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The role of the right hemisphere in speech act comprehension

Thomas Holtgraves

Department of Psychological Science, Ball State University, Muncie, IN 47306, United States

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ABSTRACT

In this research the role of the RH in the comprehension of speech acts (or illocutionary force) was examined. Two split-screen experiments were conducted in which participants made lexical decisions for lateralized targets after reading a brief conversation remark. On one-half of the trials the target word named the speech act performed with the preceding conversation remark; on the remaining trials the target did not name the speech act that the remark performed. In both experiments, lexical decisions were facilitated for targets representing the speech act performed with the prior utterance, but only when the target was presented to the left visual field (and hence initially processed by the RH) and not when presented to the right visual field. This effect occurred at both short (Experiment 1: 250 ms) and long (Experiment 2: 1000 ms) delays. The results demonstrate the critical role played by the RH in conversation processing.

1. The role of the right hemisphere in speech act comprehension

Research across a variety of areas suggests that the left and right hemispheres are specialized for different functions, and that many processes are differentially distributed over the two hemispheres (e.g., Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Gazzaniga, 2000; Rotenberg & Weinberg, 1999; Tucker & Williamson, 1984). This is clearly the case for language use. Traditionally, language processing (for most right-handed people) has been viewed as occurring primarily in the left hemisphere (LH). However, research over the past several decades has demonstrated that the right hemisphere (RH) also plays an important – albeit different – role in language use. Hence, successful language use involves the operation and coordination of the two hemispheres. What is not well understood is the specific nature of the role played by the RH in language use.

Initial research demonstrating a role for the RH in language use came from studies of patients who suffered damage to their RH. The majority of these studies demonstrated that right hemisphere damaged (RHD) individuals were impaired in terms of pragmatic processing, particularly in terms of their ability to comprehend nonliteral meanings (Foldi, 1987; Hirst, LeDoux, & Stein, 1984; Kaplan, Brownell, Jacobs, & Gardner, 1990; Wapner, Hamby, & Gardner, 1981). For example, in an early study, Hirst et al. (1984) asked participants to judge the appropriateness of conversational exchanges in which one interactant asked a question of another. In some contexts the question had a literal meaning and in others an indirect meaning. The reply from the second person responded to either the literal or indirect meaning. RHD participants were more likely than control or left hemisphere damaged (LHD) participants to judge an inappropriate response (i.e., responding to the literal meaning when the indirect meaning was intended) as acceptable. A conceptually similar finding was reported by Wapner et al. (1981) who examined memory for stories. They found the recall protocols of participants with RHD to be more literal and exact reproductions of a story; healthy participants, in contrast, generated more paraphrases reflecting a higher-level text-based integration of the story. Other studies in this vein have demonstrated that people with RHD have difficulty understanding types of nonliteral meaning such as jokes (Bihrle, Brownell, Powelson, & Gardner, 1986), sarcasm (Rehak, Kaplan, & Gardner, 1992; Shamay-Tsoory, Tomer, & Aharon-Peretz, 2005), and metaphor (Giora, Zaidel, Soroker, Batori, & Kasher, 2000; Winner & Gardner, 1977).

Neuroimaging studies of the role of the RH in the comprehension of nonliteral remarks have produced inconsistent results. Bottini et al. (1994) used positive emission tomography (PET) to examine brain regions associated with metaphor comprehension. Participants made plausibility judgments for the meaning of literal and metaphorical sentences. One important difference that emerged was for activation in the right (but not left) precuneus for metaphoric sentences. Bottini and colleagues argue that this pattern reflects activation and use of mental imagery in the comprehension of metaphors. In contrast, more recent studies using an fMRI procedure to examine processing of metaphors and matched literal targets have failed to find greater RH activation for metaphorical statements (Lee & Dapretto, 2006; Rapp, Leube, Erb, Grodd, & Kircher, 2004, 2007).

Most likely, the role of the RH in the comprehension of nonliteral remarks will be different for different types of nonliteral meaning (Kacinik & Chiarello, 2007). For example, Coulson and

E-mail address: 00t0holtgrav@bsu.edu

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colleagues have combined the measurement of event-related potentials (ERPs) with hemifield presentation to study a variety of nonliteral meanings. In general, the results of their research have demonstrated enhanced RH activity for jokes (Coulson & Wu, 2005) but not for metaphors (Coulson & Van Patten, 2007) or puns (Coulson & Severens, 2007). Importantly, the role played by the RH may vary within a particular type of nonliteral meaning. For example, in research examining different types of metaphors, Schmidt, DeBuse, and Seger (2007) demonstrated a LH advantage for processing familiar metaphors (direct retrieval), but a RH advantage for unfamiliar metaphors (interpretation required). Similarly, Pobric et al. (2008) used a transcranial magnetic stimulation procedure and found that stimulation of the right posterior superior temporal sulcus disrupted processing of novel, but not conventional, metaphors. In contrast, stimulation of the left inferior frontal gyrus impaired processing of conventional, but not novel, metaphor pairs.

Other researchers have used a divided field priming procedure in order to examine hemispheric differences in the activation of word meanings. One of the most consistent effects has been the demonstration of roughly equivalent semantic priming in the right and left hemispheres. This occurs when semantic activation is relatively automatic (short stimulus onset asynchrony (SOA), low proportion of critical trials, masked primes, etc. (see Neely, 1991) and the prime target pairs are strongly related and members of the same semantic category (e.g., sofa-chair) (Chiarello, Burgess, Richards, & Pollock, 1990). However, when the stimuli are nonassociated category members (lamp-chair), priming occurs only in the RH and not in the LH (Chiarello, 1985). These findings are taken as indicating passive activation of weakly related category members within the right, but not the left, hemisphere (Chiarello, 1998). The results of an experiment conducted by Beeman and colleagues (Beeman et al., 1994) demonstrated clearly this effect. They examined the effects of three word primes that were either weakly related or unrelated to a target, with the target lateralized to either the right or the left hemisphere. Priming occurred in the RH (and not the LH) when the three prime words were distantly related and converged on the target.

Other studies have demonstrated hemispheric differences in the time course of semantic activation. Burgess and Simpson (1988) examined priming with ambiguous words and short and long SOAs. At short SOAs both dominant and subordinate meanings were active in the LH; at long SOAs, however, only the dominant meaning remained active. In contrast, both the dominant and subordinate meanings remained active at long SOAs in the RH. Somewhat similarly, Anaki and colleagues (Anaki, Faust, & Kravets, 1998) examined lexical decision speed for lateralized literal (e.g., bee) and metaphoric targets (e.g., insult) following a central presented prime (e.g., stinging). At short SOAs, there was metaphorical priming for both hemispheres; at longer SOAs, however, priming occurred only for the RH.

Overall, then, these studies suggest that both hemispheres activate closely related semantic information, but differ in the nature of that activation. The LH engages in close semantic coding, activating a restricted set of meanings and quickly settling on a dominant meaning. The RH engages in more diffuse and courser priming, activating many different meanings and leaving them activated for a longer period of time. These differences are consistent with a variety of neurological data regarding differences between the right and left hemisphere (see Beeman, 1998; Jung-Beeman, 2005).

Although most hemifield research has examined word meaning, there have been a few studies examining hemispheric differences in discourse processing. Beeman, Bowden, and Gernsbach (2000) examined the on-line generation of text-based predictive and coherence inferences. They found priming effects for predictive inferences early in a story for the RH but not for the LH, a finding consistent with single word priming studies. That is, the RH quickly activates a diverse set of representations capable of supporting predictive inferences. Faust and colleagues (Faust, Babkoff, & Kravetz, 1995; Faust, Kravetz, & Babkoff, 1993) investigated intra-lexical and message-level sentence priming in the right and left hemispheres. The general procedure in these experiments (using Hebrew words) was to manipulate various aspects of primes (e.g., one word prime vs. incomplete sentence primes; scrambled sentence vs. unscrambled sentence) and then examine the subsequent effects on lexical decisions for targets lateralized to either the right or the left hemisphere. In general, LH priming varied as a function of the syntactic information in the prime (e.g., unscrambled vs. scrambled sentences) but RH priming did not. Instead, the priming that occurred in the RH reflected lexical priming but not message level priming. Faust (1998) argues that it is the LH that is responsible for the integration of message-level meaning, though such integration (especially for certain types of language such as figurative expressions) is supported by diffuse RH activation. More recently Long, Baynes, and colleagues (Baynes, Davis, & Long, 2005; Long & Baynes, 2002; Long, Baynes, & Prat, 2005) investigated discourse priming and reported (consistent with the studies conducted by Faust and colleagues) propositional priming only in the LH and not in the RH. In contrast, semantic priming (associative and topic) was demonstrated in both the LH and the RH. These results, combined with those of Faust, suggest that the LH, but not the RH, encodes a sentence-level representation, but both hemispheres involve the activation of semantic associates (though probably in different ways). It is important to note, however, that message-level effects examined in these experiments all pertained to direct or literal meaning (rather than indirect or nonliteral meaning). This raises the issue of whether the RH would be involved in message level meaning if that meaning was distinct from a literal reading of the sentence, an issue to be addressed in the proposed research.

2. Current research

Overall, then, studies examining individuals with brain damage have shown that people with RHD tend to display pragmatic (rather than semantic/syntactic) deficits, with the most consistent finding being that people with RHD are more likely to interpret remarks as literal when the intended meaning is otherwise. Studies of intact individuals have demonstrated RH recruitment in the activation of distant semantic associates of single words. However, there have been only a few studies examining the role played by the RH in sentence comprehension, and none examining any type of pragmatic processing.

In this research, I examined the role of the RH in the recognition of a speaker's intention in producing an utterance. This is a critical component of interactive language use because interactants must, in a sense, recognize what each person is up to in order for the conversation to proceed. One way to conceptualize language-based intentions is in terms of speech acts or illocutionary force. Illocutionary force, as defined by speech act theorists (e.g., Searle, 1969), is the action (e.g., thank, apologize, promise, etc.) a speaker intends to perform with an utterance. For example, when Bob says to Andy, "I'll definitely do it tomorrow," he would generally be regarded as having performed the act of promising. Note that illocutionary force is often conveyed without use of the relevant speech act verb (e.g., the verb promise is not part of "I will definitely do it tomorrow"). I refer to these as implicit performatives.

Research has demonstrated that recognition of the illocutionary force of implicit performatives is an important component of conversation comprehension (Holtgraves, 2008; Holtgraves & Ashley, 2001). In one of the preceding studies, participants read descriptions of situations that were followed by remarks said by