Psychonomic Bulletin & Review
2002, 9 (1), 107–112

Automatic stimulus–response associations may be semantically mediated

BERT REYNVOET, BERNIE CAESSENS, and MARC BRYSBAERT
Ghent University, Ghent, Belgium

Three experiments on numerical odd/even judgment are presented. In the first experiment, we show that tachistoscopically presented Arabic primes influence the reaction latencies (RTs) to Arabic targets in two ways: First, RTs to targets are longer when the prime and the target have a different parity status than when they share the same parity status, and second, on compatible trials, RTs are longer when the absolute distance between the prime and the target is larger. Experiments 2 and 3 extend the first finding by showing that the response compatibility effect is also obtained (1) when the primes are not part of the target set and the participants never reacted to them and (2) when the primes are presented in a different modality (verbal numerals) than are the targets (Arabic numerals). On the basis of these results, we conclude that, in masked priming, response codes are automatically activated by stimulus characteristics of the prime and that the activation of response codes is semantically mediated when the primes are meaningful.

Until a few years ago, perception of visual stimuli and selection of motor responses were considered as autonomous processing stages. For instance, Kahneman and Treisman (1984) suggested that the information about a visual stimulus in an experimental task is integrated into an episodic object file, which contains the visual features of the object, together with information about the location of the stimulus. Only when processing in the perceptual stage is finished is the information translated into specific response codes. In recent years, however, evidence has accumulated that object files contain not only perceptual information, but also response-related information. Treisman (1992) argued that repeated experience with objects leads to an integration of stimulus features with task or response information, and Danzinger and Robertson (1994) showed that the benefits of stimulus feature repetition depended on a consistent stimulus–response mapping. Probably the strongest antimodularity view of stimulus–response associations is the theory of event coding proposed by Hommel (1998a, 1998b). According to this theory, an experimental task does not result in the creation of episodic object files but in the creation of episodic event files that integrate information about both the stimulus features and the accompanying response codes, so that response codes are immediately and automatically activated.

Dehaene et al. (1998) reported an fMRI study that seems to agree more with Hommel's (1998a, 1998b) theory than with the traditional modularity view. Participants had to judge whether a number was larger or smaller than 5 by pressing a key with the left or the right hand. Before each target, a prime was presented that in half of the trials was associated with the same response (i.e., both smaller or larger than 5) and in half of the trials with a different response (e.g., prime smaller than 5 and target larger than 5). The data showed a strong response compatibility effect (RCE): Responses to targets were faster when the primes were associated with the same response than when the primes asked for a different response. Brain-imaging data showed that the difference between compatible and incompatible trials was not limited to the visual and the association areas but could be traced well into the motor cortex, indicating that the primes had activated their accompanying response code. This is the more interesting because the authors presented the primes tachistoscopically immediately before the target, so that the participants could not use deliberate guessing strategies, and the response activation thus had to be an automatic process (see Neely, 1991, for a distinction between automatic and strategic processes in priming).

In this paper, we first describe a numerical task that evoked the same pattern of behavioral results as Dehaene et al.'s (1998), and then we show that the RCE we observed was not based solely on a learned association between stimulus-specific physical features and response codes but stemmed from an association between abstract semantic features and response codes (a mechanism that had not yet been specified in Hommel's [1998a, 1998b] event-coding theory). This was done by using primes that were not part of the target set and by using primes from a different modality (verbal numerals) than the targets (Arabic numerals).

EXPERIMENT 1

Reynvoet and Brysbaert (1999, Experiment 1) showed that Arabic target numerals were named faster when they

---

B.R. is a Research Assistant of the Fund for Scientific Research, Flanders (Belgium). B.C. is supported by Grant 011D6598 from the Special Research Fund of Ghent University. Correspondence concerning this article should be addressed to B. Caessens, Department of Experimental Psychology, Ghent University, H. Dunantlaan 2, B-9000 Ghent, Belgium (e-mail: bernie.caessens@rug.ac.be).

were preceded by a prime with a close value than when they were preceded by a prime with a distant value (e.g., the target 5 was named faster after the prime 4 than after the prime 1). In a second experiment, they repeated this distance-related priming effect (see also Brysbaert, 1995) in a parity judgment task, but to do so they had to limit their stimuli to primes and targets of the same parity status (i.e., both odd or both even). In a pilot study with all types of trials, they had found a large interference effect when the prime and the target had a different parity status, which obscured the semantic priming effect. However, the value of this pilot study was limited, because Reynvoet and Brysbaert used only a small range of prime–target distances. Therefore, in the present experiment, we explored the effects of primes with a value going from the target −4 to the target +4. This allowed us to assess the combined effects of distance-related semantic priming and response compatibility. We also checked whether the RCE generalized to primes that were not part of the target set. This was done by comparing the effect of primes that were part of the target set (values of 5–10) with primes that were not part of the target set (values of 1–4 and 11–14).

Method

Targets were Arabic numerals ranging from 5 to 10; primes ranged from the target −4 to the target +4. This made a total of 54 combinations. All the participants saw four blocks of 162 trials. In half of the blocks, even targets had to be responded to with the right hand, odd targets with the left hand; in the other half, the assignment was reversed. The order of the blocks followed an ABBA design. The response assignment in the first block was counterbalanced over participants. Before each block, participants completed a practice block that consisted of 24 trials. In this block each target was shown four times. The prime was always the same as the target.

The experiment was run on a PC-compatible Pentium 3 connected to a 17-in. color screen. Each trial consisted of the following sequence of events: A forward mask, consisting of six hash marks and synchronized with the vertical retrace, was shown for 57 msec, followed by a prime and a backward mask (six hash marks), both for 57 msec, and finally by the target, which remained on the screen until the participant reacted. To reduce the physical overlap between the target and the prime, primes were made smaller (4–6 mm wide × 8 mm high) than the targets (6–8 mm wide × 10 mm high). The stimuli were presented in yellow on a black background and were in triplex font.

The participants were asked to press the left or the right key as quickly as possible with the index finger, depending on whether the target was odd or even. Both accuracy and speed were stressed. The participants were 16 first-year psychology students at Ghent University, who participated as a course requirement. They were all native Dutch speakers.

Results

Mean percentage of error was 3.5%. There was no sign of a speed–accuracy tradeoff, as was indicated by the positive correlation between reaction times (RTs) and numbers of errors in the different cells of the design ($r = .72$, $n = 54$, $p < .05$). Therefore, errors were not analyzed separately. RTs lower than 150 msec and higher than 1,300 msec were excluded from the analysis (0.9%). A 6 (target) × 9 (distance between prime and target) analysis of variance (ANOVA) revealed a main effect of the distance between prime and target [$F(8,120) = 90.13$, $MS_e = 1{,}703$, $p < .001$; see Table 1]. RTs were fastest when the prime and the target were identical, but there was also a distance-related priming effect (i.e., RTs increased when the distance between the target and the primes increased) on the order of 5.6 msec per unit of absolute distance. This distance effect was visible only when the target and the prime had the same parity status [a planned comparison showed that the RTs for an absolute distance of 2 between the prime and the target were significantly faster than the RTs for an absolute distance of 4; $F(1,15) = 15.99$, $MS_e = 1{,}538$, $p < .01$]. When the target and the prime had a different parity status, RTs were 36 msec slower [$F(1,15) = 126.38$, $MS_e = 3{,}915$, $p < .001$], and they did not differ between an absolute prime–target distance of 1 and an absolute distance of 3 [$F(1,15) = 1.53$, $MS_e = 1{,}266.83$, $p = .23$].

The main effect of target magnitude was also significant [$F(5,75) = 41.05$, $MS_e = 3{,}300$, $p < .001$]. Mean RTs for targets 5–10 were, respectively, 490, 520, 481, 492, 522, and 467 msec. Finally, target magnitude interacted with absolute distance between the target and the prime [$F(40,600) = 4.53$, $MS_e = 1{,}507$, $p < .001$]. Despite this interaction,[1] RTs for all the targets showed the same profile (see Table 1). In particular, the RCE was not absent for the primes 1–4 and 11–14, which were not part of the target set. A planned comparison for the targets 5 and 10 revealed that the compatibility effect was significant for both kind of primes, whether they were a member of the target set [36 msec; $F(1,15) = 42.82$, $MS_e = 1{,}948.81$, $p < .001$] or not [21 msec; $F(1,15) = 29.24$, $MS_e = 960.29$, $p < .001$]. However, the effect was larger for primes which were part of the target set [$F(1,15) = 6.12$, $MS_e = 1{,}203.2$, $p < .05$].

Table 1
Mean Response Times in Experiment 1 (in Milliseconds)

	Prime								
Target	T − 4	T − 3	T − 2	T − 1	T	T + 1	T + 2	T + 3	T + 4
5	490	521	482	496	430	531	477	502	487
6	514	546	490	545	457	525	507	577	521
7	470	513	445	504	426	515	461	515	477
8	473	523	467	519	447	547	477	494	487
9	523	566	518	549	450	539	513	519	517
10	475	508	461	503	425	456	448	481	449
Mean	491	529	477	519	439	519	481	515	490

Discussion

Experiment 1 replicated the basic findings of Reynvoet and Brysbaert (1999, Experiment 2): Parity responses to targets showed an identity priming effect (when the primes and the targets had the same value) and a distance-related priming effect (responses to the target were faster when the value of the prime was the target ± 2 than when the value of the prime was the target ± 4). In addition, Table 1 shows the presence of a strong RCE: Responses were 36 msec faster when the prime and the target were associated with the same response than when the prime and the target were associated with different responses, despite the fact that the time interval between the prime and the target precluded deliberate guessing strategies.

Interestingly, post hoc analyses indicated that the RCE was present for primes that were part of the target set (i.e., the values 5–10) and for primes that did not belong to the target set (i.e., the values 1–4 and 11–14), although the effect was 15 msec smaller in the latter condition. This seems to indicate that the effect was not limited to the physical stimuli that were responded to but generalized to stimuli that had a similar meaning (i.e., being odd or even). Because of the importance of this finding, we decided not to rely on post hoc analyses but to design a new experiment that specifically addressed this issue.

EXPERIMENT 2

In this experiment, we presented only a subset of the targets of Experiment 1 that would allow us to compare directly the RCE for primes that were part of the target set (and to which participants had to react on some of the trials) and that for primes that did not belong to the target set (and to which participants never reacted). If the automatically activated stimulus–response associations depend on the low-level physical features of the stimuli, we would expect an RCE for the former set of primes only. If, on the other hand, as was suggested by Experiment 1, the response codes are activated by an abstract, task-relevant feature (i.e., the parity status of the number), we would predict a similar effect for both sets of primes.

Method

The procedure was the same as that in Experiment 1. Only targets and primes differed: Targets ranged from 3 to 5 and from 8 to 10; the primes equaled the target ± 1, and the target ± 2. Identity priming was not assessed. In total, there were 24 combinations. A block consisted of 120 trials, in which each trial was shown five times. The targets 4 and 9 were treated as fillers. They were included so that each target appeared half of the time with a prime that was part of the target set and half of the time with a prime that was not used as a target. The participants were 16 first-year psychology students at Ghent University, who participated as a course requirement. They were all native Dutch speakers.

Results

Average error rate was 2.4%, and there was no speed–accuracy tradeoff ($r = +.65$, $n = 16$, $p < .05$). Trials with RTs faster than 150 msec and slower than 1,300 msec were excluded (1.3%). The mean RTs of the correct responses were analyzed in an ANOVA, with target value (four levels, value = 3, 5, 8, or 10), status of prime relative to the target set (two levels, part of the target set or not), and response compatibility (two levels, compatible [absolute prime–target distance = 2] and incompatible [absolute prime–target distance = 1]) as repeated measures.

All the main effects were significant. Mean RTs on targets 3, 5, 8, and 10 were, respectively, 506, 519, 518, and 480 msec [$F(3,45) = 14.63$, $MS_e = 2{,}966$, $p < .001$]. Trials with compatible responses were reacted to 29 msec faster than trials with incompatible responses [$F(1,15) = 34.31$, $MS_e = 3{,}218$, $p < .001$], and trials with primes that were not part of the target set were reacted to faster than trials with primes that belonged to the target set [$F(1,15) = 6.50$, $MS_e = 1{,}586$, $p < .05$]. As can be seen in Figure 1A, the last effect is entirely the result of the RTs on the incompatible

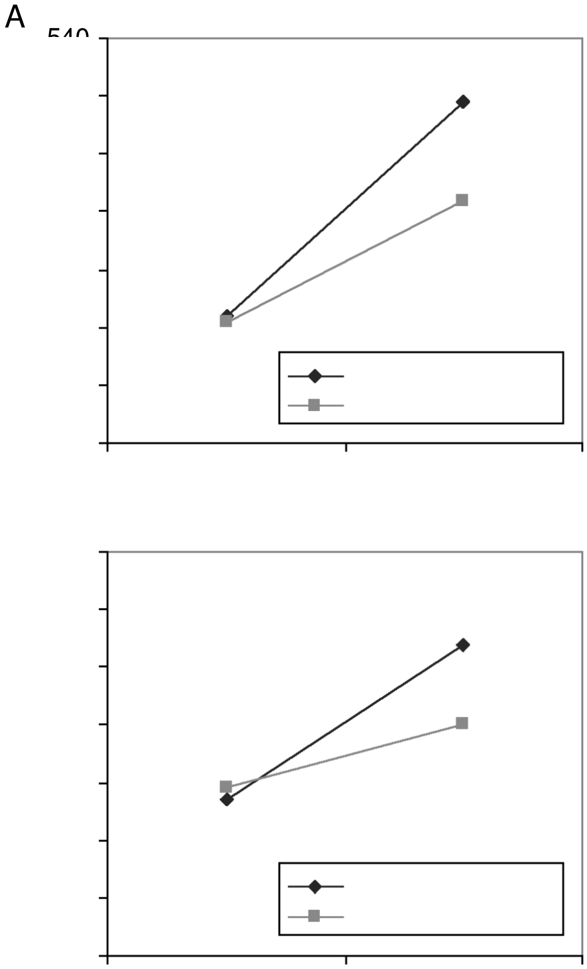

Figure 1. Mean reaction times (RTs, in milliseconds) for compatible and incompatible trials with primes that belonged to the target set and primes that did not in Experiment 2 (panel A) and Experiment 3 (panel B).

trials, leading to a significant interaction between status of the prime, relative to the target set, and response compatibility [$F(1,15) = 9.01$, $MS_e = 950$, $p < .01$]. On the incompatible trials, RTs were 17 msec longer when the prime belonged to the target set than when the prime did not. A post hoc Tukey test indicated that this difference was significant ($p < .01$). No difference was present in the compatible trials. Further post hoc comparisons indicated that the RTs were significantly longer ($p < .01$) on the incompatible trials than on the compatible trials, both when the prime belonged to the target set and when the prime did not belong to the set. Finally, there was a significant interaction effect between target value and prime status relative to the target set [$F(3,45) = 6.05$, $MS_e = 1,102$, $p < .01$]. Trials with nontarget primes were faster than trials with target primes, except for target 3.

Discussion

The main finding of Experiment 2 is that we obtained a reliable RCE with primes that did not belong to the target set and to which participants never reacted. This means that the nontarget primes also activated response codes and, thus, that the automatic stimulus–response associations were not confined to the stimuli to which participants responded. Such a generalization is possible only when the stimulus–response associations were not based completely on the physical features of the stimuli that had been linked to a response, but also on some more abstract, task-relevant semantic feature (i.e., the parity status of the number). Interestingly, the smaller RCE for primes that did not belong to the target set was entirely due to the incompatible trials. This suggests that the RCE we observed is entirely due to interference on the incompatible trials, and not to facilitation on the compatible trials (see MacLeod, 1991, for a similar finding in the Stroop paradigm).

The finding that the RCE was stronger for primes that belonged to the target set than for primes that did not belong to the target set can be interpreted in two ways. First, it might indicate that the stimulus–response associations were partly based on low-level physical features of the stimuli to which the participants had to react. On the other hand, it could also be that the stronger compatibility effect was due to the fact that the semantic representations of the target primes were better linked to the response codes than were the semantic representations of the nontarget primes. Numbers offer a nice way to disentangle these two possibilities: If the RCE is partly due to the contribution of physical stimulus features, we should be able to eliminate this part by using primes that have no physical overlap with the targets. This can be done by using verbal primes instead of Arabic primes. Reynvoet, Brysbaert, and Fias (in press) showed that the cross-modality distance-priming effect (verbal primes and Arabic targets) is the same as the within-modality priming effect (Arabic primes and Arabic targets) in a number-naming task. So, on the basis of this finding, we can make very straightforward predictions. If the stimulus–response associations are based partly on physical stimulus features, we must find the same reduced RCE for verbal primes with values that correspond to the values of the Arabic targets as for verbal primes with values that do not correspond to the values of the Arabic targets. If, however, the stimulus–response associations are based on abstract, nonmodality-specific semantic features, the results with verbal primes must not differ from those with Arabic primes.

EXPERIMENT 3

Method

The procedure was the same as that in Experiment 2, except that the primes were no longer Arabic numerals, but Dutch verbal numerals (i.e., *een*, *twee*, *drie*, *vier*, *vijf*, *zes*, *zeven*, *acht*, *negen*, *tien*, *elf*, and *twaalf*; the size of the letters was 4–6 mm wide × 8 mm high).

The participants were 16 first-year psychology students at Ghent University, who participated for course requirements. They were native Dutch speakers. The results of 2 additional participants were removed on line, because they made too many errors.

Results

The participants made, on average, 3.1% errors. Again, there was no evidence for a speed–accuracy tradeoff ($r = .70$, $n = 16$, $p < .05$). The results were analyzed as in Experiment 2. RTs faster than 150 msec and slower than 1,300 msec were excluded from the analysis (1.1%). Figure 1B shows the mean RTs as a function of response compatibility and of whether or not the prime belonged to the target set. Statistics are not needed to see that Figure 1B is an almost exact replica of Figure 1A.

The main effect of target value was significant [$F(3,45) = 8.93$, $MS_e = 2,723$, $p < .001$]. Mean RTs for targets 3, 5, 8, and 10 were 505, 520, 516, and 489 msec. Trials with primes that were part of the target set were reacted to about 5.5 msec more slowly than trials with nontarget primes [$F(1,15) = 5.64$, $MS_e = 671$, $p < .05$]. This difference was significant only for target 8, leading to a significant interaction between target and prime status relative to the target set [$F(3,45) = 4.01$, $MS_e = 1,425$, $p < .05$]. Just as in Experiment 2, the difference between primes that belonged to the target set and primes that did not was restricted to the incompatible trials. Incompatible trials, on which the prime and the target asked for a different response, took 19 msec longer to react to than did compatible trials [$F(1,15) = 34.91$, $MS_e = 1,352$, $p < .001$]. The compatibility effect was 14 msec larger when the prime belonged to the target set than when it did not, leading to a significant interaction between compatibility and prime status relative to the target set [$F(1,15) = 9.51$, $MS_e = 920$, $p < .01$]. Post hoc Tukey tests indicated that the compatibility effect was significant both when the primes were part of the target set ($p < .001$) and when they were not ($p < .05$).

An overall analysis of Experiments 2 and 3 showed that the variable experiment did not result in any significant main effect or interaction. The interaction between experiment and compatibility effect came closest to significance [$F(1,30) = 2.89$, $MS_e = 2{,}285$, $p < .10$], showing that the RCE is somewhat smaller in the third experiment. The interaction between experiment, compatibility, and prime status relative to the target set was absent [$F(1,30) < 1$, $MS_e = 935$].

Discussion

The main finding of Experiment 3 was that the interaction between prime status relative to the target set and response compatibility, obtained in Experiment 2 (Figure 1A), was not due to low-level physical features of the stimuli to which participants had to react (see Figure 1B). Exactly the same interaction was observed when there was no physical overlap between primes (words) and targets (digits). On the other hand, the slightly smaller compatibility effect found in the cross-modality condition than in the within-modality condition may indicate that the contribution of low-level physical stimulus features in the building of stimulus–response associations is not completely absent (unless one assumes that word numerals activate parity information more slowly than do Arabic numerals).

GENERAL DISCUSSION

In this paper, we have found that, in masked priming, tachistoscopically presented primes elicited a reliable RCE, even though participants never had to react to the primes (see also Dehaene et al., 1998). Furthermore, we have shown that the primes activated their response largely on the basis of a task-relevant aspect of their meaning (the odd/even status of the number).

The RCE is usually associated with the Stroop task (Stroop, 1935) and with variants of this task, such as the flanker task (Eriksen & Eriksen, 1974) or the Simon task (Simon, Acosta, Mewaldt, & Speidel, 1976), in which the distractor is presented together with the target stimulus and remains on the screen until the participant reacts. For these tasks, just as in our experiments, it has been shown that the RCE is clearest when the distractors are part of the target set (Roelofs, 1993) but that a smaller effect can sometimes be obtained with distractors that do not belong to the target set (Glaser & Glaser, 1989; La Heij, 1988; Miller, 1987; Proctor, 1978).

Traditionally, researchers have assumed that the masked priming paradigm differs from the Stroop task, because the prime is presented for a very short period of time and replaced by the target stimulus before it is fully identified. Because of this characteristic, researchers for a long time have been convinced that the effect of the prime was limited to activation in the very first stages of processing. For instance, in the word recognition literature, there is a discussion as to whether semantic priming is confined to the level of the input lexicon (Shelton & Martin, 1992) or whether it includes the semantic system as well (e.g., Perea & Gotor, 1997). Our results show that the effects of tachistoscopically presented primes need not be confined to the first processing stages but may proceed all the way up to the response preparation. This finding is in line with Dehaene et al. (1998) and other recent demonstrations of analogies between the priming and the Stroop tasks (Alario, Segui, & Ferrand, 2000; Klinger, Burton, & Pitts, 2000; Wentura, 2000).

Therefore, our results form a bridge between the research on action control and the research on semantic priming. In the former literature, it is well established that stimuli automatically evoke responses after a few stimulus–response couplings; in the latter, it is generally accepted that shortly presented stimuli activate related concepts. Our findings suggest that the automatic stimulus–response associations are more often semantically mediated than is usually thought (e.g., in Hommel's 1998a, 1998b, theory of event coding) and that the activation of stimulus-related knowledge is not limited to the first stages of processing, even for tachistoscopically presented primes. As the data of Experiment 1 show, both effects (response competition and semantic facilitation) can be observed even within the same study (see also Flowers, 1990, for a similar pattern of results in the flanker task).

REFERENCES

Alario, F. X., Segui, J., & Ferrand, L. (2000). Semantic and associative priming in picture naming. *Quarterly Journal of Experimental Psychology*, **53A**, 741-764.

Brysbaert, M. (1995). Arabic number reading: On the nature of the numerical scale and the origin of phonological recoding. *Journal of Experimental Psychology: General*, **124**, 434-452.

Danzinger, S., & Robertson, L. C. (1994, November). *Repetition effects produced by task-irrelevant features*. Poster presented at the 35th Annual Meeting of the Psychonomic Society, St. Louis.

Dehaene, S., Naccache, L., Le Clec'H, G., Koechlin, E., Mueller, M., Dehaene-Lambertz, G., van de Moortele, P.-F., & Le Bihan, D. (1998). Imaging unconscious semantic priming. *Nature*, **395**, 597-600.

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics*, **16**, 143-149.

Flowers, J. H. (1990). Priming effects in perceptual classification. *Perception & Psychophysics*, **47**, 135-148.

Glaser, W. R., & Glaser, W. O. (1989). Context effects in Stroop-like word and picture processing. *Journal of Experimental Psychology: General*, **118**, 13-42.

Hommel, B. (1998a). Automatic stimulus–response translation in dual-task performance. *Journal of Experimental Psychology: Human Perception & Performance*, **24**, 1368-1384.

Hommel, B. (1998b). Event files: Evidence for automatic integration of stimulus–response episodes. *Visual Cognition*, **5**, 183-216.

Kahneman, D., & Treisman, A. (1984). Changing views of attention and automaticity. In R. Parasuraman & D. R. Davies (Eds.), *Varieties of attention* (pp. 29-61). Orlando, FL: Academic Press.

Klinger, M. R., Burton, P .C., & Pitts, G. S. (2000). Mechanisms of unconscious priming: I. Response competition, not spreading activation. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **26**, 441-455.

La Heij, W. (1988). Components of Stroop-like interference in picture naming. *Memory & Cognition*, **16**, 400-410.

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin*, **109**, 163-203.

Miller, J. (1987). Priming is not necessary for selective-attention failures: Semantic effects of unattended, unprimed letters. *Perception & Psychophysics*, **41**, 419-434.

Neely, J. H. (1991). Semantic priming in visual word recognition: A selective review of current findings and theories. In D. Besner & G. W. Humphreys (Eds.), *Basic processes in reading: Visual word recognition* (pp. 264-336). Hillsdale, NJ: Erlbaum.

Perea, M., & Gotor, A. (1997). Associative and semantic priming effects occur at very short stimulus-onset asynchronies in lexical decision and naming. *Cognition*, **62**, 223-240.

Proctor, R. W. (1978). Sources of color–word interference in the Stroop color-naming task. *Perception & Psychophysics*, **23**, 413-419.

Reynvoet, B., & Brysbaert, M. (1999). Single-digit and two-digit Arabic numerals address the same semantic number line. *Cognition*, **72**, 191-201.

Reynvoet, B., Brysbaert, M., & Fias, W. (in press). Semantic priming in number naming. *Quarterly Journal of Experimental Psychology*. Manuscript submitted for publication.

Roelofs, A. (1993). Testing a non-decompositional theory of lemma retrieval in speaking: Retrieval of verbs. *Cognition*, **47**, 59-87.

Shelton, J. R., & Martin, R. C. (1992) How semantic is automatic semantic priming? *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **18**, 1191-1210.

Simon, J. R., Acosta, E., Jr., Mewaldt, S. P., & Speidel, C. R. (1976). The effect of an irrelevant directional cue on choice reaction time: Duration of the phenomenon and its relation to stages of processing. *Perception & Psychophysics*, **19**, 16-22.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, **18**, 643-662.

Treisman, A. (1992). Perceiving and re-perceiving objects. *American Psychologist*, **47**, 862-875.

Wentura, D. (2000). Dissociative affective and associative priming effects in the lexical decision task: Yes versus no responses to word targets reveal evaluative judgment tendencies. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **26**, 459-469.

NOTE

1. The significant interaction between target and prime occurred in all our experiments (e.g., also in Reynvoet & Brysbaert, 1999). A closer look at the data revealed that this interaction was due largely to the fact that some primes were associated with one or two targets only (e.g., prime 1 co-occurred only with the target 5). This caused a distance effect that was slightly smaller than the average effect.

(Manuscript received February 23, 2000;
revision accepted for publication February 27, 2001.)