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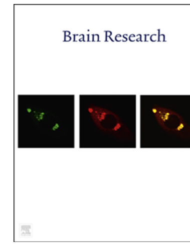

Research Report

Lexical inhibition of neighbors during visual word recognition: An unmasked priming investigation

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ABSTRACT

Two experiments investigated the lexical inhibitory effect of orthographic neighbors relative to identity priming effects in an unmasked priming paradigm combined with a lexical decision task on word targets. Targets were preceded either by the same word, by a lower frequency orthographic word neighbor, by an orthographic pseudoword neighbor or by an unrelated prime. Experiment 1 showed a standard facilitatory effect from identity primes, whereas inhibitory priming effects were observed for both types of neighbor primes. Experiment 2 examined the time-course of these effects by using event-related potential recordings. A generalized relatedness effect was found in the 200–400 ms time-window, with smaller negativities generated by related primes than unrelated primes regardless of prime type. In contrast, at 400 ms, while identity primes were associated with smaller negativities than unrelated primes, word neighbor primes were associated with greater negativities than unrelated primes. Additionally, pseudoword neighbor primes produce null effects as compared to unrelated primes. These results are discussed in terms of competition between activated lexical representations and revealed that such a mechanism is modulated by the lexical status of the prime.

1. Introduction

Successful reading requires translating visual symbols into meaning. Research in cognitive neuroscience has indicated that individual written words can be identified in less than half a second. The speed and apparent ease of this process has provided a continuing challenge for researchers seeking to understand the mechanisms involved in visual word recognition. One point on which there is presently a consensus is that individual written words are identified via their constituent letters (see Grainger, 2008, for a summary of the arguments). One consequence of this point is that a given word does not activate only the lexical representation of that particular word but also that of orthographically similar words, so-called orthographic neighbors (e.g., lift, list and pint are neighbors of lint; Coltheart et al., 1977). The effects of orthographic similarity have been the focus of several investigations in the past several decades. One central open question concerns

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the structural organization of the mental lexicon and so the present investigation aims to provide further insights into the nature of the connections between lexical representations, as well as between prelexical orthographic and lexical representations. This is accomplished by examining the time-course of visual word recognition using an unmasked priming paradigm combined with event-related potential (ERP) recordings.

There is a general consensus nowadays that word recognition involves the selection of the correct lexical representation from among a set of possible candidates (i.e., orthographic neighbors). One prominent model of visual word recognition, the Interactive-Activation model (IA model, McClelland and Rumelhart, 1981), implements competitive interactions between activated lexical representations to ensure a word's recognition while inhibiting its competitors. More precisely, the original IA model is a connectionist model with three hierarchical levels of letter string processing: a feature level (which corresponds to visual segments of letters), a letter level, and a word level. The representational units at each level feed activation to (as applicable) the levels of representation above and below them in the hierarchy, and there is lateral inhibition among representations within each level. According to this model, lexical representations that share letters with a presented word will receive bottom-up support and the orthographic overlap between the presented word and words with similar orthography will modulate the activation of lexical representations. This processing dynamic also implies that words with many orthographic neighbors will produce higher levels of resonance through excitatory connections between the different levels of representation – for instance, those at the letter level and those at word level – than words with few orthographic neighbors (Andrews, 1989, 1992, 1997).

To ensure the recognition of a visually presented word, the IA model and its successors (e.g., Davis and Lupker, 2006; Grainger and Jacobs, 1996; Perry et al., 2008) account for competitive interaction in the form of lateral inhibitory connections between activated lexical representations. According to that mechanism, any activated lexical representation spreads inhibition to all other lexical units which allows the suppression of other lexical representations that have received some activation from letter level representations. In a series of experiments using a single word reading paradigms, Grainger and collaborators showed that the size of the set of lexical candidates per se does not affect the selection of the correct representation, but rather that the presence of an activated lexical representation of a higher frequency neighbor of the presented word dominates the word recognition process (Grainger, 1990; Grainger et al., 1989; Grainger and Segui, 1990; Jacobs and Grainger, 1992). Thus, when a given word is presented in isolation, the response times in a lexical decision task are longer when the word possesses a higher frequency orthographic neighbor (see also Carreiras et al., 1997; Grainger, 1990; Perea and Pollatsek, 1998). According to the IA approach, each representation has a threshold of recognition which depends on the lexical frequency of the stimulus. At the resting state, this threshold is lower for high-frequency words and higher for low-frequency words. Consistent with this characteristic of the IA framework, several studies have reported faster reaction times and better accuracy for high-frequency words than for low-frequency words (e.g., Frost et al., 1987; Grainger, 1990; Humphreys et al., 1988; Perea and Carreiras, 1998). Once past its threshold, a lexical representation sends inhibitory input to all other lexical representations as a function of its activation level and so representations of high-frequency words produce greater inhibition than representations of low-frequency words.

To date, the majority of evidence regarding orthographic neighborhood effects comes from studies using the masked priming paradigm, in which a briefly presented prime (typically on the order of 50 ms in duration) is followed by a target item (Forster and Davis, 1984). Numerous studies have investigated priming effects from identity and neighbor primes. Overall, these studies show that word prime that is orthographically related to a lower frequency target tends to interfere with target processing (Carreiras et al., 1997; Davis and Lupker, 2006; De Moor and Brysbaert, 2000; Nakayama et al., 2008; Perea and Rosa, 2000a; Segui and Grainger, 1990), whereas the presentation of the same word or an orthographically related pseudoword as prime stimulus facilitates target processing relative to unrelated controls (Bodner and Masson, 1997; Forster, 1987; Forster and Davis, 1984; Forster et al., 1987, 2003; Forster and Veres, 1998; Grainger and Jacobs, 1993; Perea and Lupker, 2003, 2004; Perea and Rosa, 2000a; Sereno, 1991). According to the IA framework, the activation generated during prime processing is maintained upon presentation of the target stimulus and so accumulated activation in the network will produce initial facilitation when prime and target are orthographically similar, facilitation being maximal when the target is the same word as the prime stimulus. However, when the prime is a neighbor of a lower frequency target, the prime supports the activation of a lexical representation other than the representation of the target stimulus and so within-level inhibition on the word target will develop. The amount of inhibition will be maximal when primes are of higher frequency than the word targets. Consequently, the word neighbor prime is capable of substantial inhibition of its neighbors and this lengthens the recognition of the word target.

Recent research has combined the masked priming paradigm with event-related potentials (ERPs) to provide complementary data, particularly with respect to the relative timing of effects found in behavioral experiments. ERPs have been extensively used for studying visual word recognition, because this technique enables the temporal ordering (with millisecond-level resolution) of the neural processes involved during reading. Therefore this technique allows the dissociation of hierarchically different sources of information (such as orthographic, semantics) through a continuous measure of neuronal activity over time. Combined with the masked priming paradigm, this methodology has been shown to be sensitive to different levels of processing occurring during visual word identification, such as orthographic processing (Carreiras et al., 2009a, 2009b; Grainger et al., 2006; Holcomb and Grainger, 2006), lexical processing (Carreiras et al., 2009a, 2009b; Holcomb and Grainger, 2006; Massol, 2012; Massol et al., 2011), and semantic processing (Holcomb and Grainger, 2006; Midgley et al., 2009).

Most relevant to the present investigation is the study conducted by Massol et al. (2010), in which they investigated