Memory & Cognition
2005, 33 (2), 241-248

The locus of semantic priming in RSVP target search

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At what stage does semantic priming affect accuracy in target search? In two experiments, participants viewed two streams of stimuli, each including a target word among distractors. Stimulus onset asynchronies (SOAs) between the targets (T1 and T2) ranged from 53 to 213 msec. A word semantically related to one or neither of the targets preceded each trial. In Experiment 1, participants were instructed to report both targets. Although more primed than unprimed targets were reported, there was no cost for unprimed words. A strong interaction between SOA and T1 versus T2 was found, but priming did not interact with either variable. In Experiment 2, only related targets were reported. Performance was similar to that for primed targets in Experiment 1. Semantic priming does not seem to modulate how attentional resources are initially allocated between targets, but instead affects a later stage of processing, the point at which a target word reaches lexical identification.

When a word is preceded by a semantically related word, the second word may be processed more rapidly or accurately, an effect termed *semantic priming*. The theory of automatic spreading activation suggests that priming occurs when activation from the first or prime word spreads to other semantically related words and enables these linked words to achieve some threshold of activation more quickly (see Neely, 1991, for a review of this literature). In two experiments, we used a rapid serial visual presentation (RSVP) paradigm to determine whether targets presented for 53 msec in an RSVP stream can be primed and if so, at what stage in processing the priming effect occurs.

In standard semantic priming experiments, an associated prime precedes a lexical decision target (a word or a nonword). Reaction times (RTs) to words are shorter and accuracy is higher after a related prime than after an unrelated or neutral prime. Similar results are obtained when the task is to name the target. In most conditions where the target was degraded to make it more difficult to perceive, the priming effect was enhanced (Neely, 1991). Because targets in an RSVP stream may be similarly degraded, a substantial priming effect would be expected.

Other studies have explored the effects of priming when more than one target is present. In a study by Dark, Vochatzer, and VanVoorhis (1996), two simultaneous words were presented for 100 msec, followed by a visual mask. The words were preceded by an associative prime of one or neither word; both target words were to be reported. The semantically primed word was reported more often than the nonprimed word. Even when the task was to report only the word that was spatially cued, semantically primed words were likely to be reported (often mistakenly). These results demonstrate that a nominally irrelevant prime selectively activates associated words.

In the present study, we ask whether and how semantic priming affects the deployment of attentional resources in a sequential search task with two targets. (By *attentional resources*, we mean processing with the benefit of limited resources that increase processing efficiency.) Viewers have an impressive ability to detect a single target in an RSVP stream (e.g., Lawrence, 1971; Potter, 1976), but when a viewer must report two targets, important limitations are revealed. The second target (T2) is often missed when it arrives 200 to 500 msec after the onset of the first target (T1), an effect termed the *attentional blink* (AB; Chun & Potter, 1995; Raymond, Shapiro, & Arnell, 1992; see also Broadbent & Broadbent, 1987; Weichselgartner & Sperling, 1987). While the specific models vary in their details, explanations for the AB propose that a bottleneck in processing T1 delays the processing of T2, causing it to be overwritten or forgotten (Chun & Potter, 1995; Jolicœur & Dell'Acqua, 1998; Shapiro, Raymond, & Arnell, 1994).

However, the AB does not reveal the complete story of attentional processing in RSVP. When the stimulus onset asynchrony (SOA) is short (about 100 msec), a different picture emerges. T1 does not necessarily enter the bottleneck first; T2 may enter first and be "spared" the AB effect (Chun & Potter, 1995; Potter, Chun, Banks, & Muckenhoupt, 1998). When the targets and distractors are presented very briefly (for 53 msec) and the SOA is as short as 53 msec, an effect in the opposite direction of

This research was supported by Grants MH47432 and MH20007 from the National Institute of Mental Health. We thank Winston Chang and Daniel O'Connor for programming assistance and Anthony Wagner for his comments. We also thank William Maki, Sander Martens, and an anonymous reviewer for their useful comments on an earlier version of this manuscript. Correspondence should be addressed to J. L. Davenport, NE20-439, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139-4307 (e-mail: jodi@mit.edu).

the AB appears: T2 is reported more often than T1 (Potter, Staub, & O'Connor, 2002). To account for such a crossover effect of SOA on T1/T2 accuracy, Potter et al. (2002) proposed that targets are processed in two major stages. Both stages are resource limited, but in different ways.

Stage 1 is initiated when a possible target is detected on the basis of perceptual features (e.g., letters among keyboard symbols) and the viewer attempts to identify it as a particular word. When the target has been lexically identified, it moves into a strictly serial stage, Stage 2, where it is consolidated in short-term memory. Without such consolidation, the target cannot be reported at the end of the trial (Chun & Potter, 1995; Jolicœur & Dell' Acqua, 1998). Crucially, when T1 processing is in Stage 1, the onset of T2 will divert resources to itself, putting the two targets in competition for limited resources to identify the word and gain access to Stage 2. Initiation of Stage 1 can be likened to the opening of an attentional gate. The gate opens with the onset of T1. Because the detection of T1 has already opened an attentional gate before T2 arrives (Shih, 2000; Weichselgartner & Sperling, 1986), at very short SOAs T2 may benefit from the open gate, gaining more resources than T1, thus enabling T2 to be lexically identified before T1.

Because Stage 2 is serial, the other word (either T1 or T2) remains in Stage 1, where it may be lexically identified. However, unless the word can gain access to Stage 2 consolidation, it may be forgotten or overwritten while waiting in Stage 1. At SOAs of 200–500 msec, T1 is almost always identified first, so that T2 must wait for Stage 2, creating an AB effect. At shorter SOAs, T2 may be identified before T1 on many or most trials, so that T1 is subject to the AB effect.

The two-stage competition model of attention offers a framework in which we may determine at what stage in processing semantic priming affects accuracy in target search. Three possible loci are proposed: (1) Priming may influence the initial allocation of processing resources in Stage 1 before either target has been lexically identified, (2) priming may aid lexical identification—convergence on the correct lexical identity—at the end of Stage 1, or (3) priming may occur at the end of the trial, when memory of the prime serves as a retrieval cue for report. We focus on SOAs between 53 and 213 msec, when the relative performance of T1 and T2 is shifting markedly.

In contrast to the goal of the present study—to determine whether and how priming modulates the distribution of attentional resources between targets—prior studies used semantic priming as a tool to determine the level of processing T2 receives when it is blinked. These AB studies investigated whether T2 can be primed (Juola, Duvuru, & Peterson, 2000; Luck, Vogel, & Shapiro, 1996; Maki, Frigen, & Paulson, 1997) or can itself prime another word when it appears at an SOA that typically produces the AB effect (Martens, Wolters, & van Raamsdonk, 2002; Rolke, Heil, Streb, & Hennighausen, 2001; Shapiro, Driver, Ward, & Sorensen, 1997). If T2 can be primed or can prime another word, it is argued that T2 must have been momentarily identified even though it failed to be reported. That is, priming could not occur unless both the prime and the primed word were identified at a semantic level.

Maki et al. (1997) demonstrated that T1 could prime T2 even when T2 appeared at an SOA likely to cause an AB. Targets were red or green words, and distractors were gray words. A significant priming advantage of 17% greater T2 accuracy occurred when T2 was a strong associate of T1. Maki et al. also found a smaller benefit when a distractor was the prime, and there was little priming except when the distractor prime immediately preceded T2. In none of the experiments did the semantic benefit interact with the SOA between T1 and T2, which ranged from 100–400 msec. That is, a similar level of priming occurred whether or not T2 was in the AB range. Juola et al. (2000, Experiment 3), using two streams, each with one target, found that T1 primed an associated T2 additively over SOAs of 120–600 msec. Since the presence of a sizable AB did not block associative priming, the results suggested that the meaning of each word had been retrieved at a stage of processing before that critical to generate an AB effect.

Instead of determining whether T2 could itself be primed, Shapiro et al. (1997) asked whether T2 could prime a following target, T3. If a blinked T2 primes T3, that would suggest that T2 was processed to a semantic level. Indeed, a significant 4% priming effect in the report of T3 was obtained even when T2 failed to be reported; however, the priming benefit was much greater (17%) when T2 was correctly reported. Martens et al. (2002) also found that a blinked T2 produced semantic priming.

Further evidence that T2 is processed to a semantic level was provided by Luck et al. (1996; see also Vogel, Luck, & Shapiro, 1998) and Rolke et al. (2001) in ERP studies using the N400 peak, a marker that occurs when a word differs from a previously established semantic context. In the Luck et al. study, T1 was a row of identical digits that had to be identified as odd or even, and T2 was a word (e.g., *razor*) that had to be judged as related (match) or not related (mismatch) to a context word that had been presented at the beginning of the trial (e.g., *shave*; the pair *pickle–foot* would be a mismatched pair). There was no decrease in the N400 to a mismatch when T2 was in the blinked range, compared with when T2 was outside the blinked range, suggesting that semantic information had been extracted from the T2 word whether or not it was blinked. In the Rolke et al. study, there were three word targets, and T2 primed T3. The N400 was larger with a mismatch even when the prime was unreported, suggesting that a blinked prime produces automatic spreading activation.

These experiments demonstrate that semantic information is available from words shown for about 100 msec in an RSVP sequence, even if the word cannot be reported. In the present study, we ask how semantic priming affects the ability to identify targets when items are presented nearly twice as fast, for 53 msec, and the SOA varies between 53 and 213 msec. The model proposed by Potter et al. (2002) suggests that when two targets arrive in rapid succession—for example, at an SOA of 53 msec—they initially compete for attentional resources, leading to lexical identification in Stage 1. The first target identified, usually T2, will enter Stage 2, the bottleneck consolidation stage of processing. At longer SOAs, T1 arrives early enough to be identified before T2 and therefore to reach Stage 2 first, resulting in an AB effect for T2.

If semantic priming occurs under these conditions, we may use the model of Potter et al. (2002) to constrain the locus of priming. If priming serves to speed up initial word identification, it would be expected to bias the competition between T1 and T2 at an SOA of 53 msec. Critically, not only should the primed target show a benefit, but because resources are limited the unprimed target on that trial should show a cost relative to targets in trials where neither word was primed. If there is evidence of positive priming but no competition pattern (i.e., cost) is seen at a short SOA, the locus of priming is at the point of lexical identification (the end of Stage 1) or later, rather than during Stage 1. That is, the results should reveal whether semantic priming affects initial attentional selection or influences only a later stage of processing.

We addressed these questions in two experiments in which word targets were presented in a dual stream of distractors; the two streams appeared one above the other. Each trial was preceded by a prime word that was a semantic associate of one or neither of the targets.

EXPERIMENT 1

In the first experiment, participants were instructed to report both words that appeared in the RSVP stream. A prime word, in capital letters, was presented at the beginning of each trial. Participants were informed that the prime would sometimes be related to one of the lowercase target words, but they were only to report words they saw in the stream.

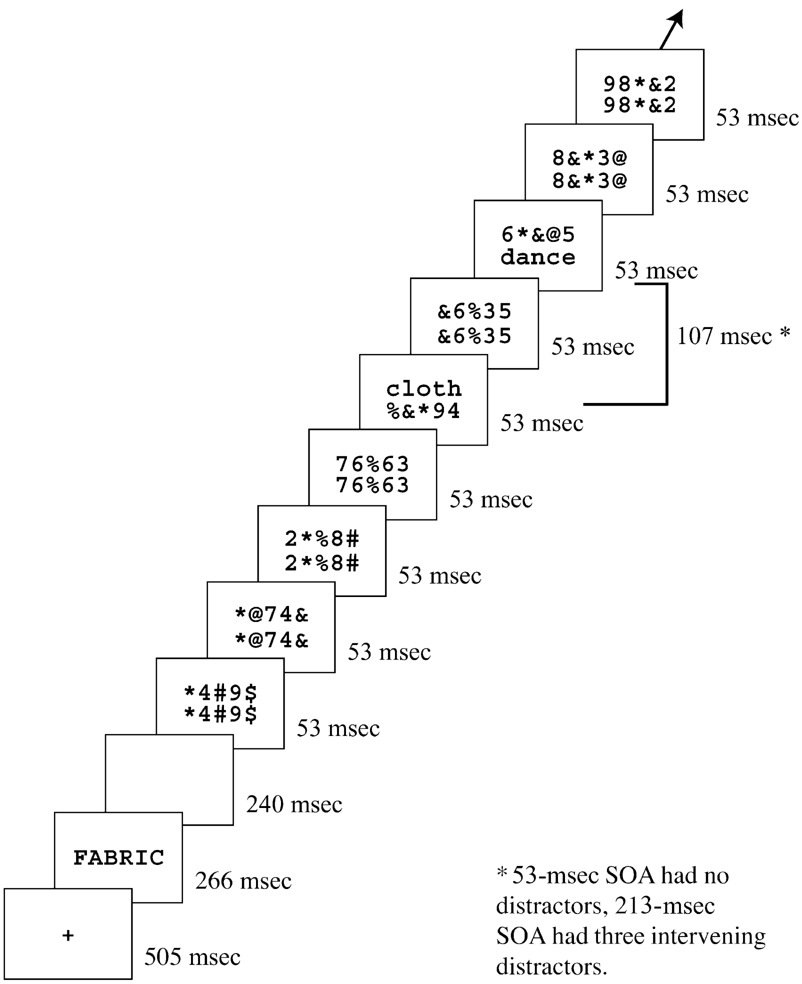

Figure 1. A sample trial from Experiment 1.

Method

Participants. Twelve students from the MIT community volunteered and were paid for their participation. All participants had normal or corrected-to-normal vision and were native English speakers.

Stimuli and Apparatus. Associated primes and targets, a total of 252 prime–target pairs, were taken from the University of South Florida word association norms (Nelson, McEvoy, & Schreiber, 1998). These norms define *cue-to-target association strength* as the percentage of participants giving the target word as a first response. Related prime–target pairs for this experiment had a median strength of 32%. The chosen target words were either 4 or 5 letters long. Two targets, matched for length, were randomly assigned to each trial. The target words appeared among distractors in two streams, one immediately above the other. The targets always appeared in different streams. The distractors consisted of random strings of symbols and digits of the same length as the words on each trial. The same random sequence appeared in both streams, except that when a target word appeared in only one stream, a distractor appeared in the other stream.

In each trial, a prime word preceded the two target words. Prime words appeared in uppercase letters, and target words appeared in lowercase letters. The first target word was randomly assigned to either top or bottom presentation position; no words were repeated during the experiment. All stimuli were black, presented on a medium-gray background, and all words were presented in Courier 20-point bold font. The stimuli were presented with MacProbe software (Hunt, 1994) on a Power Macintosh 7500/100 computer using a 17-in. monitor with a 75-Hz refresh rate. The experiment was conducted with normal room illumination.

Design and Procedure. A within-subject design was used. The three independent variables were SOA, prime type, and target status (T1 or T2). The two words were separated by SOAs of 0, 53, 107, or 213 msec. Note that at 0 SOA, the variable target status was not defined. This condition was omitted from the analysis, but the means for the different priming conditions are reported as a benchmark. The three possible prime types for a specific target word were primed, unprimed, or neither primed. In the primed condition, the target word was preceded by a semantically related prime; in the unprimed condition, the target word was preceded by a prime semantically related to the other word in the trial; and in the neither-primed condition, neither target was semantically related to the prime. In this case, the prime was randomly selected for another target word in the experiment that was not primed. For all SOAs except 0, a given target word was either first or second. The prime type for a given pair of target words and the order of the target words within a pair were counterbalanced across subjects.

There were a total of 126 trials, 18 trials with an SOA of 0 msec and 36 trials at each SOA of 53, 107, and 213 msec. Of the 108 trials with an SOA of 53 or greater, in 36 the first word was primed, in 36 the second word was primed, and in 36 neither word was primed. Half of the word pairs in each condition were 4-letter words, and half were 5-letter words, counterbalanced over SOA, prime type, and top/bottom position. The order of the trials was randomized.

Figure 1 shows a sample trial. Each trial began with a central fixation "+" for 505 msec, an uppercase prime word for 266 msec, a blank of 240 msec, and then the dual streams of distractors and targets, each appearing for 53 msec. The prime word appeared at the central fixation, and the dual streams appeared above and below the fixation. The dual streams began with four, five, or six distractors, then the first word, then zero, one, or three more distractors, then the second word, and then four more distractors. In the 0-SOA condition, the two words appeared simultaneously. The SOA between the prime and first target word ranged from 720 to 827 msec; the SOA between the prime and second target word ranged from 773 to1,040 msec.

One hundred milliseconds after the offset of the last distractor, a dialog box appeared with two spaces for entries and the message, "Please type the two words." The participants were instructed that at the beginning of each trial, a prime word in uppercase letters would appear that would sometimes be related to one of the subsequent lowercase target words, but that they were to attempt to report only the two target words that appeared. After entering the words, the participants clicked a button "OK" to continue, and the correct words were presented for 2 sec as feedback. The next trial began 200 msec later. There were eight practice trials using different sets of words.

Scoring and Analysis. Misspelled words and blanks were counted as errors. Performance on each word in the pair was scored separately. Two analyses were carried out, with SOA, target status, and priming condition as variables. The first analysis compared primed with unprimed targets to determine whether an overall difference would be found between the two. The second analysis compared unprimed with neither-primed targets to determine whether there would be a cost to unprimed targets.

In the neither-primed condition, intrusions of the prime target (e.g., reporting *metal* when the prime was STEEL, although *metal* was not presented) give an indication of the extent of correct guessing based solely on the prime. Such intrusions occurred 5.2% of the time. Most participants had very few of these intrusions; two participants accounted for 36% of the total. To correct for guessing, intrusions of the prime target in the neither-primed condition were subtracted from correct reports of the primed word in the primed condition, for each participant in each SOA $\times$ T1/T2 condition, before analysis.

Results and Discussion

Overall, 45% of the target words were reported, averaging slightly less than one word per trial. An analysis of variance (ANOVA) designed to test for facilitation of targets related to the prime compared percentage correct as a function of SOA (53, 107, or 213 msec), prime type (primed or unprimed), and target status (T1 or T2). A second ANOVA, designed to test for a selective cost to an unprimed target on trials where the other target was primed used the same unprimed condition as a baseline and compared accuracy as a function of SOA, prime type (unprimed vs. neither primed), and target status (T1 vs. T2). Both analyses omitted the SOA of 0 in order to include target status as a variable. The means for these analyses are reported in Figure 2.

In the first analysis of primed versus unprimed targets, a facilitation of targets related to the prime was found, with primed words more likely to be reported ($M = .56$) than unprimed words [$M = .38$; $F(1,11) = 34.21$, $MS_e = 0.03$, $p < .001$]. Consistent with Potter et al. (2002), there was a highly significant crossover interaction between SOA and target status [$F(2,22) = 15.09$, $MS_e = 0.02$, $p < .001$]. At an SOA of 213 msec, there was a large AB effect, with T1 ($M = .54$) reported more accurately than T2 [$M = .31$; $F(1,11) = 67.64$, $p < .001$]. The interaction between prime type and SOA was not significant [$F(2,22) = 1.94$, $MS_e = 0.01$], nor was the triple interaction between prime type, target status, and SOA [$F(1,11) < 1.0$]. These results demonstrate a strong effect of priming on target identification. However, the priming effect did not interact with SOA or target status

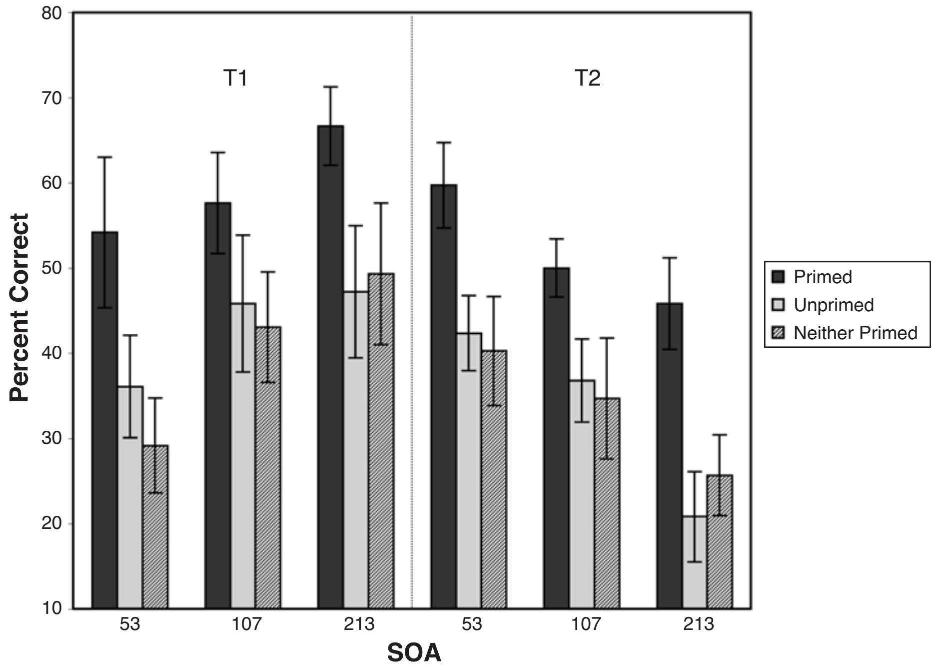

Figure 2. Percent of correct primed, unprimed, and neither-primed targets in Experiment 1.

(T1 vs. T2), which is inconsistent with an account that priming biases the initial competition between the two targets. That is, the priming benefit was no larger in the 53-msec condition than in the 213-msec condition.

The second analysis was carried out to determine whether facilitation for the primed word came at a cost for the unprimed word on the same trial. The same unprimed words were used as a baseline, and unprimed (M = .37) and neither-primed (M = .38) conditions were compared. No difference was found between the two conditions [$F(1,11) < 1.0$]. There was a main effect of target status, with T1 (M = .42) reported more accurately than T2 [M = .33; $F(1,11) = 5.526$, $MS_e = 0.05$, $p < .05$]. Again, the crossover interaction of target status versus SOA was highly significant [$F(2,22) = 15.68$, $MS_e = 0.02$, $p < .001$]. No other main effects or interactions were significant.

In a separate analysis, the 0-SOA trials followed the same pattern as the other SOA conditions: Performance on primed targets (M = .60) was significantly greater than on either unprimed (M = .33) or neither-primed (M = .34) targets [$F(2,22) = 18.05$, $MS_e = 0.02$, $p < .001$], and the latter did not differ.

The results of Experiment 1 demonstrate that priming effects occur with the brief presentation rate of 53 msec at all SOAs and replicate the crossover interaction of SOA versus target status reported by Potter et al. (2002). The pattern of results was not consistent with the hypothesis that semantic priming enables the primed target to take processing resources from the unprimed target in Stage 1, when the two items are in competition for identification. If this account were true, there should have been a significant interaction between SOA and target status in the first analysis, with a greater priming effect at 53 msec than at 213 msec. In addition, in the second analysis, the neither-primed targets should have been more accurately reported than the unprimed targets. That is, the unprimed targets should have shown a cost for being presented with another target that received the benefit of priming. However, no cost for the unprimed target was observed. These effects were not found, although a robust priming effect was present and the experiment had the power of .85 to detect a "medium-sized" main effect, and the power of .76 to detect a "medium-sized" interaction, according to Cohen's (1977) effect size measures.

Because no interaction was found for prime type versus SOA or prime type versus T1/T2, and the crossover pattern was not modulated in the primed condition (i.e., the triple interaction was not significant), priming does not appear to modulate the distribution of limited attentional resources early in processing. Since the priming benefit was roughly equal for each target at every SOA, the results support the hypothesis that priming affects processing that occurs at or after the point of lexical identification, not during preidentification processing. We postpone further discussion of these results until after reporting Experiment 2.

EXPERIMENT 2

In Experiment 2, we tested whether the priming benefit could be enhanced by controlled processing. Experiment 2 was identical to Experiment 1, with the excep-

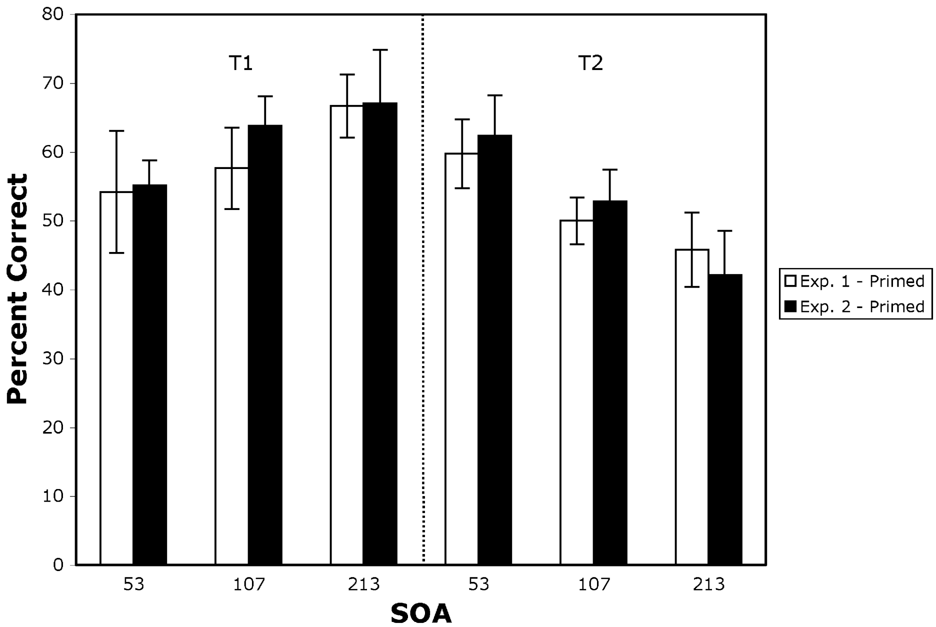

Figure 3. Percent of correct primed targets in Experiments 1 and 2. Data from Experiment 1 are provided for comparison.

tion that participants were required only to report the semantically related word. If intentional selection could modulate processing, reporting only the primed target should increase performance, compared with the incidental priming condition in Experiment 1.

Method

Participants. Twelve students from the MIT community volunteered and were paid for their participation. All participants had normal or corrected-to-normal vision and were native English speakers. None had participated in Experiment 1.

Stimuli and Apparatus. Stimuli and apparatus were identical to those of Experiment 1.

Design and Procedure. The design and procedure were identical to those of Experiment 1, except for the instructions. The participants were asked only to report the word target related to the prime. If no related target was presented, they were to leave the dialog box blank.

Scoring and Analysis. The scoring procedure, analysis, and guessing correction were identical to those of Experiment 1. Prime target intrusions occurred 5.2% of the time (the same percentage as Experiment 1). Most participants had very few intrusions; 2 participants accounted for 40% of the total.

Results and Discussion

Overall, the mean accuracy in reporting the related words was 57%. Two analyses were carried out. An ANOVA of the Experiment 2 data compared percent correct response to primed words as a function of SOA (53, 107, or 213 msec) and target status (T1 or T2). There was a significant main effect of target status with T1 ($M = .62$) reported more accurately than T2 [$M = .52$; $F(1,11) = 13.20$, $MS_e = 0.01$, $p < .01$]. Again, there was a significant crossover interaction of SOA versus target status [$F(2,22) = 8.29$, $MS_e = 0.02$, $p < .01$]. In the second analysis, an ANOVA designed to test for facilitation of primed targets in Experiment 2 relative to primed targets in Experiment 1 compared percentage correct report as a function of experiment (Experiment 1 or Experiment 2), SOA (53, 107, or 213 msec), and target status (T1 or T2). There was no significant main effect of experiment [$F(1,22) < 1.0$], and experiment did not interact with any other variables. These results are presented in Figure 3.

Having to report only the related target gave no additional priming benefit to the targets (relative to the primed condition in Experiment 1), and the crossover pattern of SOA and T1/T2 was like that of Experiment 1. If the priming effect were due to controlled processing, the instructions to report only the primed word would have facilitated report for primed words in Experiment 2, as compared with Experiment 1, in which the prime was incidental. No such difference was found, suggesting that the priming effect is automatic (given attention to the RSVP stream) rather than controlled. Performance is not improved by having to report only the related target. The results are consistent with Dark et al.'s (1996) hypothesis that primes automatically set the context in which stimuli are processed.

GENERAL DISCUSSION

In two experiments, viewers attempted to report briefly presented words in a stream of symbol–digit distractors. In both experiments, a word was presented at the beginning of each trial that was associated with one or neither of the two target words. In Experiment 1, in which both words were to be reported, semantically primed targets were reported with greater accuracy than were unprimed targets. In Experiment 2, in which only the primed word was reported, accuracy was at the same level as in the primed condition of Experiment 1.

To reveal whether priming influences the early allocation of attentional resources between targets, the SOAs between the two words were varied between 53 and 213 msec, in a modification of the AB paradigm. In the AB procedure, the processing of T1 has a marked negative effect on the processing of T2 at SOAs of about 200 msec. However, recent research by Potter et al. (2002) has shown that at still shorter SOAs, such as 53 msec, there is a crossover effect, in which T2 is reported more than T1. To account for these findings, Potter et al. (2002) proposed a two-stage competition model of attentional processing. Stage 1 begins when a potential target is detected on the basis of perceptual features and the viewer attempts to lexically identify it. After the target has been lexically identified, it enters Stage 2, where it is consolidated into short-term memory. The model proposes that targets arriving very close together in time will compete for processing resources in Stage 1 until one target is lexically identified and moves on to Stage 2 for further processing. The other target remains in Stage 1 until Stage 2 becomes available or the target is lost, creating an AB effect.

In the present study, we sought to use the two-stage competition model to determine the locus of the priming effect. We considered three possibilities: (1) Priming biases the competition between targets when they are both in Stage 1, before either target has reached lexical identification; (2) priming aids lexical identification at the end of Stage 1; and (3) priming occurs at the end of the trial, when the prime serves as a retrieval cue for target report.

If the effect of semantic priming is to facilitate the lexical identification of a single target while the two targets are in competition, priming should bias the competition in Stage 1 in favor of the primed target and against the unprimed target at an SOA of 53 msec. That is, there should be a greater benefit for the primed target at an SOA of 53 msec than at 213 msec, and the advantage for the primed target should come at a cost to the unprimed target on that trial. This account predicts a significant interaction of SOA with prime type in the first analysis comparing primed and unprimed targets, and a cost for unprimed target (accompanied by a primed target) compared with neither-primed targets in the second analysis. There was no support for the latter prediction in Experiment 1, either at an SOA of 53 msec or at longer SOAs of 107 and 213 msec. Whereas there was a large positive priming effect in each condition, there was not a hint of a cost to the other word: The means went in the wrong direction at SOAs of 53 and 107 msec (see Figure 2).

The second locus of priming that we considered was that priming aids lexical access, but not by biasing the competition in Stage 1. To distinguish this hypothesis from the biased-competition hypothesis, we proposed a change to the original competition model (see also Potter, in press). In the original model, the two targets were assumed to be processed in parallel, in a “horse race” to reach Stage 2, in which the two targets competed for limited processing resources. Any factor that could assist lexical identification of one of the words would bias the competition. However, another possibility is that the competition is focused at one point in time: the arrival of T2, when attention shifts from T1 to T2 with a high probability at a short SOA and decreases the longer the SOA (up to the point at which T1 has already entered Stage 2). Thus, at any point after the onset of T1, attention is focused exclusively on T1, or (if a switch has occurred) on T2. The targets do compete in Stage 1, but in a winner-take-all fashion. Because neither target has yet been lexically identified at the onset of T2 (unless T1 is already in Stage 2), the probability that the switch will occur is not affected by a semantic prime.

According to this hypothesis, semantic priming can aid lexical identification at the end of Stage 1 processing without a cost to the other target, which has already lost the competition for attention in Stage 1 or has already entered Stage 2. There are many reasons to suppose that the context provided by an associated prime word will aid lexical identification; indeed, this is a common assumption about semantic priming. Under conditions in which the stimulus is difficult to perceive and the main measure of performance is accuracy (as here), semantic context can lead to convergence on the correct word (e.g., Potter, Moryadas, Abrams, & Noel, 1993). This suggests that the role of context is to select among word candidates activated on the basis of perceptual properties, in a Bayesian fashion that optimizes performance under normal conditions.

Note that this second hypothesis about the locus of priming predicts that any word on the verge of being lexically identified will benefit from semantic priming, thus increasing the likelihood that the word will actually be perceived correctly. As a result, the priming effect should be constant across all conditions, as long as performance is not at ceiling or near the floor. This is approximately what we observed.

The third possibility we considered is that the priming effect occurs later in processing, after Stage 2, at the point of retrieval and report. For example, the prime could serve as a retrieval cue for a target that had only been marginally consolidated. However, Experiments 1 and 2 demonstrated that the benefit of associative priming is equally great, whether the task is simply to report the primed word or to report both words. Selective retrieval at the point of report is an unlikely explanation for the priming benefit when only the word related to the prime has to be reported; an effect at the point of lexical access seems more probable.

We conclude, then, that the most likely locus of priming in the present experiment is at the point of lexical identification. Although other factors such as SOA and target status had major effects on target report, every stimulus that was reported correctly must have made contact with the lexicon. If semantic priming increases the likelihood that correct contact is made, one would expect to find a similar increase in accuracy under all conditions, as we observed.

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(Manuscript received August 1, 2003;
revision accepted for publication June 1, 2004.)