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OBSERVATION

Inhibition From Nonword Primes in Lexical Decision Reexamined: The Critical Influence of Instructions

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Compound-cue theory predicts that lexical decisions are slower to word targets preceded by a nonword than to word targets preceded by an unrelated word. This nonword-prime inhibition effect is not predicted by spreading-activation theories. R. Ratcliff and G. McKoon (1995) obtained nonword-prime inhibition, whereas T. P. McNamara (1994b) failed to obtain it. In the present study, for both a 200-ms and 350-ms prime–target stimulus onset asynchrony, nonword-prime inhibition was obtained for participants who, as in Ratcliff and McKoon's research, received instructions that mentioned that prime and target could be related. No nonword-prime inhibition was found for participants who, as in McNamara's research, received instructions that did not mention the possibility of a prime–target relation. Neither compound cue nor spreading activation can explain this pattern. The possibility that nonword-prime inhibition results from response competition is discussed.

One of the most thoroughly studied effects in cognitive psychology is the associative priming effect. In an associative priming task, participants are required to respond to a target that is preceded by a prime. A response to the target (e.g., *dog*) is faster and more accurate if the target is preceded by a related prime (e.g., *cat*) than if it is preceded by an unrelated prime (e.g., *cup*). Associative priming was first demonstrated by Meyer and Schvaneveldt (1971) and has been replicated many times in both lexical decision and naming (see Neely, 1991, for a review).

Associative priming effects have traditionally been interpreted within the spreading-activation framework (Balota & Lorch, 1986; de Groot, 1983; Neely, 1976). According to the spreading-activation theory (Anderson, 1983; Collins & Loftus, 1975), words are represented by nodes in a semantic or associative network. The nodes representing related words are connected to each other by links. When a word is presented, the node representing the word is activated, and activation spreads out in a parallel fashion along the links from the source node to related nodes. Associative priming occurs because the node representing the target is preactivated by the activation it receives from the node representing the prime. When the target is presented, less additional activation is required to reach threshold and produce a response.

An alternative account of associative priming in lexical decision is provided by the compound-cue theory (Ratcliff & McKoon, 1988). According to the compound-cue theory, prime and target join together to form a compound cue that is matched against long-term memory. The outcome of the matching process is a familiarity value. Responses are based on the familiarity of the compound cue. Fast word decisions are made to compound cues with a high familiarity, and fast nonword decisions are made to compound cues with a low familiarity. Responses to stimuli with an intermediate level of familiarity are slower. Priming effects are predicted because the familiarity of a related prime–target pair is higher than the familiarity of an unrelated prime–target pair. Thus, in the compound-cue theory, priming is not caused by the prime's preactivation of the target in long-term memory but rather by the joint operation of the prime and target as a cue that is used to probe memory.

Recently a number of articles have appeared that tested the predictions of the spreading-activation theory and the compound-cue theory. The emphasis in these studies was on mediated priming effects and sequential effects in lexical decision. The studies have been discussed in great detail in the literature (McKoon & Ratcliff, 1992; McNamara, 1992a, 1992b, 1994a, 1994b; Ratcliff & McKoon, 1994, 1995).

In the present study, we focus on one particular effect, the

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nonword-prime inhibition effect.[1] This effect refers to an increase in response latency when a word target is preceded by a nonword prime, compared with when it is preceded by an unrelated word prime. The compound-cue theory predicts that the type of prime (neutral, nonword, unrelated, or related) affects the response latency to the target. In particular, the compound-cue theory predicts that a response to a target word preceded by a nonword (e.g., *lonk–tiger*) is slower than a response to a target word preceded by an unrelated word (e.g., *sand–tiger*). The familiarity of a nonword is lower than that of a word. This means that the familiarity of a compound cue containing a nonword and a word is lower than the familiarity of a compound cue containing two unrelated words. The compound-cue theory therefore predicts a nonword-prime inhibition effect for word targets. Spreading-activation theories predict that the type of prime has no influence on the response latency to the target, except when the prime and target are related. All other primes will not activate the target, and thus response latencies should be equal for all such primes, all other things being equal.

McNamara (1992b) studied nonword-prime inhibition in a single presentation procedure. In this procedure, participants give a response to each stimulus in the presentation sequence. The target on the preceding trial acts as a prime for the target on the present trial. The number of intervening items between two related words was varied. An associative priming effect was obtained if there were no intervening items (e.g., *lion–tiger*) or only one intervening item between the two related words (e.g., *lion–sand–tiger*). No priming was obtained if there were two intervening items (e.g., *lion–table–sand–tiger*). In terms of the compound-cue theory, this means that the compound cue contained three items: the target, the prime, and the preprime. According to the compound-cue theory, the status of the preprime (word or nonword) should influence the response to the target by changing the overall familiarity of the compound cue. Specifically, responses to word targets should be slowed down if the preprime is a nonword. This was indeed found; responses were slower if the preprime was a nonword than if it was an unrelated word. This result seems to support the compound-cue theory. However, McNamara claimed that sequential *response* effects are responsible for this result. After adjustment of the reaction times for sequential response effects, the difference between the condition with a nonword preprime and the condition with an unrelated word preprime disappeared. McNamara claimed that this result supports the spreading-activation theory and contradicts the compound-cue theory. The question is, of course, whether the adjustment carried out by McNamara is justified. McKoon and Ratcliff (1992) argued that it is not and that the compound-cue theory gives a natural explanation for the sequential effects.

A major problem with the McNamara (1992b) study was that preprime familiarity and response to the preprime were confounded. This means that the effects can be the result of either sequential response effects or differences in preprime familiarity. In a follow-up, McNamara (1994b) studied the effect of nonword primes by presenting prime–target pairs in a paired presentation procedure in which participants responded only to the target. The assumption was that response effects occur only if an explicit response is demanded. Because participants did not respond to the prime, this means that response effects should be eliminated. Thus, if the nonword-prime inhibition effect is a response effect and not a memory effect, nonword-prime inhibition should be absent. This was exactly what McNamara (1994b) found.

In response to these results, Ratcliff and McKoon (1995) performed a series of experiments in which they also studied nonword-prime inhibition effects in a lexical-decision task. In all four experiments, they observed a nonword-prime inhibition effect. It is surprising that different results were obtained by McNamara (1994b) and Ratcliff and McKoon (1995), especially because the procedures of Experiments 1 and 2 of the McNamara study and of Experiment 3 of the Ratcliff and McKoon study were identical. Neither Ratcliff and McKoon (1995) nor McNamara (McNamara & Diwadkar, 1996) have an explanation for the different results.

In March 1995, René Zeelenberg and Diane Pecher, the first and second authors of the present article, visited both Ratcliff and McKoon's and McNamara's laboratories. They participated in the nonword-prime inhibition experiments at both laboratories and noticed that the instructions given in these laboratories were not exactly the same. The following instruction given by Ratcliff and McKoon (1995) mentioned that the prime and the target are sometimes related: "Make sure you read this first letter string; sometimes it will be related to the test item that follows it; so reading the first one may help you to respond more quickly and accurately to the second letter string" (G. McKoon, personal communication, June 14, 1996). McNamara's (1994b) instruction mentioned that the participant should read the prime. However, the instruction, as follows, does not mention that the prime might be related to the target: "Remember, you should read both letter strings and then decide whether the second one is a word or a nonword." (T. P. McNamara, personal communication, October 30, 1995). We thought that the different instructions might be responsible for the different results obtained by McNamara (1994b) and Ratcliff and McKoon (1995).

In the present study, we manipulated the instruction to investigate its influence on the presence of the nonword-prime inhibition effect. One group of participants received instructions that told them to pay close attention to the prime because it might be related to the target. For this group, we

[1] In this article, the term *nonword-prime inhibition*, instead of the previously used term *nonword inhibition*, is used to refer to the increase in response latency to a word target preceded by a nonword prime relative to a word target preceded by an unrelated word prime. This change in terminology was adopted to prevent confusion with the term *nonword facilitation* (Neely et al., 1989) that is used to refer to the decrease in response latency for a nonword *target* preceded by a word prime relative to a nonword target preceded by a neutral prime.

expected to observe a nonword-prime inhibition effect. The other group was merely told to read the prime. No mention was made that the prime might be related to the target. For this group, we expected to find no nonword-prime inhibition. Otherwise, the procedure was identical to that of Experiments 1 and 2 of McNamara's (1994b) study and Experiment 3 of Ratcliff and McKoon's (1995) study.

An alternative explanation for sequential effects states that the amount of time needed to process the prime affects the response time to the target. This processing time account was inspired by McNamara (1994b). He used a 350-ms prime–target stimulus onset asynchrony (SOA), instead of a shorter SOA, because he worried that a nonword-prime inhibition effect at a shorter SOA might be obtained because of an overlap in encoding the nonword prime and encoding the target. Such a nonword-prime inhibition effect that would be due to the slower encoding of a nonword prime than a word prime would not constitute evidence against the spreading-activation theory. This processing time account predicts nonword-prime inhibition for any stimulus (word or nonword) that follows the prime. To investigate if nonword-prime inhibition is the result of longer processing times for nonword primes than for word primes, we included two nonword-target conditions, a nonword–nonword condition and a word–nonword condition. The processing time explanation predicts slower responses for nonword targets preceded by nonword primes than for nonword targets preceded by word primes (i.e., nonword-prime inhibition for the nonword targets). In contrast, compound-cue theory predicts *word-prime* inhibition for *nonword* targets. This is predicted because the familiarity of a word–nonword pair is higher than the familiarity of a nonword–nonword pair. According to the compound-cue theory, *nonword* responses are slower and less accurate to compound cues with higher familiarity. The spreading-activation theory predicts no difference between the two nonword conditions. We return to this issue in the General Discussion.

Experiment 1

In Experiment 1, we investigated the influence of instruction on the nonword-prime inhibition effect. Following McNamara (1994b) and Ratcliff and McKoon (1995), a 350-ms SOA was used. The design of the experiment closely mimicked that of McNamara's (1994b, Experiments 1 and 2) and Ratcliff and McKoon's (1995, Experiment 3) studies.

Method

Participants. Fifty first-year psychology students participated in the experiment to fulfill a course requirement. The data of 2 participants were excluded because of excessively high error rates (>20%), thus leaving a final sample size of 48, with 24 participants in each instruction condition. All participants were native Dutch speakers.

Design and materials. The instruction for the lexical-decision task was manipulated between participants. Prime type was manipulated within participants. Word targets were preceded by three different prime types: related word, unrelated word, and nonword. Nonword targets were preceded by two different prime types: word and nonword.

For the word targets, a set of 60 related prime–target pairs (e.g., *boy–girl, butcher–meat, inside–outside*) was selected from published free-association norms (de Groot, 1980; Lauteslager, Schaap, & Schievels, 1986; van der Made-van Bekkum, 1973; van Loon-Vervoorn & Van Bekkum, 1991). The mean associative strength from the prime to the target was 71.3%. For the word targets, three prime-type conditions were created from this set. A target could be preceded by either a related word, an unrelated word, or a nonword. Unrelated prime-target pairs were constructed by recombining primes and target. Nonword–word pairs were constructed by replacing the word prime with a nonword. Nonwords were pronounceable letter strings that differed by one or two letters from existing words. The nonword primes were matched with the word primes on number of letters and syllables. Similarly, a set of 40 critical nonword targets was constructed. The nonword targets were paired with either a word or a nonword prime. These primes were from a set different from the primes used to create the critical word target conditions. Nonwords were not derived from words that were related to the words with which they were paired. Each participant received 20 trials in each of the five conditions, giving a total of 100 critical trials. Counterbalancing for the word targets and for the nonword targets was achieved by creating six different lists. Across the six lists, each word target appears twice, each following a related word prime, an unrelated word prime, and a nonword prime, and each nonword target appears three times, each following a word prime and a nonword prime. Each participant received only one list. An additional set of 266 filler pairs was constructed. This set consisted of 93 unrelated word–word pairs, 30 nonword–word pairs, 113 word–nonword pairs, and 30 nonword–nonword pairs. This resulted in a total number of 366 pairs with a nonword ratio of .54 (the probability that the target is a nonword given that the prime is a word and the prime and target are unrelated) and a relatedness proportion of .15.[2] No prime or target occurred more than once. All word stimuli were common Dutch words.

Procedure. At the start of the experiment, spoken instructions were given to the participants. Each participant received one of the two instructions. Assignment to the instruction condition was random. Both instructions explained the lexical-decision task to the participants. Participants were also told that they would see two consecutive letter strings on each trial and that they should read both letter strings but respond only to the second letter string. In the

[2] The nonword ratio was introduced by Neely et al. (1989) as an indicator of the "predictability" that the target is a nonword given the absence of a relation between prime and target. They showed that the nonword ratio affected the size of the priming effect. More priming was observed for stimulus sets with a larger nonword ratio. Neely et al. argued that postlexical processes are modulated by the nonword ratio. They calculated the nonword ratio over trials with word primes only (excluding trials with a neutral prime). Because Neely et al. did not use nonword primes it is not clear whether according to them trials with nonword primes should be included in the calculation of the nonword ratio. However, as is so for neutral primes, because the absence of a relation between prime and target does not provide information about the target status (word or nonword), when the prime is a nonword it could be argued that trials with nonword primes should not be included in the calculation of the nonword ratio. Therefore, calculation of the nonword ratio in the present study was based on word–word trials and word–nonword trials only.

"Ratcliff–McKoon" instruction, the importance of reading the first letter string was stressed, and the following was added:

> If both the first and the second letter strings are words, it is possible that they are related. For example the first letter string could be *burcht* (*citadel*) and the second letter string *kasteel* (*castle*). This is not always the case, but the first letter string may be predictive for the second letter string. Again, you should just read the first letter string, and you should respond only to the second letter string.

This part of the instruction was *not* included in the "McNamara" instruction. Thus, the difference between the two instructions was whether the relation between prime and target was mentioned. The lexical-decision procedure was identical to the one used by McNamara (1994b, Experiments 1 and 2) and by Ratcliff and McKoon (1995, Experiment 3). A warning signal (* * * * *) was presented for 350 ms followed by a blank screen of 500 ms. Subsequently, the prime was presented for 300 ms followed by a blank screen of 50 ms. Then the target was presented and remained on the screen until a response was given. All stimuli were presented on the same location on the screen. After the response, 1,000 ms elapsed before the next trial began. If a response was incorrect, the word *FOUT* (*error*) was displayed for 1,000 ms, one line below the line where the target had appeared. After the word *FOUT* was erased, there was a 1,000-ms blank interval before the next trial started. Two buttons were used to register the responses. Participants responded by pushing one button with their right-hand index finger when the target was a word and by pushing the other button with their left-hand index finger when the target was a nonword. Participants were allowed to take a short break every 92 trials. Before the 366 experimental trials, 40 practice trials were given. For each participant, a new random order of trials was created.

Results

We performed analyses of variance (ANOVAs) on the trimmed mean latencies of correct responses.[3] Responses more than 2 standard deviations above or below each participant's mean were excluded. This was done separately for the word targets and the nonword targets. On the basis of this outlier criterion, 2.3% of the responses to the word targets and 4.3% of the responses to the nonword targets were excluded. For each participant and each condition, means of reaction times (RTs) and error rates were calculated. Table 1 shows the trimmed means and error percentages for all of the experimental conditions. We performed an ANOVA with instruction as a between-subjects variable and prime type as a within-subject variable. Unless otherwise noted, level of significance for statistical tests was set at .05.

Analyses of RTs. A 2 (instruction) × 2 (prime type) ANOVA on the RTs for the related and unrelated word–word conditions showed an associative priming effect. There was a significant difference between targets preceded by related primes and targets preceded by unrelated primes, $F(1, 46) = 72.07$, $MSE = 386.8$. The main effect of instruction was marginally significant, $F(1, 46) = 3.62$, $p < .07$, $MSE = 7{,}470.8$, with RTs being faster for the McNamara instructions. However, there was no interaction of prime type with instructions, $F(1, 46) < 1$, $MSE = 386.8$. This means that the type of instruction had no effect on the amount of priming. Simple main effects showed that the associative priming effect was significant in both the Ratcliff–McKoon condition, $F(1, 46) = 39.19$, $MSE = 386.8$, and the McNamara condition, $F(1, 46) = 33.02$, $MSE = 386.8$.

Table 1
Mean Lexical-Decision Latencies (Reaction Times; RTs) and Percent Errors (PEs) in Experiment 1 as a Function of Instruction and Prime Type

	Instruction			
	Ratcliff–McKoon		McNamara	
Prime type	RT	PE	RT	PE
Word target				
Related	512	1.7	480	1.0
Unrelated	547	2.9	512	2.7
Nonword	579	3.8	514	2.9
Priming	35	1.2	32	1.7
Nonword-prime inhibition	32	0.9	2	0.2
Nonword target				
Nonword	641	3.3	577	4.0
Word	649	4.4	571	3.5
Word-prime inhibition	8	1.1	−6	−0.5

To investigate the nonword-prime inhibition effect, we performed a 2 (instruction) × 2 (prime type) ANOVA on the RTs for the unrelated word–word and the nonword–word conditions. There was a main effect of prime type, $F(1, 46) = 12.71$, $MSE = 520.6$, a main effect of instruction, $F(1, 46) = 8.09$, $MSE = 7{,}398.0$, and an interaction effect, $F(1, 46) = 10.23$, $MSE = 520.6$. Simple main effects showed that the 32-ms nonword-prime inhibition in the Ratcliff–McKoon condition was significant, $F(1, 46) = 22.87$, $MSE = 520.6$. Participants were significantly slower in responding to words that were preceded by nonword primes than to words that were preceded by unrelated word primes. This was also what Ratcliff and McKoon (1995) found. The 2-ms nonword-prime inhibition in the McNamara condition was not significant, $F(1, 46) < 1$, $MSE = 520.6$. McNamara (1994b) also did not find a significant difference between the word prime and nonword prime conditions. Thus, with our instruction manipulation, we replicated the different results obtained by Ratcliff and McKoon and by McNamara.

A 2 (instruction) × 2 (prime type) ANOVA was done on the RTs to the nonword targets. There was a main effect of instruction, $F(1, 46) = 12.87$, $MSE = 9{,}359.7$. None of the other effects reached significance. Thus, response latencies for nonword targets were not affected by the prime type.

Analyses of errors. A 2 (instruction) × 2 (prime type) ANOVA on the errors for the related and unrelated word pairs yielded a main effect of prime type, $F(1, 46) = 4.97$, $MSE = 0.411$. None of the other effects reached significance. This pattern is consistent with that of the response latencies.

A 2 (instruction) × 2 (prime type) ANOVA on the errors for the unrelated word–word and the nonword–word conditions revealed that neither the main effects of instruction and

[3] Analyses performed on the untrimmed means yielded identical patterns of results in both Experiments 1 and 2.

prime type nor the interaction effect reached significance. A 2 (instruction) × 2 (prime type) ANOVA on the errors for the nonword-target conditions also revealed no significant effects.

Discussion

The results of Experiment 1 clearly show that the instruction manipulation had an effect on nonword-prime inhibition but not on priming. Specifically, only participants in the Ratcliff–McKoon condition, who were informed that the prime and target are sometimes related and that this might help them in making a decision to the targets, were slower in responding to words preceded by nonwords than to words preceded by unrelated words. The results indicate that the lack of nonword-prime inhibition cannot be ascribed to a failure of the participants to process the prime because significant priming was obtained for both groups.

In Experiment 1, we used a 350-ms SOA to mimic as closely as possible the studies of McNamara (1994b) and Ratcliff and McKoon (1995). To see whether the results were SOA specific and to further minimize the influence of strategies, we used a 200-ms SOA in Experiment 2.

Experiment 2

Method

Participants. Seventy-five students of the University of Amsterdam participated for course credit. None of the participants had participated in Experiment 1. The data of 3 participants were excluded because of excessively slow RTs (more than 2.5 standard deviations above the mean of all participants), thus leaving a final sample size of 72, with 36 participants in each instruction condition. All participants were native Dutch speakers.

Procedure. The prime was presented for 150 ms. The target was presented after a blank screen of 50 ms. This resulted in a 200-ms SOA. All other aspects of the procedure were identical to that of Experiment 1.

Results

ANOVAs were performed on the trimmed mean latencies of correct responses. On the basis of the same outlier criterion as in Experiment 1, 2.6% of the responses to the word targets and 4.2% of the responses to the nonword targets were excluded. Table 2 shows the trimmed means and error percentages for all the experimental conditions.

Analysis of RTs. A 2 (instruction) × 2 (prime type) ANOVA on the RTs for the related and unrelated pairs yielded a significant associative priming effect, $F(1, 70) = 38.61$, $MSE = 516.2$. The main effect of instruction and the Instruction × Prime Type interaction were not significant, $F(1, 70) = 1.12$, $MSE = 6{,}035.4$, and $F(1, 70) = 1.63$, $MSE = 516.2$, respectively. Simple main effects showed that the associative priming effect was significant in both the Ratcliff–McKoon condition, $F(1, 70) = 12.19$, $MSE = 516.2$, and the McNamara condition, $F(1, 70) = 28.05$, $MSE = 516.2$.

A 2 (instruction) × 2 (prime type) ANOVA on the RTs for the unrelated word–word pairs and the nonword–word pairs yielded a significant effect of prime type, $F(1, 70) = 7.81$, $MSE = 593.2$. The main effect of instruction was not significant, $F(1, 70) < 1$, $MSE = 5{,}309.9$. The interaction between instruction and prime type was marginally significant, $F(1, 70) = 3.87$, $p < .06$, $MSE = 593.2$. Simple main effects showed that the nonword-prime inhibition effect was significant for the Ratcliff–McKoon group, $F(1, 70) = 11.34$, $MSE = 593.2$, but not for the McNamara group, $F(1, 70) < 1$, $MSE = 593.2$. An ANOVA on the RTs for the nonword targets revealed no significant effects.

Table 2
Mean Lexical-Decision Latencies (Reaction Times; RTs) and Percent Errors (PEs) in Experiment 2 as a Function of Instruction and Prime Type

	Instruction			
	Ratcliff–McKoon		McNamara	
Prime type	RT	PE	RT	PE
Word target				
Related	526	1.5	535	1.0
Unrelated	545	3.1	563	2.1
Nonword	564	5.1	567	3.3
Priming	19	1.6	28	1.1
Nonword-prime inhibition	19	2.0	4	1.2
Nonword target				
Nonword	626	2.8	651	3.5
Word	634	4.0	650	4.9
Word-prime inhibition	8	1.2	−1	1.4

Analysis of errors. A 2 (instruction) × 2 (prime type) ANOVA on the errors for the related and unrelated pairs showed a significant priming effect, $F(1, 70) = 8.00$, $MSE = 0.313$. The main effect of instruction and the interaction between instruction and prime type were not significant, $F(1, 70) = 1.80$, $MSE = 0.466$, and $F(1, 70) < 1$, $MSE = 0.313$, respectively. Simple effects showed that the priming effect on error rate was significant in the Ratcliff–McKoon condition, $F(1, 70) = 5.36$, $MSE = 0.313$, and marginally significant in the McNamara condition, $F(1, 70) = 2.84$, $p < .10$, $MSE = 0.313$.

A 2 (instruction) × 2 (prime type) ANOVA on the errors for the unrelated word–word pairs and the nonword–word pairs revealed a significant nonword-prime inhibition effect, $F(1, 70) = 5.63$, $MSE = 0.711$. The effect of instruction and the interaction between instruction and prime type were not significant, $F(1, 70) = 2.48$, $MSE = 1.122$, and $F(1, 70) < 1$, $MSE = 0.711$, respectively. Simple effects showed that the nonword-prime inhibition effect for errors was significant in the Ratcliff–McKoon condition, $F(1, 70) = 4.40$, $MSE = 0.711$, but not in the McNamara condition, $F(1, 70) = 1.58$, $MSE = 0.711$.

Finally, an ANOVA on the errors for the nonword targets yielded a significant word-prime inhibition effect, $F(1, 70) = 4.88$, $MSE = 0.514$. More errors were made to nonword targets preceded by word primes than to nonword targets preceded by nonword primes. All other effects failed to reach significance.

Discussion

Experiment 2 basically replicated the pattern of results obtained in Experiment 1. Simple effects on the response latencies showed that again a significant nonword-prime inhibition effect was found for the Ratcliff–McKoon group but not for the McNamara group. In addition, a small but significant nonword-prime inhibition effect on error rates was also observed for the Ratcliff–McKoon condition but, again, not for the McNamara condition.

General Discussion

In previous studies on nonword-prime inhibition, conflicting results were obtained (McNamara, 1994b; Ratcliff & McKoon, 1995). McNamara did not obtain nonword-prime inhibition in two experiments. Ratcliff and McKoon performed four different experiments and consistently did obtain nonword-prime inhibition. These different results were puzzling, especially because the procedures used in Experiments 1 and 2 of the McNamara study and in Experiment 3 of the Ratcliff and McKoon study were seemingly identical. In the present experiment, we tested the hypothesis that the conflicting results were due to differences in instructions. The results of Experiments 1 and 2 show indeed that instruction critically determines the absence and presence of nonword-prime inhibition. In both experiments, nonword-prime inhibition was present for the group that received instructions that mentioned that prime and target were related on some trials and that this might help in making a decision to the target. Nonword-prime inhibition was absent for the groups that received instructions in which the relation between prime and target was not mentioned. Because instruction was manipulated within the experiments, using the same stimuli and participant population, we conclude that the differences regarding the nonword-prime inhibition effect are due to differences in instruction. The data of the present experiments therefore provide a reconciliation of the different results obtained by McNamara and by Ratcliff and McKoon.

Compound Cue

The nonword-prime inhibition effect has been used to test theories of priming (McNamara, 1994b; Ratcliff & McKoon, 1995). It has been assumed that Ratcliff and McKoon's compound-cue theory (1988) predicts a nonword-prime inhibition effect because nonwords have a lower familiarity than words (McNamara, 1994b; Ratcliff & McKoon, 1995). Therefore, a compound cue containing a nonword and a word has a lower familiarity value than a compound cue containing two unrelated words. Because word responses are slower to stimuli with a low familiarity than to stimuli with a high familiarity, inhibition should be found for word targets preceded by nonword primes compared with word targets preceded by unrelated word primes. In our experiments, however, nonword-prime inhibition was absent for participants who received the McNamara instruction. An interesting question is whether the compound-cue theory can explain the absence of nonword-prime inhibition in the McNamara condition.

One way in which the compound-cue theory could explain the absence of nonword-prime inhibition is by implementing a criterion shift (McNamara & Diwadkar, 1996). McNamara and Diwadkar showed that the compound-cue theory can handle the absence of nonword-prime inhibition if it is assumed that participants make lexical decisions that are based on the familiarity of the compound cue relative to some criterion. According to McNamara and Diwadkar, participants could set their criterion on the basis of familiarity of the prime. If the prime is a nonword, participants adopt a more lenient criterion than if the prime is a word. By adopting different criteria for trials on which the target is preceded by a nonword prime and for trials on which the target is preceded by a word prime, participants compensate for the differences in familiarity. This can explain the absence of nonword-prime inhibition. The criterion shift explanation assumes that participants access the lexical status of the prime and shift the criterion very quickly, because SOA and response latency are both short. It is reasonable to assume that participants will be more likely to shift their criterion if more attention is drawn to the prime, thereby reducing nonword-prime inhibition. But we found nonword-prime inhibition for the Ratcliff–McKoon instruction that draws more attention to the prime and not for the McNamara instruction that draws less attention to the prime. Thus, the results are opposite of what would be expected if a criterion shift is responsible for the lack of nonword-prime inhibition.

Another possible way for the compound-cue theory to accommodate the data pattern of the present experiments is by varying the weights on the prime and the target. In the compound-cue theory, the weights on prime and target are free to vary within some limits (Ratcliff & McKoon, 1988, 1995). The first limitation is that the weights on the items in the compound cue must sum to 1. The second limitation is that the weight on the target must be larger than that on the prime, otherwise large error rates are predicted. It seems reasonable to assume that the weights on the prime and target would be affected by the instructions. Participants in the Ratcliff–McKoon group presumably gave more attention to the prime than did participants in the McNamara group. In terms of the compound-cue model, this means that more weight was put on the prime. The nonword-prime inhibition effect should become larger as more weight is put on the prime. This is what we found. However, the associative priming effect should also be larger if more weight is put on the prime. This is not the case with our results. The priming effects in the different instruction conditions are about the same size (30 ms for the McNamara condition and 26 ms for the Ratcliff–McKoon condition, averaged over Experiments 1 and 2). The critical question is whether the compound-cue theory can explain a rather large influence of the weight on the prime on the size of the nonword-prime inhibition effect, while the size of the associative priming effect is not affected by the weight on the prime.

We tried to fit the results of the present study with the compound-cue theory to assess how well the compound-cue model could accommodate the data pattern of the present study. In our attempts to fit the data pattern, all parameters had the same value for the Ratcliff–McKoon condition and the McNamara condition, except the weight on the prime. A detailed description of the simulation is provided in the Appendix. Table 3 shows the observed and predicted priming and nonword-prime inhibition effects. It is evident that the essential aspects of the data are not captured by this fit. For the McNamara condition, the predicted nonword-prime inhibition effect is larger than observed, whereas for the Ratcliff–McKoon condition, the predicted nonword-prime inhibition effect was smaller than observed. The predicted nonword-prime inhibition effects differ by only 5 ms for the two instructions, whereas a difference of 21 ms was observed. The problem for compound-cue theory is to account for a large change in the size of the nonword-prime inhibition effect while the size of the associative priming effect does not change. To make this problem clearer, we systematically varied the weight on the prime, keeping all other parameter values constant (using the parameter values from the best fit). Figure 1 depicts the amount of nonword-prime inhibition and associative priming predicted by the compound-cue theory as a function of the weight on the prime. It shows that both the size of the nonword-prime inhibition effect and the size of the associative priming effect are predicted to increase as more weight is put on the prime. This makes it difficult for compound-cue theory to account for the dissociative effect of instruction on nonword-prime inhibition and associative priming, except when the weight on the prime is .3 or larger. However, for this range of values, the error rates for word targets following nonword primes would be high, and a rather large nonword-prime inhibition effect would be occurring for both instructional conditions.

It is interesting to note that although compound-cue theory cannot account for the data pattern of the present study, it might be able to account for the absence of nonword-prime inhibition in the presence of associative priming. To show this, we constructed an example that predicts associative priming in the absence of nonword-prime inhibition (see Appendix). This was done by setting the strength of a nonword to the image of a word in memory

Table 3
Observed and Predicted Data by Compound-Cue Theory for the Ratcliff–McKoon Condition and the McNamara Condition

	Observed		Predicted	
Prime type	Ratcliff–McKoon	McNamara	Ratcliff–McKoon	McNamara
Related	520	513	522	512
Unrelated	546	543	549	538
Nonword	570	546	567	551
Priming	26	30	27	26
Nonword-prime inhibition	24	3	18	13

Note. The observed data were obtained by averaging the mean response times of Experiments 1 and 2.

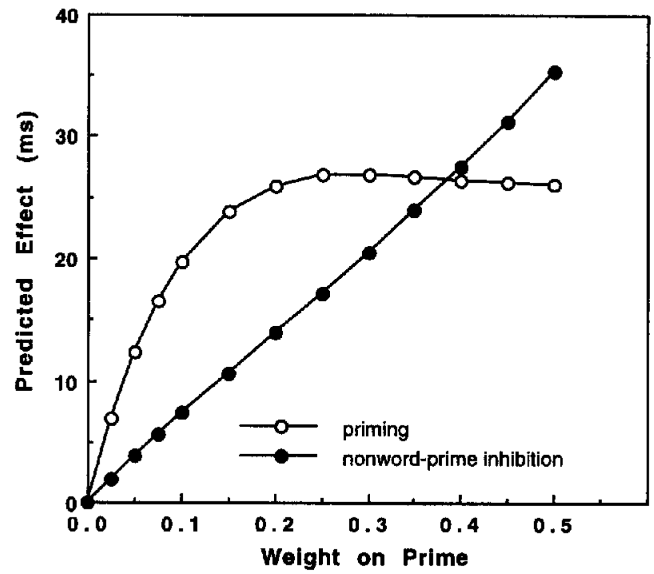

Figure 1. Amount of nonword-prime inhibition and associative priming predicted by the compound-cue theory as a function of the weight on the prime.

(S_{nonw}) equal to the strength of a word to the image of an unrelated word in memory (S_{unrel}). In fact, whether or not nonword-prime inhibition is predicted, depends mainly on the assumption one makes concerning the size of S_{unrel} relative to the size of S_{nonw}. In general, nonword-prime inhibition is predicted if it is assumed that S_{unrel} is larger than S_{nonw}.

It might seem unrealistic to set S_{unrel} equal to S_{nonw}. Ratcliff and McKoon (1988, 1995) and McNamara (1994b, McNamara & Diwadkar, 1996) have assumed that S_{unrel} is larger than S_{nonw}. However, they did not specify the basis for this difference in *residual* strengths. In general, the strength between a cue and a particular item in memory depends on overlap in features. One basis for nonzero residual strengths is overlap in orthographic or perceptual features. Words do share some perceptual features that make them distinct from other visual stimuli, such as random letterstrings. It is unlikely, however, that this is the reason for a *difference* in residual strengths between word cues and nonword cues because nonword stimuli are usually constructed in such a way that they are perceptually similar to words. A second possible basis for nonzero residual strengths is overlap in semantic features. However, such an overlap in semantic features for a word cue and an *unrelated* word in memory must, by definition, be incidental, and this might be similar to the overlap in semantic features for a nonword cue and a word in memory (due to random noise in the system). Whether this would be the case depends on the specific assumptions made about what is activated in memory by nonwords.

The example shows that it is not necessary for compound-cue theory to assume that S_{unrel} is larger than S_{nonw}. This is illustrated by the fact that in the example there is a substantial difference in familiarity between word target and nonword target conditions. Thus, compound-cue theory is still able to differentiate between word and nonword targets, even though S_{unrel} is equal to S_{nonw}. This indicates that these parameter values are not entirely unrealistic. The difference in familiarity between word *targets* and nonword *targets* in the example is due to the high values of a word to its own image in memory (S_{self}) and the strength of a word to related images in memory (S_{rel}). Nonwords, contrary to words, do not have a representation in the lexicon and are not related to words in the lexicon. Thus, the familiarity value of a compound cue with a nonword target will be determined primarily by the low value of S_{nonw}. This will result in a lower familiarity value for a compound cue with a nonword target than for a compound cue with a word target. However, the difference between a compound cue containing a nonword *prime* and a compound cue containing a word *prime* will be very small, because the low weight on the prime will result in a relatively small contribution of S_{self} and S_{rel} to the familiarity value.

In conclusion, the main difficulty for the compound-cue theory is not to account for an absence of nonword-prime inhibition in the presence of associative priming but to account for the observation that the nonword-prime inhibition effect changes from a null effect to a large effect as a function of the instruction given to the participants, while the associative priming effect is not affected and error rates remain plausibly low.

Spreading Activation

Spreading-activation theories predict facilitation for related prime-target pairs compared with unrelated pairs. No difference is predicted between an unrelated word–word pair and a nonword–word pair. This pattern of results was obtained for the McNamara group. However, the presence of nonword-prime inhibition in the Ratcliff–McKoon group poses problems for spreading-activation theories because without additional assumptions the nonword-prime inhibition effect cannot be explained. However, a large number of studies in lexical decision suggest that priming effects in lexical decision are mediated by strategic processes that operate in addition to automatic priming processes (Neely, 1976, 1977; Neely, Keefe, & Ross, 1989; Seidenberg, Waters, Sanders, & Langer, 1984; Shelton & Martin, 1992, Tweedy, Lapinsky, & Schvaneveldt, 1977). These strategic processes might also be responsible for the results of the present study. The Ratcliff–McKoon instruction explicitly mentions that word pairs are related on some trials and might therefore induce strategies that cause the nonword-prime inhibition effect. In contrast, the McNamara instruction did not mention that primes and targets are sometimes related. Participants who received the McNamara instruction will therefore be less likely to use such strategies, especially because the relatedness proportion was quite low.

Two kinds of strategic processes have been proposed. The first strategic process that might be involved is an expectancy generation strategy (Becker, 1980; Neely, 1976, 1977; Posner & Snyder, 1975). According to this account, participants generate expectancies about the target after reading the prime. The response to the target will be facilitated if the target matches the expectancy generated by the participant. If, however, the target does not match the expectancy, the response to the target will be *inhibited.* It is generally assumed that expectancy-based strategies are effective only at longer SOAs (de Groot, 1984; Neely, 1977, 1991; Posner & Snyder, 1975). Because short SOAs of 350 ms and 200 ms were used in Experiments 1 and 2, respectively, it is unlikely that this process was responsible for the observed effects in the present study. More important, expectancy-based strategies do not predict a nonword-prime inhibition effect. To the contrary, performance is predicted to be *better* in the nonword condition than in the unrelated condition. In the unrelated condition, targets will not match the expectancies generated by the participant, and this will result in inhibition. However, if the prime is a nonword, participants will not generate expectancies about the target. Thus, an expectancy-based strategy cannot predict the observed nonword-prime inhibition effect.

A second strategic process that has been proposed is a postlexical checking strategy. Several authors have suggested that after lexical access of both prime and target, but before responding, a relatedness check is made (Balota & Lorch, 1986; de Groot, 1983; Neely, 1976, 1977; Seidenberg et al., 1984). If a relation between prime and target is discovered, this means that the target is a word (a nonword cannot be semantically related to a word), and this information will facilitate responding to the target. If, on the other hand, prime and target are not related, participants will be biased to respond "nonword" and thus be slower in responding "word."

According to Neely et al. (1989), postlexical strategies are modulated by the nonword ratio. The nonword ratio is the probability that the target is a nonword given that the prime and target are unrelated. In the present study, the nonword ratio was .54. It could be argued that it is unlikely that participants use postlexical strategies because the absence of a relation is not informative if the nonword ratio is close to .50. Shelton and Martin (1992), however, argued that if participants detect that prime and target are sometimes related, they might use a postlexical strategy even when the relatedness proportion and nonword ratio are low. It is possible that the instruction that mentioned that primes and targets were sometimes related encouraged the participants to search for a relation between the prime and the target. It is generally assumed that if participants engage in a postlexical strategy, inhibition will be observed in the unrelated condition relative to a neutral condition (de Groot, 1983; Neely et al., 1989; Shelton & Martin, 1992). In the unrelated condition, participants will be biased to respond "nonword" because they do not discover a relation between the prime and the target. Because "nonword" is the incorrect response, the bias must be overcome and consequently responses will be slowed down. It is assumed that in the neutral condition, participants will not check for a relation between prime and target because the prime has no or very little meaning (Neely, 1991). Thus, responses in the unrelated condition will be slower than responses in the neutral condition. Using the same reasoning, responses in the unrelated condition are predicted to be slower than responses in the nonword prime condition because just as in the neutral condition, participants will not check for a relation if the prime is a nonword. Therefore, responses in the nonword condition are predicted to be faster than responses in the unrelated condition. This is exactly opposite of what was observed in the experiments. This prediction rests on the assumption that participants will use the identity of the prime in deciding whether to use a postlexical strategy. If this assumption is abandoned, a postlexical checking strategy will result in inhibition for all unrelated prime–target pairs. Then, responses in the unrelated condition should not differ from responses in the nonword prime condition. Thus, postlexical strategies also cannot explain the observed nonword-prime inhibition effect. In conclusion, the spreading-activation theory cannot explain the pattern of results even when additional strategies are considered.

Alternative Explanations

The fact that neither compound cue nor spreading activation gives an adequate explanation for the results of the present study raises the question of whether the nonword-prime inhibition effect should be explained by the same mechanisms that are used to explain the associative priming effect. Maybe the explanation for nonword-prime inhibition lies outside the scope of theories that are proposed to explain associative priming. That is, nonword-prime inhibition might not be caused by the same memory processes that are responsible for the associative priming effect. Instead, nonword-prime inhibition might be a result of encoding or response processes. One possible explanation concerns the time necessary to process the prime. The longer it takes to process a prime, the more this will interfere with processing of the target and may thus slow down responses to the target. Nonwords will take longer to process than words because they have a very low word frequency (i.e., a word frequency of zero). If the instruction mentions that prime and target might be related, more of the participants' attention is directed to the prime, and consequently this difference between word and nonword primes could increase. To test this explanation, we compared performance on nonword targets that followed word and nonword primes. If this processing explanation is correct, there should also be a nonword-prime inhibition effect for nonword targets, and this effect should be larger in the Ratcliff–McKoon condition than in the McNamara condition. Our results did not confirm this hypothesis. There was neither a main effect of prime type nor an interaction effect. A look at the means in the nonword-target conditions shows that in the Ratcliff–McKoon condition there is a nonsignificant difference of 8 ms in both Experiments 1 and 2 in the direction opposite of that predicted by the processing explanation. Thus, this processing hypothesis is not supported.

An alternative possibility is that nonword-prime inhibition is caused by response competition. In the lexical-decision task that we used, the participant is instructed to make lexical decisions only to the target letter strings that appear on the screen. However, participants might also make implicit lexical decisions to the prime. If the prime is a nonword and the target is a word, two conflicting responses are activated. This might result in slower RTs because the conflict has to be resolved to produce an output. If the target and prime are both words, there is no conflict. Thus, the nonword-prime inhibition effect might be caused by response competition. Response competition will be larger the more attention the participant pays to the prime. Thus, the nonword-prime inhibition effect will be more pronounced for participants that receive instructions that emphasize the importance of the prime. In both the related and unrelated word–word conditions, there is no competition between the implicit response to the prime and the response to the target because prime and target are both words. Thus, response competition will not result in an interaction of instruction with associative priming. This fits our data pattern.

Studies have shown that conflicting responses do indeed slow down response latencies even if the participant is instructed to ignore the conflicting information (Eriksen & Schultz, 1979; Evans & Craig, 1992; Ridderinkhof, van der Molen, Band, & Bashore, 1997). For example, Eriksen and Schultz (1979) have shown that RTs are slower if distractors are from a different response set than if they are from the same response set as the target. In their experiment, four target letters were divided into two response sets of two letters each. Responses were slower if a target letter was flanked by distractor letters from the opposite response set than if the distractor letters were from the same response set. Evans and Craig (1992) did a similar study with tactile stimuli and also found response competition. Response competition does occur in flanker paradigms even if the flanker stimulus is presented before the target stimulus. In the Evans and Craig study, response competition was obtained at a 100-ms SOA (but not at a 500-ms SOA). Eriksen and Schultz obtained response competition at a 250-ms SOA (but not at a 1,000-ms SOA). Like the tasks used in the flanker paradigm, the lexical-decision task is also a binary decision task. Thus, it is entirely possible that response competition plays a role in the lexical-decision task.

One aspect of the data that is problematic for the response competition explanation is the absence of a significant *word-prime* inhibition effect for nonword targets, in both Experiments 1 and 2.[4] Such an effect is predicted by the response competition explanation because two conflicting responses will be activated when the prime is a word and the target is a nonword. Although in both experiments the effects were not significant, they were in the predicted direction. To see whether the effect would be significant across experiments, we performed an analysis on the combined data of Experiments 1 and 2. An ANOVA on the RTs for the Ratcliff–McKoon group showed a significant word-prime inhibition effect of 8 ms, $t(116) = 1.81, p < .05$, one-tailed. An ANOVA on the error rates for the Ratcliff–McKoon

[4] Note that under conditions in which compound-cue theory predicts nonword-prime inhibition for word targets, compound-cue theory also predicts word-prime inhibition for nonword targets (see introduction).

group showed a significant word-prime inhibition effect of 1.2%, $t(116) = 1.75$, $p < .05$, one-tailed. The ANOVAs for the McNamara group failed to reach significance (both $ts < 1$). Thus, in both error rates and response latencies, there is a trend in the direction predicted by the response competition explanation. However, the effect for nonword targets, if it is real, is smaller than the effect for word targets. One possible reason for this is that a response competition effect for nonword targets might be masked by some additional process that occurs only for nonword targets (a process that would also be responsible for the slower RTs for nonword targets). Although this is a possibility, it remains somewhat of a puzzle why a response competition effect would be less pronounced for nonword targets than for word targets. Thus, the extent to which nonword-prime inhibition in lexical decision is due to response competition is still open to debate and a subject for future experimentation.

Summary and Conclusions

The present experiments showed that the presence of nonword-prime inhibition is modulated by the instruction given to the participants. In showing both a presence and an absence of nonword-prime inhibition within the same experiment, using the same procedure and materials and drawing participants from the same population, we provided a possible reconciliation for the conflicting results reported in the literature (McNamara, 1994b; Ratcliff & McKoon, 1995). We argued that this pattern of results cannot be explained by current accounts of the associative priming effect. This means that to give a complete explanation of the nonword-prime inhibition effect, both theories must appeal to additional processes such as response competition. Moreover, we showed that the absence of nonword-prime inhibition in the presence of associative priming is not necessarily problematic for compound-cue theory. Thus, it seems ill advised to use the nonword-prime inhibition effect to test between spreading-activation and compound-cue theories of associative priming.

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Appendix

Simulations With the Compound-Cue Model

The search of associative memory (SAM) implementation of the compound-cue theory was used to fit the pattern of results observed in Experiments 1 and 2. In SAM (Gillund & Shiffrin, 1984; Raaijmakers & Shiffrin, 1981), the familiarity of a compound cue is given by the following equation:

$$F(i, j) = \sum_k S_{ik}{}^{W_P} S_{jk}{}^{(1-W_P)}, \tag{A1}$$

in which S_{ik} is the strength from prime i to the image k in memory, S_{jk} is the strength from target j to the image k in memory, and W_p is the weight on the prime. In words, the familiarity of a compound cue is the sum over all k images in memory of the strength of the prime to an image in memory multiplied by the strength of the target to the same image in memory. Following McNamara (McNamara, 1992b; McNamara & Diwadkar, 1996) and Ratcliff and McKoon (1995), we assumed a linear relation between familiarity and response latency.

In our simulations, 10 parameters were used. The following 8 parameters had identical values for the Ratcliff–McKoon condition and the McNamara condition: S_{self} is the strength of a word to its own image in memory, S_{rel} is the strength of a word to a related word in memory, S_{unrel} is the strength of a word to an unrelated word in memory, S_{nonw} is the strength of a nonword to a word in memory, A and B are the intercept and slope of the linear function used to transform familiarities into response latency, Z_n is the total number of words in the lexicon, and x_n is the number of words in the lexicon that are related to any given word. That is, each word in the lexicon has x_n associates. The only parameter that differed between the two instruction conditions was the amount of weight put on the prime. $W1_p$ and $W2_p$ are the weight put on the prime in the Ratcliff–McKoon condition and the McNamara condition, respectively. The following constraints were set on the parameters: $S_{self} = 1.0$, $S_{rel} \geq S_{unrel} \geq S_{nonw}$, $W1_p \leq .5$, and $W2_p \leq .5$.

The following equations give the familiarities for the various types of prime–target pairs.

Related prime, word target:

$$F = (Z_n - 2x_n)(s_{unrel})^w(s_{unrel})^{1-w} + (x_n - 1)(s_{rel})^w(s_{unrel})^{1-w}$$
$$+ (x_n - 1)(s_{unrel})^w(s_{rel})^{1-w} + (s_{self})^w(s_{rel})^{1-w}$$
$$+ (s_{rel})^w(s_{self})^{1-w}.$$

Unrelated prime, word target:

$$F = (Z_n - 2x_n - 2)(s_{unrel})^w(s_{unrel})^{1-w} + x_n(s_{rel})^w(s_{unrel})^{1-w}$$
$$+ x_n(s_{unrel})^w(s_{rel})^{1-w} + (s_{self})^w(s_{unrel})^{1-w}$$
$$+ (s_{unrel})^w(s_{self})^{1-w}.$$

Nonword prime, word target:

$$F = (Z_n - x_n - 1)(s_{nonw})^w(s_{unrel})^{1-w} + x_n(s_{nonw})^w(s_{rel})^{1-w}$$
$$+ (s_{nonw})^w(s_{self})^{1-w}.$$

Word prime, nonword target:

$$F = (Z_n - x_n - 1)(s_{unrel})^w(s_{nonw})^{1-w} + x_n(s_{rel})^w(s_{nonw})^{1-w}$$
$$+ (s_{self})^w(s_{nonw})^{1-w}.$$

Nonword prime, nonword target:

$$F = (Z_n)(s_{nonw})^w(s_{nonw})^{1-w}.$$

To avoid an excessive number of errors, the familiarity distributions for the fastest nonword condition and the slowest word condition should not overlap too much.

However, because we have not made any assumptions regarding the variability of the familiarities, not much can be said about these distributions. We therefore imposed a weak restriction on the means of the distributions. In particular, we imposed the constraint that the difference in familiarity between the nonword–word condition and word–nonword condition should be at least as large as the difference in familiarity between the related word–word condition and nonword–word condition. In view of the large differences in lexical-decision times between high- and low-frequency words, this constraint does not seem too restrictive.

The best least squares fit to the observed RTs was obtained with the following parameters values: $S_{self} = 1.0$, $S_{rel} = .036623$, $S_{unrel} = .00134447$, $S_{nonw} = .00115385$, $A = 977.8731$, $B = 87.6206$, $Z_n = 3465.0112$, $x_n = 3.7286$, $W1_p = .26460915$, and $W2_p = .18660144$. Table A1 gives the corresponding familiarity values. Predicted RTs are given in Table 3.

By using the same equations, it can also be shown that the compound-cue theory does not necessarily predict nonword-prime inhibition. To show this, we constructed an example in which S_{unrel} was equal to S_{nonw}. The parameters were set at the following values: $S_{self} = 1.0$, $S_{rel} = .8$, $S_{unrel} = S_{nonw} = .0001$, $A = 700$, $B = 40$, $Z_n = 10000$, $x_n = 10$, $W_p = .1$. Table A2 shows the resulting familiarity values and predicted RTs. As can be seen, the familiarity value for a related pair is substantially higher than the familiarity value for an unrelated pair. However, there is hardly a difference in familiarity between an unrelated word–word pair and a nonword–word pair (i.e., no nonword-prime inhibition). Importantly, there is a large difference in familiarity between pairs with word targets and pairs with nonword targets. Thus, with these parameter values, the model would not predict an excessive number of errors.

A final note concerns the large size of S_{rel} and S_{self} compared with S_{unrel} and S_{nonw} in our example. In the examples used by Ratcliff and McKoon (1988, 1994, 1995) and by McNamara (1992b), the retrieval strengths were $S_{self} = S_{rel} = 1.0$, $S_{unrel} = 0.2$, and $S_{nonw} = 0.1$. With these values, compound cue predicts an associative priming effect because the size of the lexicon is very small in their examples (e.g., a lexicon of 10 words in Ratcliff & McKoon, 1994, 1995; a lexicon of 12 words in McNamara, 1992b). For a larger, more realistic size of the lexicon (10,000 words in our example), however, no associative priming would be predicted with these parameter values. This is because the familiarity is calculated over 10,000 words in the lexicon. Only 2 of the 10,000 values that are summed to calculate the global familiarity of a compound cue are responsible for the priming effect. Therefore, the ratio of S_{rel} to S_{unrel} must be larger than that in the examples used by McNamara and Ratcliff and McKoon to predict priming for a more realistic size of the lexicon.

Table A1
Familiarity Values for the Word-Target and Nonword-Target Conditions

	Condition	
Prime type	Ratcliff–McKoon	McNamara
Word target		
Related prime	5.2037	5.3167
Unrelated prime	4.8965	5.0247
Nonword prime	4.6895	4.8760
Nonword target		
Nonword prime	3.9981	3.9981
Word prime	4.1752	4.1205

Table A2
Familiarity Values and Predicted Reaction Times (RTs)

Prime type	Familiarity	Predicted RT
Word target		
Related prime	5.7272	471
Unrelated prime	4.6553	514
Nonword prime	4.6537	514
Priming	1.0719	43
Nonword-prime inhibition	0.0016	0
Nonword target		
Nonword prime	1.0000	
Word prime	1.0016	

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