Critical influence of particular experiences in the perception of letters, words, and phrases

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Letters are generally easier to identify in regular words or pseudowords than alone or in irregular items. This advantage seems to imply that word perception depends on knowledge of general structure. We found, however, that the perceptual advantage of letters in pseudowords over single letters could be increased by preexposing the pseudowords, or reversed by preexposing the single letters. Similarly, preexposure of words alone or in phrases resulted in a perceptual advantage for whichever display had been experienced. The success of identification also depended on the type of task previously performed on test items, and on the reinstatement of prior processing and perceptual context, rather than on only the test items and task themselves. We concluded that memory preserves information about the details of particular perceptual experiences, and that identification depends critically on the similarity of current demands and processing context to the demands and contexts of particular previous experiences.

Until recently, theories about the perception of written materials have been dominated by the assumption that perception relies primarily on stable, general knowledge about language units. This assumption was encouraged by observations of stable differences in the perceptibility of various units, such as the general dominance of words over other units in perception. For example, letters are generally perceived more easily when presented in natural words than when presented alone or in letter strings (Reicher, 1969; Wheeler, 1970), pseudowords (McClelland & Johnston, 1977), or morphemes (Baron & Thurston, 1973). Similarly, words also appear to dominate phrases, in that words are better identified alone than in either ordinary or nonsensical phrases (Osgood & Hoo-sain, 1974).

The stability of this word advantage encouraged investigators to seek its cause in stable properties of words. Meaning was eliminated because orthographically regular pseudowords may be as well perceived as words (Baron & Thurston, 1973). Perceptibility was found, however, to be correlated with pronounceability (Gibson, Shurcliff, & Yonas, 1970), frequency (Morton, 1979), and aspects of structural regularity, such as the positional frequency (Mason, 1975), the sequential dependency (Rumelhart & Siple, 1974), and the cluster frequency

(Estes, 1975) of component letters. These correlations prompted accounts of the word advantage based primarily on knowledge of structural regularity, in which identification depends on detectors for familiar structural units at a variety of levels of complexity, acting in parallel (e.g., Estes, 1975), or on interactions of structural regularities implicit in representations of familiar words (e.g., McClelland & Johnston, 1977; McClelland & Rumelhart, 1981). Other accounts emphasize the correlation with item frequency, and suggest that familiarity may augment the use of knowledge of regularity (Healy & Drewnowski, 1983) or, in the extreme case, replace it (Seidenberg, 1986).

The common theme of these accounts is that perception depends primarily on knowledge of general properties of words, accumulated across many experiences. This assumption accounts for observations of stable differences in perception between items, but also implies that such stability is the rule. It is well known that contextual and "priming" manipulations can modify perception to some degree: for example, repeated presentations of familiar words are identified more easily than earlier presentations (e.g., Dannebring & Briand, 1982). However, these episodic effects are generally thought to be minor, transient perturbations in the performance of a basically stable system responding to the general familiarity of test items.

In contrast, we are impressed by the prevalence and durability of such episodic effects. For example, repetition effects can be observed with familiar words after a week (Jacoby, 1983a) and may endure as long as a year (Kollers, 1976), suggesting that the means by which a word is identified can be modified relatively permanently by as little as a single prior presentation. It is worth consider-

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ing why a single additional presentation of an already familiar word should produce an observable change in identification in Jacoby's and Kolars's experiments, and why such effects are not ordinarily observed. The answer to both questions appears to be that, in these experiments, the investigators made a deliberate attempt to reinstate characteristics of the previous experience in the test.

In general, the benefit given by exposing a familiar item prior to test appears to depend on the similarity of the preexposure and the test presentations. For example, whereas repetition of words leads to perceptual benefit, items repeated in a different symbolic domain (e.g., words to pictures or pictures to words) receive no significant benefit in speeded identification (Warren & Morton, 1982; Winnick & Daniel, 1970). However, recent work on the relationship between perception and recognition (Jacoby, 1983b; Jacoby & Witherspoon, 1982) and classification (Whittlesea, 1987b) suggests that perception may rely on much more specific detail of previous events. The case (Kolars, Paley, & Stelmach, 1980) and list context (Jacoby & Dallas, 1981) of earlier experiences of words may influence identification on a later occasion, so that performance on what is nominally the same item may depend on reinstatement of apparently extraneous detail as much as on the identity of the item. This suggests to us that perception may depend more heavily on the specific familiarity of a stimulus in its test context than previous accounts acknowledge.

We wish to explore the implications of assuming that perception depends primarily on memory for the details of particular perceptual experiences. This view of memory suggests that the facilitation accruing to an item depends on its similarity to past events; that the similarity of present and past events depends not only on physical structure, but also on the processing and contextual detail involved in both; and that past experiences influence performance in parallel, to the degree of their similarity to the current stimulus, task, and context (Jacoby & Brooks, 1984; Whittlesea, 1987b). Ordinarily, in dealing with familiar members of populous domains, perception relies on large numbers of past experiences in parallel, granting a kind of statistical stability to perception, so that effects of a particular experience ordinarily are not noticeable. In consequence, perceptibility should be robustly predictable on the basis of general attributes, which serve as rough indices of the overall similarity of past experiences to a present encounter with an item. However, if a few distinctive or unusual experiences of an item are available, and the test selectively reinstates their characteristics, then performance may depart considerably from the norm. It is this extreme case, in which performance depends predominantly on a limited number of previous experiences, that enables the investigator to discriminate reliance on general versus particular properties of experience.

A rigorous test of the relative contributions of general and specific knowledge to perception would require manipulation of each while the other is held constant. Because both assume that information about large numbers

of previous events is ordinarily influential in performance with familiar stimuli, only an approximation of this test can be achieved. First, the arbitrariness with which manipulation of episodic properties can affect later perception is limited by the difficulty of providing unusual and distinctive experiences of familiar stimuli. Second, although it is possible to manipulate episodic properties to some degree while holding stimulus regularity constant, it is extremely difficult to manipulate regularity, except by selection of different items, which entails a strong risk of confounding differences in regularity with differences in specific familiarity. Parametric manipulation of episodic properties and regularity are only possible in totally novel domains, but such investigations involve questions of new learning rather than of how the memory system functions ordinarily.

Within these restrictions, we attempted to investigate the nature of memory supporting perception of written materials. Our primary tactic was to assess the stability of perception under a variety of conditions. Prior to a perceptual test, we manipulated the physical context and purpose for encountering stimuli. The test reinstated properties of some of these experiences, but not others. If identification depends primarily on structural (general) information about past events, we would expect to find that perception is fairly stable under these changes. In contrast, if identification depends heavily on episodic (specific) information about particular prior events, then we would expect that the relative perceptibility of items will depend to a large degree on specific properties of the experiences we provided earlier, and on the similarity of the test conditions to those experiences. We paid particular attention to effects due to particular experiences that changed the order of difficulty of various tasks. We took such disordering interactions as critical effects of prior experiences.

To maximize the distinctiveness of the experiences that we provided from background experiences of text, we began our exploration with a series of experiments using pseudowords, discussed in Part I. In Part II, we extended the investigation to comparisons of natural words, phrases and letters.

PART I

Studies with Pseudowords

In the studies in Part I, we compared the perceptibility of letters alone and in pseudowords. Although pseudowords may be perceived less well than words, they may be expected to show as much stability as words following various experiences if perception relies primarily on knowledge of general structure, but marked instability if perception depends primarily on memory for particular experiences. Between studies, we manipulated the subject's prior experience of the target letters in various tasks and contexts, but, critically, the test phase of all four experiments was identical. In Experiment 1, a baseline condition, subjects identified single letters and letters in

pseudowords without specific prior experience. In Experiment 2, we required subjects to copy the pseudowords prior to the perceptual test, with the intent of providing experience of the pseudowords as integrated perceptual units. Such experiences may facilitate later identification of the component letters, because re-presentation of the pseudoword would provide a familiar context for the target letters. In Experiment 3, the same stimuli were shown in the training phase, but subjects were encouraged to break up the pseudowords, treating the letters relatively individually. The purpose of this experiment was to determine whether the *task* in which pseudowords were encountered, as opposed to simple *exposure* of the pseudowords, influenced their later usefulness as perceptual contexts. Finally, in Experiment 4, subjects were preexposed to single letters in an array of nonlinguistic symbols, the same array that was used in the test phase of all experiments to measure the perceptibility of individual letters. The purpose of this manipulation was to determine whether such specific experience might produce a perceptual advantage for single letters over letters in pseudowords. To assist the reader in making comparisons among these conditions, results of all four studies are presented in Figure 1.

Experiment 1

In Experiment 1 of this series, we measured the relative perceptibility of letters alone and in pseudowords without preexposure, as a baseline for the subsequent studies.

Method

Subjects. Thirty undergraduate students participated for course credit.

Stimuli. Stimuli for this and all other experiments in Part I consisted of single letters and pronounceable, orthographically legal pseudowords (see Appendix). Because an extension of this project involves perceptual generalization, the pseudoword stimuli were constructed as members of categories based on prototypes. Complete details of these stimuli have been reported elsewhere (Whittlesea, 1987b). Briefly, 30 items were generated from two prototype strings (FURIG and NOBAL), 10 differing from one prototype or

the other by 1 letter (e.g., FERIG, KOBAL), 10 by 2 letters (e.g., FEKIG, KOBAT), and 10 by 3 letters (e.g., PEKIG, KOBET). On single-letter trials, one of the 10 letters composing the prototype strings was presented.

Procedure. The subjects were tested on 30 pseudoword and 30 single-letter trials, presented in random sequence. Stimuli were presented tachistoscopically on a Zenith monitor driven by an Apple IIe microcomputer. Each trial commenced with a display of orientation arrows flanking the space in which stimuli were presented. On a keypress by the subject, a stimulus was exposed for about 50 msec. On single-letter trials, the letter was presented in the location it would occupy in a pseudoword (e.g., the letter F was presented in the first position), and pattern masks, each consisting of an asterisk in a rectangle, were presented in the four other locations.

Immediately following offset of both types of stimulus, masks were displayed in all five locations for 1 sec. Simultaneously, a caret was displayed beneath one of the five masks, cuing the subject to report the letter that had just occurred in that position, guessing if necessary. Each position was cued an equal number of times, in an apparently random series. On single-letter trials, the caret was presented at the location where the letter had occurred. On pseudoword trials, the target letter was always one of the 10 used on single-letter trials, and each was cued three times.

Results and Discussion

Mean probability of identifying a target letter presented alone ($p = .50$, $SE = .04$) and in pseudowords ($p = .49$, $SE = .04$) did not differ significantly [$F(1,29) = 0.031$]. The lack of difference between these conditions is mildly surprising because the one previous study that investigated relative perceptibility of letters alone and in pseudowords (McClelland & Johnston, 1977) found an advantage for letters in pseudowords. Their pseudowords, however, were one-letter distortions of natural words. In contrast, they found no advantage for unrelated letter strings (generated by scrambling letters of natural words, subject to the constraint of nonpronounceability). Our pseudowords, generated as distortions of a nonsense prototype, may resemble their unrelated letter strings more closely than their pseudowords in whatever property determines perceptibility of novel items.

These results were an ideal starting point for the project, suggesting that our pseudoword strings received no perceptual benefit from the subject's extraexperimental experience beyond that accruing to single letters, whether from knowledge of orthographic regularity, particular experiences of words, familiar units, phonological codes, or whatever. These results established a baseline against which to compare any perceptual advantage resulting from particular experiences of the stimuli prior to the test.

Experiment 2

We began our investigation of the perceptual consequences of particular experiences by introducing a training phase in which subjects were required to copy some of the pseudowords that would be presented in the identification test. This training experience has predictable consequences for later identification of letters in the repeated pseudowords. Repetition of words (Kolers, 1975), pictures (Warren & Morton, 1982), handwriting,

Figure 1. Identification probabilities for Experiments 1-4. See text for explanation.

and (male or female) voice (Morton, 1979) all produce long-lasting perceptual benefits. More specifically, repeated pseudowords are known also to show this effect (e.g., Salasoo, Shiffrin, & Feustal, 1985; Whittlesea, 1987b). The novel question in this study was the degree to which the experience of copying the pseudowords would facilitate identification of their constituent letters when presented alone. If the repetition benefit was due to learning about item components or about some general property of the situation (computer, typeface, task, etc.), then there should be no difference in the benefit of letters presented alone or in pseudowords. However, if subjects additionally learned something about the organization of letters within pseudowords, then letters presented in repeated pseudowords should be identified more accurately than repeated letters presented alone. In this case, we would observe a perceptual advantage of higher order units, analogous to the word advantage in form and perhaps in mechanism, but induced by experience of novel letter strings in a simple task.

Method

Subjects. Thirty undergraduate students participated for course credit.

Procedure. In a preexposure phase, subjects were shown 10 of the pseudowords (those differing from their prototypes by two letters; see Appendix) on the computer monitor. Each pseudoword was exposed three times, but the presentation order was random. The subjects were required to copy the stimuli on paper. These preexposure trials were subject-paced. The subjects were not warned to expect any subsequent test. Following this phase, the subjects received the same perceptual test as did the subjects in Experiment 1. Thus, one third of the test pseudowords were exact repetitions from the preexposure phase, and the remainder differed by one (nontarget) letter from a preexposed item. The results offered below do not distinguish between practiced items and novel items similar to practiced items; differences between these types are explored in detail elsewhere (Whittlesea, 1987a). The average delay between last exposure of a pseudoword in the first phase and its presentation at test was about 5 min.

Results and Discussion

Letters presented in pseudowords were identified with greater probability ($p = .69$, $SE = .04$) than letters alone ($p = .54$, $SE = .04$) [$F(1,29) = 30.272$, $p < .001$]. These results constitute a pseudoword advantage, consisting of superior perception of (or interference about) elements presented in higher order units than of the elements alone.¹

This pseudoword advantage is evidently a product of the preexposure experience, and demonstrates that the perceptibility of letter-string stimuli is easily modified. Comparison of Experiments 1 and 2 (see Figure 1) shows a strong interaction of training condition (prior exposure of pseudowords vs. no prior exposure) with stimulus condition at test (pseudowords vs. single letters) [$F(1,58) = 17.611$, $p < .001$]. Simple effect analysis indicated that preexposure of the pseudowords had little or no effect on the perceptibility of single letters [$F(1,116) = 0.558$], but did increase perceptibility of letters presented in pseudo-

words [$F(1,116) = 12.157$, $p < .001$]. Because the effect of prior exposure is disproportionate between single-letter and pseudoword test conditions, subjects must have learned something about the interrelationships of components within pseudowords, rather than simply about their individual components or about general properties of the experimental situation. This suggests that the repetition advantage occurs because of fast learning about the organization of components within items.

The pseudoword advantage obtained here is similar in form to the advantage normally obtained for letters in words over single letters, and invites the speculation that the perceptual advantage of words also results from learning about specific organizations of letters within higher order units, rather than from learning about orthographic properties of words in general. Before pursuing this speculation, we attempted to determine just how specific was the learning about pseudowords.

Experiment 3

Our next experiment was conducted to determine whether the advantage of wholes over parts is a necessary consequence of exposure to the wholes, or whether it results in part from the purpose for which the stimuli are encountered. In this study we replicated the entire procedure of Experiment 2, except that we altered subjects' interaction with the preexposed pseudowords. Whereas subjects in Experiment 2 were required to copy the stimuli, subjects in Experiment 3 performed a letter-comparison task, in which they compared the item with its prototype, copying the matching letters in one location and the nonmatching letters in another location on a response sheet. Based on previous studies (Whittlesea, 1987b; Whittlesea & Cantwell, 1987), we expected that the letter-comparison task would encourage relatively individual learning about elements, at least in comparison with the configural processing encouraged by the demand to copy whole pseudowords. Any difference in the patterns of identification accuracy between Experiments 2 and 3 could be attributed to this change in processing requirements, because the stimuli used in the two experiments were identical in both training and test phases.

Method

Subjects. Thirty undergraduate students participated for course credit.

Procedure. The procedure was identical to that of Experiment 2, except that instead of copying preexposed pseudowords, the subjects were required to compare them with their prototypes. The relevant prototype item was displayed on the monitor directly above each target item; the vertical space between the two was approximately half the height of a letter. No mention was made of the categorical nature of the stimuli or of the status of the prototype. The subjects were provided with a protocol on which two columns of five blank spaces appeared, the columns labeled "Same" and "Different." The subjects were required to copy each letter of the target pseudoword onto the corresponding space on the protocol, but using the spaces of the "Same" or "Different" column depending on whether the letter matched the corresponding letter of

the prototype. Thus, as in Experiment 2, the five letters of each stimulus were attended and reproduced, but in Experiment 3 were processed relatively individually, and appeared on the subject's protocol in a broken-up format.

Results and Discussion

The probability of identifying a letter alone ($p = .60$, $SE = .04$) did not differ significantly from accuracy on letters in pseudowords ($p = .61$, $SE = .04$) [$F(1,29) = 0.248$]. However, these probabilities were higher than their respective baselines in Experiment 1 [$F(1,58) = 4.409$, $p < .05$], indicating that subjects had benefited in some fashion from the preexposure. More important, simple effect analysis indicated that in Experiment 3 letters alone were better perceived [$F(1,116) = 4.417$, $p < .05$], and letters in pseudowords worse perceived [$F(1,116) = 7.810$, $p < .01$] than in Experiment 2 (see Figure 1).

This effect demonstrates that variation in the quality of the training experience differentially affects the facilitation of various types of units, and thus determines the relative perceptibility of those units. Specifically, the training of Experiment 2 was designed to give subjects practice in perceiving whole pseudowords, whereas the training of Experiment 3 was designed to teach subjects to perceive individual letters in a multielement display. If the test consisted of perceiving a letter in a familiar letter context (pseudoword test, Figure 1), then we should expect the training of Experiment 2 to be more appropriate. If, instead, the test consisted of perceiving a letter in a non-letter display (single-letter test, Figure 1), then we should expect the training of Experiment 3 to be more appropriate.

Comparison of Experiments 1 and 2 demonstrates that the perceptibility of letters is not a given of the context in which they are tested, but may be influenced by prior exposure of the letter in the same context (pseudoword test in Experiment 2). However, the results of Experiment 3 demonstrate that "same context" cannot be construed as simple exposure to the same array. Instead, the type of processing carried out is critical to the utility of the training experience for a later test.

Experiment 4

If the particular characteristics of previous experiences are critical to later perception, then there ought to be some conditions of training that would produce an advantage for the single-letter test condition. A natural condition to investigate is one in which subjects encounter the target letters in a training phase in precisely the same perceptual display as will be used in a single-letter test. Following this training condition, the identification of letters in pseudowords should be at a relative disadvantage, because the perceptual context provided by a pseudoword at test would not match the context in which target letters were read in training.

Method

Subjects. Thirty subjects participated for course credit.

Procedure. In a preexposure phase, the 10 target letters were exposed, one letter per trial, in the location on the monitor they would later occupy in single-letter and pseudoword tests. The remaining locations were occupied by masks, as they would be on single-letter test trials. Each letter was presented three times, in a random series. The subjects were required to copy the letters on paper. Trials were subject-paced. The test phase was identical to that of Experiments 1-3.

Results and Discussion

In this case, single letters were perceived with greater probability ($p = .80$, $SE = .04$) than letters in pseudowords ($p = .61$, $SE = .04$) [$F(1,29) = 39.795$, $p < .001$]. This letter advantage is of about the same magnitude as the pseudoword advantage observed in Experiment 2, but in the opposite direction (see Figure 1). Single letters were better perceived in Experiment 4 (following single-letter training) than in Experiment 2 (following pseudoword copying) [$F(1,116) = 24.136$, $p < .001$], whereas the reverse was true for letters in pseudowords, which were better perceived in Experiment 2 than in Experiment 4 [$F(1,116) = 3.98$, $p < .05$].

The perceptual advantage of single letters in this case demonstrates that higher order linguistic units do not necessarily have an advantage over their components. Moreover, because the single-letter training condition resulted in an actual advantage for single letters at test rather than equality with letters in pseudowords, it suggests that perceptual success depends not only on the context of earlier experiences or on the context of a letter at test (which was constant between experiments), but on reinstatement of the context of earlier experiences in the test display. If the identification system did not preserve information about the nonletter contextual elements, this training condition should result in equal perceptibility of letters in both test conditions, because subjects would have available only letter-identity and -position information. We evidently cannot think of the single-letter training and test conditions as "neutral" presentations of single letters with literally no context. Instead, the mask elements, despite their nonletter status, provide a definite context whose reinstatement improves test performance.

General Discussion: Pseudoword Studies

In general, we found that perceptibility of letters both alone and in pseudowords differed considerably following various experiences. We also found that the character of particular experiences was interactive with test condition. For optimal performance on perceiving a letter in a pseudoword, it is evidently advantageous to experience the letter as part of the pseudoword array in which it will later be tested (Experiment 2). By comparison, it is less advantageous to have been given previous experience in treating the same arrays as collections of separate letters (Experiment 3) or to have seen the same letters in the same

positions, but surrounded with nonlinguistic units (Experiment 4). Least advantageous is to have had no previous experience with the letters in position in the general experimental setting (Experiment 1).

For optimal performance on the test task of perceiving a letter in a nonlinguistic array, it is most advantageous to have seen the letter in that same array (Experiment 4). By comparison, it is less advantageous to have seen the letter in the context of other letters, even though the processing emphasized the letters as individual units (Experiment 3). Far less advantageous is to have seen the letters in the context of other letters when the processing encouraged treating the array of letters as an integrated whole (Experiment 2), or to have had no previous experience with the letters in the general experimental setting (Experiment 1). We interpret these interactions of prior experiences with subsequent performance to mean that the experiences we provided influenced subsequent performance through their appropriateness as resources for further processing under particular demands (e.g., Morris, Bransford, & Franks, 1977) rather than through alteration of some global aspects of memory.

Given that the test phase was identical in all four experiments, these results suggest a very marked degree of instability of perception. However, we were unable to manipulate perceptibility with complete arbitrariness. Over the four experiments, the perceptibility of letters presented alone was more variable than that of letters presented in pseudowords: accuracy of perceiving letters alone ranged from a low of .50 in Experiment 1 to a high of .80 in Experiment 4, whereas the accuracy of perceiving letters in pseudowords ranged from .49 in Experiment 1 to .69 in Experiment 2. Some readers may wish to interpret this as evidence that pseudoword perception is accomplished partly on the basis of general knowledge of regularity; however, we wish to advance two other explanations for this finding. First, the test in all four experiments required subjects to report a single letter from the test displays. This requirement reinstates the training requirements of Experiments 3 and 4, but not of Experiment 2, in which subjects were initially required to copy entire stimuli. If later processing is specific to the demands as well as to the contexts of earlier experiences, then the test condition of Experiment 2 is not optimal. In fact, when subjects are required to report whole stimuli at test, the accuracy of identifying each letter increases considerably (Whittlesea, 1987a; Whittlesea & Cantwell, 1987). The issue of reinstatement of processing requirements is examined in detail in Part II.

Second, we suggest that the presentation of a letter in a context of masks in the training phase of Experiment 4 was more distinctive from background experiences than was the presentation of the same letter in a context of letters in Experiment 2, with the result that test performance in Experiment 4 depended more specifically on experiences provided within the experiment. As indicated in the

introduction, the similarity of the test experience to experiences outside of the experiment sets a limit on the arbitrariness with which particular experiences can modify subsequent perception, a limit that will be seen more clearly in experiments with natural words in Part II.

Given this constraint, we believe that we have observed a degree of variability of performance that is at least surprising if perception is thought to depend primarily on knowledge of general structure. An advantage for higher order units can be created (Experiment 1 vs. Experiment 2), modified (Experiment 3), or reversed (Experiment 4) following appropriate experiences. Because the set of test stimuli was identical across these experiments, general attributes of preexperimental experience, such as knowledge of structural regularity, could not have been responsible for the differences in identification accuracy observed. Instead, these effects demonstrate an influence of specific experiences lasting at least as long as the experimental session. The perceptibility of letters in these studies appears to rely heavily on the demanded processing (Experiment 2 vs. Experiment 3) and reinstatement of the specific contexts of earlier experiences (Experiment 1 vs. Experiments 2 and 4). We conclude that the task in which one encounters an item (e.g., a letter) determines what aspects of the available context will be attended and will become a functional part of the experience of the item. In turn, whatever elements become a functional part of the experience will serve to facilitate identification of the item, if they are reinstated.

PART II

Studies with Natural Words

Experiments with pseudowords permit excellent control of structural properties and novelty, but suffer from the inherent problem that pseudowords are artificial, and so may be thought to invoke different identification processes than natural materials. We therefore attempted to evaluate the importance of episodic detail for the identification of natural words and phrases. In the first experiment to be described, we manipulated the experience of words within phrases, and in the second, the experience of letters within words.

Experiment 5

The purpose of Experiment 5 was to discover whether the processing demands of previous experiences exercise as much impact on word and phrase identification as they do on the identification of nonwords (Experiment 2 vs. Experiment 3). In the experiments above we manipulated physical context of target letters both in training and at test, but manipulated processing demands only in training. In the following experiments, we extended the manipulations to varying the task as well as the perceptual array at test in order to determine whether success in identification depends on an interaction of previous and

current processing, as it evidently depends on reinstatement of perceptual context.

Method

Subjects. Thirty subjects participated for course credit.

Stimuli. We generated 81 three-word phrases, approximately half of which were of the form adjective-adjective-noun ("heavy steel box") and half of the form noun-verb-adverb ("rocks flew fast"). The phrases were designed to be sensible, but not specifically familiar to subjects. The component words were all of at least moderate frequency, and of lengths varying between three and five letters.

Design and Procedure. This experiment, like most of those above, consisted of a training phase followed by a perceptual test phase. In the training phase, the subjects were exposed to one-third of the 81 phrases in each of three conditions. In the first condition (whole-phrase), they were shown a phrase on the monitor and required to copy it on paper. In the second condition (word-in-phrase), they were shown a phrase and required to copy one word, which was indicated by a caret. The three possible phrase positions were interrogated equally often, and in random sequence. In the third condition (single-word), the subjects were shown one word (redundantly indicated by a caret) and required to copy it. This word was taken from a phrase not used in another condition and presented on the screen in the location it occupied in the phrase. The remaining two locations were filled with five Xs.

Trials of the three conditions were randomly intermixed, and each item was displayed three times in the random sequence, for a total of 243 trials. Trials were subject paced: on one keypress, a prompt consisting of the phrase "Copy the phrase" or "Copy the word" was displayed to indicate which activity was required on that trial; on a second keypress, the stimulus was displayed; and on a third, the screen was cleared.

In the test phase, the subjects were informed in advance of each trial whether they would have to report a single word or a whole phrase, but were not warned of the position in which a target word would appear or of which position they might have to report. As in the training phase, a single word was presented in one location (the location it had occupied in a training trial), and the other locations were filled with Xs. The display was presented for 30 msec, immediately following which the stimulus display was replaced by three rows of five Xs, each located in one of the phrase positions. In the case of the word-in-phrase or the single-word test, the target word was indicated by a caret that remained on the screen until the masking display ended 1 sec later.

The critical aspect of the design was that stimuli were completely crossed between training and test, so that one-third of the items presented in each training condition were tested in each of the three test conditions. In the case of a stimulus transferred from a phrase to a word condition, two-thirds of the phrase was dropped (the position of the remaining item being equated across trials), whereas in the reverse condition, two-thirds was added. On test trials involving dropped context or cuing a word in a phrase, the remaining or cued word was always one that had been reported in a whole phrase, cued in a whole phrase, or presented alone. On trials involving whole-phrase report at test, we scored only a target word whose position was yoked to the target locations in the other two conditions, and this target word had also been shown and/or cued in one of the previous conditions. The phrases assigned to each condition were randomly reassigned between subjects, so that over the group of subjects there was no systematic relationship between particular conditions and particular phrases. Average delay between the last occurrence of a target word in Phase 1 and presentation of the word in Phase 2 was about 10 min.

Results and Discussion

Results are shown in Table 1. There were an overall interaction of training $\times$ test conditions [$F(4,116) =$

Table 1
Experiment 5: Mean Proportion of Targets Identified
in Crossed Training and Test Conditions

Training Condition	Test Condition					
	Whole-Phrase		Word-in-Phrase		Single-Word	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Whole-Phrase	.60	.04	.56	.04	.31	.03
Word-in-Phrase	.34	.04	.43	.04	.42	.03
Single-Word	.24	.03	.30	.03	.41	.03

49.289, $p < .001$] and an overall main effect of training [$F(2,58) = 36.587$, $p < .001$]. The real interest in this study, however, lies in planned comparisons of particular cells, employing the Newman-Keuls *a posteriori* test. First, this study replicates the findings of Experiments 2, 3, and 4, which demonstrated that no level of unit (pseudoword or single letter) possesses a stable perceptual advantage over the other. Phase 1 of those studies required subjects to copy the larger unit, to copy individual components from the larger unit, or to copy the smaller unit, and Phase 2 required either cued report of a letter from the larger unit or cued report of a letter presented in its original location with fillers in the other locations of the larger unit. The comparable cells of the present design consist of pairs with word-in-phrase test and single-word test (second and third columns of Table 1) following whole-phrase, word-in-phrase, or single-word training. Parallel to the pseudoword advantage of Experiment 2, items in the whole-phrase/word-in-phrase condition (i.e., whole-phrase training followed by word-in-phrase test) were better perceived than items in the whole-phrase/single-word condition ($p < .01$). The equality of letters alone and in pseudowords found in Experiment 3 was replicated by the equivalence of the word-in-phrase/word-in-phrase and word-in-phrase/single-word conditions. This pair of comparisons again demonstrates the differential impact of earlier processing on later perception. Finally, the letter advantage of Experiment 4 was replicated by better perception of single-word/single-word items than of single-word/word-in-phrase items ($p < .01$). Together, the three comparisons echo the conclusion of the pseudoword studies that the relative perceptibility of different units is unstable, but varies predictably with particular experiences.

Next, to examine the importance of reinstating processing from training to test, we compared the upper-left four cells of Table 1: whole-phrase/whole-phrase, whole-phrase/word-in-phrase, word-in-phrase/whole-phrase, and word-in-phrase/word-in-phrase. The display presented to subjects in all four of these conditions was identical; the only difference was whether the subject was required to report all of the display or a single element in training or in test. These factors were found to interact [$F(1,29) = 10.05$, $p < .001$], indicating that performance on later exposures is dependent not only on respecification of context, but also on performing the same processes. A main effect of training that favored report of the whole display was also found [$F(1,29) = 44.006$, $p < .001$], indicat-

ing that processing larger units in earlier experiences is more useful for any type of later report.

There is no comparably neat analysis in which the processing is held constant and the array changes, unless we define the processing solely in terms of the type of unit reported. It seems more reasonable to interpret processing as the extraction of information from the perceptual array, and under this definition one cannot change the presented array without also changing the processing.

The most dramatic comparison of the power of reinstatement of a combination of processing and perceptual context involves the conditions reported in the four corner cells of Table 1, which either maintained the same display and task for training and test (whole-phrase/whole-phrase and single-word/single-word) or switched the size of unit reported for a different size of display (whole-phrase/single-word and single-word/whole-phrase). This analysis yielded a strong interaction of training and test contexts [$F(1,29) = 67.384$, $p < .001$], which was parallel to the interaction found in the comparison of Experiments 2 and 4. This indicates an advantage for maintaining both processing and perceptual array between training and test. In addition, main effects that favored phrases were found for both training [$F(1,29) = 27.442$, $p < .001$] and test [$F(1,29) = 5.203$, $p = .028$]. These analyses suggest some overall benefit of the higher level unit (phrases), but primarily demonstrate the value of maintaining the array type for earlier and later occasions.

These results may seem to suggest that performance is necessarily specific to the particular properties of previous experiences, so that the perceptual-memory system does best what it has done before, regardless of the type of processing and the stimulus structure to which it is applied. However, these data show that exact reduplication of item, context, and processing demands does not necessarily produce optimal identification accuracy. The condition reflected in the middle cell of Table 1 (word-in-phrase/word-in-phrase), which reflects complete reinstatement, does not result in better recall than either the word-in-phrase/single-word or the whole-phrase/word-in-phrase condition, a finding reminiscent of the equality of letters identified alone and in pseudowords following the split-pseudoword training of Experiment 3. If we have correctly interpreted the processing conducted during word-in-phrase training, the subjects learn about each word in the phrase independently of the others. Such analytic coding makes perception robust across changes in context, as demonstrated by the equal perceptibility of words in old phrases or of words presented alone following this training, but does not permit perception to make use of reinstated context, resulting in less facilitation than is possible if one encodes the target with its context. In contrast, nonanalytic coding of the stimulus display as a whole permits optimal perception if the context is reinstated at test, but also entails the risk of perceptual failure if context is not reinstated in a later display, as demonstrated by the comparison of the whole-phrase/whole-phrase and

whole-phrase/single-word cells. We conclude that later performance is dependent on the quality of earlier particular experiences, but is specific to reinstatement of earlier experiences only if those experiences involve encoding the display as a nonanalytic whole.

Optimal perception in these data occurred when the larger unit (phrases) was reported as a whole in both training and test, suggesting an overall benefit for reprocessing larger units. However, this is the reverse finding from that of the pseudoword experiments, in which optimal identification accuracy was found for reprocessed single letters, the smaller unit. In addition, whereas the perceptibility of single letters was more variable than that of letters in pseudowords in Experiments 1–4, the perceptibility of words presented in phrases, ranging from .24 to .60 accuracy, was more variable than the perceptibility of words presented alone, ranging from .31 to .42. This might suggest that words and pseudowords enjoy a special status, relatively immune to the influence of particular experiences. However, the variability of words reported alone was nearly as great as that for words presented and reported in phrases, ranging from .30 to .56, so that the argument for a special status of words can apply only to encounters with words in isolation. This issue is discussed again following the next experiment, which presents evidence relevant to this issue.

Experiment 6

The standard demonstrations of the word advantage compare the perceptibility of letters presented in words with that of letters presented alone. As discussed in the introduction, the finding of a stable difference between these conditions is usually interpreted as evidence that word perception depends on stable knowledge, such as information about structural regularity. However, the standard demonstrations of the stability of word perception do not specifically cue any particular experiences, so that such influence could not show itself. We suggest that these demonstrations may reflect a kind of statistical stability, that under these conditions word perception depends on simultaneous facilitation of performance by masses of previous experiences of words. In contrast, if distinctive experiences are available and the test context is similar to the contexts of those experiences, then reliance on information about particular events may be revealed by variability in the perceptibility of words.

In Experiments 1–4 we found that perception of letters in pseudowords is easily modified by particular experiences, and in Experiment 5 we found that reports of natural words may also vary considerably if previous and current contexts and processing are manipulated. In Experiment 6 we again attempted to assess the stability of word perception, this time by requiring subjects to report letters from words rather than to report whole words. The experiment is a formal analogy to Experiment 5; the design and procedures are identical, except that phrases are replaced by natural words, and natural words by single

letters. As before, this design permits evaluation of the effects of reinstating both the processing and perceptual contexts of earlier experiences.

Method

Subjects. Thirty undergraduate students served in this experiment for course credit.

Stimuli. We selected 90 moderately high frequency five-letter words from the Thorndike and Lorge (1963) norms.

Design and Procedure. The design was analogous to that of Experiment 5, with whole-word substituting for whole-phrase, letter-in-word for word-in-phrase, and single-letter for single-word, the cross of training and test conditions again giving nine cells. One exception to the analogy was that whereas in Experiment 5 we had used three-word phrases, interrogating each position three times within a cell, we now employed five-letter words, interrogating each position twice within a cell. The second exception was that whereas no word had been used in two trials in Experiment 5 (the 81 phrases being composed of 243 different words), the limits of the alphabet required us to repeat letters across trials. The actual letter presented on a single-letter trial was selected by assigning each of the 30 words not used in word trials to particular single letter trials, and on each trial presenting one letter of the appropriate word, that letter being the one in the position to be interrogated on that trial. As in Experiment 5, the assignment of items to conditions was randomly reassigned between subjects. In consequence, the frequency, identity, and position of target letters occurring in particular conditions in single-letter presentations could be expected to match those of target letters in word presentations across subjects, and was not systematically related to experimental conditions.

Results and Discussion

Overall results are shown in Table 2. Comparing the results of reporting a single letter from a word or a letter presented alone following the three kinds of training (second and third columns of Table 2), we found that experience of a single letter was not sufficient to make a letter more perceptible in a single-letter array than in the context of a natural word. Thus in this experiment we did observe an overall word superiority effect.

Although this word advantage was reliable, it did not appear to be based on stable differences in processing. First, considering the comparison of reporting a single letter from a single-letter or a whole-word display following display and report of a single letter or whole word (top and bottom cells of columns 2 and 3 of Table 2), we observe a strong interaction of training and test conditions [$F(1,29) = 36.551, p < .001$], indicating that the advantage of identifying a letter in a word depends on previous salient experiences. Second, when the array remains the same between training and test (upper left four

cells of Table 2), there is a striking replication of the results of Experiment 5. There is a strong interaction of training and test conditions [$F(1,29) = 25.722, p < .001$], indicating that when the array is held constant at the whole-word level, reinstating the previously experienced processing context facilitates performance. This is the same effect found in Experiment 5 when the array was held constant at the level of a sensible phrase. In addition, as in Experiment 5, a main effect favoring the larger unit in training (phrases in Experiment 5, words in Experiment 6) was found [$F(1,29) = 15.141, p < .001$], indicating that earlier experience of larger units is more useful to any type of later report. Third, the comparison of the four corner cells again shows that when extreme combinations of processing and perceptual array were crossed between training and test, there was a highly significant interaction [$F(1,29) = 127.607, p < .001$]. This again indicates that maintenance of the characteristics of the prior processing episode results in superior identification of the target. We conclude that the perception of letters presented alone and in words is less stable and more systematically associated with particular experiences than one would expect if perception relies primarily on knowledge of general properties of experience.

In this experiment, the perception of letters in words, ranging in accuracy from .33 to .80, was more variable than the perceptibility of letters presented alone, ranging from .25 to .34, although the variability of reporting single letters ranged from .25 to .65. This contradicts the idea, mentioned after the last experiment, that words enjoy a special status, being more stable under variations of specific experience than larger and smaller units. Instead, the degree to which the perceptibility of words can be manipulated through exposure in particular tasks and contexts appears to depend on particular conditions of stimulus displays and report conditions, and on the alternative that subjects also have to examine and report.

Experiment 7

Experiments 2–6 demonstrated that reinstating the perceptual context of previous experiences facilitates performance on a later test if previous task demands encouraged processing the target together with its context. We next attempted to discover whether the effects of context range only from facilitatory to neutral, or whether presentation of a target in a context that had been previously associated with a different item might actually *interfere* with perception of the target.

Method

Subjects. Thirty students served in this experiment for course credit.

Stimuli. Ninety phrases were employed, consisting of the 81 phrases from Experiment 5 plus 9 more phrases of similar structure.

Design and Procedure. Like the studies reported above, this experiment consisted of a training phase and a perceptual test. In the training phase, the subjects were exposed to 40 of the phrases and to 30 individual words taken from the remaining phrases. The individual words were sampled equally often from the three phrase

Table 2
Experiment 6: Mean Proportion of Targets Identified
in Crossed Training and Test Conditions

Training Condition	Test Condition					
	Whole-Word		Letter-in-Word		Single-Letter	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Whole-Word	.80	.04	.65	.04	.25	.04
Letter-in-Word	.60	.04	.70	.05	.34	.04
Single-Letter	.33	.04	.44	.04	.34	.04

positions, and were presented on the monitor in those locations. These items (phrases or words) were presented three times each, in random sequence. The subject's task in this phase was to copy each display on paper. Succeeding displays were subject-paced.

The 70 target words were presented in seven test conditions that differed in the degree to which a word's original context was reinstated (see Table 3). In the first condition (phrase/same-phrase) the word was presented in its original context. In the second condition (phrase/new-context) the target was exposed in the context of two words from one of the phrases not used in Phase 1. The resulting phrase made sense, but only the target element was familiar. In the third condition, (phrase/re-paired context) the target was presented with the unused context of a phrase/new-context target or of a phrase/drop-context target (fourth condition). For example, if "dirty black walls" and "heavy steel boxes" had been presented in Phase 1, "steel" would be presented alone (phrase/drop-context) or in a novel context (phrase/new-context), and "black" would be presented in the phrase "heavy black boxes" (phrase/re-paired context). Again, the phrases so formed were sensible, and in this case consisted entirely of familiar components in familiar locations, but the pairing of context and target was novel. Finally, as already implied, in the fourth condition (phrase/drop-context) a word originally presented in a phrase was now presented alone. Unlike the procedure in the pseudoword experiments, no filler symbols replaced the dropped phrase components, but the single word was presented in its original location on the screen.

In the fifth condition (word/same-word) a target originally presented alone was again presented alone, in the same screen location as before. As in the phrase/drop-context condition, no filler symbols were presented in the other phrase positions. In the sixth (word/new-context) a target presented alone in Phase 1 was shown in a context taken from one of the phrases not presented in Phase 1. Finally, in the seventh condition (word/re-paired context) a target originally exposed alone was presented in the unused original context of a phrase/drop-context or phrase/new-context item.

Thus all targets used in Phase 2 had been exposed before, and no context words were paired with more than one target in the test phase. Phrases were reassigned to conditions between subjects, with the constraint that re-paired phrases must be sensible. This constraint eliminated very few reassignments: the rather nonspecific character of the phrases enabled us to interchange their components quite easily. This reassignment effectively ensured that no phrases were confounded with particular conditions. The 10 targets within each condition were sampled from each phrase position approximately equally often.

The 70 displays formed by these conditions were presented in random order. On each trial one display was presented for 30 msec and was immediately followed by a masking display of three rows of five Xs, each located over one phrase position. The subject's task was to identify and copy down whatever was displayed (phrase or word), guessing if necessary. Subsequent trials were subject-initiated. Average delay between last presentation of a target in Phase 1 and presentation in Phase 2 was about 10 min.

Results and Discussion

Protocols were scored for number of target words correctly reported in each condition (see Table 3). A signifi-

cant effect of training condition was found [$F(6,174) = 41.658, p < .001$]. In Newman-Keuls a posteriori comparisons, all pairs of means were significantly different ($p < .05$), except the comparisons of phrase/re-paired phrase with word/re-paired phrase and with word/new-phrase, and of word/re-paired phrase with word/new-phrase. That is, in Table 3, all comparisons that differ by more than .06 (mean proportion of correct identification) are significantly different.

The optimal condition for perception following exposure of a target in a phrase was same-phrase, followed by drop-context, new-context, and finally re-paired context. A similar pattern was evident following exposure of a word alone, consisting of the order same-word, new-context, and re-paired context. These patterns of results suggest that the later perceptibility of a word depends heavily on reinstatement of its context: in both cases, exact reinstatement of the earlier context (whether that context consists of words or the absence of words) fosters optimal perceptual accuracy, whereas each alteration from the original context causes a decrement in perceptual accuracy.

One of the purposes of this experiment was to determine whether a familiar but inappropriate context could actually interfere with perception. For this purpose, we focus on the fact that re-paired context following phrase training resulted in poorer perception than did either of the possible candidates for a "neutral test context" condition. That is, the re-paired condition was worse than a condition in which the original context was dropped, leaving only the target word, and worse than a condition in which a new context was substituted. The results were somewhat more marginal following word training, but the difference between new and re-paired context conditions is at least in the same direction. This analysis suggests that context is a two-edged sword, facilitating perception if preserved, but degrading perception if altered in any way. This is particularly true if the context is specifically familiar but originally associated with another item.

This discussion implies that there is no "neutral" condition against which the effects of adding, dropping, or changing context may be evaluated. The word/same-word condition is as close as one can come to a "no-context" condition, and yet maintenance of the original circumstances is as important to later perception of the word as reinstatement of the context words is to perception of a phrase/same-phrase target, as is illustrated by comparison of each of these conditions with the relevant new context or re-paired context conditions (see Table 3). Although under some circumstances, the subjects might treat one or the other of these conditions as neutral, this analysis suggests that there is no a priori means of defining a context-free condition.

The two most important points to be taken from this experiment are that (1) dependence on previous contexts builds very rapidly with natural words presented in natural contexts (phrases), and (2) as in the studies above, the relative perceptibility of different levels of unit (words or phrases) are observed to be unstable when episodic

Table 3
Experiment 7: Mean Proportion of Targets Identified
Following Phrase or Word Preexposure

Training Condition	Context at Test							
	Same		New		Re-paired		Dropped	
	M	SE	M	SE	M	SE	M	SE
Phrase	.61	.03	.43	.03	.31	.02	.52	.03
Word	.70	.03	.34	.03	.28	.03		

properties are manipulated. The latter point is clearly illustrated by comparison of four critical cells, phrase/same-phrase, phrase/drop-context, word/same-word, and word/new-context, which parametrically manipulate words versus phrases at earlier and later encounters. In this analysis, perceptual accuracy depends on an interaction between context at training and at test [$F(1,29) = 147.408$, $p < .001$]. The interaction supports the same interpretation as the interaction between the single-letter and pseudoword advantages discussed in Part I and the four-corner analyses in Experiments 5 and 6, namely that perceptual success on a subsequent occasion depends on the quality of reinstatement of context from earlier exposures to the item.

A main effect of test context favoring the smaller unit (words) was also obtained from this last analysis [$F(1,29) = 52.008$, $p < .001$]. This effect is opposite to that reported in Experiment 5, and may be due to the fact that, in this study only, the smaller unit was presented at test without masks occupying the remainder of the display, and was in consequence easier to detect.

GENERAL DISCUSSION

Overall, these experiments demonstrate that when specific familiarity is manipulated independent of general properties of experience, one can observe considerable variability of both the absolute and relative perceptibility of letters, words, pseudowords, and phrases. This variability appears to be strongly associated with episodic properties made available through particular experiences provided within the experiments. In general, identification accuracy was found to depend on an interaction of present and past processing contexts in which particular items had been encountered. These results indicate that identification of lexical and nonlexical written materials depends heavily on specific information about particular experiences when such experiences are distinctive and similar to the test context.

Defining the precise degree to which perceptual processes depend on episodic information is difficult. A thorough assessment of the relative importance of episodic and general knowledge for perceptual processing would require, in addition to the manipulation we conducted, that general properties be varied independently of episodic properties. Unfortunately, as discussed in the introduction, manipulation of general properties is largely confounded with variation of episodic properties, so that complete parametric comparisons cannot easily be conducted. However, the influence of particular episodes is clearly not restricted to minor alterations of the degree to which some units are advantaged over others in perception. The disordering interactions observed in the experiments above demonstrate that variations in previous experiences can eliminate or reverse the general advantage of one linguistic unit over another, thereby forcing a reinterpretation of the source of the advantage. On this basis, we conclude that the influence of particular experiences is critical in the perception of written materials.

The experiments in this paper were designed to maximize the dependence of performance on a very few previous experiences, in order to demonstrate unambiguous reliance on information about specific properties of experience. In consequence, our experimental conditions are extreme cases, consisting of testing identification shortly after preexposing a limited set of items in unusual circumstances. Even within these special circumstances, the arbitrariness with which we could modify later perceptual success through reinstatement of previous processing and context was limited. It may therefore seem that our results are of limited generality, and that outside our specially constructed circumstances more general processes might serve. However, we believe that the short interval between training and test is not a major consideration, because strong effects of context and processing demands have been observed over much longer periods (e.g., Whittlesea & Cantwell, 1987). We also speculate that the constraints on our ability to modify perception arbitrarily may reflect a failure on our part to present subjects with perfectly distinctive experiences of familiar stimuli rather than that they illustrate an influence of general knowledge structures.

Episodic accounts assume that current processing depends on parallel influence of all prior experiences, to the degree of similarity between past and present events. In consequence, when previous experiences are not distinctive or test contexts do not specifically resemble particular prior experiences, performance based on knowledge about specific properties of events would be predictable from the average properties of prior experiences in general. Although words reliably show an advantage over other units when no special effort is made to reinstate contexts, as demonstrated by the long history of the word superiority effect, and the success of word perception is correlated with general attributes of past experiences, this advantage need not arise from reliance on context-free attributes of particular words or structural attributes of words in general. We argue that the standard finding of stable perceptibility of particular items, and stable differences between classes of items, could as easily result from statistical stability granted by non-specific access to multiple previous experiences as from inherent stability given by primary reliance on general knowledge of the past. Thus a coherent account of perception, explaining both the evident sensitivity of perception to the episodic aspects of experience as well as the well-documented predictability of perception on the basis of general properties, might consist either of purely episodic representation, or alternatively of a kind of hybrid representation of general properties of experience together with some episodic information.

Because the latter possibility suggests that use of general information will predominate when stimuli are not specifically similar to previous experiences, we have attempted to discriminate reliance on general and specific knowledge through studies of generalization of perceptual facilitation from a set of known experiences to novel stimuli (Brooks & Whittlesea, 1987; Whittlesea, 1987b).

In these projects, we discovered that perceptibility of targets could be greatly modified when the simultaneous similarity of a target to an entire set of previous experiences was manipulated independently of the regularity or typicality of the target. We therefore conclude that the critical influence of episodic information is not limited to circumstances in which prior experience of a single item dominates current processing; consequently, we do not regard the episodic effects observed in the experiments described above as a special case, but instead as a particularly clear example of normal function.

A variety of published models of perception fall midway between the extremes of episodic and general-knowledge representation. These models assume that memory retains information about each separate word the subject knows rather than explicitly representing orthographic rules. The robustness of the word advantage permits such structural models to be successful in emulating many of the phenomena of word perception without explicitly incorporating episodic information. For example, McClelland and Rumelhart's (1981) interactive activation model enjoys considerable success employing only detectors for whole words, position-specific letters, and features. Parallel processing of whole-word units permits such systems to predict some surprising phenomena: for example, low similarity to a multitude of past events may facilitate identification as much as high similarity to one event, so that novel items may actually be more easily perceived than items previously experienced (Whittlesea, 1987b; see Carr & Pollatsek, 1986, and Henderson, 1982, for recent reviews of this issue). However, we argue that models relying on dedicated detectors cannot duplicate the variability in identification performance observed in the experiments described above, and that this limitation stems from failure to incorporate information about specific experiences with particular items. In contrast, the more recent distributed memory models of McClelland, Rumelhart, and their associates (e.g., McClelland & Rumelhart, 1985; Rumelhart, McClelland, & the PDP Research Group, 1986) are capable in principle of simulating these episodic effects, because an arbitrary number of the units representing a prior event could be assigned to representation of aspects of the context or response. (Whittlesea, in press, presents a modified parallel distributed processing model that simulates the data of our Experiments 1-4 by preserving representations of experiences given by variable attention demands.)

Because of the degree to which accounts based on general and specific knowledge share predictions, there may in principle be no way to decide between them. However, we believe that the combination of present task and specific past experiences will be important in any comparison in which the degree of integration of linguistic units is varied across tasks, such as transitions between reading single words and proofreading (e.g., Healy & Drewnowski, 1983) or reading text (e.g., Levy & Kirsner, 1986). We appreciate the conclusion drawn by

McNeill and Lindig (1973) in the related area of speech perception:

What is perceptually real is what one pays attention to. . . . There is no clear sense in which one can ask what the "unit" of speech perception is. Interesting questions exist concerning the distribution of attention during speech processing. . . . But there is no comparably motivated question concerning psychological primacy of some linguistic level over others. (p. 403)

We wish to suggest that one interesting answer to one question of distribution of attention is that perception responds to the demands of the current task and the perceptual characteristics of the stimulus and its context, with the assistance of memory for prior processing episodes.

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NOTE

1. Many of the experiments in this paper are apparently open to the criticism that subjects may have employed sophisticated postperceptual guessing to improve their identification accuracy. Because we did not employ pairs of test items differing only on the target letter, a subject who did not perceive a target letter could constrain its possible identities if he/she had perceived the remaining letters and remembered from the training phase the complete identity of the item bearing those letters. However, the forced-choice technique that eliminates this problem (Reicher, 1969) is an excellent control for a set of issues different from those addressed in this paper. Our intention was to document the flexibility of the perceptual memory system rather than to distinguish between stages of the identification process, which was the intent of the forced-choice technique. However, sophisticated guessing based on knowledge of permissible letter combinations could explain the results of Experiment 2 only if it were conceded that the limited number of exposures to stimuli in the training phase were a sufficient basis to affect the process of identification; but that is precisely our point. Furthermore, the use of sophisticated guessing based on stable letter patterns is insufficient by itself to explain the difference in results of Experiments 2 and 3. Finally, guessing based on letter combinations could not explain the superiority of single-letter perception in Experiment 4 or the superior perception of single letters following single-letter training rather than word training in Experiment 6, nor could a deductive strategy explain why the perception of single words was superior following single-word rather than phrase training in Experiments 5 and 7.

APPENDIX

Pseudoword Stimuli in Experiments 1-4

<u>N</u> OKAL	<u>N</u> EKAL	<u>P</u> EKAL	<u>F</u> UKIG	<u>F</u> EKIG	<u>P</u> EKIG
<u>N</u> OBEL	<u>N</u> OTEL	<u>N</u> YTEL	<u>F</u> UREG	<u>F</u> UTEG	<u>F</u> YTEG
<u>N</u> YBAL	<u>N</u> YBAP	<u>N</u> YTAP	<u>F</u> YRIG	<u>F</u> YRIP	<u>F</u> YTIP
<u>N</u> OBAL	<u>T</u> OBAL	<u>T</u> OBEL	<u>F</u> URIK	<u>T</u> URIK	<u>T</u> UREK
<u>P</u> OBAL	<u>P</u> OBYL	<u>P</u> OBYK	<u>P</u> URIG	<u>P</u> URYG	<u>P</u> URYK

Note—All of these stimuli were presented in the pseudoword condition of the test phases of Experiments 1-4. The underlined letters were cued by following the presentation with a caret presented under that location. The single-letter test stimuli were derived from these materials by replacing all the nonunderlined letters with nonletter masks consisting of an asterisk in a rectangle. The whole test phase consisted of 60 trials in which the 30 pseudoword and the 30 derived single-letter stimuli were presented in a pseudorandom order. The training phases of Experiments 2 and 3 used the middle columns of the two arrays below, and Experiment 4 used the derived single-letter stimuli of these two columns.

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