Psicológica (2006), 27, 225-242.

Semantic priming effects with and without perceptual awareness

Juan J. Ortells*, Concepción Vellido, María Teresa Daza and Carmen Noguera

Universidad de Almería

The present research was aimed to reply and extend several recent findings showing qualitatively different behavioral effects produced by words perceived with vs. without awareness. Participants made a semantic categorization task on a target that was preceded by a prime word belonging either to the same (20% of trials) or to a different category (80%). The prime was always presented briefly and followed either immediately or after a delay by a pattern mask. In contrast to prior studies, the masking type varied randomly from trial to trial. For trials with an immediate mask (which avoided conscious identification of the prime), a significant facilitatory semantic priming was found. For trials with a delayed mask (on which participants were able to identify the prime), a significant "reversed" semantic priming was observed. The present findings provide further evidence that perceiving a stimulus with or without awareness can lead to qualitatively different behavioral consequences, which reflect the contribution of strategy-based (controlled) and automatic components, respectively.

The semantic priming paradigm has traditionally provided a powerful tool for the investigation of cognitive processes related to memory and language, perception or attention (e.g., Ochsner, Chiu, & Schacter, 1994). In a typical version of this paradigm, participants are required to make any kind of response (e.g., naming, lexical decision, semantic judgement) to a target stimulus, which is preceded by either an unrelated word or a semantically (and/or associatively) related word prime. Semantic priming is

---

* This research was partly supported by a Grant SEJ2004-01863/PSIC from Ministerio de Educación y Ciencia, Dirección General de Investigación (Spain), to the first author. Requests for reprints and correspondence should be sent to Juan J. Ortells, Departamento de Neurociencia y Ciencias de la Salud. Facultad de Humanidades y Ciencias de la Educación. Universidad de Almería. 04120. Almería. Spain (email: jortells@ual.es). We thank Juan Botella, Luis Jiménez and an anonymous reviewer for their helpful comments on a earlier version of this article.

observed when responses to the target are faster and/or more accurate for the related than for the unrelated prime-target pairs. An usual interpretation of semantic priming (e.g., Collins & Loftus, 1975) is that presenting a prime stimulus (e.g., CAT) would activate its corresponding internal representation (node) in memory, and such an activation would spread to other related nodes, thus facilitating the processing of related targets (e.g., DOG). That spread of activation in memory has often been considered as a fast-acting automatic process, occurring without intention or awareness (e.g., Posner & Snyder, 1975a; 1975b). The strongest evidence for automatic spread of activation comes from the demonstrations of semantic priming produced by unattended stimuli that are presented outside the "spatial focus" of attention (e.g., in parafoveal locations; see for example Ortells, Abad, Noguera & Lupiáñez, 2001; Ortells & Tudela, 1996), or visually degraded (e.g., displayed for a short time exposure and followed by a mask) such that participants claim to be unaware of stimuli' identity (e.g., Balota, 1983; Cheesman & Merikle, 1985; Marcel, 1983a; 1983b).

On the other hand, there is ample evidence that semantic priming would also reflect the operation of slower-acting and resources demanding controlled processes, such as an expectancy-based strategic mechanism (see Neely, 1991, for a review). One of most often cited studies in support of the involvement of both automatic and controlled components in semantic priming, was conducted by James H. Neely (1977). Participants made a lexical decision task on target stimuli, which (in the case of word trials) consisted of exemplars of several semantic categories (e.g., robin, door, hand). The target stimulus was preceded by either a short (400 ms) or longer (700 ms) time interval by a prime word, which consisted of a category name (e.g., BODY, BUILDING, BIRD). Participants were instructed that whereas some category name primes (e.g., BIRD) would always be followed by targets that were exemplars of that category (e.g., robin), other category name primes (e.g., BODY) would be followed, on a high trial proportion, by targets from a different category (e.g., door). For a prime-target stimulus onset asynchrony (SOA) of 400 ms, a facilitation effect was always observed for related targets (as compared to a control condition consisting of a series of "Xs"), regardless of whether the target was either an expected (e.g., BIRD followed by robin), or an unexpected (e.g., BODY followed by hand) stimulus. By contrast, with a longer (700 ms) prime-target SOA (which would supposedly reflect the operation of expectancy-based strategies), category name primes facilitated responses only to the *expected* related targets (e.g., BODY followed by door), but interfered with responses to the unexpected (though related) targets (e.g., BODY followed by arm).

Note, however, that whereas it is widely accepted the involvement of strategic components in semantic priming, this is not the case regarding automatic mechanisms. Experimental research addressing the extent of processing (e.g., perceptual vs. semantic) for unattended and/or unconsciously perceived stimuli has been plagued by continual controversy and contradictory results, much of them would argue against *automaticity* of semantic priming (for a review see Holender, 1986). This is the case, for example, of a number of studies suggesting that the mere exposure to a prime stimulus do not necessarily result in semantic priming. Rather, the likelihood to obtain reliable priming effects would depend on the way in which the prime is processed. Thus, the semantic priming effect can be drastically reduced or even eliminated when participants are explicitly instructed to process the prime word at a very shallow level, such as indicating whether the prime was in lower- or uppercase letters, or searching for a particular letter in the prime word (e.g., Besner, Smith, & MacLeod, 1990; Friedrich, Henik, & Tzelgov, 1991; Henik, Friedrich & Kellog, 1983; Henik, Friedrich, Tzelgov, & Tramer, 1994; Kaye & Brown, 1985; Smith, Theodor & Franklin, 1983). A potential limitation of such a kind of task manipulations is that they could interfere with normal reading. Accordingly, Smith, Besner and Miyoshi (1994) conducted a series of lexical decision experiments in which, rather than manipulating the prime processing task, they varied the "context" in which prime stimuli were seen, such that they were either very easy or somewhat more difficult to perceive consciously. On every trial, a prime word (that participants were instructed to simply read) was presented for either a short (84 ms) or a longer (280 ms) duration prior the presentation of a 14-ms pattern mask (a string of 8 @s). Following an inter-stimulus interval of 400 ms after offset of the masking pattern (thus resulting in a prime-target SOA of either 498 or 694 ms, for short and long prime presentations, respectively), an either unrelated or semantically related target stimulus was presented, on which participants made a lexical decision task. The manipulation of the prime-mask SOA (i.e., the prime duration) was either blocked or mixed. For the blocked-presentation condition, a between-participants design was used, such that one group of participants saw only short-duration primes, whereas the other group saw only long-duration primes. In the mixed-presentation condition, a within-participant (random) design was used, in which both short- and long-duration primes varied randomly from trial to trial. Smith et al. (1994) found that performance in the mixed-presentation condition differed from performance in the blocked-presentation condition. For the long (280 ms) display duration, a reliable facilitation effect was always found, which was of a similar magnitude for both blocked- and mixed-presentation conditions.

But with a briefer (84 ms) display duration, which made the prime difficult to read, the semantic priming effect reached statistical significance only in the blocked-, but never in the mixed-presentation condition. According to Smith et al. (1994), whether priming effects from difficult-to-read primes would actually reflect an automatic semantic activation, in the sense that it is initiated without intention or awareness by the onset of a prime, then those effects would be not influenced by the concurrent presentation of easy-to-read primes (i.e., the mixed condition). But this was not the case, as semantic priming was modulated by the context manipulation, a finding that challenges the automaticity hypothesis (see also Schlaghecken & Eimer, 2004).

Yet, it should be noted that both the prime-mask SOA (84 ms) and the prime-target SOA (approximately 500 ms) that were used by Smith et al. (1994) in their short-display condition, do not seem to be short enough to preclude a consciously controlled processing of prime words on that condition. There is ample evidence that a prime-mask SOA of 84 ms is clearly above most participants' threshold for subjective awareness (e.g., Cheesman & Merikle, 1985; 1986; Merikle, Joordens, & Stolz, 1995; Ortells, Fox, Noguera & Abad, 2003). Likewise, a number of priming studies suggest that controlled processes can operate at prime-target SOAs of 500 ms or even shorter (e.g., Daza, Ortells & Fox, 2002 ; Merikle & Joordens, 1997; Ortells, Daza & Fox, 2003). It could then be argued, as acknowledged in fact by Smith et al. (1994, Footnote 5, page 112), that it was the strategic or expectancy-based component, rather than the automatic component that was affected by their context manipulation. Consequently, the non-significant facilitation effect from brief-duration primes that was observed in the mixed-presentation condition could represent the small automatic component of priming that remained after the strategic component was eliminated.

Although Smith et al. do not believe that to be case, a limitation of their experimental procedure is that it does not allow disentangling the contributions of automatic and controlled processes to performance. A similar weakness is shown by the *traditional dissociation* studies of perception without awareness, which have often used a *facilitation paradigm*, whereby effects on unconscious perception produced the same pattern of results as it did conscious perception (for reviews of this literature see Daza & Ortells, 2002; Ortells, Daza, Noguera, Carmona, Fox & Abad, 2002; Reingold, 2004). According to Debner and Jacoby (1994), because both types of processes can contribute to performance in a similar vein (i.e., facilitating), it is difficult to determine whether the supposedly unconscious influences might partly or completely be attributed to any residual conscious perception.

However, over the last two decades a number of alternative research approaches for studying semantic processing without attention and/or awareness have been developed, which provide more powerful methodologies to distinguish between automatic and controlled influences (e.g., Daza et al., 2002; Debner & Jacoby, 1994; Draine & Greenwald, 1998; Greenwald, Draine & Abrams, 1996; Merikle & Joordens, 1997; Reingold & Merikle, 1988). The experimental logic is to contrast conscious (controlled) and unconscious (automatic) perception in order to determine whether a stimulus can have qualitatively different consequences on cognitive or affective reactions (e.g., positive vs. negative priming effects) depending on whether it was either consciously or unconsciously perceived.

A good example comes from a recent semantic priming study by Ortells, Daza and Fox (2003), which showed that individuals could use predictive strategies based on stimulus redundancy only when the predictive stimuli are consciously perceived, whereas information perceived without awareness leads to more automatic reactions that cannot be controlled by individuals. Participants were required to make a two-choice semantic categorization (animals vs. body parts) task on a central target word, which was preceded by a prime word that on the 20% of the trials (related condition) it was a highly-associated word of the same semantic category (e.g. COW – bull; HAND – finger), whereas on the 80% of the trials (unrelated condition) it belonged to a different semantic category to that of the target (e.g., COW – finger; HAND – bull). The prime word was always centrally displayed for 33 ms, and followed either immediately or after a variable delay (depending on the experimental condition) by a pattern mask (a string of seven ampersands). Irrespective of whether the prime word was followed by an either immediate[1] or delayed mask, participants were encouraged to use the predictive information provided by the prime word to

[1] A number of previous studies (e.g., Cheesman & Merikle, 1985; 1986; Daza et al., 2002; Merikle et al., 1995) have consistently found that a prime-mask SOA of 33 ms is clearly *below* most participants' threshold for *subjective* awareness. This result has been confirmed in a series of recent experiments in our labs. Thus, when we required participants to make a forced-choice binary task (e.g., an animate/inanimate judgment) on words presented for 33 ms and immediately masked, their discrimination performance, as measured by d', a bias-free measure of stimulus discriminability derived from signal-detection theory, deviated significantly from chance. Yet, participants consistently reported a complete phenomenal lack of stimulus awareness, thus suggesting that words presented under immediate masking conditions were *below* a subjective threshold, but *not below* an objective threshold for stimulus awareness.

optimize their categorization performance. So, given a particular prime word, they should expect that the upcoming target would belong to a different semantic category, as the unrelated trials were much more frequent than the related trials (see Neely, 1977, for a similar procedure). To investigate the time-course of semantic priming effects from words presented under immediate vs. delayed masking conditions, the prime-target SOA was manipulated between-participants at four levels: 200, 300, 400 and 500 ms. Ortells et al. (2003) found a significant crossover interaction between masking type and prime-target relationship, which showed that perception with and without awareness can lead to qualitatively different behavioral consequences. With a delayed mask, the reaction times (RTs) were slower on (the less frequent) related trials than on unrelated trials. Such a reversed (i.e., negative) priming effect suggest that participants consciously identified the prime words followed by a delayed mask, and learnt to use them in a strategic manner to anticipate the semantic category (i.e., the opposite category) of the target word (see also Logan, Zbrodoff & Williamson, 1984). Also, that reversed (strategic) priming effect was significant at a prime-target SOA of 400 ms or longer (500 ms), but not at the shortest SOA intervals of 200 and 300 ms, a finding that is consistent with prior research showing that controlled processes build up much more slowly (and are often more sustained) than automatic processes (e.g. Di Pace, Longoni, & Zoccolotti, 1991; Neely, 1977; Ortells et al., 2001; Posner & Snyder, 1975a; 1975b; Shenaut & Ober, 1996; Shiffrin & Schneider, 1977). By contrast, when the prime was immediately followed by the mask, such that most of participants claimed to be unaware of the word's identity, RTs were faster on related than on unrelated trials. This semantic facilitation effect reached significance at SOAs of 400ms and shorter, but disappeared completely at the longest SOA of 500-ms (see Daza et al., 2002, for a similar result pattern with a Stroop-type task).

Overall, the findings by Ortells et al. (2003) showed that the behavioral consequences of perceiving a stimulus with or without phenomenological awareness are qualitatively different not only by the sign (i.e. negative vs. positive) of the corresponding priming effect, but also by the time course of each priming effect. The demonstration that an immediately masked prime word facilitated categorization responses to related targets at short prime-target SOAs, suggests the involvement of an automatic semantic activation process with a fast development and a rapid decay over time (see also, Daza et al., 2002; Di Pace et al., 1991; Draine & Greenwald, 1998; Neely, 1977; Posner & Snyder, 1975a; 1975b; although see Deacon, Uhm, Ritter, & Hewitt, 1999). Yet, the lack of a reversed priming effect at the shorter SOAs does not necessarily reflect the absence of strategic influences at those time intervals. Rather, it could be that the strategic processes contribute immediately, but their influence is overridden by an equally large automatic influence. As the automatic influence subsides (i.e., as the SOA interval is lengthened), the strategic influences would then predominate. Note also that in Ortells et al. (2003)' experiments, the masking type, which would supposedly affect the prime word' awareness, was manipulated in a blocked within-participant design. This has been, in fact, the typical procedure used by prior priming studies examining qualitative differences between perception with and without awareness, such that the immediate and delayed masking conditions varied across either different participants (e.g., Daza et al., 2002; Debner & Jacoby, 1994; Merikle & Joordens, 1997), or different trial blocks (e.g., Ortells et al., 2003). Obtaining a differential priming pattern as a function of masking type when this factor is manipulated in a within-participant (random) design, it would be a relevant finding for at least two reasons. Firstly, it would demonstrate the consistency and generality of that kind of dissociation procedure to investigate semantic priming effects as a function of prime awareness. Second and of more importance, it would provide further and strongest evidence that the facilitation effects observed with an immediate mask (under which participants reported a complete absence of conscious awareness of word's identity) do reflect the operation of automatic processes, in the sense that those effects would be not affected by context manipulations. Otherwise, if semantic priming from immediately masked words would also reflect any kind of strategic or controlled influence, we would then expect that such an facilitation effect might be eliminated (or significantly reduced) by the concurrent presentation of delayed masking trials, in which participants are clearly aware of the prime word's identity.

Accordingly, the main aim of the present research was to replicate and extend the Ortells et al. (2003)' findings when both immediate and delayed masking conditions varied randomly from trial to trial within an experimental session. Our experiment was procedurally similar to that of Ortells et al., with just two exceptions: (1) the presence of either an immediate or a delayed mask was manipulated in a within-participant design, such that the two masking conditions varied randomly within a block ; (2) the prime-target SOA remained fixed at 400 ms.[2]

---

[2] Note that a prime-target SOA of 400 ms was the only SOA interval in which both the facilitatory and reversed priming effects (under immediate vs. delayed masking conditions, respectively) had reached statistical significance in Ortells et al. (2003)' study.

METHOD

Participants. Thirty-four undergraduate students at the University of Almería participated in a single experimental session for course credit. All had normal or corrected to normal vision, and were aged between 19 and 27 years (mean = 24).

Apparatus and Stimuli. Stimuli were displayed on a VGA color monitor controlled by E-Prime software (Schneider, Eschman, & Zuccolotto, 2002) implemented on an IBM/ PC compatible computer. Responses were collected on a computer keyboard; response accuracy and latency to the nearest millisecond were measured by the E-Prime software. All stimuli were displayed in gray characters (with each character subtending about .29 degrees horizontally and .49 degrees vertically) against a black background and they were centered both horizontally and vertically at a viewing distance of approximately 60 cm. Eight concrete and familiar words in the Spanish language, 4 "animals" (COW, BULL, FROG, TOAD) and 4 "body parts" (HAND, FINGER, FACE, EYES) were used as both prime and target stimuli throughout the experiment, with the only difference being that they were displayed in uppercase characters when appeared as a prime, and in lowercase characters when appeared as a target stimulus. A random string of seven grey letters (MDGTKSN) subtending about 2.46 degrees horizontally and .49 degrees vertically, was used as the pattern-mask. Participants indicated the category (animal vs. body part) of the target by pressing either the "M" or the "C" key on the computer keyboard. Mapping of responses and correct key (M or C) were counterbalanced across participants.

Design and Procedure. Participants were tested individually in a sound-damped, dimly lit room. General task instructions were displayed on the monitor and were also presented verbally. The timing of the specific stimulus events on each trial was as follows (see Figure 1): (1) A fixation display (*) was presented for 500 ms; (2) an uppercase prime word presented for 33 ms; (3) a mask (i.e., MDGTKSN), which was either immediately presented following the prime display offset (immediate masking trials), or after a delay of 234 ms (a blank screen). In this latter case (delayed masking trials), the mask duration was of 133 ms; (4) a lowercase target word (presented until response) on which participants made a categorization (animal vs. body part) judgment. Whereas the prime-mask SOA was of either 33 ms or 267 ms for immediate and delayed masking trials, respectively, the prime-target SOA was always of 400 ms.

For each masking condition, the 80% of trials were *unrelated* trials, on which the target belonged to a different semantic category as that of the prime. The remaining 20% were related trials on which the target was always a highly -associated word of the same semantic category as that of the prime (e.g. COW – bull; HAND – finger). The computer emitted a 500 ms beep if participants made an error. Following the participants' response a new trial began.

Each participant took part in a single session (lasting about 16 minutes) consisting of one block of 40 practice trials followed by one block of 320 experimental trials, from which 256 trials were unrelated (80%) and 64 (20%) were related. Half of both practice and experimental trials were "immediate masking trials" and the other half "delayed masking trials", with both masking conditions varying randomly from trial to trial. The target word belonged to either "animals" or "body-parts" categories on the same number of trials. After completing the experimental session, participants were asked about whether they had generally been able to identify the prime words preceding the masking pattern. As in the study by Ortells et al. (2003; see also Daza et al., 2002) participants were informed about that differential proportion of unrelated and related trials, and they were instructed to use the predictive information provided by the prime word in order to optimize their categorization performance.

RESULTS

Mean reaction times (RTs) and error percentages were entered in two 2 x 2 analysis of variance (ANOVA), with masking condition (immediate vs. delayed) and prime-target relationship (unrelated vs. related) as within-participants (random) factors.

In the analysis of RTs, there was a significant crossover interaction between masking type and prime-target relationship ($\underline{F}$ (1, 33) = 20.3, $\underline{MSE}$ = 24676.5, $\underline{p}$ < .0001), which showed, as in Ortells et al. (2003)' study, a differential priming pattern as function of masking condition (see Table 1). For the delayed masking trials, a reversed (i.e., negative) priming effect of –38 ms was found ($\underline{F}$ (1,33) = 14.75; $\underline{MSE}$ = 1655.13, $\underline{p}$ < .0005), such that RTs on (the less frequent) related trials were reliably *slower* than RTs on unrelated trials. Such reversed priming indicates that participants were aware of the prime words followed by a delayed mask and learnt to use them in a strategic manner to anticipate the semantic category (i.e., the opposite category) of the target word. By contrast, for immediate masking trials an opposite facilitation effect (i.e., faster RTs on related relative to unrelated trials) of 16 ms was observed ($\underline{F}$ (1, 33) = 4.59; $\underline{MSE}$ = 945.02, $\underline{p}$ < .039). This result again replicates that of Ortells et al. (2003), thus suggesting that a prime word presented for 33 ms and immediately masked may be processed at a semantic level of representation.

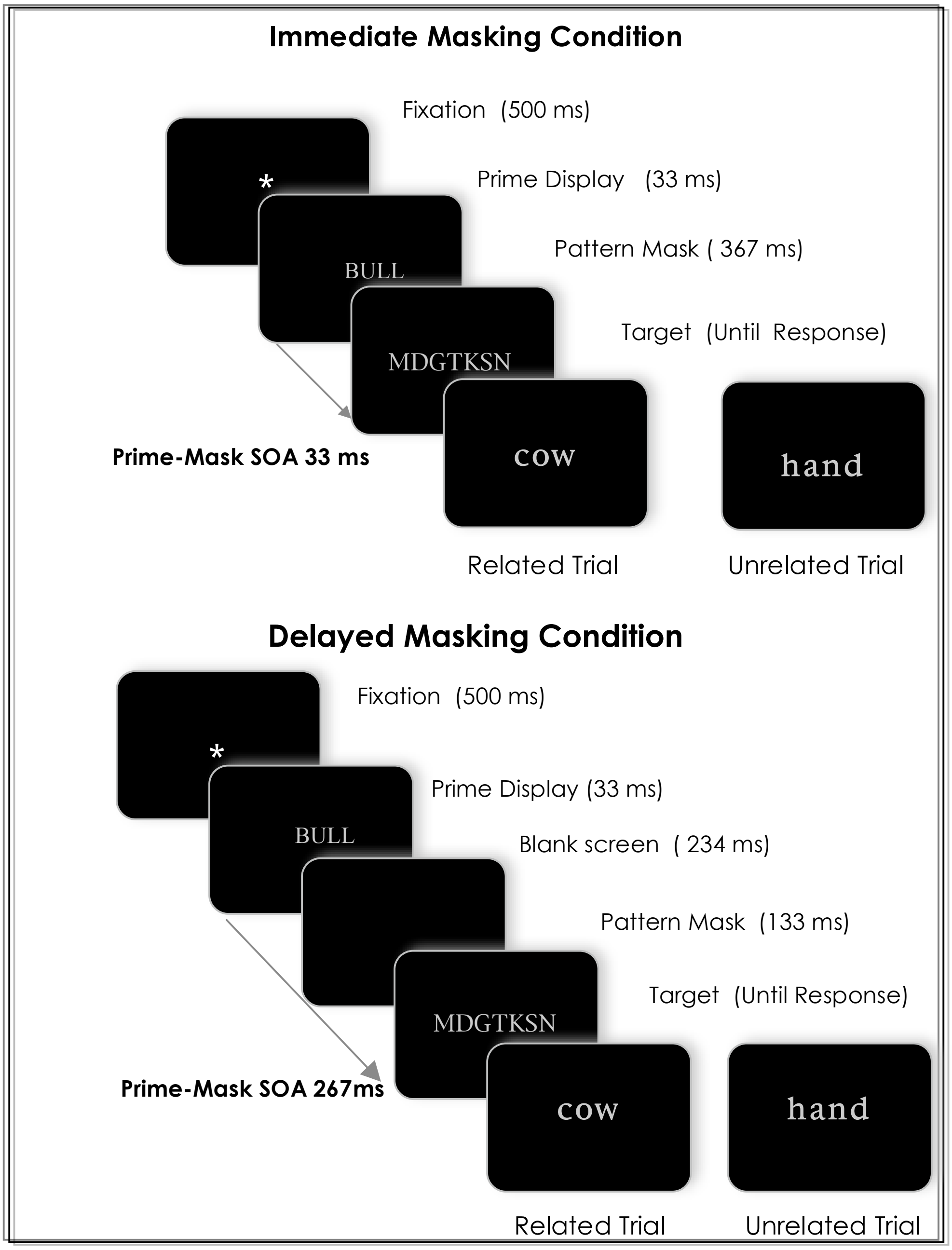

Figure 1. Sequence of events for both immediate and delayed masking trials. Examples shown here have been translated into English.

Table 1. Mean reaction times (in milliseconds), error percentages (in parentheses), and differences (in milliseconds) in RTs (facilitatory (+) or reversed (-) priming) as a function of Masking condition (immediate vs. delayed) and prime-target relationship (unrelated vs. related).

	Masking Condition	
Prime-Target Relationship	**Immediate**	**Delayed**
Related	712 (5.2)	739 (7.9)
Unrelated	728 (4.2)	701 (5.1)
	+ 16	- 38

In the analysis of error percentages there were significant main effects for masking condition (F (1,33) = 4.66, MSE = 0.023, $p < .0038$) and prime-target relationship (F (1,33) = 5.73, MSE = .023, $p < .0023$), such that there was a smaller error percentage for immediate (4.7) than for delayed masking trials (6.5), and for unrelated (4.6) as compared to related trials (6.6).

DISCUSSION

The question of whether semantic processing of the information can occur without attention and/or awareness has been the focus of much research and controversy for many years. Much of this controversy stems from the use of experimental paradigms whereby the relative contribution of automatic (unconscious) components to performance cannot be clearly dissociated from that of controlled or strategic processes. This occurs, for example, whenever behavioural (or electrophysiological) effects on unconscious or unattended processing produce the same pattern of results (e.g., facilitatory priming) as it did conscious or controlled processing. Under these circumstances, it is always possible to argue that supposedly unconscious or automatic influences might rather reflect any residual strategic or controlled processing.

Yet, over last years an increasing number of studies have attempted not only to prove the existence of unconscious cognition, but also to demonstrate that unattended stimuli of which participants are not aware can lead to qualitatively different consequences (e.g., positive vs. negative priming effects) to when we are aware of those same stimuli (e.g., Daza et al., 2002; Debner & Jacoby, 1994; Draine & Greenwald, 1998; Greenwald et al., 1996; Merikle & Joordens, 1997; Ortells et al., 2003). A good example stems from a series of recent studies in which the likelihood that a prime words was perceived with or without awareness was controlled by varying the stimulus quality, such that the prime word was always followed by a mask appearing either immediately (i.e. a prime-mask SOA of 33 ms) or after a time delay following the word offset (e.g., Daza et al., 2002; Merikle & Joordens, 1997; Merikle et al., 1995; Ortells et al., 2003). The result pattern that is consistently shown in these experiments is that individuals can use predictive strategies based on stimulus redundancy, such that predicting the color (e.g. Daza et al., 2002; Merikle & Joordens, 1997), or the semantic category of forthcoming targets (e.g., Ortells et al., 2003) only when the predictive stimuli (i.e., the prime words) are consciously perceived (e.g., with a delayed mask). But when participants claim to be unaware of stimuli' identity (e.g., with an immediate mask) behavioral effects with an opposite sign are rather observed, thus suggesting that predictive stimuli can also be processed in the absence of perceptual awareness. Note, however, that in all prior studies using that kind of dissociation procedure, the different masking conditions varied either across different groups of participants (e.g., Debner & Jacoby, 1994; Merikle & Joordens, 1997; Daza et al., 2002), or across different blocks of trials (e.g., Ortells et al., 2003). By contrast, in the present research the immediate and delayed masking trials were randomly intermixed within the experimental session.

There were two main findings in the present study. First, we replicate and extend the results reported by Ortells et al. (2003; see also Daza et al., 2002; Merikle & Joordens, 1997) in showing that presenting a word under immediate versus delayed masking conditions gave rise to qualitatively different behavioral consequences (i.e., positive versus negative semantic priming effects, respectively), even when both kinds of masking displays were intermixed and varied randomly from trial to trial. The demonstration of a "crossover" interaction between priming effects and masking type with a task demanding a semantic level of representation (i.e., an "animals" vs. "body parts" judgment), is consistent with behavioural and neuroscientific evidence (e.g., Copland, de Zubicaray, McMahon, Wilson, Eastburn, & Cheney, 2003; Deacon, Hewit, Yang & Nagata, 2000; Dehaene, Naccache, Le Clec, Koechlin, Mueller, Dehaene-Lambertz, van de Moortele, & Le Bihan, 1998; Kiefer, 2002) suggesting that semantic activation can occur without conscious identification of word stimuli, at least when they are presented below what Cheesman and Merikle (1986) refer to as a "subjective threshold".

Secondly, obtaining reliable facilitation effects from immediately masked words despite the concurrent presentation of consciously-perceived prime words (i.e., delayed masking trials), provides further and strongest evidence that those priming effects reflect the involvement of *automatic* processes. Some prior studies (e.g., Smith et al., 1994; see also Schlaghecken & Eimer, 2004) have shown that semantic priming effects can be modulated (i.e., eliminated) by context manipulations. But as noted elsewhere, presenting the masked prime word for 84 ms, and using a prime-target SOA of approximately 500 ms, as occurred in Smith et al.'s experiments, seems to be far from representing optimal conditions to assess the contribution of automatic influences. This was not the case in our research, in which the prime-mask SOA that was used on the immediate masking trials (33 ms) was below threshold for subjective awareness (see Footnote 1). Also, to the extent that strategic processes would also have operated with an immediate mask, a reversed priming effect should then emerge for that masking condition, but not a reliable (and opposite) facilitation effect, as was actually the case. This is, in fact, a main *advantage* of our dissociation procedure, which allows obtaining qualitatively differences in performance depending of whether a stimulus is perceived with or without phenomenological awareness.

Given the small number of stimuli used in our experiment (i.e., two semantic categories, each of them having four items only), one could argue that after some practice, priming effects similar to those reported here could emerge with other sorts of stimuli, such as letters or digits that are randomly grouped together. In other words, it could be the case that the positive priming effects under the immediate masking trials were due to repeated exposures of the same prime-target pairs, thus suggesting an "associative" (i.e. a lower perceptual level) rather than a semantic basis for that supposedly automatic priming. But several observations are pertinent here. Firstly, our related trials always consisted of categorically related word pairs that were both strongly associated (in forward and backward directions) and semantically similar (i.e., with a high semantic overlap)[3].

---

[3] Several recent experiments (e.g., Abad, Noguera & Ortells, 2003) have shown positive and negative semantic priming effects (from attended and unattended prime words, respectively) only when the prime-target pairs were *highly- associated* words belonging to the same semantic category. In contrast, no priming evidence was observed for categorically related prime-target pairs that were weak associates and did not share many

There is evidence that priming effects in the absence of "semantic relatedness" are usually the result of controlled mechanisms. In contrast, semantic relatedness seems to be necessary and sufficient to produce automatic priming effects (e.g. Seidenberg, Waters, Sanders & Langer, 1984; Thompson-Schill, Kurtz, & Gabrieli, 1998). For example, Thompson-Schill et al. (1998) used asymmetrically associated word pairs in a priming procedure aimed to minimize potential influences of controlled (strategic) processes (e.g. a short prime-target SOA of 250 ms; a low proportion of related trials). They found reliable positive priming for semantically related prime-target pairs, regardless of the degree (i.e., forward vs. backward) of associative relatedness. Yet, for semantically unrelated words, no automatic priming was found, even if there was an associative (i.e. forward) prime-target relationship (see also McRae & Boisvert, 1996).

On the other hand, given the relative frequencies for related (20%) and unrelated trials (80%) in our study, there was no particular prime-target pair that occurred with more probability than others throughout the experiment. To illustrate, if "HAND" was the prime word, the upcoming word target could be "finger" (on related trials[4]), or "cow", "bull", "frog", or "toad" (on unrelated trials), with these five words being equiprobable. Accordingly, even if participants were able to consciously identify the prime words followed by an immediate mask, they could only learn that the category of the upcoming target would more likely be the opposite to that of the prime (e.g. HAND followed by an "animal" word). Yet, they would be unable to predict the word target's identity. Lastly, the implementation of such a kind of associative learning is minimized by the fact that the primes being immediately followed by a mask were intermixed with primes followed by a delayed mask.

Taken together, the present findings strengthen those previously reported by Ortells et al. (2003; see also Daza et al., 2002), which suggest that the qualitatively different semantic priming effects stemming from conscious and unconscious perception in this kind of dissociative procedure do indeed reflect the contribution of strategic (controlled) and automatic processes, respectively.

---

semantic features (e.g. giraffe-mouse; face-heart).

[4] To the extent that the related trials always consisted of strong associates from the same semantic category, the target stimulus following the prime word "HAND" on a related trial could only be the word "finger", but never the words "face" or "eye".

RESUMEN

Efectos de priming semántico con y sin conciencia perceptiva. El presente trabajo pretende replicar y extender los resultados de algunos estudios previos que demuestran que la percepción consciente vs. no-consciente de palabras puede producir efectos comportamentales diferentes. Los participantes realizaban una tarea de categorización semántica sobre una palabra objetivo que era precedida por una palabra previa que podía pertenecer o a la misma categoría (20% de los ensayos) o a una categoría semántica diferente (80%). La palabra previa se presentaba brevemente y era seguida inmediatamente o tras una demora por una máscara visual. A diferencia de trabajos previos, el tipo de máscara variaba de forma aleatoria de ensayo a ensayo. En los ensayos con la máscara inmediata se encontró un efecto facilitatorio de priming semántico. Con la máscara demorada (que permitía la identificación consciente de la palabra previa) se encontró un efecto opuesto (negativo) de priming. Estos resultados proporcionan pruebas adicionales de que la percepción con y sin conciencia produce consecuencias comportamentales cualitativamente diferentes, las cuales reflejan la contribución de procesos controlados (estratégicos) y automáticos, respectivamente.

REFERENCES

Abad, M. J. F., Noguera, C., & Ortells, J. J. (2003). Influence of prime-target relationship on semantic priming effects from words in a lexical-decision task. *Acta Psychologica, 113,* 283-295.

Balota, D.A. (1983). Automatic semantic activation and episodic memory. *Journal of Verbal Learning and Verbal Behavior, 22*, 88-104.

Besner, D., Smith, M.C., & MacLeod, C.M. (1990). Visual word recognition: A dissociation of lexical and semantic processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*, 862-869.

Cheesman, J. & Merikle, P.M. (1985). Word recognition and consciousness. En D.Besner, T.G. Waller, y G.E. McKinnon (Eds.). *Reading research: Advances in theory and practice*. New York: Academic Press.

Cheesman, J., & Merikle, P. M. (1986). Distinguishing Conscious from Unconscious Perceptual Processes. *Canadian Journal of Psychology, 40*, 343-367.

Collins, A.M., & Loftus, E.F. (1975). A spreading activation theory of semantic processing.
Psychological Review, 82, 407-428.

Copland, D.A., de Zubicaray, G.I., McMahon, K., Wilson, S.J., Eastburn, M., & Cheney, H.J. (2003). Brain activity during automatic semantic priming revealed by event-related functional magnetic resonance imaging. *Neuroimage*, *20*, 302-310.

Daza, M.T., & Ortells, J.J. (2002). Aproximaciones actuales al estudio de la percepción sin conciencia. *Revista de Psicología General y Aplicada, 55*, 203-223.

Daza, M. T., Ortells, J. J., & Fox, E. (2002). Perception without awareness: Further evidence from a Stroop priming task. *Perception & Psychophysics, 64*, 1316-1324.

Deacon, D., Hewit, S., Yang, C.M. , & Nagata, M. (2000). Event-related potencial indices of semantic priming using masked and unmasked words: evidence that the N400 does not reflects a post-lexical process. *Cognitive Brain Research, 9*, 137-146.

Deacon, D., Uhm, T., Ritter, W., & Hewitt, S. (1999). The lifetime of automatic priming effects may exceed two seconds. *Cognitive Brain Research, 7*, 465-472.

Debner, J. A., & Jacoby, L. L. (1994). Unconscious perception: Attention, awareness, and control. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*, 304-317.

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

Di Pace, E., Longoni, A. M., & Zoccolotti, P. (1991). Semantic processing of unattended parafoveal words. *Acta Psychologica, 77*, 21-34.

Draine, S. C., & Greenwald, A. G. (1998). Replicable unconscious semantic priming. *Journal of Experimental Psychology: General, 127*, 286-303.

Friedrich, F.J., Henik, A., & Tzelgov, J. (1991). Automatic processes in lexical access and spreading activation. *Journal of Experimental Psychology: Human Perception and Performance*, *17*, 792-806.

Greenwald, A. G., Draine, S. C., & Abrams, R. L. (1996). Three cognitive markers of unconscious semantic activation. *Science, 273*, 1699-1702.

Henik, A., Friedrich, F., & Kellogg, W. (1983). The dependence of semantic relatedness effects upon prime processing. *Memory & Cognition, 11*, 366-373.

Henik, A., Friedrich, F.J., Tzelgov, J., & Tramer, S. (1994). Capacity demands of automatic processes in semantic priming. *Memory and Cognition*, *22*, 157-168.

Holender, D. (1986). Semantic activation without conscious identification in dichotic listening, parafoveal vision, and visual masking: A survey and appraisal. *The Behavioral and Brain Sciences, 9*, 1-66.

Kaye, D.B., & Brown, S.W. (1985). Levels and speed of processing effects on word analysis. *Memory & Cognition, 13*, 425-434.

Kiefer, M. (2002). The N400 is modulated by unconsciously perceived masked words: further evidence for an automatic spreading activation account of N400 priming effects. *Cognitive Brain Research, 13*, 27-39.

Logan, G. D., Zbrodoff, N. J., & Williamson, J. (1984). Strategies in the color-word Stroop task. *Bulletin of the Psychonomic Society, 22*, 135-138.

Marcel, A. J. (1983 a). Conscious and unconscious perception: Experiments on visual masking and word recognition. *Cognitive Psychology, 15*, 197-237.

Marcel, A.J . (1983 b). Conscious and unconscious perception: An approach to the relation between phenomenal experience and perceptual processes. *Cognitive Psychology, 15*, 238-300.

McRae, K., & Boisvert, S. (1996). The importance of automatic semantic relatedness priming for distributed models of word meaning. *Proceedings of the Eighteen Annual Conference of the Cognitive Science Society, 18*, 278-283.

Merikle, P. M., & Joordens, S. (1997). Parallels between perception without attention and perception without awareness. *Consciousness and cognition, 6*, 219-236.

Merikle, P. M., Joordens, S., & Stolz, J. A. (1995). Measuring the relative magnitude of unconscious influences. *Consciousness and Cognition, 4*, 422-439.

Neely, J. H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. *Journal of Experimental Psychology: General, 106*, 226-254.

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

Ochsner K. N., Chiu C-Y P., & Schacter D. L. (1994) Varieties of priming. *Current Opinion in Neurobiology*, *4*, 189-194.

Ortells, J.J., Abad, M.J.F., Noguera, C., & Lupiáñez,J. (2001). Influence of prime-probe stimulus onset asynchrony and prime precuing manipulations on semantic priming effects with words in a lexical decision task. *Journal of Experimental Psychology: Human Perception and Performance, 27,* 75-91.

Ortells, J.J., Daza, M.T., & Fox, E. (2003). Semantic activation in the absence of perceptual awareness. *Perception and Psychophysics*, *65*, 1307-1317.

Ortells, J.J., Daza, M.T., Noguera, C., Carmona, E., Fox, E., & Abad, M.J.F. (2002). Perception without awareness: The qualitative differences approach. In Serge P. Shohov (Ed.), *Trends in Cognitive Psychology* (pp. 19-42). Nova Science Publishers, Inc. New York.

Ortells, J. J., Fox, E., Noguera, C., & Abad, M.J.F. (2003). Repetition priming from attended vs. ignored single words in a semantic categorization task. *Acta Psychologica, 114*, 185-210.

Ortells, J.J., & Tudela, P. (1996). Positive and negative semantic priming of attended and unattended parafoveal words in a lexical decision task. *Acta Psychologica,* 94, 209-226.

Posner, M.I., & Snyder, C.R.R. (1975 a). Attention and cognitive control. En R. Solso (Ed.). *Information Processing and Cognition: The Loyola Symposium.* Hillsdale. New Jersey: Erlbaum.

Posner, M.L., & Snyder, C.R.R. (1975 b). Facilitation and inhibition in the processing of signals. En P.M.A. Rabbitt y S. Dornic (Eds.). *Attention and performance V.* New York: Academic Press.

Reingold, E. M. (2004). Unconscious perception: assumptions and interpretative difficulties. *Consciousness and Cognition, 13*, 117-122.

Reingold, E. M., & Merikle, P. M. (1988). Using direct and indirect measures to study perception without awareness. *Perception and Psychophysics, 44*, 563-575.

Schlaghecken, F., & Eimer, M. (2004). Masked prime stimuli can bias “free” choices between responses alternatives. *Psychonomic Bulletin & Review, 11*, 463-468.

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). *E-Prime User's guide*. Pittsburgh: Psychology Software Tools, Inc.

Seidenberg, M. S., Waters, G. S., Sanders, M., & Langer, P. (1984). Pre- and postlexical loci of contextual effects on word recognition. *Memory & Cognition, 12*, 315-328.

Shenaut, G. K., & Ober, B. A. (1996). Methodological control for semantic priming in Alzheimer´s disease. *Psychology and Aging*, *11*, 443-448.

Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending and a general theory. *Psychological Review*, *84*, 127-190.

Smith, M.C., Besner, D., & Miyoshi, H.(1994). New limits to automaticity: context modulates semantic priming. *Journal of Experimental Psychology: Learning, Memory & Cognition, 20*, 104-115.

Smith, M.C., Theodor, L., & Franklin, P. E. (1983). The relationship between contextual facilitation and depth of processing. *Journal of Experimental Psychology: Learning, Memory & Cognition, 9*, 697-712.

Thompson-Schill, S. L., Kurtz, K. J., & Gabrieli, J. D. E. (1998). Effects of semantic and associative relatedness on automatic priming. *Journal of Memory & Language, 38*, 440-458.

(Manuscript received: 24 March 2006; accepted: 3 May 2006)