Hemispheric differences in word meaning processing:

Alternative interpretations of current evidence

Several models of hemispheric differences in word meaning processing converge on one proposal. After initial broad activation of a word's features or meanings, the left hemisphere (LH) focuses to the word's core meanings by inhibiting less related or inconsistent features or interpretations. Thus, only *strongly related* meanings are maintained. Conversely, in the right hemisphere (RH) *weakly related* features of meaning remain activated, purportedly facilitating the processing of unexpected interpretations, non-literal meanings, or inferences (Beeman, 1998, Burgess & Lund, 1998; Chiarello, 1998; Koivisto & Laine, 2000). This proposal is referred to as the *standard model* in the rest of this paper.

The standard model has become widely accepted. It is used to guide research into language deficits after left- and right-hemisphere brain damage (e.g., Brownell, 2000; Copland, Chenery, & Murdoch, 2002). However, several aspects of the method and interpretation of evidence cited in support of the standard model require consideration and investigation. This review discusses four such aspects: prime presentation, priming measure, level of processing, and targeted aspect of meaning. Then an alternative interpretation of the evidence is provided.

1. Prime presentation

The standard model is mainly based on evidence from semantic priming studies with divided visual field (dvf) presentation. Stimuli are presented to the side of the visual field so that the visual information initially reaches only the contralateral hemisphere. Performance advantages for stimuli presented to one visual field over the other are

interpreted as processing advantages of the target hemisphere for the particular type of stimulus used.

In semantic priming studies, participants view two words, a prime and a target, in succession. In dvf presentation, the target is always presented laterally. But primes can be presented either laterally or centrally. Evidence for the standard model in paired priming studies comes mainly from studies with lateralized primes. For example, using both conditions Chiarello and colleagues (Chiarello, Burgess, Richards, & Pollock 1990) found expected hemispheric differences only with lateral primes. The authors argued that lateral primes are better to capture hemispheric differences because they maximize lateralization of processing, However, the standard model addresses hemispheric differences in the processing of words under typical processing conditions. For reading, that condition is central presentation. Thus, evidence from studies with central primes would be most relevant to the standard model. Further research is required to determine similarities or differences between the two forms of presentation.

2. Priming measure

Evidence in support of the standard model relies on three measures of semantic priming. *Priming* is the difference between unrelated and related prime-target pairs; *facilitation* the difference between trials with so-called neutral primes and those with related primes; and *inhibition* the difference in neutral and unrelated prime trials. Results illustrate that these measures are not always consistent. For example, Nakagawa (1991) reported significant *inhibition* for weakly related prime-target pairs presented to the rvf-LH (consistent with the standard model), and these word pairs also showed *priming* (inconsistent with the standard model).

To avoid basing arguments on the measure(s) that provides the desired results, researchers and other readers consistently should evaluate *priming* data, for several reasons. First, *priming* can be derived from all studies. Further, the validity of neutral primes has been questioned, because frequently repeated and semantically empty primes might be processed differently from other word primes (e.g., Brown, Hagoort, & Chwilla, 2000; Jonides & Mack, 1984). Also, several dvf studies demonstrate difficulty obtaining interpretable reaction times to neutral primes (e.g., Anaki, Faust, & Kravetz; Burgess & Simpson; Shears & Chiarello, 2003).

3. Level of processing

The standard model addresses semantic processing. However, most relevant dvf studies have used associated prime-target pairs. Several authors have argued that association reflects relationships at the word form level (e.g., Fodor, 1983). Thus, observed hemispheric asymmetries might be attributed to word-form rather than word-meaning processing. Further studies need to investigate whether similar priming effects can be achieved with non-associated semantically related stimuli.

4. Targeted aspect of meaning

Studies used in support of the standard model address two different aspects of meaning. Some of these studies investigate strength of semantic relatedness, that is, they compare prime-target pairs that are either strongly or weakly related. Others investigate effects of meaning dominance. These studies use ambiguous words as primes, and compare priming for targets related to the dominant (most frequent) and subordinate (less frequent) prime meaning. In the standard model, dominant meanings are subsumed under *strongly related* meanings, and subordinate meanings are identified with weakly related

meanings. Thus, the strong/weak distinction in the standard model conflates two different aspects of meaning: strength of relatedness and meaning dominance.

Investigations of prime meaning dominance typically also confound these two relationships, because they pair the ambiguous prime with a strongly associated target related to the dominant (more frequent) prime meaning, and a weakly associated target that is related to the subordinate (less frequent) target meaning (e.g., Burgess & Simpson, 1985). Thus, observed hemispheric differences could be due to strength of semantic relatedness, meaning dominance, or an interaction of both. One study that tried to address this confound (Atchley, Burgess, & Keeney, 1999) did not include the critical condition of a target strongly related to the subordinate meaning of the prime; therefore, further research is required to address this confound, and separate the effects of these two aspects of meaning.

5. An alternative interpretation of current evidence

Studies with central primes and their priming results suggest that for semantic relatedness, rvf-LH and lvf-RH semantic priming effects reflect the degree of similarity between prime and target, with less-related meanings showing less priming than strongly-related meanings (Nakagawa, 1991; Chiarello, Burgess, Richards, & Pollock, 1990; Chiarello, Richards, & Pollock, 1992). This result is inconsistent with the standard model, which proposes rvf-LH inhibition for less-related meanings. For dominance, priming effects are consistent with the standard model (rvf-LH priming for only dominant meanings; lvf-RH priming for both dominant and subordinate meanings) (Burgess & Simpson, 1985; Atchley, Burgess, Audet, & Arambel, 1996; Atchley, Story, & Burchanan, 2001).

If strength of semantic relatedness alone does not lead to inhibition for rvf-LH stimuli, the observed inhibition for subordinate meanings would suggest two possible interpretations: it reflects an interaction of weak activation for subordinate meanings and weak priming for less-related word pairs, or complete inhibition of subordinate meanings. The latter possibility would suggest that LH processing creates activation states that reflect only consistent meanings, and inhibit inconsistent meanings.

Interestingly, this evidence from studies with central primes/lateralized targets shows the same rvf-LH stimuli priming patterns as those in studies with central primes/ central targets that address the same aspects of meaning. Thus, this reading of the dvf evidence might suggest that for such priming studies responses are driven solely by LH processing. However, as is clear from this review, more research is needed to clarify the issues and confounds listed above.

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