Journal of Experimental Psychology:
Learning, Memory, and Cognition
1986, Vol. 12, No. 1, 108–115

0278-7393/86/$00.75

Automatic Activation of Episodic Information in a Semantic Memory Task

Gail McKoon and Roger Ratcliff
Northwestern University

Four experiments are presented in which priming between newly learned associates and priming between well-known associates were examined in lexical decision. All four experiments found priming between newly learned associates, including conditions in which the Stimulus Onset Asynchrony (SOA) between prime and target was short (150 ms) and in which the probability was low (1/12) that the prime and target of a pair would be associated to each other. It was concluded, contrary to suggestions by Carroll and Kirsner (1982) and Tulving (1983), that newly learned associates can prime each other, and that they can do so at short SOAs.

The speed with which one concept can activate another through a newly learned association is a fundamental characteristic of memory performance that has not yet been unambiguously determined. On the one hand, Ratcliff and McKoon (1981a, 1981b) have found that in item recognition of nouns studied in short sentences, one noun primes another with only 100 ms intervening between presentation of the two nouns, and that in lexical decision, priming occurs with only 300 ms intervening (McKoon & Ratcliff, 1979, Experiment 3). Despite these results, Tulving (1983) argues that episodic information must be accessed slowly and strategically, and, in lexical decision, Carroll and Kirsner (1982) and Neely and Durgunoglu (1985) have found little evidence that concepts activate each other through newly learned associations. The purpose of the present article is to provide additional data to show that newly learned associates do activate each other very quickly in lexical decision.

In recognition, there is empirical agreement that the speed of activation is quite fast. Neely and Durgunoglu (1985) had subjects study pairs of words and then measured priming between the words of a test pair (one designated the prime, the other the target). The prime was presented 150 ms before the target, and the subject's task was to decide whether the target had appeared in the list of words studied. When the prime and target were from the same studied pair, response time to the target was about 76 ms faster than when the prime and target were from different pairs. Similarly, using words studied in short sentences, Ratcliff and McKoon (1981a, 1981b) found that words of the same sentence primed each other relative to words of different sentences, even when the interval between prime and target (the Stimulus Onset Asynchrony, SOA) was as short as 100 ms.

In contrast, there is disagreement about the status of episodic priming in lexical decision. McKoon and Ratcliff (1979) found evidence for priming between newly learned associates at 300 ms SOA as well as evidence for priming in a sequential response task in which subjects responded to both the prime and target. But Carroll and Kirsner (1982) did not find statistically reliable evidence for episodic priming (though they did find 16 ms of priming) in a procedure in which subjects were required to decide whether pairs of letter strings were both words. Carroll and Kirsner found insignificant episodic priming even though they did find significant priming between well-known semantic associates (e.g., *dog–cat*). Neely and Durgunoglu (1985) failed to find either episodic or semantic priming at 150 ms SOA between prime and target, although more recently Durgunoglu and Neely (in press) found episodic priming under limited conditions. These data are difficult to combine into a consistent pattern, but one generalization does appear in the experiments where subjects responded to single-word probes (not double-word probes as in Carroll and Kirsner's experiments). These are the experiments reported by Durgunoglu and Neely (in press), Neely and Durgunoglu (1985), and McKoon and Ratcliff (1979). The generalization is that whenever priming is obtained between semantic associates at a short SOA (e.g., 150–300 ms), episodic priming is also obtained; and when semantic priming is not obtained at a short SOA, neither is episodic priming.

In the General Discussion of this article, the experiments of Carroll and Kirsner (1982), Durgunoglu and Neely, and Neely and Durgunoglu (1985) will be examined and suggestions made as to why they did not obtain episodic priming in lexical decision. But first, four experiments are presented. These are experiments with lexical decision that examine the speed with which newly learned associates prime each other and whether newly learned associates prime each other if the probability of a priming event is low. The results of these experiments show that newly learned associates do activate each other in lexical decision and that they do so very quickly, even at low probabilities. Thus, priming between episodic associates is shown to be an automatic process according to the definition of automatic given by Posner and Snyder (1975a, 1975b). This is particularly important because Carroll and Kirsner (1982) have attributed episodic priming to slower, strategic processes.

This research was supported by National Institute of Health Grant HD18812 to Gail McKoon and Natural Science Foundation Grant BNS 82 03061 to Roger Ratcliff. We wish to thank Kim Kirsner, Marilyn Smith, and especially Jim Neely for thoughtful discussions of this work.

Correspondence concerning this article should be addressed to Gail McKoon, Psychology Department, Northwestern University, Evanston, Illinois 60201.

It should be stressed that the kind of automaticity argued to apply to episodic priming is the kind defined by Posner and Snyder (1975a, 1975b) and not the kind defined by Schneider and Shiffrin (1977) and Shiffrin and Schneider (1977). The notion of automaticity studied by Schneider and Shiffrin (1977) concerns the production of a response given a stimulus. The notion defined by Posner and Snyder (1975a, 1975b) concerns the activation or retrieval of one piece of information in memory by another (e.g., activation of *doctor* by *nurse*). It is the latter notion of automaticity that is of concern in the present article.

The first experiment was designed to show that newly learned associates prime each other quickly. There were a series of study–test trials, with pairs of words to be learned in the study phase and strings of letters for lexical decision in the test phase. Each item in the test phase consisted of a prime and a target, with the SOA between them either 50 ms or 150 ms. The prime was either a word from the studied pairs or, in the neutral condition, the word READY. The target was either another word from the studied pairs or a nonword. If the target was a word and the prime was not READY, then the prime and target were either from the same studied pair (*same-pair* condition) or different studied pairs (*different-pair* condition). If the words of the newly learned pairs could activate each other as quickly as 150 ms, then response times for targets in the same-pair priming condition would be faster than response times in the different-pair condition or the *neutral* condition. At 50 ms SOA, there would be no differences among conditions. Experiment 2 was designed to show that there would still be priming even if the probability was very low that a prime and target came from the same pair. Experiment 2 also included conditions in which the prime and target were associated semantically (e.g., *dog–cat*) in order to compare episodic and semantic effects.

Experiments 1 and 2 differed from the earlier experiments in which McKoon and Ratcliff (1979) obtained episodic priming. In Experiment 1, there were no semantic priming conditions (e.g., *dog* priming *cat*) as there were in McKoon and Ratcliff (1979), and in Experiment 2, where there were semantic conditions, the SOA was relatively long, 250 ms. So Experiments 3 and 4 were designed to be more exact replications of McKoon and Ratcliff (1979), including semantic priming conditions while using a short SOA.

Experiment 1

Method

Subjects. Eighteen subjects participated in the experiment for extra credit in an introductory psychology course; each subject participated in one session lasting about 1 hr.

Materials. For the experimental design, there were 108 pairs of words; these are the pairs listed in Appendix 2 of McKoon and Ratcliff (1979). Examples of the pairs are *city–grass, angel–nurse, beggar–gallant,* and *canoe–shallow.* The pairs were chosen so as to be relatively easy to learn but so that the words would not be preexperimentally associated to each other. There were also 696 words, with no special characteristics, used for fillers in the study and test lists and 162 pronounceable nonwords used in the test lists.

Design and procedure. Presentation of stimuli and collection of responses were controlled by a microcomputer driven by an Apple computer. Stimuli were presented on a CRT screen and responses collected on the CRT's keyboard.

At the beginning of the experiment, subjects were given 64 strings of letters for lexical decision practice. These were presented in the same way as the test items in the experiment proper. Then there were 3 practice study–test trials, and then 76 study–test trials of the experiment. Each trial consisted of a list of pairs of words to study followed by a test list of prime-target pairs. After the practice and after every 6 trials of the experiment, a cued-recall test was given.

Each study–test trial began with an instruction to the subject to initiate the trial by pressing the space bar on the keyboard. Then six pairs of words were presented for study, one at a time, for 4 s each. After the last pair, a warning signal was given for 1 s and then the test list began. The sequence of events for each item in the test list was as follows: warning signal (+) for 200 ms; blank screen for 200 ms; prime for 50, 150, or 500 ms in the same position on the screen as the warning signal; blank in place of the prime, and target on the line below where the prime had been until subject's response; the word ERROR for 2,000 ms if the response was incorrect; and blank screen for 500 ms (following either a correct response or the error message). The 500 ms SOA was used only once on each trial for a filler or nonword test pair; this SOA was included to encourage subjects to look at and process the primes. On our 46 trials there were six test items, and on 30 trials there were seven test items. For the test items, subjects were instructed to decide as quickly and accurately as they could whether the target was a word or nonword; they responded *word* by pressing the /? key of the CRT keyboard and *nonword* by pressing the Z key. At the end of a trial, there was either the instruction to press the space bar to begin the next trial or an instruction to turn to the next page of a cued-recall booklet.

The cued-recall tests were included to ensure that the subjects attempted to learn the word pairs. Each page of the cued-recall booklet presented 12 cues, 2 chosen randomly from each of the immediately preceding six study lists. The cues were always the left-hand members of their pairs, and the subject's task was to write down the right-hand member. They were given unlimited time. When they finished, they pressed the space bar to initiate the next study–test trial.

The conditions of interest in the experiment were constructed from the 108 pairs of words for the experimental design. There were three priming conditions: the prime for a target was either the word that had appeared with it as a pair in the study list (same-pair condition), a word that had appeared in a different pair in the study list (different-pair condition), or the word READY (neutral condition). Priming condition was crossed with SOA, 50 ms or 150 ms. Thus there were six experimental conditions, with 18 observations per condition per subject. The pairs of words were assigned to conditions randomly for each second subject.

The experiment was designed with a low probability of test items in the different-pair condition, so that subjects would not learn to expect that prime and target would be from different studied pairs. In order to make the probability of the different-pair condition relatively low, fillers were included in the test list to make the probabilities of the same-pair and neutral conditions relatively high. For the fillers, either the prime and target were both words from the same pair in the study list or the prime was the word READY and the target was a word from the study list. There were also test items for which the target was a nonword; the prime was either a word from the study list or the word READY.

Considering all the test items in all the trials, the probabilities of the conditions were as follows: prime and target from different study pairs, 2/27; prime and target from the same study pair, 8/27; READY prime and target from the study list, 8/27; prime from the study list and target nonword, 5/27; and READY prime and target nonword, 4/27. Considering all the test items, the probability of SOA at 50 ms was 1/2 and the probability of SOA at 150 ms was 1/2, except that in every test list the SOA for one of the filler or nonword test items (chosen randomly) was 500 ms. These 500 ms SOA test items were included to encourage subjects to look at and process the primes.

Items were assigned to study and test lists in random order except that test items in the experimental conditions were never placed in the first

Table 1
Experiment 1: Response Times for Correct Responses (in Milliseconds) and Percentage Errors (%E)

Conditions	SOA 50 RT	SOA 50 %E	SOA 150 RT	SOA 150 %E	SOA 500 RT	SOA 500 %E
Experimental test items: target = word						
Same-pair prime	482	7	447	4		
Different-pair prime	491	5	487	2		
Neutral prime	476	4	475	5		
Filler test items: target = word						
Same-pair prime	505	5	471	3	484	4
Neutral prime	496	2	499	2	508	1
Filler test items: target = nonword						
Word prime	464	15	455	25	372	33
Neutral prime	524	14	489	21	425	21

Note. SOA = Stimulus Onset Asynchrony. Response times are based on the following average numbers of observations per subject: Experimental test items, target = word – 17; Filler test items, target = word – 40 at SOAs 50 and 150, 24 at SOA 500; Filler test items, target = nonword – 27 at SOAs 50 and 150, 9 at SOA 500.

position in a test list. No word or nonword appeared in a test list more than once (except the neutral prime READY). A prime word was always a left-hand member of a pair in the study list; a target word was always a right-hand member.

Results

Means were calculated for each subject in each condition and means of these means are shown in Table 1.

For the experimental test items, at the 50 ms SOA, there were no apparent differences among the three priming conditions, same-pair, different-pair, and neutral conditions. But at the 150 ms SOA, a priming word from the same pair as the target word speeded response time to the target, relative to both the different-pair and neutral conditions. For response times, analysis of variance (ANOVA) showed that the effect of priming condition was significant, $F(2, 34) = 7.5$, $p < .01$, that the effect of SOA was not significant, $F(1, 17) = 2.6$, and that the interaction of these two variables was significant, $F(2, 34) = 4.5$, $p < .05$. A post hoc test showed that, at the 150 ms SOA, response times in the same-pair condition were faster than response times in the neutral condition, $F(1, 34) = 9.8$, $p < .01$. Response times in the different-pair condition were not significantly slower than in the neutral condition, $F(1, 34) = 1.8$. Average standard error of the means was 6.4 ms. For errors, only the interaction of priming condition and SOA was significant, $F(2, 34) = 4.1$, $p < .05$, average standard error, 1%. The differences between error rates in the different-pair condition (2%) and the same-pair (4%) and neutral (5%) conditions (at 150 ms SOA) were not significant in post hoc tests.

Data for the filler test items are also shown in Table 1. When the target was a word, response times show the same pattern as the experimental test items: no difference between the same-pair and neutral conditions at 50 ms SOA, and a 28 ms difference at 150 ms SOA. When the target was a nonword, a word prime led to faster responses than the neutral prime.

In the cued-recall tests, subjects wrote responses to 47% of the cues; 85% of the responses they wrote were correct.

Discussion

The results of Experiment 1 are straightforward and can be quickly summarized. At 50 ms SOA between prime and target, there was no difference among conditions. The 50 ms was not enough time for subjects to process the prime in such a way as to give advantage to a decision on the target. But 150 ms was enough time; a prime from the same studied pair as the target facilitated response time for the target, relative to both a neutral prime (READY) and a prime from a different studied pair. Thus, these results show that newly learned associates can activate each other, and they can do so quickly.

Experiment 2

Experiment 1 shows that episodic priming in lexical decision fulfills one of the criteria for labeling a process as automatic (Posner & Snyder, 1975a, 1975b), namely that the process have a very fast onset. In Experiment 2, episodic priming was tested against a second criterion for automaticity, that the process occur even if its probability is low. There were two conditions in the experiment which varied in the probability that a prime and target came from the same studied pair. In one condition, this probability was relatively high (1/4) and priming was expected between a prime and target from the same studied pair. In the other condition, the probability was low (1/24). If episodic priming is an automatic effect, then it should still be observed in this condition. Semantically associated pairs (e.g., *dog–cat*) were also included in the design in an effort to compare priming effects for episodic and semantic associates.

Methods

Materials. 120 triples of words used by McKoon and Ratcliff (1979, Appendix 1) were used in this experiment. Two words of each triple were chosen so as to be highly associated preexperimentally, for example, *green grass.* The third word of each triple, not associated preexperimentally to either of the first two, was chosen so as to form an easily learned pair with the target word, for example, *city grass.* The 120 triples were randomly divided into 80 triples to be used to make up the experimental design and 40 triples to be used as filler words in the study and test lists. There were also other filler words and pronounceable nonwords to complete the study and test lists.

Design. Different groups of subjects were tested in the high probability condition and the low probability condition; each condition was a one-session experiment lasting about 50 min. A session consisted of 20 trials preceded by 3 practice trials; in each trial, 5 pairs of words were presented for study and 12 pairs of words were tested. For 8 of the test pairs, the correct answer was *yes* (the target was a word) and for 4 of the test pairs, the correct answer was *no* (nonword). Study and test lists were presented in the same way as for Experiment 1 except that the prime word was always displayed for 250 ms.

In the high probability condition, the test list contained four pairs from the experimental design. For one of these pairs, the prime and target had appeared in the study list as a pair (e.g., *city grass* studied and *city grass* tested); this was the episodic priming condition. For another of these pairs, the prime and target had appeared in the study list in different pairs (e.g., *city dog* studied, *table grass* studied, and *city grass* tested); this was the episodic unprimed condition. For the other two pairs of the experimental design, neither the prime nor the target was studied. In one pair, the semantic priming condition, the prime and target were preexperimentally associated (e.g., *green grass*) and in the other pair, the semantic unprimed condition, they were not (e.g., *city grass*).

The 8 test pairs that were not part of the experimental design included 2 pairs in which the prime and target had been presented as a pair in the study list and 2 pairs in which neither the prime nor the target had been studied but in which the prime and target were preexperimentally semantically associated. Thus, of the 12 pairs in the test list, there were 6 in which the prime and target were associated (3 episodically and 3 semantically). Finally, two words from the study list and two words that had not been studied were used as primes for nonword targets.

In the low probability condition, the test list contained two pairs from the experimental design instead of the four pairs used in the high probability condition. (Thus 2 subjects were needed in the low probability condition to use all the experimental materials used by 1 subject in the high probability condition.) One of the pairs appeared in an episodic condition, the primed condition on half the trials and the unprimed condition on the other half of the trials. The other of the experimental pairs appeared in a semantic condition, primed on half the trials and unprimed on the other half. Construction of the test lists was controlled so that only one primed condition appeared in any single test list. The test pairs that were not part of the experimental design included three pairs where the prime and target words had both been studied in different pairs from each other and three pairs in which neither prime nor target word had been studied and in which prime and target were not semantically associated. There were also 4 test pairs in which the target was a nonword; for 2 of these, the prime was a word that had been studied, and for the other 2, it was a word that had not been studied. Thus, of 12 test pairs, in only one were the prime and target associated (half the time semantically and half the time episodically).

Constraints on construction of the test lists and randomization were the same as in Experiment 1. Written cued-recall tests were given after every five trials, and were made up of two words randomly selected from the left-hand members of the studied pairs of each of the preceding five trials.

Subjects. Forty Dartmouth undergraduates participated in the experiment for extra credit in an introductory psychology course. There were 16 subjects in the high probability condition and 16 matching subjects in the low probability condition. These subjects were matched in that for every replication of the experimental design, 2 low probability subjects each saw half of the experimental materials (a different half) in the same order of presentation as 2 high probability subjects saw all of the experimental materials. There were also 8 extra subjects in the low probability condition because only half as much data could be obtained from the low probability subjects as from the high probability subjects.

Table 2
Results of Experiment 2: Response Times for Correct Responses (in Milliseconds) and Error Percentages (%E)

Condition	Episodic association	Semantic association
Low probability		
Primed	478	485
%E	0.4	0.8
Unprimed	498	509
%E	0.8	2.7
High probability		
Primed	485	499
%E	0.4	1.5
Unprimed	517	527
%E	2.1	1.7

Note. In the low probability condition, $n = 24$; in the high probability condition, $n = 16$.

Results

Mean response times and error rates were calculated for each subject in each condition; means of these means are shown in Table 2. Overall, the standard error of the mean response times was 15 ms. In general, differences in mean response times are reflected in differences in error rates.

For the 24 subjects in the low probability condition, primes associated to their targets led to faster response times than primes unassociated with targets; 20 ms faster for episodic association and 24 ms faster for semantic association. ANOVA showed this speedup significant, $F(1, 23) = 6.17$, $p < .02$. The effect of kind of association, episodic or semantic, was not significant, $F(1, 23) = 1.21$, and neither was the interaction of the two factors, $F(1, 23) < 1$. For errors, all effects were significant; primed versus unprimed, $F(1, 23) = 22.4$; episodic versus semantic, $F(1, 23) = 8.3$; the interaction, $F(1, 23) = 5.0$, all $ps < .05$.

For the 16 subjects in the high probability condition, episodic primes speeded response times by 32 ms and semantic primes speeded response times by 28 ms. Data for these 16 subjects was combined with data from the matching 16 low probability subjects for ANOVA (with probability as a between-subjects factor). Associated primes speeded response times significantly, $F(1, 30) = 7.05$, $p < .02$. None of the other effects for response time were significant (all $Fs < 1.6$). For error rates, the effects of priming, $F(1, 30) = 11.5$, and the triple interaction between probability, priming, and episodic versus semantic, $F(1, 30) = 6.5$, were significant. The main effect of episodic versus semantic was not significant, $F(1, 30) = 2.9$, and all other Fs were less than 1.5.

Discussion

Experiment 2 demonstrates that episodically related associates prime each other even when the probability of testing episodic relations is low (1 test out of 24); thus, episodic activation meets

Table 3
Experimental Conditions and Results of Experiment 3

	Study List		Test list			
Condition	Associate	Target	Prime	Target	RT (ms)	Error (%)
1	green	grass	green	grass	630	1
2	green	grass	X	grass	662	2
3	city	grass	city	grass	632	1
4	city	grass	X	grass	653	2
5	city	grass	green	grass	633	2
6	city	grass	X	grass	670	1
7	—	—	green	grass	656	3
8	—	—	X	grass	683	3
			X	word	700	3
Fillers			X	nonword	724	5

Note. X is some word from the study list, but not *city* or *green.*

the probability criterion for an automatic process (Posner & Snyder, 1975a, 1975b). The experiment also found no significant differences between priming due to episodic associations and priming due to semantic associations. Although the experiment might not have had the power to detect such differences, it is at least the case that there are not large differences in the two kinds of priming at low probability. For example, it is not the case that episodic priming disappears at low probability, whereas semantic priming does not.

Experiments 3 and 4

Experiment 1 showed that episodic associates can activate each other quickly. But the experiment did not include all of the conditions used by McKoon and Ratcliff (1979) when they originally found episodic activation. Because Carroll and Kirsner (1982) suggested that McKoon and Ratcliff's (1979) effects were due to strategic processes and because we disagree with their interpretation, we thought it important to replicate McKoon and Ratcliff (1979), as nearly as possible, consistent with showing that the episodic activation effects were not strategic. Accordingly, Experiment 3 was the same as Experiment 1 of McKoon and Ratcliff (1979) except that subjects were not required to make a response to the prime so that SOA could be controlled. Experiment 4 replicated Experiment 3 with minor differences in the probabilities of episodic and semantic test pairs.

Method

Subjects. In each experiment, 32 subjects participated in one 50-min session in order to receive extra credit in an introductory psychology course.

Materials. For the experimental designs of both experiments, 128 triples of words were used; these are shown in Appendix 1, McKoon and Ratcliff (1979), and are described in the Materials section of Experiment 1 of this article. In addition to these triples, there were also a set of common words to be used as fillers in the study and test lists, and a set of pronounceable nonwords.

Procedure. For each subject, there were 32 trials preceded by 2 practice trials. A trial consisted of a study list of six pairs of words and a test list of nine test items. The study and test items were presented in the same way as in Experiment 1, except that the pairs of the study list were presented for 3 s each and a prime was always shown for 150 ms. A cued-recall test was given after practice and after every eight trials; it was made up of left-hand members of two pairs from each of the eight preceding study lists.

Design. There were eight experimental conditions in each experiment; these are shown in Tables 3 and 4. It should be noted that some of the conditions are identical; this is to control the relative probabilities of the conditions in which primes are associated to targets and conditions in which primes are unassociated. The differences between Experiments 3 and 4 are shown in the experimental conditions. Experiment 3 had the same conditions as in McKoon and Ratcliff (1979). In Experiment 4, two of the conditions in which semantic associates were tested were eliminated.

Table 4
Experimental Conditions and Results of Experiment 4

	Study list		Test list			
Condition	Associate	Target	Prime	Target	RT (ms)	Error (%)
1–4	city	grass	city	grass	642	1
5–6	city	grass	X	grass	667	1
7	—	—	green	grass	667	3
8	—	—	X	grass	699	4
			X	word	699	2
Fillers			X	nonword	737	4

Note. X is some word from the study list, but not *city* or *green.*

For each experiment, the 128 triples of words were divided into eight groups of 16 triples each; these eight groups were combined with the eight experimental conditions and eight groups of subjects (four per group) in a Latin square design. Order of presentation of study and test materials was rerandomized for every second subject.

The triples to be used on each trial were chosen by dividing the experimental conditions into four sets, Conditions 1 and 2, Conditions 3 and 4, Conditions 5 and 6, and Conditions 7 and 8. The two conditions of each set were used on alternate trials. For a trial, the triples of a condition were chosen randomly from the 16 assigned to the condition. Then the appropriate pair of words from the triple was assigned randomly to one of the four middle positions of the study list. The first and last pairs of the study list were composed of filler words. Filler words were also used in the study list for Conditions 7 and 8, in which none of the words of the triple was studied.

In the test list, the test items for the four conditions for the trial were assigned to random positions, except they were never assigned to Position 1. Then the other five positions in the list were filled. For these other five positions, in one the prime and the target were both words from the study list, and for the other four, the prime was a word from the study list and the target was a nonword. The five filler items were assigned to random positions in the test list except that the left-hand member of a studied pair could not appear in the test position immediately preceding its right-hand member when the right-hand member was a target in an unprimed condition. No word or nonword appeared in the test list more than once except that in Experiment 4, on half of the trials, one word from the study list was repeated in the test list in order to fill all the test list positions. This word was never placed in the test position immediately preceding the other member of its study pair. All words in the test list had appeared in the study list except for the prime and target of Condition 7, the target of Condition 8, and the prime of Condition 5 of Experiment 3.

To compare the two experiments, in Experiment 3, 1/18 of all the test items were newly learned associates (Condition 1; *city–grass*). In Experiment 4, this probability was 4/18. In Experiment 3, 3/18 of all test items were semantically associated (Conditions 1, 5, and 7); in Experiment 4, this probability was 1/18. We had thought these differences in probability of episodic and semantic associations might affect the results of the experiments, but, in fact, they did not.

Results

Means were calculated for each subject in each condition; means of these means are shown in Tables 3 and 4. To summarize, there are two patterns in the data. First, targets primed by an associated word have response times about 30 ms faster than targets primed by an unassociated word. Second, targets in Conditions 7 and 8, targets which did not appear in the study list, have slower response times than targets in the other conditions, which did appear in the study list. These two patterns are also reflected in error rates.

For Experiment 3, ANOVA of response times showed a main effect of the four pairs of conditions (Conditions 1 and 2, 3 and 4, 5 and 6, and 7 and 8) due to slower response times in Conditions 7 and 8, $F(3, 93) = 6.19$, $p < .01$. There was also a main effect of associated versus unassociated primes, $F(1, 31) = 28.3$, $p < .01$. The interaction was not significant, $F < 1$. Standard error for the response times was 7.4 ms. ANOVA for errors showed no significant effects. On the cued-recall tests, subjects wrote responses for 67% of the cues; 71% of these responses were correct.

For Experiment 4, ANOVA on response times showed that Conditions 7 and 8 had slower response times than the other conditions, $F(1, 31) = 16.6$, $p < .01$. The effect of associated primes was also significant, $F(1, 31) = 15.0$, $p < .01$. The interaction was not significant. The average standard error of the mean was 6.5 ms. For errors, the only significant effect was the interaction, $F(1, 31) = 5.9$, $p < .02$. On the cued-recall tests, subjects wrote responses to 49% of the cues, and 87% of these were correct.

Discussion

Experiments 3 and 4 were designed to show that episodic priming in lexical decision has a fast onset, under the experimental conditions used by McKoon and Ratcliff (1979). In this, the experiments were successful: at 150 ms SOA, there was significant priming for newly learned associates, as well as for semantic associates that were presented in the study list and semantic associates that were not presented in the study list. The results of Experiments 3 and 4 replicated those found by McKoon and Ratcliff (1979, Experiment 1) in that priming was obtained in all conditions, and in that the size of the priming effect was about the same in all conditions. The one difference in results is that the priming effect for semantic associates not presented in the study list was larger than other priming effects in McKoon and Ratcliff (1979), but this was not true in the present experiment. Also, response times in the present experiment are about 100 ms slower than in McKoon and Ratcliff (1979); this may be due to different subjects or to differences in the procedure.

We had thought that the relatively high probability of testing semantic associates in Experiment 3 might have contributed to the finding of episodic priming. But when this probability was reduced in Experiment 4, albeit by a small amount, episodic priming was not affected.

General Discussion

The results of these experiments replicate and extend the results found in McKoon and Ratcliff (1979). In Experiment 1, newly learned associates primed each other quickly, at 150 ms SOA, and in Experiment 2, they primed each other even if there was only a low probability that prime and target would be from the same studied pair. Experiments 3 and 4 replicated the experiments of McKoon and Ratcliff (1979) and obtained priming at a 150 ms SOA. The priming effects are summarized in Table 5. The table shows the consistency with which both episodic and semantic priming effects were obtained at the 150 and 250 ms SOAs.

Across the experiments, several different ideas about episodic priming in lexical decision can be evaluated. For example, it is not the case that episodic priming is obtained only in the presence of semantic priming or only in the absence of semantic priming: There were no semantic priming conditions in Experiment 1 (or in Experiments 2 and 3 of McKoon & Ratcliff, 1979), but there were such conditions in Experiments 2, 3, and 4. It is also not the case that episodic priming is obtained only when there is a relatively high probability that an episodically associated prime-target pair will be tested; this probability was very low in Experiment 2. In fact, it may be the case that *no* particular context of priming events is required; in Experiment 2, the probability of any prime (semantic or episodic) was only 1/12, and in Experiments 3 and 4, manipulation of the relative probabilities of semantic and episodic test pairs had no effect. Furthermore, priming can be obtained under a variety of experimental conditions: when only short SOAs are included in the experiment (Experiments 3 and 4), whether or not nonwords are included in the study list (McKoon & Ratcliff, 1979), and whether or not nonstudied words are included in the test list (Experiment 2).

The results of the four experiments presented here show clearly that episodic associates can activate each other in lexical decision and that they do so quickly. The first conclusion that follows from these results is that fast activation of one concept by another in lexical decision is not limited to concepts that are connected by well-learned associations. Instead, even newly learned associations can lead to fast activation between concepts. Thus we would argue for dismissal of Carroll and Kirsner's (1982) claim that episodic priming in lexical decision is necessarily the result of slower strategic processing.

A second possible conclusion is that episodic priming in lexical decision is subject to experimental manipulation. This conclusion is suggested by the fact that we find episodic priming but Carroll and Kirsner (1982), Durgunoglu and Neely (in press), and Neely and Durgunoglu (1985) do not (except under limited conditions). With respect to Carroll and Kirsner (1982), interpretation is difficult because it may be that they did, in fact, find a small effect of episodic activation. Response times for words that were tested in the same pair on second test as on first test were 16 ms faster than response times for words tested in a different pair on second test. This difference of 16 ms is not much smaller than some of the effects found in the current experiments (e.g., 20 ms in Experiment 2). The 16 ms difference is also about the size of the standard error of measurement in Carroll and Kirsner's experiment, and it could be that increasing the power of the experiment (using more than 14 subjects) would have made it significant. However, even if the 16 ms difference is real, it still is much smaller than the semantic priming effect found by Carroll and Kirsner (1982). But the size of the semantic priming effect might have been due to strategic priming. A strategic effect is possible because there was a relatively high proportion of semantic associates at test, and because the decision required of subjects (whether pairs of test items were both words) may have led to relatively slow response times.

Table 5
Summary of Priming Condition Results From Experiments 1–4

Experiment (Exp.)	Semantic Target: Studied	Semantic Target: Not studied	Episodic Target: Studied	Episodic & semantic Target: Studied
Exp. 1				
50 ms SOA				
RT			+9	
%E			−2.0	
150 ms SOA				
RT			+40	
%E			−2.0	
Exp. 2				
Low prob:				
250 ms SOA				
RT	+24		+20	
%E	+1.9		+0.4	
High prob:				
250 ms SOA				
RT	+28		+32	
%E	+0.2		+1.7	
Exp. 3				
150 ms SOA				
RT	+37	+27	+21	+32
%E	−1.0	0.0	+1.0	+1.0
Exp. 4				
150 ms SOA				
RT			+32	+25
%E			+1.0	0.0

Note. SOA = Stimulus Onset Asynchrony; Prob = probability.

Durgunoglu and Neely (in press) and Neely and Durgunoglu's (1985) results raise more clearly the possibility that episodic priming (as well as semantic priming) in lexical decision is subject to experimental manipulation. There are two points to be made about their results. The first is that their results are difficult to evaluate because they are at odds with other previous research in that they failed to find semantic priming effects. Although their materials do show semantic priming when tested without previous study (Durgunoglu & Neely, in press), when tested with previous study, there was no semantic priming at a 150 ms SOA. In contrast, den Heyer, Briand, and Dannenbring (1983) found semantic priming at a 75 ms SOA in a replication of experiments presented by Neely (1977), who had found semantic priming at 250 ms SOA. Why Neely and Durgunoglu (1985) did not obtain semantic priming is a question for which we have not been able to think of a convincing answer.

The second point about Neely and Durgunoglu's (1985) results is the question of why they found no episodic priming at the short (150 ms) SOA in their experiments. One possibility is that subjects did not process the priming word for meaning when the SOA was short. That this is a real possibility has been shown by Smith (1979) and Henik, Friedrich, and Kellogg (1983) who found that if subjects perform a letter search task on the priming word, then there is no facilitation of the response to the target. Another possible explanation of why Neely and Durgunoglu (1985) found no episodic priming is that subjects can adopt a strategy that focuses attention away from the newly learned episodic information and so tends to eliminate episodic priming. Durgunoglu and Neely (in press) suggest a variety of factors that might contribute to such a strategy. For example, subjects might think episodic information less useful or less accessible when there were very long test lists, relatively few test words from the studied list, or relatively few long SOAs. This notion does have some support, specifically from work with perceptual identification, where the amount of facilitation given to perceptual identification of a word by previous study of the word depends on the proportion of test words that have been previously studied (Jacoby, 1983). However, even if subjects did adopt a strategy that focused attention away from newly learned information, this strategy would not also eliminate semantic priming. Nevertheless, whatever the specific reason, the possibility must be considered in future research that fast automatic activation (Posner & Snyder, 1975a, 1975b) depends on appropriate processing of the prime or on strategies that can be manipulated by experimental procedures (Henik et al., 1983; Smith, 1979).

Neely and Durgunoglu (1985) and Durgunoglu and Neely (in press) also argue that the lack of episodic priming in their experiments causes problems when priming results are interpreted with respect to the distinction between episodic and semantic memory systems. However, by and large, whenever semantic priming is observed at short SOAs, episodic priming is also observed. And whenever semantic priming is not obtained, neither is episodic priming. Thus, experimental results are consistent with the claims made in McKoon and Ratcliff (1979): the episodic/semantic distinction does not allow predictions of when episodic or semantic priming effects will be obtained in lexical decision.

In conclusion, the results of the lexical decision experiments presented in this article can be combined with the results of experiments that have examined priming between newly learned associates in recognition (Ratcliff & McKoon, 1981a, 1981b). In both kinds of experiments, priming is found at short SOAs between prime and target. Tulving (1983) has suggested that episodic memories are always accessed by slow strategic processes and that only semantic memories are accessed by fast automatic processes. The present results combined with the recognition results show that this is not the case, that both kinds of memories can be accessed quickly. Thus, as noted by McKoon, Ratcliff, and Dell (in press), automatic versus strategic processing differences do not provide a basis for distinguishing between episodic and semantic memories.

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Received June 15, 1984
Revision received July 7, 1985 ■