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Reading a standing wave: Figure-ground-alternation masking of primes in evaluative priming

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ABSTRACT

We propose a new masking technique for masking word stimuli. Drawing on the phenomena of metacontrast and paracontrast, we alternately presented two prime displays of the same word with the background color in one display matching the font color in the other display and vice versa. The sequence of twenty alterations (spanning approx. 267 ms) was sandwich-masked by structure masks. Using this masking technique, we conducted evaluative priming experiments with positive and negative target and prime words. Significant priming effects were found – for primes and targets drawn from the same as well as from different word sets. Priming effects were independent of prime discrimination performance in direct tests and they were still significant after the sample was restricted to those participants who showed random responding in the direct test.

1. Introduction

The exploration of unconscious influences on behavior and decision making is an evergreen topic in cognitive psychology. In this context, the response priming paradigm (see e.g., Neumann & Klotz, 1994; Rosenbaum & Kornblum, 1982; Vorberg, Mattler, Heinecke, Schmidt, & Schwarzbach, 2003) constitutes an important experimental approach to shed some light on the issue of unconscious perception and its influences (for review and overview of masked priming see, e.g., Kinoshita & Lupker, 2003; for an overview of subliminal response priming see Kiesel, Kunde, & Hoffmann, 2007). Typically, the trial procedure in a response priming paradigm is as follows: First, a prime stimulus is presented for up to a few hundred milliseconds. Subsequently, a target stimulus is presented. The participants' task is simply to categorize the target stimulus in a binary choice task. Crucially, the prime is compatible or incompatible to the correct target response.

Typically, response times (RTs) are faster and/or error rates are lower if prime and target are response-congruent (i.e., they belong to the same response category). As the prime is of no relevance for the participants' task, the priming task is considered an indirect test of the influence of an item on behavior (see, e.g., Draine & Greenwald, 1998).

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1.1. Masking and unconscious perception

To explore unconscious perception, the prime has to be presented in a way that at least the critical feature (i.e., the feature that is compatible or incompatible to the target response) is not consciously perceived. Typically, this is achieved through very short presentation durations and through methods of visual masking (see e.g., Breitmeyer & Ögmen, 2006 for a general overview on visual masking; for discussions on several mechanisms causing visual masking see, e.g., Herzog, 2007; Macknik & Martinez-Conde, 2007). To test for the efficiency of masking, a direct test usually follows the indirect test. Most often, the direct test asks for categorization of the masked primes. Performance at chance level in this direct test is the traditional criterion for assuming subliminal processing of the prime in the indirect test.

Using this basic approach, clear subliminal priming effects have been found for simple geometric forms. For example, Vorberg and colleagues (2003) presented left-directed or right-directed arrows as primes. The primes were masked by the target which indicated a direction as well. Participants were faster to press a key corresponding to the target's direction if the prime had already indicated this direction, as compared to the incompatible case.

Other studies have explored whether masked primes are processed up to the level of semantic meaning. For example, Draine and Greenwald (1998) used the evaluative priming paradigm (Fazio, Sanbonmatsu, Powell, & Kardes, 1986) for this purpose. Participants had to categorize positive and negative words with regard to their valence. Masked primes were positive and negative words as well. With clearly visible primes, a response priming effect is typically found, that is, participants react faster if prime and target have the same valence (see Klauer & Musch, 2003 for a review). Draine and Greenwald found this pattern of results with masked primes as well (see also Wentura & Degner, 2010).

Methods to mask words have not changed much over the years. Masking is usually achieved by a technique known as pattern masking. *Pattern masks* are fields of fairly complex visual patterns, which are neutral with regard to informational content. Examples of pattern masks are fields composed of irregular unaligned lines or unsystematically scattered simple geometric figures. If the masks structurally resemble the to-be-masked stimulus, they are also termed *structure masks*. For example, a random row of consonants would serve as a structure mask for words. Usually, the to-be-masked stimulus is directly overwritten by the mask or sandwiched between two mask presentations (see, e.g., Breitmeyer & Ögmen, 2006). Although several refinements have been developed, inherent drawbacks to this technique remain.

Critically, most of the common masking techniques share two particular drawbacks. First, they only allow the subliminal stimulus to be presented very briefly. This means that its presentation duration (or energy) is not comparable to the presentation duration in experiments using supraliminal stimuli (see also Wentura & Frings, 2005). Second, and even more importantly, pattern masking exerts its influence at a very late stage of information processing. Conscious perception of the critical information is prevented because the mask interferes with analyzing the weak information from the briefly presented word. Participants know that they saw something, but are just unsure about what it was (see also Macknik & Martinez-Conde, 2007, 2009 for the role of feedback processes and differences of these processes for attention and awareness). It is possible that such fragmentary conscious information could inform guessing, which would make it difficult to ascertain whether masking was in fact successful (see Holender, 1986; Kouider & Dupoux, 2004). Obviously, it would be appealing to have a masking technique that exerts its influence at earlier stages of information processing by preventing more information (e.g., also information regarding presences or absence of letters) from reaching consciousness.

1.2. Figure-ground-alternation masking

A very efficient alternative to pattern masking is *metacontrast* masking (Fehrer & Raab, 1962). This involves a spatially adjacent but non-overlapping mask (e.g., a black ring with an inner diameter corresponding to the black circle which is the to-be-masked stimulus), which is presented briefly after the to-be-masked stimulus. This backward mask impedes visual brightness information by a cortical mechanism not yet completely understood (see, e.g., Breitmeyer, 2007). Presenting the mask before the to-be-masked stimulus can result into a comparable masking effect named *paracontrast* (which is, however, of lesser magnitude). Metacontrast has been successfully used in experiments with simple geometric shapes, for example in response priming experiments aiming to show direct parameter specification and automatized response preparation (Neumann & Klotz, 1994; Vorberg et al., 2003).

At first glance, the effectivity of metacontrast masking seemed limited to fairly simple visual forms, and unfortunately the technique did not appear useful to mask words, which are basically composed of multiple delicate visual shapes. However, by drawing on two analogies, we suggest a masking technique—based on the interplay of metacontrast and paracontrast—that seems promising.

First, Wentura and Frings (2005; see also Bermeitinger, Frings, & Wentura, 2008) proposed a *repeated masking technique* in the domain of semantic priming (a similar method was used, for example, by Henke et al., 2003, for investigating nonconscious formation and reactivation of associations by way of the medial temporal lobe). This involves 20 cycles of interchanging the prime word and the (structure) mask to prolong the overall presentation duration of the prime. Second, our approach draws on a phenomenon called the 'standing wave illusion' (Macknik & Livingstone, 1998; see also Enns, 2002). *Standing wave masking* is the alternation of two video frames, one showing a flickering vertical bar, the other containing two flanking flickering bars. The result is that the central bar remains invisible. Thus, standing wave masking could be also described as a combination of backward and forward masking.