological construction pro-
cess, and feature forgetting may take place
to a considerable degree at various stages of
the identification process.

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