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The effects of multiple script priming on word recognition by the two cerebral hemispheres: Implications for discourse processing

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Abstract

The present study examined left (LH) and right (RH) hemisphere involvement in discourse processing by testing the ability of each hemisphere to use world knowledge in the form of script contexts for word recognition. Participants made lexical decisions to laterally presented target words preceded by centrally presented script primes. (four sentences describing common situations). To examine the maintenance of script information across intervening text, there were six types of primes. These consisted of either single scripts or combinations of two different scripts: (1) a related script, (2) an unrelated script, (3) a related script + a neutral "filler," (4) a related script + an unrelated script, (5) an unrelated script + a related script, and (6) a neutral baseline condition. Results indicated that in the LH, only related scripts or related scripts preceded by unrelated scripts facilitated target word recognition. In contrast, the RH gained significant facilitation from all combinations of script primes, including related scripts followed by either filler materials or unrelated scripts. These results are consistent with the theory that the RH contributes in a critical way to discourse comprehension by maintaining widespread meaning activation for an extended period. This unique ability of the RH may be especially important for integrative processes needed to achieve global coherence during discourse processing.

Keywords: Hemispheres; Visual fields; Scripts; Priming; Discourse processing

1. Introduction

Anectodal as well as clinical evidence from right brain damaged individuals first provided hints that the right hemisphere (RH) might play a unique role in processing language in contexts that extend beyond the meanings of individual words or sentences. Thus, although they usually do not appear aphasic, RHD patients are often tangential in conversation, jumping from topic to topic and introducing new topics without bridging the gap for listeners. They are frequently unable to maintain the theme of a conversation and are prone to missing the overall point of a conversation or story (for reviews, see Beeman, 1998; Brownell & Martino, 1998). Many studies inspired by these early accounts have also shown that injury to the RH can disrupt discourse comprehension, i.e., the ability to understand a group of sentences that describes a sequence of events, as in a story or conversation (e.g., Chiarello, 2003; Tompkins, Baumgaertner, Lehman, & Fassbinder, 2000). The present study tested an explanation for the distinct role of the RH in discourse processing, that focuses on the ability of this hemisphere to maintain widespread script-related meaning activation for an extended period (e.g., Burgess & Simpson, 1988; Chiarello, 1991, 2003; Faust & Kahana, 2002). We suggest that this unique ability may underlie

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the contribution of the RH to the integrative processes needed to achieve global coherence during discourse processing. This would be consistent both with reports on difficulties in discourse comprehension demonstrated by RHD patients and with divided visual field studies indicating that the RH is more likely than the left hemisphere (LH) to process a wide range of word meanings and to maintain activation over long prime–target intervals (e.g., Atchley, Burgess, & Keeney, 1999; Beeman et al., 1994).

Previous research has implied substantial hemispheric differences in the nature and time course of information retrieval during word processing. Thus, the findings of visual half field studies indicate that while each hemisphere has access to a structured store of semantic knowledge, the LH and the RH differ in their sensitivity to different types of semantic relationship (for reviews, see Chiarello, 2003; Faust & Lavidor, 2003). Taken in its entirety, the literature on word-level semantic processing by the two hemispheres suggests that the LH is biased toward the maintenance of close lexical-semantic associations, while the processing of more loosely related semantic relations relies mainly on the RH. According to Beeman's coarse versus fine semantic coding model (Beeman, 1998; Beeman et al., 1994), when people read or hear a word, the LH uses relatively fine semantic coding to quickly select a single relevant meaning or a few relevant features, discarding others. This makes the LH extremely adept for most language tasks. In contrast, the RH employs relatively coarse semantic coding to weakly activate several meanings and many features of the word, including features that are only distantly related to the input word, given the context. The idea that the RH is especially sensitive to weak but overlapping activation from distantly related words was explicitly tested in a summation priming paradigm. Beeman et al. (1994) presented series of three weakly related prime words (e.g., "white," "ceremony," "tuxedo," or "foot," "cry," "glass") followed by laterally presented target words ("wedding" or "cut," respectively). They found that under conditions that encouraged intentional meaning processing, the RH gained more benefit than the LH from the multiple weakly related primes whereas the LH was more facilitated from a single, strongly related prime than from the three weakly related summation primes. Beeman et al. (1994) concluded that in the RH, meaning activation is distributed over many representations, rather than one or a few representations being much more active than the others.

In addition to the different scope of word meanings activated in each hemisphere, previous research has also shown hemispheric differences in the time course of meaning availability. Thus, findings of several priming studies have suggested that the RH activates weakly related semantic information more slowly and maintains it longer than the LH, making distantly related, unusual word meanings available for longer time periods (e.g., Anaki, Faust, & Kravetz, 1998; Burgess & Simpson, 1988; Faust & Kahana, 2002). These studies show that as a result of the different patterns of meaning availability, information that has been already suppressed in the LH might still be activated in the RH (e.g., subordinate and metaphoric word meanings).

Several studies that examined sentence processing by the two cerebral hemispheres have extended this model beyond the word level. Thus, the relatively sustained and nonspecific semantic processing by the RH versus the rapid, selective and more controlled semantic processing by the LH led to the hypothesis that the two hemispheres use different mechanisms to comprehend sentences. In a series of sentence priming studies (e.g., Chiarello, Liu, & Faust, 2001; Faust, 1998; Faust, Bar-Lev, & Chiarello, 2003; Faust & Chiarello, 1998) it was found that the LH uses the intralexical as well as the message-level information contained in the sentence to facilitate word recognition, whereas the RH relies mainly, although not solely, on intralexical information, that is, on the processing of semantic relations between single words appearing in the sentence. The most effectual use of message-level mechanisms by the LH, as compared to the use of intralexical mechanisms by the RH, occurs with highly structural and constrained linguistic contexts which require controlled, selective, and fast linguistic processing. According to this model, the advantages of the slow and nonselective sentence processing in the RH may become evident only when the sustained activation of multiple meanings, including contextually nonrelevant meanings, contributes to language comprehension, e.g., when several considerations must be integrated or when an initially attractive interpretation must be abandoned in favor of another (e.g., Faust & Chiarello, 1998; Faust et al., 2003).

In an ERP study, Federmeier and Kutas (1999) also reported important differences between the two hemispheres in processing sentence contexts. However, they characterize these differences as "predictive" versus "integrative" in the LH and RH, respectively. According to their interpretations, the LH selectively activates semantic features associated with the item most likely to be encountered in the upcoming words, whereas the RH directly compares the features of items in the context with those of the current word. Although proposing a different conceptualization of hemispheric differences in sentence processing, this model too suggests that language processing by the LH is more selective and constrained than that of the RH.

However, to gain a more complete understanding of how, in extracting and maintaining different types of information from language contexts, the LH and the RH each make their unique and critical contribution to language processing, the effects of contexts containing more than one complete sentence should also be investigated.