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Interaction of Prime Repetition with Visual Degradation: Is Priming a Retrieval Phenomenon?

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Pronunciation of a word can be facilitated by preceding its presentation with that of an associatively related word. This associative priming effect has been interpreted as produced by activation spreading through a network. In such models, processing of the prime cannot be made conditional on unforeseen events. We manipulated the degradation and relatedness of a word following the prime, and observed the effects on the time taken to pronounce a repetition of the prime. Contrary to the predictions of spreading activation accounts, we observed that pronunciation of the repeated prime was fastest when the second word was degraded and related to the prime. We interpret this to mean that degradation of the second word caused unitization of that word with its prime. We argue that such qualitative shifts may be best understood in terms of changes in retrieval processing. © 1990 Academic Press, Inc.

Perception of a word can be facilitated by preceding its presentation with that of a semantically- or associatively-related word. For example, the word "PLANT" is more rapidly pronounced if preceded by the word "GREEN" than if presented in isolation (i.e., GREEN-PLANT rather than @@@@@ - PLANT). This effect, often called "associative priming," can be made larger by perceptually degrading the target word (e.g., Becker & Killion, 1977). Thus the effect of presenting the prime "GREEN" on pronunciation time would be larger if the target word were "pLAnT" than if it were "PLANT." In this paper, we explore the basis for the associative-priming effect and its interaction with degradation of the target word. We show that "associative priming" is potentially a misnomer for the effect. Rather than relying on priming produced by spreading activation, as is commonly claimed, the effect may arise from a change in retrieval processes.

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The associative-priming effect owes its name to a theoretical account of the effect. In a "priming" account, nodes corresponding to words that are associatively related are stored close together or are connected via strong links in an associative network. The associative-priming effect is often described as reflecting the automatic spread of activation from a prime, which lowers the thresholds of nodes representing words that are associatively related to the prime (e.g., Anderson, 1976, 1983; Collins & Loftus, 1975; Collins & Quillian, 1969; Neely, 1977). Neely (in press) notes that spreading activation accounts explain the interaction between target degradation and associative priming by assuming that degradation slows the rate at which visual features activate their corresponding letter and word nodes.

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The interaction occurs because priming reduces the amount of evidence required to reach the recognition threshold, thereby reducing the difference in time to reach the threshold at two different rates. Neely also reviews accounts of the interaction based on expectancy rather than spreading activation, including Becker's (1980, 1985) verification model. Although expectancy accounts differ from spreading activation accounts on a number of grounds, the important point for our purposes is that both types of account explain priming as occurring in a forward direction from the prime to the target, and as not being fundamentally altered by degradation of the target word.

These accounts hold that visual degradation of the target *reveals* priming by slowing visual processing. In contrast, the retrieval view that we promote holds that visual degradation can *create* priming. The notion is that a visually degraded target combines with a related prime to form a compound cue to allow their identification, whereas a nondegraded target is more likely to be identified separately. Returning to the earlier example, when "GREEN - pLAnT" is presented, the prime combines with and participates in the identification of the target word. In contrast, when "GREEN - PLANT" is presented, the target is likely to be identified relatively independent of the prime because of the greater ease of its identification. Thus the interaction of priming with visual degradation results from a change in the unit of processing along with a change in the baseline against which priming is measured (i.e., @@@@@ - pLAnT vs. @@@@@ - PLANT). The direction of the priming effect is not only forward from the prime to the target, but also backward from the target to the prime. When the target is degraded, the prime and target are co-processed to allow their identification.

This retrieval view of priming effects is similar to Ratcliff and McKoon's (1988) cue-combination theory used to explain effects on lexical-decision performance. Ratcliff and McKoon build on Gillund and Shiffrin's (1984) model of episodic recognition memory to explain priming effects. They show that many effects previously attributed to automatic spreading activation can be as well explained by assuming that subjects use a compound cue consisting of the prime and target to access memory. An important difference between their view and ours is that they hold that a target word always combines with its prime, whereas we argue that the segmentation or unitization of a cue and its prime depends on factors such as visual degradation of the target word. By both accounts, the terms "prime" and "priming effect" are misnomers because effects do not result from changes in the threshold of some node that is invariably used for identification of a word, but rather come from the target word being combined with its context to form a larger unit. Regardless, because the terminology has become standard, we will use the terms "prime" and "priming effect," but treat the terms as theoretically neutral. We refer to our view as a "retrieval account" to emphasize the possibility that priming results from qualitative differences in retrieval (changes in the unit of processing with the demands of a later task) rather than quantitative differences in processing (reduction in the amount of processing in the later task). Also, we have argued elsewhere (e.g., Jacoby & Brooks, 1984; Whittlesea & Cantwell, 1988) that encoding and retrieval factors of the sort that have been traditionally considered for episodic memory play an important role in performance of supposedly semantic memory tasks such as word identification. Indeed, we question the utility of the distinction between semantic and episodic memory. Consideration of these larger issues will be deferred until the General Discussion.

Both the spreading activation and retrieval accounts can explain the interaction of associative priming with visual degradation of the target. However, the two accounts differ in terms of the role given to differential processing of the prime in producing that interaction. Spreading activation is by nature an unconditional mechanism, because the spread of activation is in the forward direction from the prime to the node corresponding to the target, and so cannot be conditional on the visual details of the target presentation. The activation of the node corresponding to the prime and the spread of activation to related nodes is the same whether or not the target is degraded, or indeed even presented. In contrast, the retrieval view holds that the processing of the prime depends on the presentation and degradation of the target. The prime combines with the target only if the two are related, and reliance on the compound increases when the target is visually degraded. In consequence, the effects of a prime are conditional on the visual details of the target. It is this difference in predicted effects of visual degradation on processing of the prime that we used to choose between spreading-activation and retrieval accounts of priming effects. Although these alternative accounts make similar predictions for identification of degraded and nondegraded targets following related and unrelated primes, their predictions about identification of a word presented subsequent to the target differ.

In order to test these alternative predictions, we added a third event to the series of stimuli that are typically used to assess priming effects. For example, instead of the more usual presentation of "GREEN - pLAnT," we sequentially presented "GREEN - pLAnT - GREEN" (see Table 1 for a paradigm of the experiments). Subjects were required to pronounce the third word, which is a repetition of the first. The time to pronounce that word was compared to the time taken to pronounce the same word when the interpolated word was not visually degraded (i.e., GREEN - PLANT - GREEN). The first word of the series corresponds to the prime in standard priming experiments, and the interpolated word corresponds to the usual target. Our experimental manipulations were aimed at examining the relationship between these items. The third word (the target word in our procedure) is a repetition of the first and essentially serves as a transfer test that allows us to assess whether visual degradation of the interpolated word (the usual target

TABLE 1
PARADIGM OF EXPERIMENTS 1–3

	Prime		Interpolated word		Transfer target
Duration	60 ms		150 ms		RT
Offset		*0 ms*		*variable*	
	GREEN		PLANT		GREEN
	GREEN		pLAnT		GREEN
	@@@@@		PLANT		GREEN
	@@@@@		pLAnT		GREEN
	GREEN		WALTZ		GREEN
	GREEN		waLTz		GREEN
	@@@@@		WALTZ		GREEN
	@@@@@		waLTz		GREEN

Note. These eight conditions exhaust the combinations of presence of prime, degradation of interpolated word, and relatedness of interpolated word to the transfer target. The transfer target was presented until identified. Offset between interpolated word and transfer target was 0, 400, and 1000 ms in Experiments 1, 2, and 3. Repetitive use of stimuli is for illustration only: different stimuli were used on each trial.

word) has any effects on the processing of the earlier-presented prime.[1]

By the retrieval account, pronunciation of the transfer target is predicted to be faster when the interpolated word is visually degraded. This is because the prime (the first word) participates in identification of a succeeding word (the interpolated word) more heavily when that word is degraded. When the prime has participated in identification of the interpolated word (when the interpolated word is presented in degraded format), then it is readily available to assist identification of its repetition. In contrast, when the prime has received relatively little processing in identification of the interpolated word (when the interpolated word is presented in non-degraded format), then it is less available to assist processing of its repetition. The easiest prediction from a spreading activation account, in contrast, would be that visual degradation of the interpolated word would have no effect on pronunciation time for the transfer target. One might even use assumptions about the decay of activation to make a prediction opposite to that of a retrieval account. It might be reasoned that visual degradation of the interpolated word slows its identification and consequently allows greater decay of activation of the prime prior to its repetition than would be produced had the interpolated word not been degraded. Similarly, it might be argued that slowing the identification of the interpolated word results in a lower terminal activation of its node and consequently reduces the amount of reciprocal activation spreading back to the node representing the prime and transfer stimulus. The effect of either of these would be faster pronunciation of the transfer target when the interpolated word was not, rather than was, degraded, an effect opposite to that predicted by the retrieval account.

Because the prime and transfer target were identical in our experiments, a long presentation of the prime would enable subjects to anticipate the demand to pronounce the transfer target by identifying the prime and readying a response. To prevent this, the prime was presented for a brief duration (60 ms), and was immediately followed by presentation of the interpolated word, thereby making it unlikely that the prime would be fully identified when first presented. The interpolated word was also presented briefly (150 ms). The delay between offset of the interpolated word and the onset of the transfer target varied across experiments, as did the task that subjects had to perform on the interpolated word. In earlier experiments, subjects were told to remember the interpolated word and to report that word after pronouncing the target word. In the last experiment reported (Experiment 4), subjects were required to pronounce the interpolated word in advance of the transfer target. The changes across experiments were made to establish the generality of observed effects.

In addition to the conditions described above, each of the experiments included conditions that are akin to the neutral conditions against which priming is usually measured. In those conditions, presentation of the prime was replaced by presentation of a neutral stimulus (i.e., @@@@@ - pLAnT - GREEN; @@@@@ - PLANT - GREEN). Neither the spreading activation nor retrieval account of priming effects specifically predicts an effect of visual degradation of the interpolated word on pronunciation of the target when the prime is not presented, although both could accommodate a finding that pronunciation was slower when the interpolated word is degraded. However, these baseline condi-

[1] Our three-word paradigm should not be confused with another interposition paradigm, in which a neutral or unrelated word is interpolated between two semantically related words (e.g., GREEN - BRUSH - PLANT), with the object of assessing whether associative priming effects can survive an intervening distraction (e.g., Masson, in press).

tions are useful for revealing any effects, other than interactions with priming, that come from visually degrading a word presented prior to a target word that is to be pronounced. For example, there might be a psychological refractory period after identification of an interpolated word (cf. Kantowitz, 1974), and the slower identification of a word that was visually degraded, as compared to a word that was not, might make it more likely that the refractory period would extend into the presentation of a target word. For both the baseline conditions and the two previous conditions, this would suggest that the pronunciation of the transfer target would be slowed following a visually degraded interpolated word. However, the retrieval account of priming effects predicts an interaction between presence versus absence of the prime and visual degradation of the interpolated word. When the prime is absent (replaced by a neutral stimulus), degrading the interpolated word certainly should not speed and might even slow pronunciation of the target word. However, when the prime is presented, visually degrading the interpolated word is expected to speed pronunciation of the transfer target.

For all the experimental conditions described to this point, the interpolated word was associatively related to the target word. Each of the experiments also contained other conditions for which the interpolated word and transfer target word were unrelated (e.g., GREEN - WaLTz - GREEN; GREEN -WALTZ - GREEN; @@@@@ - WaLTz - GREEN; @@@@@ - WALTZ - GREEN). By the retrieval account of priming effects, a prime combines with a target to form a higher-order unit only when the two are related. Consequently, an interaction between presence versus absence of the prime and visual degradation is not predicted when the prime and the interpolated word are unrelated. As well as allowing us to check on the validity of that prediction, the inclusion of conditions in which the interpolated word was unrelated to the transfer target allowed us to assess the independent effects of repeating the prime as the transfer target (called repetition priming by some investigators) separately from those of associative priming.

As indicated previously, primes were presented for only a very brief interval, in order to prevent premature identification of the transfer target. This introduces the complication that processing of the prime would likely be incomplete when the interpolated word appeared, with the result that continued processing of the prime might interfere momentarily with processing the interpolated word. Evidence that such a refractory period does occur is given in Experiments 2 and 3. A refractory period following a prime would obscure any facilitation due to associative priming and could even cause primed words to be named more slowly than unprimed words (Experiment 4). In consequence, the standard associative priming effect might not be observed in naming the interpolated words. However, the influence of the prime on processing the interpolated word could still be inferred from the pattern of performance on the transfer target. Moreover, this brief-presentation procedure may be more useful for understanding the processing relationship between a prime and target than the standard paradigm, because, as will be described later, the incomplete processing of the prime makes it more likely that its influence on the target is more likely to be truly perceptual rather than post-lexical.

The experiments below demonstrate that degraded presentation of the interpolated word results in superior performance on the transfer target, but does so only when the prime is present and the stimuli related. This pattern is consistent across the experiments, but within some experiments the interaction of the three factors was of only marginal reliability. For this reason, as well as analyzing the results of individual experiments, we present a summary analysis of all experiments, demonstrating a highly reliable interaction of the factors.

EXPERIMENT 1

Method

Subjects. Twenty-five undergraduate students participated for course credit.

Procedure. On any particular trial, subjects were presented three stimuli in brief succession. The subject's task was to watch all three, pronounce the third stimulus as rapidly as possible, and then report the middle stimulus. Because of the tasks involved with each, and the correspondence of the first two with the stimuli in the standard priming paradigm, the three stimuli are referred to below as prime, interpolated word, and transfer target, with respect to order of presentation.

Each trial commenced with the display of a fixation stimulus. On a keypress by the subject, the prime was presented for approximately 60 ms, the interpolated word for approximately 150 ms, and the transfer target until the subject responded by naming it into a microphone. Lastly, subjects were required to report the interpolated word from memory, a requirement intended to enforce its identification. Subjects were not required to identify the prime. The three stimuli were presented without any offset interval and were presented in the same location on the video monitor. The experiment was conducted using a Zenith monitor driven by an accelerated Apple IIe computer. The stimuli subtended a visual angle of approximately five degrees horizontally.

Within subjects, we manipulated the presence of the prime, the degradation of the interpolated word, and the relatedness of the interpolated word and transfer target. Each of the eight combinations of these factors was presented on 15 trials, for a total of 120 trials (see Table 1 for an example of the experimental paradigm). The prime, when present, was always identical to the transfer target, and when absent was replaced by a row of @ signs. Because the prime (when presented) was identical to the transfer target, complete identification of the prime could anticipate the demand to pronounce the transfer target; it was to prevent such short-circuiting of the task that prime words were presented for short durations and immediately succeeded by the interpolated word.

The degradation of the interpolated word was manipulated by presenting it either in uniform upper case (non-degraded condition: e.g., PLANT) or in mixed upper and lower case (degraded condition: e.g., pLAnT). The mixture of upper and lower case was varied across stimuli. The prime and the transfer target were always presented in uniform upper case. The relatedness of the interpolated target word with the other stimuli was set either at related (e.g., GREEN - PLANT - GREEN) or unrelated (e.g., GREEN - WALTZ - GREEN).

Because the words would be presented in a rapid sequence in the same location on the monitor, we thought it important that all stimuli in a trial be of the same length, so that each would effectively mask the prior item. We therefore created our set of related items by generating a list of 200 pairs of words that we thought to be fairly strongly associated (e.g., WARM - COLD, WALTZ - DANCE, TABLE - CHAIR) subject to the constraint that all words were between four and six letters in length, and that the words in any pair were of the same length. The pairs were a mixture of antonyms (WHITE -BLACK), near-synonyms (STINK - SMELL), same-category associates (KNIFE - SPOON), and associates from different categories (DOCTOR - CLINIC). In a separate study, we asked 30 students to give free associations to the first term of each pair, and selected the 120 pairs from our pool that were most often given spontaneously by subjects.

Sixty of these pairs were used in trials on which the interpolated word was to be related to the other stimuli. Unrelated pairs were created by re-pairing the other half of the pool, subject to the constraint that the resulting pair were again of the same length. In order to control for any differences among our pairs in strength of association, assignment of pairs to the related and unrelated conditions was re-randomized between subjects. The order of presentation of the eight experimental conditions was also re-randomized between subjects, as was the order of presentation of particular pairs.

Analyses. Prior to analysis, median latencies for pronouncing the transfer target were computed across the 15 trials of each condition within subjects. These median latencies were then used as the data for a global, randomized blocks analysis of variance of the effects of presence of the prime, degradation of the interpolated word, and relatedness of the interpolated word and transfer target.

The retrieval account predicts that degradation of the interpolated word will result in faster pronunciation of the transfer target when the interpolated word is degraded and the stimuli related, but not in any other combination of the factors. In contrast, the spreading activation account predicts that if degradation of the interpolated word has any effect in any condition, it would be to slow pronunciation of the transfer target. To evaluate these predictions, we examined the simple–simple effects of degrading the interpolated word at each combination of prime presence and relatedness of the stimuli. Because there are only two levels of degradation, these simple–simple comparisons amount to a posteriori t-tests, adjusted for between-subject variance across the conditions.

In addition to reaction time data for the transfer target, we recorded the accuracy of naming both the transfer target and the interpolated word. Accuracy on both was near ceiling (97% and 96% for the interpolated word and transfer target), so no analysis was conducted.

Results and Discussion

Means and standard errors of latencies for pronouncing the transfer target for each condition are shown in Table 2. The global analysis indicated only a main effect of the presence versus absence of the prime ($F(1,24) = 10.50$, $p = .003$). However, analysis of the simple–simple effects demonstrated that when the prime was present and the interpolated word was related, then degradation of the interpolated word speeded performance by about 50 ms (see column 1 of Table 2; $F(1,24) = 8.42$, $p < .01$). In contrast, degradation of the interpolated word had no reliable effect on pronunciation of the transfer target under any other combination of prime presence and relatedness of the interpolated word ($F(1,24) = 0.24, 0.17$, and 0.00 for the comparisons in columns 2, 3, and 4 of Table 2). This indicates that degradation of the interpolated word influences pronunciation of the transfer target only if the prime presents that word that will later serve as the transfer target and the stimuli are related. Even then, degradation of the interpolated word is inversely related to speed of pronouncing the transfer target. These conclusions are consistent with the predictions of the retrieval account, but conflict with those of the spreading activation account.

Inspection of the table also reveals that earlier presentation of a transfer target as the prime speeded pronunciation by about 40 ms relative to nonpresentation (an effect of "repetition priming"; column 3 vs. col-

TABLE 2

EXPERIMENT 1: MEAN RESPONSE LATENCIES TO TRANSFER TARGET IN MILLISECONDS

Interpolated word	Relatedness of interpolated word and presence of prime: Related		Unrelated	
	Present	Absent	Present	Absent
Degraded	712 (27)	796 (35)	764 (37)	801 (34)
Non-degraded	760 (34)	785 (37)	755 (40)	801 (39)

Note. Standard errors in parentheses.

umn 4), and that relatedness of the interpolated word had little independent effect when the interpolated word was degraded, but may have a larger effect (about 15 ms) when it was not degraded (an effect of "associative priming"; column 2 vs. column 4). These effects are discussed in the Summary after Experiment 4.

EXPERIMENTS 2 AND 3

As a check on the reliability of the findings of Experiment 1, we conducted two near-replications. The only difference between these studies and Experiment 1 was that we introduced a 400-ms offset between the termination of the interpolated word and the onset of the transfer target in Experiment 2, and in Experiment 3 we increased that offset to 1000 ms. The effect of introducing these offset periods is to allow the subject more time to complete processing of the interpolated word prior to presentation of the transfer target. Part of the motivation for this manipulation was to investigate whether brief presentation of a word results in a refractory period for pronouncing a succeeding word, as suggested in the Introduction. If incomplete processing of a word does cause a refractory period, then one could expect the transfer target to be reported more quickly in these studies than in Experiment 1, in which the transfer target was presented immediately after the brief (150 ms) presentation of the interpolated word.

Increasing the offset from zero to 400 and 1000 ms was also expected to influence the size of the degradation effect. In terms of a retrieval account, delaying the presentation of the transfer target amounts to a retention interval manipulation and would be expected to reduce the size of the difference between degraded and nondegraded presentations of the interpolated word. According to that account, a related prime will more likely participate in the identification of a degraded interpolated word compared with an undegraded word. If the transfer target (which is identical to the prime) is presented while a degraded interpolated item is still being processed along with the prime, information about the prime is immediately available to assist processing the transfer target. This results in an advantage for transfer targets that follow shortly after degraded, related interpolated words. The longer the transfer target is delayed, the more likely that processing of the interpolated word is completed, with the result that information about the prime is no longer being processed and is less available to assist pronunciation of its repetition. In consequence, the advantage of degraded over undegraded presentation of the interpolated word for pronouncing the transfer target would decrease with increasing SOA. However, to the extent that degradation still has an effect at a greater SOA, the retrieval account predicts, as before, that the transfer target will be pronounced faster when the interpolated word is degraded rather than undegraded, and that this advantage will hold only when the prime is present and related to the interpolated word.

Spreading activation accounts also predict that delaying the transfer target will decrease the size of the degradation effect, because the activity of the node representing the transfer target will decay over time. However, these accounts predict, as before, that any effect of degradation of the interpolated word will be in the direction of an advantage for transfer targets following an undegraded rather than a degraded presentation of the interpolated word.

Method

Subjects. Twenty-five undergraduate students participated in each experiment for course credit.

Procedure. The procedure was identical to that of Experiment 1, save for the introduction of a 400-ms delay between the offset of the interpolated word and the onset of the transfer target in Experiment 2, and a 1000-ms interval in Experiment 3.

Results and Discussion

Means and standard errors of latencies for pronouncing the transfer target for each condition are shown in Tables 3 and 4. Relative to Experiment 1, transfer targets were pronounced about 220 ms faster on average in Experiment 2, and 270 ms faster in Experiment 3. This pattern was apparent whether the prime was present or absent, whether the interpolated word was related or unrelated to the target, and whether it was degraded or not. This suggests that brief presentation of a word causes a refractory period for identifying a subsequent word, even if that word is related. This is a curious finding, because it is opposite to the beneficial effects of prior presentation of a related word documented as the associative priming effect. The small difference between latencies in Experiments 2 and 3 suggests that the refractory period lasts no more than about 500 to 600 ms from onset of the earlier word (150 ms presentation of interpolated word plus 400 ms offset), and so this effect would not be observed in the standard priming paradigm, in which the prime is exhibited for a second or more. Its source is likely that the interpolated word is still being processed when the transfer target is presented and that continuation of this processing interferes with processing the subsequent item. This refractory period will be discussed further when reporting Experiment 4.

As predicted by the retrieval account, degrading the interpolated word facilitated pronunciation of the transfer target when the prime was present and the stimuli were related, as in Experiment 1, but the size of the effect was reduced from 48 ms in Experiment 1 (column 1 of Table 2; $r^2 = .26$, $F(1,24) = 8.42$, $p < .01$) to 24 ms in Experiment 2 (column 1 of Table 3: $r^2 = .12$, $F(1,24) = 3.23$, $p = .08$) and to 16 ms in Experiment 3 (column 1 of Table 4: $r^2 = .10$, $F(1,24) = 2.77$, $p = .10$). In contrast, when the prime was not present or when the stimuli were unrelated, degrading the interpolated word did not facilitate perception of the transfer target ($F(1,24) = 0.17$, 0.09, and 0.22 for columns 2, 3, and 4 in Experiment 2 (Table 3), and 2.82,[2] 0.26, and 0.87 in Experiment 3 (Table 4)). Again, these results are consistent with the predictions of a retrieval account of associative priming and not with those of a spreading activation account.

TABLE 3
EXPERIMENT 2: MEAN RESPONSE LATENCIES TO TRANSFER TARGET IN MILLISECONDS

Interpolated word	Relatedness of interpolated word and presence of prime: Related		Unrelated	
	Present	Absent	Present	Absent
Degraded	502 (32)	564 (34)	549 (34)	562 (34)
Non-degraded	526 (32)	558 (29)	554 (34)	571 (40)

Note. Standard errors in parentheses.

TABLE 4
EXPERIMENT 3: MEAN RESPONSE LATENCIES TO TRANSFER TARGET IN MILLISECONDS

Interpolated word	Relatedness of interpolated word and presence of prime: Related		Unrelated	
	Present	Absent	Present	Absent
Degraded	484 (18)	504 (16)	505 (21)	511 (21)
Non-degraded	500 (17)	487 (16)	496 (21)	522 (21)

Note. Standard errors in parentheses.

EXPERIMENT 4

As indicated previously, the general speeding of response to the transfer target observed in Experiments 2 and 3 relative to Experiment 1 may occur because the delay permitted subjects to complete their identification of the interpolated word before the transfer target appeared, so that it interfered less with processing the later item. This raises the possibility that, in some

[2] This F-value is of approximately the same size as that of column 1: however, the difference of the means is in the opposite direction.

way, differential interference produced by presenting degraded versus undegraded words was responsible for the results of Experiments 1 through 3.

However, differential interference is unlikely to be the entire explanation of the degradation effect, because it could not explain why degraded presentation of the interpolated word causes an advantage for the transfer target only if the stimuli are related and the prime provides an advance exposure of the transfer target. Nonetheless, we eliminated the possibility of differential interference in Experiment 4 by requiring subjects to identify the interpolated word before we presented the transfer target. This leads to the complication that the SOA between transfer targets 1 and 2 is of uncertain length, because it is determined by the subject's response latency to the interpolated word. However, this study provides yet another opportunity to test the predictions of the two accounts.

This design also permits direct examination of the speed of pronouncing the interpolated word following various prime conditions. However, given the evidence from Experiments 2 and 3 that brief presentations are followed by a refractory period, we would expect the brief exposure of the prime (60 ms) to interfere with pronunciation of the interpolated word, which follows the prime immediately. In consequence, any facilitatory effects of a related prime might be difficult to observe owing to interference from continued processing of the prime.

Method

Subjects. Twenty-five undergraduate students participated for course credit.

Procedure. The procedure of Experiment 4 was similar to that of the last three experiments, save that the interpolated word remained on the screen until the subject identified it into a voice key, upon which the transfer target was presented for identification. Response latencies were measured for both words.

Results and Discussion

Means and standard errors of median responses across subjects and conditions for the interpolated word and the transfer target are shown in Tables 5 and 6, respectively. Examining the data for pronouncing the interpolated word, it is clear that degraded presentation was indeed more difficult than undegraded presentation, resulting in latencies longer by about 25 ms ($F(1,24) = 16.73, p < .001$).

The standard associative priming effect was not observed in pronouncing the interpolated word: not only was there no overall advantage for a related over an unrelated prime, but the interpolated word was pronounced fastest if it was not degraded and the prime was absent. Nonetheless, there is evidence that these data reflect an effect of associative priming, complicated by a refractory period following the brief presentation of the prime. Moreover, the priming effect appears to be interactive with degradation, such that degraded items receive more benefit following a related prime than do nondegraded items.

First, consistent with the idea that brief primes cause a refractory period, unprimed interpolated words were pronounced faster in general than primed words ($F(1,24) = 3.39, p = .07$). However, degraded items following a related prime were pronounced about as fast as unprimed words, suggesting that these words gained some benefit

TABLE 5

EXPERIMENT 4: MEAN RESPONSE LATENCIES FOR INTERPOLATED WORD IN MILLISECONDS

	Relatedness of interpolated word and presence of prime		
Interpolated word	Related present	Unrelated present	Absent
Degraded	565 (19)	577 (20)	563 (14)
Non-degraded	555 (18)	545 (16)	523 (14)

Note. Because relatedness of interpolated word to transfer target is irrelevant for absent prime and test of interpolated word, data for the third column has been collapsed. Standard errors in parentheses.

TABLE 6
EXPERIMENT 4: MEAN RESPONSE LATENCIES FOR TRANSFER TARGET IN MILLISECONDS

Interpolated word	Relatedness of interpolated word and presence of prime: Related		Unrelated	
	Present	Absent	Present	Absent
Degraded	301	371	334	380
	(20)	(14)	(19)	(17)
Non-degraded	316	365	327	374
	(15)	(14)	(16)	(15)

Note. Standard errors in parentheses.

from priming that counteracted the cost associated with the refractory period.

More specifically, unprimed, nondegraded words were pronounced 32 ms faster than nondegraded words following a related prime, whereas unprimed degraded words were pronounced only 2 ms faster than degraded words following a related prime (columns 1 vs. 3 in Table 5). This difference results in a reliable interaction of degradation with prime presence ($F(1,24) = 5.51$, $p = .03$). Taking the latencies of unprimed words as a baseline for evaluating the influence of a related prime, this suggests that degraded words following a related prime received a 30 ms benefit relative to undegraded words following a related prime. In turn, it suggests that degraded words are facilitated following a related prime, and the amount of facilitation is sufficient to cancel the effects of the refractory period, whereas undegraded words receive less facilitation.

In contrast, both degraded and undegraded words following an unrelated prime are pronounced slower than corresponding unprimed words, and there is little difference in the degree of that slowing (columns 2 vs. 3 in Table 5). In that case, degradation and presence of the prime do not interact to determine pronunciation latency ($F(1,24) = .39$). Unprimed nondegraded words were pronounced 22 ms faster than nondegraded words following an unrelated prime, and unprimed degraded words were pronounced 14 ms faster than degraded words following an unrelated prime. Again taking latencies of unprimed words as a baseline, degraded words following an unrelated prime have only an 8 ms advantage over nondegraded words following an unrelated prime. This suggests that when the prime is unrelated, the difference between response latencies of degraded and nondegraded words is due only to the level of degradation.

We conclude that the results of the above analyses reflect an effect of associative priming, partially obscured by a refractory period following the brief presentation of the prime. Moreover, in accord with the standard observations regarding visual degradation and associative priming (e.g., Becker & Killion, 1977), this priming effect is larger when the interpolated word is degraded than when it is not. Nevertheless, because of the clear differences between the pattern of our results and the standard associative priming effect, some readers may wish to think that our procedure results in a wholly new type of associative priming effect, a "brief priming effect." More conservatively, we interpret the results to reflect the same basic principles as the standard effect. In either case, we argue that it is a situation in which a spreading activation mechanism would be expected to operate, and so it is suitable for contrasting spreading activation and retrieval accounts of priming effects.

Turning now to the data regarding pronunciation of the transfer target (Table 6), the pattern of performance is quite similar to that observed in the three earlier experiments, despite the change in procedure. One remarkable aspect of these data is that mean response time across all conditions is faster than in any previous experiment, being about 150 ms faster than in Experiment 3, 200 ms faster than in Experiment 2, and 420 ms faster than in Experiment 1. This large decrease in response latency further supports the idea that targets preceded by briefly presented words experience a refractory period, in that the major change in procedure in this experiment was to require subjects to complete processing of the interpolated word and report it prior to presentation of the transfer target. Moreover, the rough estimate of the duration of the refractory period given in Experiments 2 and 3, of about 500 to 600 ms, corresponds to the average latency of reporting the interpolated word in this experiment, which is about 555 ms (measured by the onset of pronunciation; see Table 5).

Analysis of simple–simple effects in the transfer data again demonstrated that when the prime was presented and the stimuli were related, degrading the interpolated word led to marginally faster pronunciation of the transfer target (column 1 in Table 6: $F(1,24) = 3.05$, $p = .08$; $r^2 = .11$). As in previous experiments, this is the only combination of prime presence and relatedness of the interpolated word for which an inverse relationship, or indeed any relationship, was observed between degradation of the interpolated word and latency of pronouncing the transfer target ($F(1,24) =$ 0.55, 0.49, and 0.56 for the comparisons in columns 2, 3, and 4 of Table 6).

This pattern is very similar to that of Experiment 2 (which is the appropriate comparison, given that subjects' responses to the interpolated word delayed presentation of the transfer target by about 500 ms in the present experiment). However, the design of Experiment 4 has the advantage of eliminating any accounts that attribute the effect of degrading the interpolated word to differential memory load or differential interference with the transfer target, because subjects had already pronounced the interpolated word before pronouncing the transfer target.

Summary of the Experimental Data

Although the effect sizes are small and the significance of effects marginal in some cases, the pattern of performance was highly consistent across the four experiments. For these reasons, we combined all of the data in a single analysis. In order to illustrate the more important effects, Table 7 presents data from all four experiments, collapsed across experiments. This four-way ANOVA demonstrated that subjects reliably pronounced the transfer target faster (17 ms advantage) when it was preceded by a related intervening item rather than an unrelated one (an effect of "associative priming"; $F(1,96) = 14.30$, $p < .001$). It also demonstrated that pronunciation of the transfer target was faster (36 ms advantage) when it had been presented earlier as the prime (an effect of "repetition priming"; $F(1,96) = 57.63$, $p < .001$).

More importantly, the three-way interaction of degradation of the interpolated item, presence of the prime, and associative relatedness of the stimuli was also reliable ($F(1,96) = 48.06$, $p < .001$). As is clear from inspection of Table 7, the interaction means that performance on the transfer target is fastest when it had been presented earlier as the prime, and the interpolated word was degraded and related to the prime. When the interpolated word was unrelated, degradation did not produce a reliable main effect, nor did it interact with the presence of the prime. Even when the stimuli were related, the effect of degradation when the prime was absent (column 3, Table 7) was, if anything, to slow pronunciation of the transfer target. Thus the interaction indicates that degraded presentation of a related, interpolated word enables the prime to facilitate pronunciation of its repetition. This result follows from the re-

TABLE 7
All Experiments: Mean Response Latencies for Transfer Target in Milliseconds

Interpolated word	Relatedness of interpolated word and presence of prime: Related		Unrelated	
	Present	Absent	Present	Absent
Degraded	500	559	538	564
	(19)	(20)	(21)	(20)
Non-degraded	525	549	533	567
	(20)	(20)	(21)	(22)

Note. Standard errors in parentheses.

trieval account, but contradicts the major prediction of a spreading-activation account.

Less informatively, the between-experiments factor (differences among Experiments 1 to 4) was, or course, reliable ($F(3,96) = 48.06$, $p < .001$). The analysis also demonstrated an interaction of the experiments with presence of the prime ($F(1,96) = 3.71$, $p = .006$), illustrating a decline in the effect of prime presence/absence as the SOA between the interpolated item and the transfer target increased over Experiments 1–3. As discussed in Experiments 2 and 3, we interpret this decline to mean that the greater the SOA, the greater the likelihood that processing the interpolated word along with the prime was complete before the transfer target appeared. In consequence, the prime was less likely to be immediately available to assist processing the transfer target at longer SOAs. The utility of a previous experience of a word which either is or is not coprocessed with an intervening word is discussed below.

General Discussion

Presentation of a word as a prime does more to speed its later pronunciation if the word was earlier presented as a prime for an associatively-related, visually-degraded word than for any other combination of conditions. This interaction of prime-repetition and visual degradation effects is important for choosing among accounts of associative priming. The interaction was predicted by a retrieval account but cannot be explained by a spreading-activation account of associative-priming effects. First, we discuss the prime-repetition effect in the context of other effects of repetition on word identification. We argue that those effects cannot be explained as produced by the temporary activation of nodes in a fixed associative network. Next, we consider alternative accounts of the interaction of prime-repetition and visual degradation, including claims that might be made as an attempt to salvage an automatic spreading activation view of priming effects. Finally, we discuss the possibility that effects that have traditionally been interpreted as resulting from spreading activation can be reinterpreted as produced by effects on retrieval processes. The model that we adopt is similar to a compound-cuing model proposed by Ratcliff and McKoon (1988), but differs from their model in that we assume that the degree to or probability with which a word forms a compound cue with its prime varies across situations. We argue that specification of factors that control unitization and segmentation should be returned to its position of central concern for theories of word identification.

Effects of Repetition on Word Identification

The interaction of prime-repetition with visual degradation that we observed can be explained in terms of differential involvement of the prime in identifying the word interpolated between its repetitions. The explanation assumes, along with Ratcliff and McKoon (1988), that the basic priming phenomenon (that a word is more easily identified when preceded by an associatively related word than a neutral stimulus) results because the target word combines with the prime to form a compound cue which assists retrieval of the target from memory. However, our explanation differs from theirs in assuming that the probability that identifying the target relies on a target–prime compound varies across situations. An assumption like this is necessary if one is to explain both the basic priming advantage and also the increased effect of priming for degraded targets. If the probability of a word forming a compound with a related prime were constant, then the effect of prime presence/absence would be independent of any factors other than associative relatedness, including degradation of the target.

There are a number of ways in which variable reliance on a prime-target compound could arise. First, it is possible that, on any particular primed trial, the prime and target either form a compound or are processed independently with some probability. Increasing the degradation of the target makes it more difficult to identify independently and increases the proportion of trials on which the compound is formed. This all-or-none hypothesis is difficult to test, because it requires that one measure processing reliably on single trials. Second, it is possible that on every trial the prime and target are processed independently, while simultaneously their compound is formed and processed (a main-effects-plus-interaction account, similar in spirit to McClelland & Rumelhart's, 1981, interactive-activation model). The effect of increasing the degradation of the target is to reduce the effectiveness of independent processing of the target, thereby increasing the relative importance of processing the compound. Although attractive for its simplicity, this alternative is actually indifferent to the issue of the size of unit and type of processing conducted in identification. By assuming that the system conducts processing at all possible levels, it promotes the view that processing is rigid and inflexible rather than adaptive to changing circumstance. A third possibility is that the degree of integral processing of the two items is truly variable. We have argued for the possibility of truly variable co-processing elsewhere (e.g., Hayman & Jacoby, 1988; Whittlesea, 1987; Whittlesea & Cantwell, 1987; Whittlesea & Brooks, 1988). In this case, increasing the degradation of the target might serve to increase the degree to which the prime participates in processing the target, with the consequence that the processing of both becomes increasingly interdependent.

All three of these possibilities point to a qualitative rather than a quantitative change in processing, suggesting that the effect of degrading the target is to shift the burden of identification from independent processing of the target to a compound formed of the prime and target. This qualitative shift in processing permits us to explain not only the basic priming phenomenon but also the interaction of prime-repetition with visual degradation. When the interpolated word is visually degraded (making its separate identification more difficult) identification of the interpolated word relies more heavily on a compound cue for accessing memory. In that case, the repeated presentation of the prime immediately follows processing involving its earlier presentation. In contrast, when the interpolated word is not visually degraded (making its separate identification easy), processing of the prime is less involved in identification of the interpolated word. Consequently, relatively independent identification of the interpolated word intervenes between the earlier processing of the prime and its repetition, and processing involving the prime is less available to assist identification of its repetition. It is the difference in intervening activity between the earlier presentation of the prime and its repetition that is held responsible for the interaction of the prime-repetition effect with visual degradation of the interpolated word.

Effects of prior processing on word identification. Unitization of a word with a context word sometimes produces an effect that is opposite to the interaction of prime repetition with visual degradation that we observed here. If one accepts our interpretation of the data, we observed that a word more unitized with its context (the prime presented with a degraded, related interpolated word) is more quickly pronounced later than a word less unitized with its context (the prime presented with an undegraded, related interpolated word). The opposite effect is observed when a long delay, produced by the presentation of other words, intervenes between the presentation of a word and its repetition (e.g., Jacoby, 1983b; Osgood & Hoosain, 1974). For example, Jacoby (1983b) showed that reading a word in isolation (e.g., &&&& - COLD) did more to enhance its later perceptual identification, tested by presenting the word in isolation, than did earlier reading a word in the context of an antonym (e.g., HOT - COLD). When a long delay intervenes between the earlier presentation of a word and its test, the compatibility of the processing of the word on the two occasions is important because it influences whether a memory for the first presentation will be retrieved and will influence processing of the second presentation of the word. In contrast, when the delay between first and second presentations of the word is very short and repetitions of the word are separated by a single word, it appears that compounding the first presentation with the intervening word (degraded condition) facilitates processing of the repetition more than does processing the first word more independently (undegraded condition). That is, when the repetition is presented during or immediately after the intervening word, the benefit of maintaining the unit of processing between earlier and later presentations is more than offset by the benefit of making processing of the prime more immediately available for the following repetition.

There is a great deal of evidence to show the importance of the match between the processing of an item upon its prior presentation and later test. McNeill and Lindig (1973) showed that detection is fastest when the linguistic level (unit size) of the target and search list is the same. Also, the word superiority effect depends on a letter-string being treated as a well-integrated unit rather than a series of individual letters (Hayman & Jacoby, 1988; Whittlesea & Cantwell, 1987) and can be modified in size and even direction by manipulation of the processing unit. Similarly, Whittlesea and Brooks (1988) have shown that manipulations that influence the integration of words within phrases are important for later perceptual identification of words presented in those phrases. Findings reported by Kolers as evidence for his "remembering operations" view of perception (e.g., Kolers, 1973) also show the importance of the compatibility between study and test processing.

We (e.g., Jacoby, 1983a, 1983b; Jacoby & Brooks, 1984; Whittlesea & Cantwell, 1987) have interpreted such processing-specificity effects as evidence that word perception relies on memory for prior episodes rather than on a lexicon that is separate from the rest of memory. Our argument is that the effects of earlier presenting a word on its later identification are too situation-specific to be produced by the activation of a node in some stable network that is invariably used across situations to allow word identification. By an episodic view, memory for an earlier presentation of a word is retrieved and participates in identification of the word when it is later repeated. It is important to note that by "retrieval of memory for prior episodes," we do not mean to imply that repetition effects rely on people consciously recollecting an earlier presentation of a word (e.g., Jacoby & Dallas, 1981). Similar to our account of other repetition effects, we see the interaction of prime-repetition with visual degradation of an interpolated word as arising from effects on accessing memory rather than from involvement of a separate lexicon.

Data-driven versus conceptually-driven processing. Jacoby (1983b) interpreted the results of his experiment, described earlier, as showing that reading a word in the context of its antonym relied more heavily on conceptually-driven processing, and consequently required less data-driven processing, than did reading a word presented in isolation. Others (e.g., Stanovich & West, 1983) have claimed that visually degrading words presented in context has a similar result, causing heavier reliance on conceptually-driven processing along with a reduction in data-driven processing. However, the claim that reliance on context in identifying words results in a reduction in data-driven processing is essentially equivalent to the spreading-activation account of associative-priming effects. These accounts suggest that providing a related context (the prime) reduces the load on data-driven processing of the target. Processing of the prime (the context) is not assumed to vary dependent on whether the word following it is degraded, but rather, identification is assumed to rely more heavily on earlier conceptually-driven processing. Identification is assumed to rely more heavily on previously-conducted conceptually driven processing when targets are degraded and not to affect the degree of that processing. In consequence, the only effect of degradation is a reduction in data-driven processing. A difficulty for such accounts is that they are unable to explain the interaction of prime repetition with visual degradation of an interpolated word. That interaction points toward a qualitative rather than a quantitative shift in processing: a change in the unit of processing. Apparently, when an interpolated word was associatively related to the prime and visually degraded, the prime was "brought forward" to participate in identification. This is a shift to conceptually-driven processing, contingent on the conditions of test of the later item, not a precomputed influence of conceptually-driven processing revealed by conditions of test. Similarly, Levy and Kirsner (1989) provide very convincing evidence that reading a word in context, as compared to out of context, produces a qualitative change in processing. Rather than simply influencing data-driven processing, visual degradation and, perhaps, other manipulations produce qualitative changes in processing.

Alternative Accounts

Can other mechanisms be added to spreading activation to account for the interaction of the prime-repetition effect with visual degradation? One possibility is that, because of its brief presentation, a prime may have been identified only when followed by a related word that served as a source of temporally backward priming (cf. Kiger & Glass, 1983). Temporally backward priming refers to the observation that identification of a word (e.g., "bed") presented shortly after a related word (e.g., "pan") may be facilitated even though the direction of association is from the second to the first. Because the temporal sequence is opposite to the direction of association, these effects are usually interpreted to reflect feedback of automatic spreading activation from the node representing the later word to the node representing the earlier word. A similar effect, called "retrospection," refers to facilitation of identifying a prime presented before, but identified after, a related word (e.g., Briand, den Heyer, & Dannebring, 1988; Dark, 1988), and is interpreted the same way. Our three-stimulus paradigm is similar to that of "retrospection," except that in our case the prime is actually re-presented rather than recalled from memory, and the subject is required to pronounce the repeated prime before reporting the interpolated word. In Experiment 4 above, the procedure is even more similar, because in that case subjects were required to identify the interpolated word before the repeated prime. Our observation of an interaction of prime repetition with degradation of the interpolated word (the nominal target in the "retrospection" paradigm) causes the same problems for feedback of activation as it does for forward spreading activation. If feedback was the correct interpretation of the earlier results, then temporally backward priming (facilitation of pronouncing the transfer target when the interpolated word was related) should have occurred in our experiments regardless of whether the interpolated word was visually degraded. Indeed, one might expect more temporally backward priming when the interpolated word was not degraded, because easier identification of the interpolated word would allow less decay of the activation of the prime prior to onset of backward priming.

A number of models based on assumption other than automatic spreading activation are current (again, see Neely, in press, for a review). One interesting class is the connectionist or parallel distributed processing (PDP) models (cf. McClelland & Rumelhart, 1985, 1986; Rumelhart & McClelland, 1986), which dispense with dedicated word nodes and instead distribute processing over the interconnections of hidden units. Such models have had great success in simulating a variety of phenomena of lexical processing (e.g., Seidenberg & McClelland, 1989). Despite their power, clarity, and success, however, PDP models have a blind spot for exactly the issue in which we are interested, namely the unitization/segmentation issue. Although these models produce the kind of co-processing of initially separate events that we think is necessary to explain our data, they do so chronically rather than under the control of the circumstances of later test. This is not a terminal problem: with the addition of some processing subsystems sensitive to the attentional demands of the situation, PDP models can be made to simulate qualitative shifts in performance (e.g., Whittlesea, 1989. However, the connectionist architecture per se is transparent to the issue of segmentation and unitization, and few authors of PDP models have felt the need to accommodate qualitative changes in processing. We hope that demonstrations like the present one will arouse renewed interest in the problem.

A model proposed by Neely and Keefe (in press) can account for the interaction of the prime-repetition effect with visual degradation. Their model holds that priming results from three different processes: spreading activation, expectancy, and semantic-matching. It is semantic-matching that would be responsible for the interaction of prime repetition with visual degradation. The semantic-matching notion is that people sometimes check to see whether a target is related to its prime as a way of verifying a decision. This semantic checking is assumed to be post-lexical in that a target word gains lexical access prior to semantic matching. To explain the interaction with visual degradation, it could be argued that the use of semantic-matching for verification was more likely when the interpolated word was visually degraded.

There is nothing in our data to let us choose between a semantic-matching account and a retrieval account of the interaction of prime repetition with visual degradation. However, there are some potentially important differences between the two accounts. First, the semantic-matching account assumes that the use of semantic relationship as a basis for verification is post-lexical. By a retrieval account, in contrast, priming reflects a change in the cues used to access memory. Whereas semantic-matching models assume that the prime and target are always processed separately, and the relationship between them evaluated in a separate step, our retrieval view assumes that the unit of processing varies across situations, ranging from relatively independent processing of the prime and target when both are easily identified on their own, to co-processing when identification is made difficult by factors such as degradation. We do not make a distinction between pre- and post-lexical access because we question the existence of a lexicon that is separate from the rest of memory. Second, it might be possible to use a retrieval account to reduce the total number of separate processes that are held responsible for priming effects.

Extensions of a Retrieval Account of Priming Effects

Neely (in press) provides an excellent review of current findings and theories of semantic priming effects. He agrees with Ratcliff and McKoon's (1988) claim that their compound-cue theory is capable of explaining many priming effects that were earlier said to be produced by spreading activation. However, he argues that a sufficient number of effects are left unexplained by the compound-cue theory to warrant retaining spreading activation as one of a number of processes responsible for priming. Adding one assumption, that the degree to which a cue forms a compound with its prime varies across situations, makes the compound-cue theory much more powerful. Interactions of the prime-repetition effect with factors in addition to visual degradation can be used to determine whether that additional power is warranted.

Some have explained the interaction of frequency in the language with priming as involving spreading activation and as arising in the same way as does the interaction of visual degradation (cf. Neely, in press, for a review). Against an account of that form, the interaction of frequency with the prime-repetition effect might be similar to that found for visual degradation. Repetition of a prime might have a target effect when a low- rather than a high-frequency associatively-related word is interpolated between its repetitions (e.g., VODKA - GIMLET - VODKA vs. VODKA - LIQUOR - VODKA). If so, the argument against a spreading-activation account of the interaction of priming with word frequency would be the same as that for visual degradation. An important factor for priming is the stimulus onset asynchrony of the prime and target (again, see Neely for a review). The interval between presentation of a prime and target might also influence the probability of the two forming a compound cue for accessing memory. Similarly, the proportion of related prime-target pairs in the test list and the cue validity of the prime for the target have been shown to influence the amount of facilitation in lexical decision tasks. For example, Tweedy, Lapinski, and Schvaneveldt (1977) showed that increasing the proportion of related targets increased the size of the context effect, and Schwanenflugel and Shoben (1985) demonstrated that decreasing the range of expected sentence completions by increasing the constraint of sentence stems slowed response to unexpected sentence completions. These factors might also interact with the prime-repetition effect, producing faster response to the repeated target when the proportion of related prime-interpolated word pairs or the cue validity of the prime for the interpolated word is increased. Interaction of any of these factors with prime repetition would be damaging to spreading activation accounts, because each would suggest a qualitative shift in the unit of processing.

The above examples all relate to factors that influence the amount of facilitation produced by associative priming. However, presentation of a prime can also produce inhibition. Interactions with the prime-repetition effect are not likely to be useful for specifying the mechanism underlying inhibition effects. In the experiments reported above, manipulation of visual degradation had no effect when the interpolated word was unrelated to the prime. This makes it doubtful that the prime repetition effect can be used to show that inhibition arises from a deleterious effect of using a compound cue that includes an unrelated prime to access memory. However, inappropriate compounding of the target with an unrelated prime may be the source of the inhibition. As suggested by Posner and Snyder (1975), inhibition might arise because the subject answers the "wrong question."

Questions about the factors influencing segmentation have lost their position of central importance for theories of word identification. This is because it is often assumed that processing is parallel across units of representation such as those corresponding to features, letters, and words (e.g., McClelland & Rumelhart, 1981). However, the unit of representation used to identify a word is variable, is retained, and has an effect on later performance. The interaction of prime repetition with visual degradation adds another demonstration of this point. Interactions of this sort give renewed prominence to questions about the factors that determine unitization and segmentation. We prefer to think about those factors in terms of their effects on the accessing of memory rather than claiming that word identification depends on a memory system that is separate from the rest of memory.

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