Comprehension of discourse relations in the right and left cerebral hemispheres

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Introduction

Studies of patients with right hemisphere damage suggest deficits in their ability to understand language at the discourse level. These studies have sometimes failed to include left-hemisphere damaged controls because the tasks are not suitable for an aphasic population. This raises questions about whether the observed deficits are specific to the right hemisphere or are a more general product of brain damage. We introduce a paradigm from the discourse processing literature known as item-priming-in-recognition (IPIR) to examine the memory representation of short prose passages in left and right hemisphere damaged patients.

The paradigm requires participants to read a series of brief passages and then view a list of words presented one at a time for a recognition judgment. Unbeknownst to the participant, prime-target pairs are embedded in the list. These pairs are used to assess the memory representation for three types of relations contained in the passages: propositional relations, appropriate associates to ambiguous words, and passage topics. Prior work with normal subjects using split-field presentations has demonstrated right visual field/left hemisphere sensitivity to propositional, associate and topic relations (Long & Baynes, 2002). In contrast, the left visual field/right hemisphere was sensitive to associate and topic relations, but not propositional ones. We hypothesized that propositional relations rely on syntactic operations not supported by the right hemisphere, but that topic and associate relations can be derived from lexical representations and are supported by both hemispheres. We tested that hypothesis in patients with focal lesions to the right or left hemisphere.

Subjects

All subjects had a single unilateral cerebral vascular accident at least one year prior to enrollment. All were right-handed native speakers of English with no prior neurological or psychiatric disease. They were of mixed aphasia types but all had a reading score on the Western Aphasia Battery of at least six and continued to use reading in their daily lives. Twenty-two left hemisphere damaged (LHD), ten right hemisphere damaged (RHD), and thirteen control subjects have participated. Enrollment continues.

Materials

The study materials consisted of 56 two-sentence passages used previously (Long, Oppy, & Seely, 1997; Till, Mross, & Kintsch, 1998). Each pair of passages was constructed around an ambiguous noun (see Table 1). The homograph appeared at the end of either the first or second sentence and its meaning was disambiguated by the context. Associates of each meaning were used as either the appropriate or inappropriate targets depending upon the preceding context. Topics represented the modal response of a group of pilot participants who were asked to provide a one word theme for the passages. Each passage contained a sentence with at least two propositions that reflected a relation and its arguments (Kintsch, 1974).

Following the study phase, participants received a list of prime-target pairs and fillers for recognition judgments. A pair of each type (propositional, associate and topic) was associated with each passage. There were also four practice passages with a recognition list constructed in the same way.

Procedure

Participants were seated comfortably in front of a computer screen. Each passage was presented centrally on the computer screen. After a group of four passages, a recognition list was presented one word at a time. Test items were presented centrally and remained on the screen until the subject responded. Subjects were instructed to use a labeled key to respond “YES” if the word had appeared in one of the passages they had just read and “NO” if it had not. Subjects responded with the hand ipsilateral to their lesion site. Responses and response latencies were recorded for each item.

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Results

Data were analyzed for accuracy and reaction time with repeated measures ANOVA.

Accuracy

In the propositional conditions, there was a significant effect of brain damage [$F(2, 42) = 3.32, MSe = 22.8, p = .04$] and a marginal interaction of brain damage and proposition type [$F(2, 42) = 3.18, MSe = 2.98, p = .07$]. Control subjects showed a significant advantage for targets paired with words from the same proposition. LBD subjects showed no significant propositional priming, as we would predict. RBD subjects showed a small, but unreliable, advantage for words in different propositions. In both the associate and topic priming conditions, there was a main effect of association [$F(2, 42) = 50.99, MSe = 10.24, p < .001$] and [$F(2, 42) = 71.67, MSe = 10.95, p < .001$], respectively, with all groups having more difficulty rejecting the context-appropriate target than the inappropriate one.

Reaction time

Only the propositional priming data could be analyzed. There was a main effect of BD [$F(2, 42) = 3.62, MSe = 833.994, p = .04$] and a reliable interaction between BD and proposition condition [$F(2,42) = 3.49, MSe = 61.210, p = .04$] Only controls were facilitated by primes paired with targets from the same proposition. Neither BD group showed a significant facilitation.

Discussion

Our prediction that LHD would impair the ability to represent propositional relations in memory was supported. LHD patients showed no sensitivity to propositional relations. However, we also found no propositional priming in RHD patients who have intact LHS. Only control participants showed reliable propositional priming. In contrast, all three groups showed priming for contextually appropriate word meanings and topics. We find this compatible with the idea that both hemispheres have a semantic network that supports a memory representation in which related concepts in a passage are connected.

Conclusions

Our tentative conclusions are (1) the ability to represent propositional relations is impaired by brain damage in either hemisphere and (2) both hemispheres can represent semantic relations and information about the appropriate topics of sentences.

References