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Early morphological processing is sensitive to morphemic meanings: Evidence from processing ambiguous morphemes

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ABSTRACT

In three priming experiments, we investigated whether the meanings of ambiguous morphemes were activated during word recognition. Using a meaning generation task, Experiment 1 demonstrated that the dominant meaning of individually presented ambiguous morphemes was reported more often than did other less frequent meanings. Also, participants tended to produce responses that were consistent with the morphemic meaning of the subliminally presented prime words. Experiment 2 employed a masked priming lexical decision task (prime display duration = 40 ms) and showed that the recognition of targets which took the dominant meaning of ambiguous morphemes was facilitated by all morpheme-sharing primes, regardless of their intended interpretation. In contrast, morphological priming for subordinate targets was observed only in the subordinate priming condition. Using an unmasked priming task (prime display duration = 100 ms). Experiment 3 revealed that lexical decision responses were facilitated only when the morphemic interpretations in primes and targets were matched. These data indicate that the different meanings of an ambiguous morpheme are activated early during word recognition and that it takes time to select the appropriate morphemic interpretation. The results are discussed with reference to a modified lemma model of word recognition.

Introduction

Human language is characterized by an arbitrary linkage between symbols and meanings. For instance, there are no obvious reasons for the letter sequence "c-o-o-k" to be associated with the action of preparing food. Morphemes, however, can help regularize the form-meaning association, as words that share the same morpheme are usually related in meaning (e.g., "cooker", "cookery", and "cookbook"; Lavric, Clapp, & Rastle, 2007; Spencer, 2001). Indeed, language users can even combine existing morphemes in creative ways to express novel ideas, such as "facebook" ("face" + "book") and "unfriend" ("un-" + "friend"). Previous studies have found a reliable morpheme effect on word recognition (e.g., Crepaldi, Rastle, Coltheart, & Nickels, 2010; Marslen-Wilson, Tyler, Waksler, & Older, 1994; Rastle, Davis, & New, 2004; Taft, 1994; Tsang & Chen, 2010). Moreover, the effects of morphemes cannot be reduced to formal or conceptual processing at the lexical level (Feldman, 2000; Rastle, Davis, Marslen-Wilson, & Tyler, 2000), supporting a unique and independent role of morphemes in recognizing words. Although it is now a standard practice to incorporate morphemes into theories of word recognition, many details about morphological processing are unsettled. For instance, it remains controversial whether early morphological processing relies purely on surface orthographic structure (i.e., the morpho-orthographic view) or morphemic meaning (i.e., the morpho-semantic view; Bertram, Hyönä, & Laine, 2011; Davis & Rastle, 2010; Feldman, O'Connor, & Moscoso del Prado Martín, 2009; Rastle & Davis, 2008).

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One popular approach in testing the relative importance of morpho-orthographic and morpho-semantic processing in word recognition is to investigate the semantic transparency effect. This is commonly done by comparing the strength of morphological priming produced by transparent words (e.g., "departure"; the stem "depart" is semantically related to the whole-word) against that produced by opaque words (e.g., department; the stem "depart" is semantically unrelated to the whole-word). The presence of semantic transparency effect has been taken as evidence of morpho-semantic processing during word recognition. Employing a masked priming lexical decision procedure, Frost, Forster, and Deutsch (1997) demonstrated that prior exposure to both transparent and opaque words could facilitate subsequent target word recognition in Hebrew. Moreover, the strengths of facilitation in the two conditions were statistically equivalent, indicating the absence of morpho-semantic constraints. Similar results have also been obtained in English (Marslen-Wilson, Bozic, & Randall, 2008; Rastle et al., 2004), French (Longtin, Segui, & Hallé, 2003), Spanish (Duñabeitia, Perea, & Carreiras, 2008), and Russian (Kazanina, Dukova-Zheleva, Geber, Kharlamov, & Tonciulescu, 2008), using not just behavioral (reaction times and error rates), but also neurophysiological measures (fMRI: Gold & Rastle, 2007; ERP: Lavric et al., 2007). The absence of morpho-semantic effects in these studies led Rastle and Davis (2008; also see Taft & Forster, 1975) to propose an obligatory morphological analysis driven entirely by surface morpho-orthographic structure in word recognition: Letter sequences that look like morphemes will be segmented, regardless of whether they contribute to word meanings or not. Therefore, both transparent and opaque words will be decomposed, but monomorphemic words like "brothel" is analyzed holistically because "-el" is not a legal suffix in English.

According to Rastle and Davis (2008), morphemic meaning only plays a role in lexical access at the later stage of word recognition, where "illegal" or meaningless combinations of morphemes (i.e., opaque words) will terminate morphological processing and trigger semantic re-analysis (Lavric, Rastle, & Clapp, 2011). This hypothesis appears to agree well with studies that revealed a significant semantic transparency effect. For example, Marslen-Wilson et al. (1994) employed the cross-modal priming paradigm to compare the strengths of morphological priming by transparent and opaque primes (e.g., "departure" vs. "department"). In six experiments, facilitation was found only in the transparent condition. Opaque primes either did not influence target word detection or led to inhibition. Morpho-semantic constraints were also found in the comprehension of novel French words, such that morphological priming occurred in processing interpretable novel words (e.g., "rapidifier" and "installage), but not non-interpretable ones (e.g., "sportation"; Meunier & Longtin, 2007). In addition, morpho-semantic activation could be observed in a visual-visual intra-modal priming experiment (Sandra, 1990), in which an explicit semantic relationship between the constituent morpheme and the prime word (e.g., "bread–buttercup") led to facilitation in lexical decision. Contrary to the masked priming experiments, participants in these studies were fully aware of the primes because they were presented either auditorily or visually for a longer duration (>60 ms). Differences between transparent and opaque words in these studies were thus reflective to later stages of word recognition, confirming the two-stage mechanism that Rastle and Davis proposed.

On the other hand, a number of recent studies have shown that the early stage of morphological processing does not necessarily involve morpho-orthography only. For instance, masked morphological priming appears to survive orthographic changes between primes and targets (e.g., bought – buy, Crepaldi et al., 2010; fetish – fete, McCormick, Rastle, & Davis, 2008). More importantly, in some experiments, the strength of facilitation produced by transparent words was stronger than that by opaque words (Diependaele, Sandra, & Grainger, 2005; Morris, Frank, Grainger, & Holcomb, 2007). Indeed, as illustrated by Feldman, O'Connor, and Moscoso del Prado Martín (2009), in at least 75% of the published masked priming experiments, there is a consistent trend for stronger facilitation in the transparent than in the opaque condition. When data across studies were pooled, the difference between transparent and opaque conditions actually reached statistical significance (but see Davis & Rastle (2010) for alternative interpretations). These data thus provide support for the idea that early morphological processing is not just a morpho-orthographic event but also a morpho-semantic one.

The involvement of both morphemic form and meaning in early morphological processing is consistent with the distributed connectionist approach to morphology (e.g., Plaut & Gonnerman, 2000; Seidenberg & Gonnerman, 2000), which suggests that a morphological representation emerges due to the stable correlation between form and meaning among words within the same morphological family. In other words, morphology can be coded as an intermediate level of representation between orthography and semantics. While being a localist model in nature, a similar idea is adopted in the hierarchical framework of word recognition proposed by Taft (2004; Taft & Nguyen-Hoan, 2010; also see Crepaldi et al., 2010). According to this model, morphology is coded at the "lemma" level, an abstract layer of representations situated between form and functional information (e.g., semantic and syntactic features). Morpho-semantic priming can thus be attributed to the pre-activation of the same lemma shared between prime and target. Moreover, given the emerging nature of these morphological representations, the model hypothesizes the following: (a) Ambiguous morphemes (e.g., "stick", which means "adhere" or "twig" depending on the context) have distinct lemmas for different meanings. (b) The interpretation of an ambiguous morpheme will be biased towards the previously activated meaning during prime word processing. (c) The morphological processing of a target word will be facilitated more strongly by the prior exposure to a prime word containing the ambiguous morpheme with the same interpretation (i.e., sharing both form and lemma) than that with a different interpretation (i.e., sharing form only).

These predictions have received support in the meaning generation task by Taft and Nguyen-Hoan (2010). In their experiment, participants were instructed to report the first