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Specific and non-specific match effects in negative priming

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ABSTRACT

The negative priming effect occurs when withholding a response to a stimulus impairs generation of subsequent responding to a same or a related stimulus. Our goal was to use the negative priming procedure to obtain insights about the memory representations generated by ignoring vs. attending/responding to a prime stimulus. Across three experiments we observed that ignoring a prime stimulus tends to generate higher identity-independent, non-specific repetition effects, owing to an overlap in the coarse perceptual form of a prime distractor and a probe target. By contrast, attended repetition effects generate predominantly identity-specific sources of facilitation. We use these findings to advocate for using laboratory phenomena to illustrate general principles that can be of practical use to non-specialists. In the case of the negative priming procedure, we propose that the procedure provides a useful means for investigating attention/memory interactions, even if the specific cause (or causes) of negative priming effects remain unresolved.

1. Introduction

Priming occurs when exposure to one stimulus (the prime) either facilitates or impairs responding to a related stimulus in a subsequent display (the probe). In many investigations of priming, the temporal separation between presentation of the prime and probe is quite brief (no more than a few seconds); a method referred to elsewhere as *immediate priming* (Leboe, Leboe, & Milliken, 2010; Leboe, Whittlesea, & Milliken, 2005). Since the emergence of cognitive psychology as a field several decades ago, the popularity of priming methodologies (both immediate and less immediate) has been quite high. Initially, such studies focused primarily on sources of facilitation in responding to a probe after prior exposure to an identical prime (the phenomenon of repetition priming, for reviews, see Bowers, 2000; Masson & Bodner, 2003; Tenpenny, 1995) or a related prime (e.g., the phenomenon of semantic priming, see Hutchinson, 2003; Neely, 1991 for reviews). By the mid-1980s, however, there emerged a fresh and expanding interest in priming effects owing to high-profile demonstrations that responses to a probe can be impaired after prior exposure to a related prime (the phenomenon of negative priming Lowe, 1985; Tipper, 1985, Tipper & Cranston, 1985; Neill & Westberry, 1987).

Since the earliest days of negative priming, a number of variations on the basic procedure have emerged and researchers have employed a range of stimulus materials (see Fox, 1995; Milliken, Joordens, Merickle, & Seiffert, 1998; Neill, Valdes, & Terry, 1995; Tipper, 2001 for reviews). The most common methodology involves presenting a prime and probe display on each of a succession of trials. Both the prime and probe display contains two stimuli; a target that participants must make some judgment about and a distractor. For example, the prime display might consist of a target word (e.g., *VIOLIN*) to be identified aloud or categorized with a button-press response and a distractor word (e.g., *BUTTON*). The experimental conditions are then defined by the association between the prime target and distractor and the identity of the probe target and distractor. On *unrelated* trials, the probe target and distractor both differ from the prime target and distractor. Using the examples provided above, on such trials the probe might consist of *PENCIL* as the target and *MONKEY* as the distractor. On *attended-repeated* trials, the probe distractor differs from both the prime target and distractor, whereas the probe target would be identical to the prime target (e.g., the probe target would be *VIOLIN*, whereas the probe distractor might be *MONKEY*). Finally, on *ignored-repeated* trials, the probe distractor differs from both the prime target and distractor, whereas the probe target would be identical to the prime distractor (e.g., the probe target would be *BUTTON*, whereas the probe distractor might be *MONKEY*). Performance in responding to targets on unrelated trials provides the baseline for measuring immediate priming effects. The typical result observed with this procedure is that performance is faster and/or more accurate on attended repetition trials than on

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unrelated trials (a positive repetition effect), whereas performance is often slower and/or less accurate on ignored repetition trials than on unrelated trials (a negative repetition effect).

Subsequent to the expansion of interest in negative priming approximately > 30 years ago, research on negative priming effects proceeded somewhat dichotomously. Investigations by Steve Tipper and colleagues (Milliken & Tipper, 1994; Tipper & Baylis, 1987; Tipper, Brehaut, & Driver, 1990; Tipper & Driver, 1988; Tipper, Lortie, & Baylis, 1992; Tipper, MacQueen, & Brehaut, 1988; Tipper, Weaver, & Houghton, 1994) inspired many to use the negative priming methodology as a tool for investigating attentional processes, and theoretical accounts that emerged placed a large emphasis on attentional mechanisms. In particular, a *distractor inhibition hypothesis* developed out of this tradition and continues to be a highly competitive explanation for negative priming effects, and related effects in which the perceiver must select against processing one or more sources of information (e.g., Healy, Campbell, & Hasher, 2010). By this view, ignoring a prime distractor inhibits underlying mental representations responsible for processing that stimulus. The outcome is that people are impaired when responding to an identical or similar probe target. The idea that negative priming effects are especially informative of attentional inhibitory processes has motivated many investigators to use the methodology as a way to measure the attentional capacities of special subgroups, such as children (Frings, Feix, Röthig, Brüser, & Junge, 2007; Tipper, Bourque, Anderson, & Brehaut, 1989), the elderly (Tipper, 1991), and individuals with a mental disorder (Goeleven, de Raedt, Baert, & Koster, 2006; MacQueen, Tipper, Young, Joffe, & Levitt, 2000).

In parallel with these attention-oriented applications of the negative priming methodology, other researchers forwarded the competing notion that negative priming effects are fundamentally memory phenomena. Most notably, Trammell Neill and colleagues (Neill & Mathis, 1998; Neill & Valdes, 1992; Neill, Valdes, Terry, & Gorfein, 1992; see also Bodner & Masson, 2003, 2014; Lowe, 1998; Park & Kanwisher, 1994) provided compelling demonstrations that the size and occurrence of negative priming effects seem to correspond to known principles of memory. For example, Neill (1997) had participants complete a flanker task in which they identified a target letter positioned between two distractor letters. The onset of the distractors either occurred at once with the onset of the target, or their onset was delayed by 400 ms. The resulting match or mismatch in target-distractor onset asynchrony had a strong influence on the size of the NP effect observed, with the occurrence of greater NP effects when the target-distractor onset of the prime event matched that of the probe event. Such demonstrations (see also Chao & Yeh, 2008; Fanini, Nobre, & Chelazzi, 2006; Fox & de Fockert, 1998; Grison & Strayer, 2001; Malley & Strayer, 1995) are analogous to a host of memory studies revealing that success in remembering tasks depends on overlap between conditions present at the time of encoding and those present during attempts to remember (Bower, 1981; Fisher & Craik, 1975; Godden & Baddeley, 1975; Neill et al., 1992; Neill, Terry, & Valdes, 1994; Neill & Valdes, 1992; Smith & Vela, 2001; Thomson & Tulving, 1970; Tulving & Thomson, 1973). By now, these encoding/retrieval *match* influences on remembering performance are well-established, reflected in the principles of encoding specificity (Thomson & Tulving, 1970; Tulving, 2002; Tulving & Thomson, 1973) and transfer-appropriate processing (Morris, Bransford, & Franks, 1977, but see Poirier et al., 2012, for a recent critical discussion of the role of encoding/retrieval match in determining performance of remembering tasks). From this memory-centered perspective, negative priming effects occur due to retrieval of a memory representation for the prime episode at the time of the probe event. The process of ignoring the prime distractor forms part of the episodic memory representation for the prime event, which impairs responding to that same stimulus when it becomes the probe target. This approach is widely referred to as the *episodic retrieval account*.

The proposal of theoretical alternatives for an empirical observation motivates considerable efforts to test which one is superior; it is not surprising that researchers are eager to contribute to the declaration of a winner (e.g., Frings, 2008, 2011; Frings, Rothermund, & Wentura, 2007; Ihrke, Behrendt, Schrobsdorff, Herrmann, & Hasselhorn, 2011; Leboe et al., 2005; Leboe et al., 2010; Leboe, Mondor, & Leboe, 2006; Rothermund, Wentura, & De Houwer, 2005, and see Frings, Schneider, & Fox, 2015 for a more thorough, recent review of competing accounts of negative priming). Nevertheless, theoretical approaches offered to account for negative priming effects are robust and can be readily modified to accommodate empirical challenges. As a result, the debate as to the relative merits of the distractor inhibition and episodic retrieval accounts of negative priming effects has continued without a firm resolution. Meanwhile, additional competitive explanations for negative priming effects have been suggested (e.g., the temporal discrimination account, Milliken et al., 1998). Together, these efforts have been valuable at promoting the thorough documentation of the factors that make negative priming effects bigger, smaller, or disappear. Even so, it does seem reasonable to question the utility of continued efforts to empirically rule out one or more theoretical explanations for a phenomenon when the efforts of some of the cleverest cognitive scientists have been unsuccessful in achieving this objective.

Perhaps a different level of analysis would provide a new and useful function for the negative priming methodology. Regardless as to which theoretical approach regarding the cause of negative priming effects is ultimately correct (and it remains quite possible that either all or none of the main competitors are), the distractor inhibition hypothesis and the episodic retrieval accounts do highlight the two central cognitive processing components of conventional variants of the negative priming procedure. First, there is an attentional component in that participants must ensure that their response is driven by one stimulus (the target) and not another (the distractor) – the distractor inhibition hypothesis emphasizes that feature of the design. Second, there is a memory component, in that the prime event has its effect on future performance – the episodic retrieval account emphasizes this “past imposes its will on the present” feature. In the current study, we focus on these two essential features of the negative priming procedure because they represent a unique opportunity to investigate interactions between attention and memory.

2. The current study

Steve Tipper and colleagues originally used their negative priming investigations to reveal the degree to which people process ignored information. In particular, their observation that negative priming can be observed for a prime distractor image that is semantically-related to a probe target image supported conceptual-level processing of ignored information (Tipper, 1985). An appreciation for the memory component inherent in negative priming studies motivates a similar question. Our reasoning is that overlap between an aspect of the prime distractor and an aspect of the probe target can only influence the presence or magnitude of a negative priming effect if that feature of the prime distractor is present within the memory representation created by the prime event. Similarly, overlap between the prime target and the probe target can only influence positive priming effects when that source of facilitation is present within the memory representation created by the prime event.

These assertions seem obvious, and perhaps they are, but there are relatively complex implications stemming from them. For example, our theoretical position, which will be elaborated upon further in the General Discussion, is that the presence of a feature within a prime event does not require that it forms a component of the memory representation generated from that event. Our rationale receives inspiration, first, from the idea that memory does not preserve information about the objective properties of an event. Instead, memory preserves the component processes that a person engages in during that event (Craik & Lockhart, 1972; Leboe-McGowan & Whittlesea, 2013; Lockhart & Craik, 1990; Whittlesea, 1997). In that case, it is possible to use the presence or absence of priming effects to infer the contents of a

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