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Automatic and Strategic Priming in Recognition

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Automatic and strategic components of priming in recognition were investigated in four experiments. In each experiment, subjects studied unrelated sentences and then were presented a test list of words for recognition. In the first experiment, the probability that a priming pair (two words from the same sentence tested sequentially) occurred in the test list had no effect on the size of the facilitation of response to the second word of the pair. This shows that the priming effect satisfies one of the criteria required of an automatic process. The other three experiments investigated the time course of processing by manipulating the time between the onsets of the prime word and the target word. In Experiment 2, it was found that facilitation (prime and target from the same sentence) occurred by 150 milliseconds, but inhibition (prime and target from different sentences) did not occur until later in processing. These results show that priming satisfies the other two criteria for an automatic process, rapid onset of facilitation and no inhibition until later in processing. In the third and fourth experiments, strategic facilitation took longer than 700 milliseconds to be produced but inhibition was produced faster than 700 milliseconds. These results support the two-factor theory of Posner and Snyder. Implications for models of discourse processing are also discussed.

Recently, McKoon and Ratcliff (1980a, 1980b) and Ratcliff and McKoon (1978) have developed a new technique for investigating the representation of textual information in memory. The technique involves priming in item recognition. Priming can be defined as the facilitation of the response to a test item by a preceding item. For example, Ratcliff and McKoon (1978) presented sentences to subjects for study and then tested single words for recognition (subjects had to decide whether a test word was in one of the study sentences). Response time to a word immediately preceded in the test list by a word from the same sentence was over 100 milliseconds faster than the response time to a word immediately preceded by a word from a different sentence. The size of the priming effect was found to be greater if the priming pair was from the same proposition than if the priming pair was from different propositions. It was argued that this result provided strong support for the view that the structure of sentences is propositional. McKoon and Ratcliff (1980a) developed this technique further by showing that the magnitude of the priming effect varies as a function of the distance between the prime and test words in the propositional structure of paragraphs. Thus, the technique appears to be useful for investigating the structure of paragraphs because it is possible to index the distance between two propositions in terms of the size of the priming effect.

A major question that arises is to what extent priming in item recognition is the result of an automatic process and to what extent it is the result of a strategic process that is under the control of some attentional mechanism (cf. Posner & Snyder, 1975a; 1975b). This question is of some importance

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in evaluating the validity of the priming technique for if priming effects were the result of a strategic, covert rehearsal process, then they could be attributed to the particular strategy used and not to the structure of the text. The question as to the kind of processing involved in priming is also important for theoretical reasons because priming reflects an activation process that is a basic component of retrieval processes (Ratcliff & McKoon, 1978). In this paper we will use three different methods to investigate the automatic and strategic components of priming in an item recognition task. Each of the three methods has been used in previous research involving experimental tasks other than item recognition.

In letter matching, word matching (Posner & Snyder, 1975a), and lexical decision (Tweedy, Lapinski, & Schvaneveldt, 1977), the separation of automatic and strategic components of priming has been accomplished by manipulating the probability that a prime predicts the following test item. Tweedy et al. (1977) examined the semantic facilitation effect in lexical decision (*nurse* is recognized as a word faster if it is preceded, or primed, by a semantically related word such as *doctor*). They found that the size of the semantic facilitation effect decreased from about 75 milliseconds to about 30 milliseconds as the probability that a prime and the following test word were semantically related decreased from 7/8 to 1/8. They interpreted this as evidence for the operation of two separate activation processes: an automatic process providing about 26 milliseconds of facilitation (by linear extrapolation to zero probability) and a strategic process providing the remainder of the facilitation. The strategic process is supposed to arise because the subject recognizes that there is a semantic relationship between a prime word and its target word and develops strategies to make use of this knowledge in predicting targets. The first experiment presented in this paper attempts to separate automatic and strategic components of priming in item recognition by manipulating the probability that a priming event occurs in a test list, that is, the probability that sequentially presented test words belong to the same study sentence.

Posner and his colleagues (Posner & Boies, 1971; Posner & Klein, 1973; Posner & Snyder, 1975a; 1975b) have investigated the time course of activation in a letter matching task in order to investigate the relative onset times of automatic and strategic processes. Posner and Snyder (1975a) obtained the time course of processing by varying the time between prime onset and target onset, in other words, the stimulus onset asynchrony (SOA). In their task, the subject was presented with a prime letter which was followed by a pair of test letters. The subject was required to make no decision involving the prime. With respect to the test pair, the subject was required to press one button if the letters matched each other and another button if the letters did not match. Facilitation of the decision occurred when the prime matched both test letters. The facilitation had a very rapid onset and reached asymptote when the SOA was between 100 and 150 milliseconds. On the other hand, an increase in response time, that is, inhibition, which occurred when the prime did not match the test letters but the test letters matched each other, had a much slower onset and did not reach asymptote until the SOA was between 300 and 400 milliseconds. These results were interpreted as supporting the view that automatic activation occurs early in processing and provides benefits (facilitation) but no costs (inhibition) while strategic activation occurs later in processing and can provide greater benefits but also involves significant costs. Experiment 2 of this paper was designed to investigate the time course of facilitation and inhibition in priming in item recognition by manipulating the SOA between the prime and target word.

An experiment by Neely (1977) provides

further evidence for the separation of automatic and strategic components of activation. Neely sought to separate the automatic and strategic components in a lexical-decision task by instructing subjects to engage in a specific strategy that involved switching expectations from one category to another. Subjects were presented with a prime that was one of three category names or a row of X's. The subjects were told that, if the prime was the category name "bird," then they should expect the test letter string to be a member of that category, which it was with high probability. If the category was "body," the tested letter string was, with high probability, a part of a building. If the category presented was "building," then the test letter string was, with high probability, a body part. Subjects were told to shift their attention when they saw "building" or "body" in order to expect a member of the other category. The time course of processing was examined by varying the prime–target SOA. For the categories "building" and "body," there was facilitation for a target that was a word and a member of the prime category at short SOA's (250 msec). This was interpreted as reflecting automatic activation. At longer SOA's (750 msec), the response to a target that was a word and a member of the prime category was inhibited. Furthermore, the expected target (e.g., a body part if "building" was the prime) produced facilitation at longer SOA's. The result that there was both facilitation and inhibition at longer SOA's was taken as supporting the view that, at longer SOA's, a relatively slow, limited-capacity, attentional mechanism is involved.

Experiments 3 and 4 of the present paper used Neely's method to examine the strategic component of activation in item recognition. Subjects were presented with two independent sentences and were then presented with a prime–target pair (subjects had to decide whether the target was in one of the study sentences). Subjects were instructed that, if the prime were from one sentence, then the target would be from the other sentence with high probability and that they should attempt to prepare for the target by recovering the other sentence. The SOA between prime and target was varied from short to long to trace out the time course of processing.

To summarize, the four experiments presented in this paper were designed to determine to what extent the priming effects obtained in item recognition are due to automatic processing and to what extent to strategic processing. Automatic priming effects must meet the three criteria established by previous research. They must be unaffected by the probability of a priming event, they must occur early in the time course of processing, and they must provide facilitation but no inhibition. Strategic priming effects, on the other hand, must occur later in processing and provide both facilitation and inhibition. Each of these criteria was applied to priming in item recognition in the research reported here. In Experiment 1, the probability of a priming event was varied. In Experiments 2, 3, and 4, the time course of processing was examined in order to determine the relative onset times of facilitation and inhibition.

Experiment 1

Experiment 1 was designed to investigate the effect on priming of varying the probability that a prime predicts the target. Subjects were presented with five sentences and then presented with a test list of 32 single words; for each word they were required to respond "yes" or "no" as to whether the word was in one of the study sentences. The probability that a word from one sentence was immediately followed by a word from the same sentence was manipulated from there being seven priming pairs per test list to one priming pair every two test lists. Following the logic of Tweedy et al. (1977) and Posner and Snyder (1975a), only the strategic and not the automatic component of priming should be affected by this manipulation.

Method

Subjects. Forty-eight Dartmouth undergraduates participated in the experiment for extra credit in an introductory psychology course. Each subject participated in one session lasting about 50 minutes.

Materials. The 225 sentences used as study materials were of the form NOUN1 VERB1 NOUN2 CONJUNCTION NOUN3 VERB2 NOUN4, where each noun and verb was different and articles were added as appropriate. These sentences were obtained from the sentence pool used by Ratcliff and McKoon (1978). Each sentence represented three propositions: PROPOSITION 1 = (VERB1, NOUN1, NOUN2), PROPOSITION 2 = (VERB2, NOUN3, NOUN4), and PROPOSITION 3 = (CONJUNCTION, PROPOSITION 1, PROPOSITION 2). In the test lists, only nouns were presented for recognition. Distractors were nouns that did not appear in any study sentence. Neither distractors nor study sentences were repeated within a session.

Design and procedure. A study–test recognition memory procedure was employed. Study list and test item presentation were controlled by a microcomputer driven by Dartmouth's time-sharing computer system.

Each subject was presented with 45 trials, of which the first 5 were for practice. Each trial consisted of a study list immediately followed by a test list. Each study list was made up of 5 sentences displayed on a CRT screen one at a time for 7 seconds each. The 5 sentences for each study list were chosen randomly without replacement from the total set of 225 sentences.

Each test list was composed of 32 individual words, presented on the CRT screen one at a time. The subject was to respond to each word by pressing either a "yes" or a "no" key (the "/" and "Z" keys, respectively, on the CRT keyboard), according to whether the word had been in any of the sentences just studied. A test word remained on the screen until a response was made; then the next test word appeared after a 100-milliseconds pause. Which key was pressed and response time were recorded for each response. Subjects were instructed to respond as quickly and accurately as possible.

Of the 32 test words, 20 were positive words, nouns from the studied sentences, and 12 were distractors, nouns not used in any sentence. A test list was constructed in the following manner: First, words that were to be primed were placed in randomly chosen positions in the test list, but not in positions 1 or 2. Then, for each of these words, its priming word was placed in the immediately preceding test position. Second, words that were to be unprimed were placed in random positions in the test list (but not in positions 1 or 2), and then, for each of these, a randomly chosen word from some other studied sentence was placed in the immediately preceding test position. Finally, the remaining positive test words and distractors were placed in the remaining test positions in random order. The constraints placed on the construction of the test list were that there could not be a word from one of the studied sentences in the two positions preceding a priming pair of that sentence (Ratcliff and McKoon, 1978, showed that the priming effect has largely dissipated after one intervening test item), that there could not be a word from one of the studied sentences in the three positions immediately preceding an unprimed word of that sentence, and that no word could appear in the test list more than once. Order of presentation of materials was rerandomized after every second subject.

In each test list, eight positive words were designated targets. In the high-probability condition, seven of these were primed, that is, preceded by another word from the same proposition of the same sentence, and one was unprimed, that is, preceded by a word from some other sentence. In the intermediate-probability condition, one target was primed and seven were unprimed. In the low-probability condition, one target was primed in every second test list and all other targets were unprimed. The probability manipulation was a between-subjects variable, with 16 subjects participating in each condition.

A sentence recognition test, given after every five trials, was used to encourage subjects to study the sentences carefully. For each sentence presented in the recognition test, the subject had to respond according to whether it was exactly the same as a sentence previously studied. A sentence from the preceding five trials was presented on the recognition test with probability 1/4. If a sentence was presented, then the probability that the correct answer was "no" was 1/3. These negative sentences were identical to sentences that had been presented except that the meaning had been changed by substitution of one noun or verb.

Results and Discussion

Response times longer than 2000 milliseconds (less than 3% of responses, equally distributed across conditions) were eliminated from the analyses. Only correct "yes" responses preceded by correct "yes" responses were included in the analyses in order to be as sure as possible that both the primed word and the priming word were in memory. All analyses were based on mean response times for each subject in each condition.

If the priming effect obtained in item recognition is the result of an automatic process, then the probability that a target word will be primed should not affect the magnitude of the priming effect. There should be a significant priming effect even when the probability of a target word being primed is very low. On the other hand, if some or all of the priming effect is due to strategic processes, then the magnitude should decrease as probability decreases. The results of this experiment support the first alternative. Priming did not decrease with probability; there was a significant priming effect even in the lowest-probability condition. Thus priming appears to be automatic. In the high-probability condition, the mean response time to primed targets was 733 milliseconds (16% errors) and the mean response time to unprimed targets was 804 milliseconds (28% errors). In the intermediate-probability condition, primed targets averaged 725 milliseconds (14% errors) and unprimed targets, 779 milliseconds (20% errors). In the low-probability condition, mean response times were 727 milliseconds (9% errors) and 797 milliseconds (21% errors), respectively. Analysis of variance showed that the priming effect was significant, $F\ (1,45) = 72$, $p < .001$. Both the F for probability conditions and the F for the interaction of priming and probability were less than one. Average standard error of the means was 23 milliseconds.

These results show that the priming effect obtained using this procedure is not affected by the probability of a priming event. Even when probability ranges as low as .025, the priming effect has not been reduced to zero. Thus, priming in item recognition meets the first criterion for an automatic process. That the priming should be automatic is not surprising in view of what the requirements of strategic processes would be in this experiment. The obvious strategic process would involve retrieving the sentence that contained each test word and activating the whole sentence. In this experiment, there is little need to perform any such process (but see Experiments 3 and 4, where the use of this strategy is required). On the other hand, in the experiment of Tweedy et al. (1977), where the task was relatively easy, it was reasonable for subjects to try to retrieve a semantic associate of the prime and thus produce significant strategic facilitation.

Experiment 2

The second experiment was designed to examine the time course of the priming effect. Five sentences were presented to the subject, one at a time, for study. The test list consisted of prime–target pairs to which subjects responded "yes" or "no" according to whether the target word was in one of the study sentences (no response was made to the prime). The time between the onset of the prime and target, the SOA, was varied in order to examine the time course of priming effects. By examining the time course, we can determine whether there are components of the priming process that can be labeled automatic and strategic. An automatic component must meet the criteria that it occur early in processing and provide facilitation but no inhibition. A strategic component must meet the criteria that it occur later in processing and provide both facilitation and inhibition (Posner & Snyder, 1975a).

Method

Subjects. Sixteen Dartmouth undergraduates participated in the experiment for extra credit in an introductory psychology course. Each subject participated in one session lasting about 50 minutes.

Materials. The 450 sentences (from Ratcliff & McKoon, 1978) used as study materials were of the form NOUN1 VERB1 NOUN2, where each noun was different and articles were added as appropriate. In the test list, only nouns were presented for recognition. Distractors were nouns that did not appear in any study sentence. Neither distractors nor study sentences were repeated within a session.

Design and procedure. A study–test recognition memory procedure was employed. Each subject was presented with 105 trials, of which the first 15 were for practice. Study lists were made up of five sentences each (drawn randomly without replacement from the total set of sentences). The sentences were presented one at a time on a CRT screen for 5 seconds each. There was a sentence recognition test (constructed in the same manner as in Experiment 1) after every 18 trials.

Each test list was composed of six prime–target pairs. The first item, the prime, could be either a word from one of the studied sentences or a string of eight randomly chosen letters. Subjects were required to make no response to the prime. The second item of each pair was a test word; the subject was to respond to this word by pressing either a "yes" key or a "no" key, according to whether the word had been in any of the sentences just studied. Each prime–target pair was preceded by a 200-millisecond warning signal, then the prime was displayed for 50, 150, 450, or 800 milliseconds. The test word was then displayed until the subject responded, and the response was followed by a 150-millisecond pause before the warning signal for the next pair. Which key was pressed and response time were recorded for each response. Subjects were instructed to be fast and accurate.

There were two (within-subject) independent variables in the experiment, the SOA between prime and test word (50, 150, 450, or 800 msec) and priming condition. The five priming conditions and the probability with which each was tested were: a word from a studied sentence primed by random letters (probability 8/27), a word from a studied sentence primed by a word from the same sentence (8/27), a word from a studied sentence primed by a word from a different sentence (2/27), a word not from any studied sentence primed by random letters (4/27), and a word not from any studied sentence primed by a word from a studied sentence (5/27). Subjects were told that, if the prime were a word, then there was a very high probability that the test word would be from the same sentence (if it were from one of the studied sentences).

For each test list, pairs were selected so that, over all test lists, the five priming conditions would be tested according to the above probabilities. Restrictions on construction of the test lists were that a test word from a studied sentence could not be in the test pair immediately preceding another test word from the same sentence and that no word could be tested more than once. Otherwise, words were selected randomly to fill the test pairs. Order of presentation of materials was rerandomized after every second subject.

Results and Discussion

Response times longer than 2000 milliseconds and shorter than 200 milliseconds (less than 4% of responses, equally distributed across conditions) were eliminated from the analyses. All analyses were based on mean response times for each subject in each condition. The results are displayed in Table 1.

Both priming condition and SOA significantly affected response times, $F(2,30) = 11.2$, $p < .001$ and $F(3,45) = 4.5$, $p < .01$, respectively. The interaction of these two variables was also significant, $F(6,90) = 4.1$, $p < .01$. The average standard error of the means was 36 milliseconds.

If at least some of the priming effect between two words of the same sentence is due to an automatic activation process, then priming should appear at short SOA's, perhaps by 150 milliseconds. Orthogonal comparison of random-letter priming to same-sentence priming at 150 milliseconds showed a significant difference, $F(1,90) = 4.2$, $p < .05$. Furthermore, if subjects' expectations led to a strategic activation process, then there should be inhibition of response to a test word from a different sentence than the prime word at later SOA's. Although this inhibition effect is not large, orthogonal comparison between random-letter priming at 450 and 800 milliseconds SOA's and different-sentence priming at 450 and 800 milliseconds SOA's showed a significant difference, $F(1,90) = 4.8$, $p < .05$.

TABLE 1
RESULTS FROM EXPERIMENT 2

	Mean response time (msec)		
SOA	Random letters prime	Same sentence prime	Different sentence prime
50 msec	692 (.15)	695 (.13)	701 (.14)
150 msec	699 (.13)	656 (.12)	703 (.17)
450 msec	675 (.14)	595 (.13)	714 (.23)
800 msec	703 (.20)	608 (.09)	729 (.22)

Note. Proportion of errors appears in parentheses.

These results mirror those found by Posner and Snyder (1975a) in a letter matching task. They found evidence for a fast activation process with an onset at about 200 milliseconds and a slower inhibition process with onset between 300 and 400 milliseconds. The temporal parameters found in the present experiment for activation processes in recognition appear to be relatively close to those found in letter matching (although the priming effect in recognition is typically twice the size of that found in letter matching). Thus, these results support an extension of the Posner and Snyder (1975a; 1975b) two-component theory to item recognition.

These results also show that the component processes of priming in item recognition meet the appropriate criteria for onset time. The automatic component has a fast onset, appearing by 150 milliseconds, and provides facilitation but no inhibition. A strategic component appears later in processing (450 milliseconds) and provides both facilitation and inhibition.

EXPERIMENT 3

The third experiment was designed to investigate more explicitly the time course of strategic processing. Subjects were presented with two unrelated sentences and then presented with a single prime–target pair. A target from one sentence was much more likely to be preceded by a prime from the other sentence than from the same sentence. Subjects were instructed that, upon presentation of a prime word, they should attempt to think of the other sentence in order to anticipate the target word. The amount of facilitation when the prime and target were from different sentences and the amounts of inhibition and facilitation when the prime and target were from the same sentence were measured as a function of SOA.

Method

Subjects. Four volunteer subjects participated in the experiment for four 50-minute sessions each.

Materials. The 450 sentences (from Ratcliff & McKoon, 1978) used as study materials were of the form NOUN1 VERB1 NOUN2, where each noun was different and articles were added as appropriate. Only nouns were tested for recognition. Distractors were nouns that did not appear in any study sentence. No study sentence or distractor was repeated within a session.

Design and procedure. In each session, 240 trials were presented, of which the first 15 were for practice. On each trial, two sentences (drawn randomly without replacement from the total set) were studied and one prime–target pair was tested. The sentences were displayed one at a time on a CRT screen for 4 seconds each. Immediately after the second sentence, the priming item (a string of random letters or a word) was presented for 200, 700, or 1800 milliseconds, and then the test word was presented. The test word remained on the screen until the subject made a response, pressing either a "yes" key if the word had appeared in one of the studied sentences or a "no" key if it had not. Which key was pressed and response time were recorded for each response. Subjects were instructed to be fast and accurate.

There were two (within-subject) independent variables in the experiment, the SOA between prime and test word (200, 700, or 1800 msec) and priming condition. The five priming conditions and the probability with which each was tested were: a word from a studied sentence primed by random letters (probability 2/15), a word from a studied sentence primed by a word from the same studied sentence (probability 2/15), a word from a studied sentence primed by a word from the other studied sentence (probability 6/15), a word not from any studied sentence primed by random letters (probability 1/15), and a word not from either studied sentence primed by a word from a studied sentence (probability 4/15). Subjects were told that if the prime were a word, then there was a very high probability that the test word would be from the other studied sentence (if it were from a studied sentence). The subjects were instructed to remember this fact and try to think of the other sentence in order to anticipate the test word. The test pair for each trial was selected so that, over all trials, the five priming conditions would be tested according to the above probabilities. Nouns from each of the four positions in the study sentences were selected for the test pair equally often. Order of presentation of materials was rerandomized for every subject for every session.

Results and Discussion

Response times longer than 2000 milliseconds and shorter than 200 milliseconds (less than 2% of responses, equally distributed across conditions) were eliminated from the analyses. The results are displayed in Table 2.

These results show that, at an SOA of 700 milliseconds, there was significant inhibition in the same-sentence priming condition (105 msec of inhibition with a standard error of 13 msec), but little facilitation in the different-sentence priming condition. At 1800 milliseconds, there was both inhibition and facilitation. When the prime and test word were from the same sentence, there was 112 milliseconds of inhibition (standard error, 17 msec), and a relatively high probability (.14) of error. When the prime and test word were from different sentences, there was 82 milliseconds of facilitation (standard error, 11 msec). Thus the subjects were able to begin the process of switching away from the sentence that contained the prime relatively early in processing (by 700 msec), but they required a relatively longer time to activate the other sentence enough for facilitation to appear. The time course of the inhibition appears the same as that found by Neely (1977), but the time course of the facilitation is considerably slower

TABLE 2
RESULTS OF EXPERIMENTS 3 AND 4

	Mean response time ± standard error (msec)		
	Random letters prime	Same sentence prime	Different sentence prime
Experiment 3			
SOA			
200 msec	533 ± 10 (.01)	523 ± 10 (.01)	532 ± 5 (.04)
700 msec	458 ± 7 (.00)	563 ± 11 (.02)	444 ± 4 (.01)
1800 msec	491 ± 10 (.01)	603 ± 14 (.14)	409 ± 4 (.01)
Experiment 4			
SOA			
100 msec	516 ± 10 (.08)	467 ± 8 (.01)	519 ± 6 (.04)
2000 msec	475 ± 10 (.01)	591 ± 20 (.10)	398 ± 5 (.03)

Note. Proportion of errors appears in parentheses.

than that found by Neely. In lexical decision, Neely found that switching from one semantic category to another required about 750 milliseconds, but in this experiment switching from one sentence to another required rather more than 700 milliseconds. This is probably because retrieving a whole sentence (even though a small one) requires more time than retrieving a semantic category.

The results show little facilitation in the same sentence priming condition at the shortest SOA. This aspect of the results is pursued in Experiment 4. The random letter priming condition shows a typical decrease in response time from the shortest SOA to the longer SOA's (see Neely, 1977, Table 3) that can be attributed to an expectancy or a general preparedness effect.

EXPERIMENT 4

In Experiments 1 and 2, we obtained evidence for an automatic component of processing in priming in item recognition. In Experiment 1, the amount of priming between two words of the same sentence was not affected by the probability of a priming event. Experiment 2 showed that priming between two words of the same sentence appeared early in processing (by 150 msec). Thus, we expected that the results of Experiment 3 would also demonstrate an automatic priming effect. That is, we expected facilitation between two words of the same sentence at the shortest SOA (200 msec). In fact, we did obtain facilitation, but the effect was very small, only 10 milliseconds. There are two ways to interpret this result. One way is to hypothesize that because both study sentences were presented (and rehearsed) immediately before the prime onset, all words of the sentences were primed maximally. So no facilitation would be expected. The other interpretation is that there was facilitation, but it happened to be small relative to the variance in the data, perhaps because some inhibition had begun to appear. We tested this second interpretation in Experiment 4 by repeating Experiment 3 with a shorter SOA (100 msec instead of 200 msec).

Method

Experiment 4 was identical to Experiment 3 except that there were only two SOA's, 100 and 2000 milliseconds, and only 165 trials per session. The same four subjects as in Experiment 3 participated in the experiment for two sessions each.

Results and Discussion

Response times longer than 2000 milliseconds and shorter than 200 milliseconds (less than 1% of responses, equally distributed across conditions) were eliminated from the analyses. The results are shown in Table 2.

As in Experiment 3, there were both inhibition and facilitation at the longest SOA. When the prime and test word were from the same sentence, there was 116 milliseconds of inhibition (standard error, 22 msec). When the prime and test word were from different sentences, there was 77 milliseconds of facilitation (standard error, 11 msec).

At the 100-millisecond SOA, there was facilitation in the condition where the prime and test word were from the same sentence. The amount of facilitation was 49 milliseconds (standard error, 13 msec). (Orthogonal comparison showed this difference significant, $F(1,14) = 7.05$, $p < .02$)

In Experiment 3, it was not clear whether there was facilitation early in processing between a prime and test word from the same sentence. In Experiment 4, this effect is clearly obtained. Thus, as in Experiments 1 and 2, we find that priming between two words of the same sentence meets the criteria required for classification as an automatic process.

GENERAL DISCUSSION

In this paper we have examined the components of facilitation in item recognition. We found in Experiment 1 that the size of the priming effect was not affected by manipulating the probability that a priming event occurred in the test list. Even when the probability was very low, there was still a significant priming effect. This result suggests that the priming effect found in item recognition is mainly attributable to automatic processes (in the sense of Posner & Snyder, 1975a; 1975b). By way of contrast, in the lexical decision task (Tweedy et al., 1977), it was found that over half the size of the priming effect in a high-probability condition was attributable to strategic processes because reducing the probability that a prime was predictive reduced the priming effect by over half.

Experiment 2 investigated the time course of processing by presenting prime–target pairs and measuring facilitation as a function of the SOA between the prime and target. It was found that facilitation appeared as early as 150 milliseconds, which, like the result of Experiment 1, argues that facilitation is an automatic process in this item recognition task. It was also found that, if the target and prime were from different sentences, then inhibition occurred with an onset later in processing (450 msec).

Experiments 3 and 4 were designed to investigate an explicit strategic process in the item recognition priming paradigm. Two sentences were presented to the subject and if the prime were from one sentence, then the target was from the other sentence with a high probability. Subjects were explicitly told to switch attention from the sentence of the prime and to think of the other sentence. Facilitation was measured as a function of the time between the onset of the prime and the onset of the target. At intermediate and long SOA's, it was found that inhibition occurred in the low-probability condition in which the prime and the target were from the same sentence. This indicates that the subjects were indeed performing according to instructions. However it took a relatively long time (probably a second or more) to produce facilitation to the target in the high probability condition in which the prime was from the other study sentence. This result is extremely important in evaluating the priming technique. In earlier experiments aimed at testing hypotheses about sentence and paragraph structure (McKoon & Ratcliff, 1980a; 1980b; Ratcliff & McKoon, 1978), the time interval between the prime and target was deliberately kept very short. Thus the priming obtained in the earlier experiments could not have been due to strategic facilitation processes.

The results of the experiments presented here can be summarized in terms of the criteria that determine whether a component of processing should be labeled automatic or strategic. A strategic priming process has a relatively slow onset and provides both facilitation and inhibition. Experiments 2, 3, and 4 show that strategic processing in priming in item recognition meets these criteria. Inhibition required at least 450 milliseconds to appear and facilitation more than 700 milliseconds. Automatic processing must be present even when the probability of a priming event is very low, must have a relatively fast onset, and must provide facilitation but no inhibition. The four experiments show that priming in item recognition meets all of these criteria.

The results presented in this paper have important implications for two classes of theory: the two-component theory of Posner and Snyder (1975a; 1975b) and discourse processing theories. First, the results presented here support the two-factor theory of Posner and Snyder. This theory postulates two distinct components of activation: a fast inhibitionless process and a slower limited-capacity process. This theory has been examined in both letter matching and lexical-decision tasks (Posner & Snyder, 1975a; 1975b; Neely, 1977). The results here extend the theory by demonstrating that similar processes operate with newly learned information in item recognition: there are both a fast facilitation which produces no inhibition and a slower facilitation that has inhibition associated with low probability alternatives.

Models of discourse processing (e.g., Kintsch & Vipond, 1978; Clark & Haviland, 1977) require the operation of retrieval processes during comprehension. In the model of Kintsch and Vipond (1978), the subject creates a connected memory representation of the input text by three main processes. First, new input propositions are connected by argument repetition to a limited number of old propositions in working memory; this structure is stored in long-term memory, with some set of old propositions remaining in working memory to be connected to new input on the next cycle. If this process fails, that is, if an input proposition cannot be connected by argument repetition to the propositions in working memory, then a second process is initiated. This process is a resource-consuming search of text propositions stored in long-term memory. If this search fails to find a proposition that can be connected by argument repetition to the input proposition, then a third, also resource-consuming, process is initiated, namely, inference. We see here a distinction very similar to that proposed by Posner and Snyder (1975a; 1975b). The process of connecting propositions that are active in working memory may be automatic, but the process of recovering propositions from long-term memory and inferring new propositions may be strategic. On the other hand, the results of the present experiments show priming to be mainly an automatic process. Thus, it is possible that connecting propositions by argument repetition may also be accomplished by an automatic process, whether the propositions are in working memory or in long-term memory. Perhaps only some kinds of inferences require strategic processes. Resolution of these issues requires further research; however, it is clear that empirical investigations of automatic and strategic processes of retrieval of textual information have important implications for models of discourse processing.

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