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Long-term semantic priming of propositions representing general knowledge



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ABSTRACT

Six experiments investigated semantic priming of individual propositions that reflect common knowledge. Participants performed a sentence-completion task in which each sentence expressed a single proposition, and the same or similar proposition was expressed in prime-target sentence pairs that shared no words. The primary goal was to evaluate the degree to which long-lasting facilitation in primed target sentences reflected memory for abstract proposition meaning versus memory for the operations used to construct proposition meaning and select a response. Priming effects persisted over delays exceeding 15 min, were not attributable to explicit memory processes, did not depend on either repeated syntactic structure or response decision, and were greater than facilitation attributable to priming individual word meanings. In total, the evidence provides initial support for operation-independent, long-term semantic priming of propositions outside the context of connected discourse. This extends the empirical evidence for long-lasting facilitation that theories of semantic priming must explain.

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Introduction

Early demonstrations of semantic priming by Meyer and colleagues (Meyer & Schvaneveldt, 1971; Meyer, Schvaneveldt, & Ruddy, 1975), and the majority of subsequent semantic priming research, has relied on two relatively simple verbal tasks: lexical decision and word naming. In some respects, the term *semantic priming* became synonymous with facilitation effects in these tasks (see McNamara, 2005). Theory and evidence from these lines of research established semantic priming as a short-lived facilitation on semantically related words.

However, there is growing evidence that tasks requiring greater degrees of semantic processing produce non-strategic priming effects that persist beyond what theories

based on the simpler tasks can explain (Becker, Moscovitch, Behrmann, & Joordens, 1997; Joordens & Becker, 1997; Tse & Neely, 2005, 2007; Was, 2010; Woltz, 2010; Woltz & Was, 2007). It appears that semantic priming has different durations and perhaps different underlying mechanisms with different task demands. So far, the evidence for longer-term semantic priming has come from tasks that have increased semantic processing demands, but these tasks all assess priming with respect to individual words. In popular theoretical views of knowledge representation, the fundamental unit of knowledge that has a truth value is the proposition (e.g., Anderson, 1983, 1993; Kintsch, 1974). In this research we extended the range of complexity in semantic priming tasks to include the processing of propositions representing general knowledge. We investigated relatively long-term semantic priming in expressions of isolated propositions, and evaluated alternative explanations to the premise that the persistent facilitation is attributable to increased mem-

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ory strength in abstract representations of semantic knowledge. The alternative explanations tested correspond to those debated in recent research on long-term semantic priming in words.

The idea of semantically mediated access to proposition memory is hardly new; memory for propositions encoded during text processing has received considerable attention in reading research. However, we suggest that such research cannot easily isolate the role of abstract proposition memory from the broader meaning context in which the propositions are embedded. Furthermore, much of this research has investigated memory for newly formed episodic propositions in discourse. Our purpose was to investigate the nature of semantic priming in isolated propositions that represent general knowledge, with the goal of extending the emerging theoretical understanding of long-term semantic priming.

Evidence and explanations of long-term semantic priming

As noted, most theories of semantic priming cannot explain evidence for longer-term semantic priming effects in word processing tasks. This differs from evidence and theory pertaining to long-lasting repetition priming effects that may depend on memory for perceptual or encoding operations (Kolers, 1973, 1976; Tulving & Schacter, 1990). Temporary semantic priming effects can be explained by spreading activation processes (McNamara, 1992; Neely & Kahan, 2001), compound cue theories (Doshier & Rosedale, 1989; Ratcliff & McKoon, 1988) and distributed network memory models (Masson, 1995; Plaut & Booth, 2000). These theoretical explanations posit memory processes that are displaced quickly by subsequent processing, so none predicts that semantic priming effects would be detected after several intervening trials (for discussion of this see Becker et al., 1997, and McNamara, 2005). Yet, Joordens and Becker (1997) reported priming effects in lexical decisions that spanned as many as eight intervening trials. Tse and Neely (2007) reported similar evidence within a lexical decision task.

Joordens and Becker (1997) suggested that, compared to previous research, it was the increased semantic processing demanded by their version of the lexical decision task that produced the longer-term semantic priming effects. Consistent with this idea, Becker et al. (1997) reported semantic priming effects that persisted over 20 unrelated trials in a task that required animacy decisions of category exemplars. Tse and Neely (2005, 2007) found lexical decision priming after a 30-s unrelated task. Their priming manipulation consisted of studying multiple semantically related words rather than a single lexical decision trial. Woltz and Was (2007) and Was (2010) reported long-term priming effects in category exemplar decisions. Participants showed persistent facilitation in deciding if two exemplars were members of the same category when they had made previous decisions about different exemplars from the same category. Finally, Woltz (2010) reported long-lasting semantic priming effects in a task that required participants to decide if two words were synonyms. The facilitation showed a slow, gradual decline but was still evident after 14 unrelated trials.

The evidence linking longer-term semantic priming to task complexity suggests that proposition priming would be relatively long lasting given the inherent semantic complexity of encoding propositions versus individual words. If so, it is important to consider whether the current theoretical view that accounts for long-term word-level priming could explain persistent proposition priming. Becker et al. (1997) proposed a connectionist network model that was unique in positing persistent rather than temporary changes in activated network connections from processing a semantically related prime word. Each target word is presumed to have a partly overlapping network representation with semantically related words. The time required for target words to settle to their network activation patterns is reduced when previous prime-word processing has strengthened a subset of the target stimuli connections.

Other connectionist networks account for temporary semantic priming (e.g., Masson, 1995; Plaut & Booth, 2000), but the network proposed by Becker et al. (1997) uniquely explains long-term semantic priming effects by the impact of stimulus inputs on connection weights in the network. Other connectionist models view network units as somewhat similar to switches: Meaning representations are comprised of patterns of units being turned on or off. Priming, then, is the result of a target network state being similar to that created by a previous prime word. Such a network only allows for temporary activation states because unrelated stimuli change the pattern of units turned on (Masson, 1995). In contrast, Becker described the depth of attractor basins for target words resulting from persistent weight changes in network connections from prior activation. In this way, facilitation due to overlapping patterns of activation between prime and target stimuli can be longer lasting and resistant to intervening stimuli.

The Becker et al. (1997) distributed network model's ability to account for long-term semantic priming at the word level suggests that a similar approach could be used to explain long-term priming in semantically related propositions. Sharkey (1990) discussed the representation of proposition units in memory within a connectionist model of text comprehension. This model describes a proposition level within a connectionist network in which there are existing patterns for different proposition units. These proposition patterns are activated based on the text being read, such that one proposition pattern is ultimately activated. A model such as this, but one that incorporated the Becker et al. (1997) incremental learning mechanism with attractor basins, could presumably account for persistent semantic priming in both word and proposition representations.

A different explanation for long-term semantic priming effects at the word level also has applicability to priming effects at the proposition level. The unique feature of this explanation is that it attributes performance facilitation to repeated operations performed on the semantic content of stimuli, rather than to strength changes in the semantic representations themselves. Evidence supporting this view comes primarily from experiments using tasks requiring category exemplar decisions (Hughes & Whittlesea, 2003;

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