Consciousness and Cognition 29 (2014) 235–247

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Inhibitory mechanisms in single negative priming from ignored and briefly flashed primes: The key role of the inter-stimulus interval

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ARTICLE INFO

Article history:
Received 6 May 2014
Available online 3 October 2014

Keywords:
Negative priming
Masked prime
Inhibitory mechanism
Interstimulus intervals

ABSTRACT

The influence of interstimulus intervals (ISIs) on priming effects was investigated using a single-prime negative priming (NP) paradigm. In all experiments, a brief (16 ms), centrally displayed prime (a Chinese character, to be ignored) appeared, followed by a pattern mask and then a centrally displayed target (another semantically related or unrelated Chinese character); the task required semantic categorization (animate/inanimate) of the target. An ISI could occur either between prime and mask (Experiments 1 and 5) or between mask and target (Experiments 2–4). The results revealed NP when a 470 ms ISI occurred between prime and mask (Experiments 1 and 5) and when a 700 ms ISI occurred between mask and target (Experiments 3 and 4). In contrast, when a long prime-target SOA was maintained but the mask-target ISI was shortened, NP disappeared (Experiment 4). The results indicated that a persisting mask/distractor (without ISI) located in the same position as the following target interfered with the buildup of inhibition, but an ISI between prime and mask or mask and target eliminated this interference, and that inhibition processes induced by an ignore instruction were implemented faster with an ISI placed between prime and mask than with an ISI placed between mask and target.

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1. Introduction

When faced with a large number of information sources, people tend to pay attention to relevant material and ignore irrelevant material. Subsequently, the ignored material is subject to impaired processing (Frings & Wentura, 2005; Milliken, Joordens, Merikle, & Seiffert, 1998; Neill & Kahan, 1999; Ortells, Fox, Noguera, & Abad, 2003; Tipper, 1985; Tipper & Cranston, 1985). For example, responses are slower and less accurate to a previously ignored object than to a new object. This phenomenon is known as negative priming (NP; Tipper, 1985). A typical NP experiment involves two consecutive displays, prime and probe. On each display, participants attend to a target object while ignoring a distractor. NP is assumed to occur with responses to a target on the probe display that are slower or less accurate when the target either matches, or shares attributes with, a recently ignored distractor on the prime display. Many studies have attributed this

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http://dx.doi.org/10.1016/j.concog.2014.08.020
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phenomenon to an inhibitory mechanism of attention that results from actively selecting against irrelevant distractors (e.g., Houghton & Tipper, 1994; Tipper, 1985; Tipper & Cranston, 1985).

However, many studies have challenged the idea of selective inhibition in NP, noting that the phenomenon can be observed even when the prime display consists of a single non-target prime (i.e., a single distractor; e.g., Frings & Wentura, 2005; Milliken et al., 1998; Neill & Kahan, 1999; Neill, Kahan, & Ver Wys, 1996; Wood & Milliken, 1998) and when both the prime and probe displays include only a single stimulus, for example, in a binary task, such as lexical decision-making or semantic categorization, or in a response compatible/incompatible task (Daza, Ortells, & Nogurea, 2007; Machado, Guiney, & Struthers, 2013, Experiment 5; Machado, Wyatt, Devine, & Knight, 2007, Experiment 3; Noguera, Ortells, Abad, Carmona, & Daza, 2007; Ortells, Fox, & et al., 2003). The act of ignoring a single prime in these studies might involve the same inhibitory mechanisms that can suppress distracting items presented in irrelevant locations, as in traditional NP tasks (see Tipper, 2001, for a similar line of argument). Therefore, it is likely the manipulations affecting prime processing, such as asking participants to ignore a single prime, determine the emergence of single-prime NP (e.g., Neill & Kahan, 1999; Noguera et al., 2007; Ortells, Fox, & et al., 2003; Ortells, Fox, Noguera, & Abad, 2006). Several other manipulations have also been shown as important factors to trigger NP:

- Presenting the prime for a relatively short time (e.g., 50 ms or less) and then masking it (i.e., weak activation) (e.g., Neill & Kahan, 1999; Neill et al., 1996; Ortells, Fox, & et al., 2003; Noguera et al., 2007). For example, in Ortells, Fox, & et al. (2003), negative priming emerged not only when the first stimulus was actively ignored but also when the duration of the prime was limited to 50 ms (or 20 ms) and a mask followed. When the duration of the prime was increased to 80 ms (or 100 ms), robust positive priming (PP) occurred even when participants were instructed to actively ignore the first stimulus (Ortells, Fox, & et al., 2003, Experiments 2 and 3; see also Milliken et al., 1998, Experiment 3). This kind of negative effect from weak activation has also been found in other studies (Eimer & Schlaghecken, 2002; Frings & Wentura, 2005; Milliken et al., 1998; Neill & Kahan, 1999). Some researchers, using pictures as primes, have also found NP when primes were masked and PP when primes were visible (Banse, 2001; Hermans, Spruyt, De Houwer, & Eelen, 2003).
- Using a relatively long prime-target SOA (600 ms or longer) (Eimer & Schlaghecken, 1998; Machado, Guiney, & Mitchell, 2011; Machado et al., 2007; Machado et al., 2013; Ortells, Fox, & et al., 2003). For instance, in Experiment 4 of Ortells, Fox, & et al. (2003), the participants were asked to actively ignore a single prime that was presented for 50 ms and followed immediately by a pattern mask (50 ms); after a variable interval, the single target appeared. PP was observed when the prime-target SOA was 300 ms and robust NP with an SOA of 800 ms. Other compatibility studies also found negative effects with longer intervals between distractor and target (Eimer & Schlaghecken, 1998; Machado et al., 2007, Experiment 3A).

Regarding the mechanisms of single-prime NP from masked primes, Ortells, Fox, & et al. (2003) demonstrated that an instruction to actively ignore a prime word produced either reduced positive priming (relative to an attend instruction) or negative priming, depending on the presentation duration of that word. According to Ortells, Fox, & et al. (2003), the prime which is presented for a relatively long time (e.g., 100 ms) is likely to be deeply processed, an "ignore" instruction could reduce the magnitude of priming effects, but will not be strong enough to reverse the priming to negative. Alternatively, the to-be-ignored prime which is presented for a briefer period (50 ms or less) and post-masked is already low activated, a top-down "ignore" instruction will be enough to reverse the priming effect from positive to negative. They further noted that weak activation may be necessary, but not sufficient; a relatively long prime-target SOA would also be necessary to obtain reliable NP from ignored single words, since the inhibition requires time to develop.

However, using conditions identical to those of Ortells, Fox, & et al. (2003) – long prime-target SOA, ignore instructions, briefly presented prime and then masking – Daza et al. (2007) produced contradictory findings. Their study used similar prime-target SOAs (600 ms), but the ignored primes were presented for 33 ms, followed immediately by a 567 ms pattern mask, in order to prevent conscious identification of the prime; then the single target appeared and was displayed until the response. PP was observed instead of the predicted NP; however, NP was found when a 434-ms blank interval was inserted between the brief (33 ms) prime and shorter mask of 133 ms. According to Daza et al., in the immediate masking condition, the prime was perceived without awareness, leading to more automatic reactions that could not be controlled and resulting in PP. In the delayed masking condition, the prime was consciously perceived (i.e., followed by a blank interval, and then masked), making it possible to intentionally follow the ignore instruction and resulting in reliable NP. However, the role of the state of consciousness in single-prime NP remains unclear.

We note other crucial differences between Daza et al. (2007) and Ortells, Fox, & et al. (2003). As shown in Table 1, the brief primes were followed by a persistent mask with 0-ms prime-mask ISI (inter-stimulus interval) and 0-ms mask-target ISI in the immediate mask condition in Daza et al.; a prime-mask ISI was included in the delayed mask condition in Daza et al.; a long mask-target ISI was included in Ortells, Fox et al. This pattern of results suggests that NP depends on the duration of the prime-mask ISI or the mask-target ISI. With persistent masking (a relatively longer masking without following or being followed by an ISI), PP is more likely to occur.

Houghton, Tipper, Weaver, and Shore (1996) used the traditional location NP paradigm to reveal the influence of ISI on negative priming effects. In Houghton et al. (1996), at the start of each trial, the four locations were occupied by question marks ("?") for 1500 ms. Then the prime display (where targets "O" and distractors "+" replaced any two of the "?") was presented for 150 ms. In the long prime conditions, the prime display remained on the screen until they were replaced

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