

Right-hemisphere-damaged Subjects' Ability to Use Context in Inferencing

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Right-hemisphere-damaged (RHD) patients' ability to use contextual information is a subject of debate. Many investigations have concluded that RHD patients cannot make contextual inferences beyond the literal level. For example, in a study of the ability of RHD patients to correctly interpret idiomatic expressions, Myers and Linebaugh (1981) found that RHD patients more frequently chose a literal interpretation than the correct metaphorical one. Similarly, in 1985, Myers, Linebaugh, and Mackisack-Morin concluded that RHD patients were more impaired than left-hemisphere-damaged patients in extracting intended or implicit meanings from pictorial stimuli. Finally, Cicone, Wapner, and Gardner (1980) found that RHD patients were likely to misidentify inferred emotions of characters presented in short story paragraphs.

Not all investigators have agreed that RHD patients have difficulty with inferencing. In a study of text comprehension, Stackowiak, Huber, Poeck, and Kerschensteiner (1977) found that RHD patients did not differ from normal controls in their ability to match idioms contained in short paragraphs to one of five pictures. Similarly, Brookshire and Nicholas (1984) did not find any significant differences between RHD and normal subjects on a paragraph comprehension task. Both groups remembered main ideas better than details, and it did not make a difference whether test items directly or indirectly stated information from the paragraph.

Whether or not RHD subjects are able to correctly draw inferences does not seem to be an all-or-none phenomenon. Gardner, Brownell, Wapner, and Michelow (1983) reported RHD subjects often made plausible inferences regarding story characters' emotional reactions, but the inferences regarding story content were incorrect. This hypothesis is consistent with a recent proposal by Myers (1990), who stated that the core deficit in RHD communication is *faulty* inferencing processing, not necessarily an absence

of inferencing. Gardner et al. (1983) hypothesized that the misinterpretations were due to a disassociation between the general ability to make logical inferences and the ability to apply general world knowledge, or extralinguistic information, to the specifics of a situation.

It therefore may be argued that the previously reported contradictory findings arose from a failure to take into account the degree to which use of context involves integration of text-supported information with extralinguistic information. As Brookshire and Nicholas (1984) found, it may be that RHD patients can use within-text information to help them infer the intended meaning. However, even when the text is redundant and supports nonliteral interpretation, RHD patients may continue to have difficulty if they must apply extralinguistic information to make the appropriate inferences. Thus, the crucial variable may not be the degree to which an inference is supported by within-text information, but the degree to which application of outside knowledge is required to draw the correct situation-specific inference.

This study was designed to clarify some of the existing issues regarding RHD subjects' ability to use information within the text as well as extralinguistic information to draw inferences. Two specific questions were addressed:

1. Relative to neurologically normal subjects, do RHD subjects have more difficulty answering inferential questions about a story in contrast to explicit questions?
2. Relative to neurologically normal subjects, can RHD subjects make inferences that require application of their world knowledge to text-specific situations?

METHOD

Subjects

Two groups of subjects participated in this study. Group 1 consisted of 15 adults with right hemisphere damage due to stroke. The mean time post onset was 20 weeks. Group 2 consisted of 15 neurologically normal adults matched as closely as possible to the experimental group in terms of age and education. Both groups performed similarly on the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975). All subjects were right hand dominant, spoke English as their primary language, and passed hearing discrimination testing. In addition, all subjects passed at least two out of three measures employed as visual screening tasks: (a) a verbal picture description task (Cookie Theft picture from the Boston Diagnostic

TABLE 1. AGE, SEX, YEARS OF EDUCATION (ED), TIME POST ONSET IN WEEKS (TPO), CT SCAN RESULTS (CT), HEARING DISCRIMINATION (HD), COOKIE THEFT DESCRIPTION (CTD), ORAL SENTENCE READING (OSR), RANDOM LETTER MATCHING (RLM), AND MINI-MENTAL STATE (MMS) PERFORMANCE FOR RIGHT-HEMISPHERE-DAMAGED (RHD) SUBJECTS

<i>Sub</i>	<i>Age</i>	<i>Sex</i>	<i>ED</i>	<i>TPO</i>	<i>CT Scan</i>	<i>HD</i>	<i>CTD</i>	<i>OSR</i>	<i>RLM</i>	<i>MMS</i>
1	52	M	19	16	R midbrain	+	+	+	+	30
2	79	M	8	4	R int. capsule	+	+	+	+	25
3	66	M	16	7	R parietal lobe	+	+	+	+	30
4	72	M	8	4	R occipital lobe	+	+	-	+	26
5	73	F	12	4	R basal ganglia	+	+	+	-	28
6	77	F	10	6	R temp-par	+	+	+	+	29
7	64	F	10	6	R front-par	+	+	-	+	26
8	66	F	12	12	R par-occip	+	+	-	+	29
9	75	M	8	15	negative CT	+	+	+	+	29
10	72	F	16	3	R parietal	+	+	+	+	29
11	69	M	14	8	Mult infarcts R	+	+	+	-	25
12	56	M	16	196	R parietal	+	+	+	+	23
13	70	M	11	4	R parietal	+	+	+	+	29
14	61	M	14	10	unavailable	+	+	+	+	27
15	67	M	7	6	R MCA	+	+	-	+	25
mean	67.9		12.0	20						27.3

Aphasia Examination [BDAE], Goodglass & Kaplan, 1983), (b) oral sentence reading from the BDAE, and (c) a random letter-matching task. A complete summary of subject characteristics may be found in Tables 1 and 2.

Stimulus Materials

Film. A 9-minute animated film was selected as the stimulus in an attempt to simulate a real-life situation. The film selected, *The Story of Strega Nona* (dePaola & Deitch, 1978), presents a story in both narration and dialogue. It is a well-structured film, consisting of six concise episodes. A cohesion analysis, carried out by the authors, demonstrated complete cohesive ties to either the text, the picture, or both throughout the story. The length and complexity of the film provided the opportunity to examine two distinct types of inferences.

Questions. Two sets of questions were developed to address comprehension of the film. Set 1 contained 23 inferential questions. In developing the questions, the target inferences, questions, and expected responses were determined independently by two authors, then compared and revised

TABLE 2. AGE, SEX, YEARS OF EDUCATION (ED), HEARING DISCRIMINATION (HD), COOKIE THEFT DESCRIPTION (CTD), ORAL SENTENCE READING (OSR), RANDOM LETTER MATCHING (RLM), AND MINI-MENTAL STATE (MMS) PERFORMANCE FOR NORMAL SUBJECTS

<i>Sub</i>	<i>Age</i>	<i>Sex</i>	<i>ED</i>	<i>HD</i>	<i>CTD</i>	<i>OSR</i>	<i>RLM</i>	<i>MMS</i>
1	61	M	17	+	+	+	+	30
2	55	M	18	+	+	+	+	30
3	63	F	8	+	+	+	+	28
4	74	M	10	+	+	+	+	29
5	67	F	12	+	+	+	+	30
6	69	F	12	+	+	+	+	30
7	67	M	16	+	+	+	+	30
8	68	M	9	+	+	+	+	28
9	73	M	6	+	+	-	+	21
10	77	F	12	+	+	+	+	30
11	71	F	8	+	+	+	+	26
12	67	F	16	+	+	+	+	30
13	67	F	16	+	+	+	+	30
14	68	M	16	+	+	+	+	30
15	68	F	16	+	+	+	+	29
mean	67.7		12.8					28.7

until unanimous agreement was reached. Inference questions were then divided into two types. The first type contained information judged to be dependent on knowledge from *outside* the text (general world knowledge), and thus were coded "O." The second type of inference questions could only be answered by synthesizing information from *within* the text, and thus were coded "W." The three authors jointly reviewed and labeled each inference question as W or O. One week later, questions were reviewed again, in random order, and relabeled. Interjudge reliability was 83%. Set 2 contained 23 explicit questions. Questions and expected responses were determined independently by two authors, then revised jointly. Both sets of questions were ordered to follow the sequence of events in the story.

Procedure

Each subject was tested individually. Subjects were told they would be viewing a short 9-minute film and were informed they would be asked to respond to two sets of questions following the film. Subjects were seated directly in front of the television screen, and the volume was set to a level comfortable to the subject. After viewing the film, the subjects were asked

to answer a set of pre-recorded inference questions as completely as possible. Next, they were presented with the explicit questions, also pre-recorded. Subjects' verbal responses were audio-recorded and transcribed verbatim for analysis.

Analysis

Subjects' responses were scored as accurate or inaccurate. Inter-scorer reliability was 85% for the RHD group and 91% for the normal group. Separate scores for each group were obtained for inference and explicit questions, and for W versus O inference questions. Group comparisons were then made.

RESULTS

In order to test group performance on both inferential and explicit question sets, a Repeated Measures Multivariate analysis of variance (MANOVA) was completed. Results indicated a significant F (Hotellings value .824, $p < .000$). To determine which variables contributed to these overall differences, Univariate analyses were applied (SPSS, 1990). Results indicated a significant main effect for group, $F(1,28) = 21.6$, $p < .001$, and a significant main effect for question type, $F(1,28) = 7.88$, $p < .01$. There was no interaction between group and question type, $F(1,28) = 1.12$, $p > .05$. Individual subject performance and mean performance for each group and question type is summarized in Table 3.

Post hoc t -tests demonstrated the normal group performed significantly better than the RHD group on explicit questions (18.5 vs. 13.3) and inferential questions (17.5 vs. 11.3). The RHD group performed significantly better on explicit questions compared to inferential (13.3 vs. 11.3). There was no difference between question type for the normal group.

Next, a MANOVA was completed to determine group performance on inferential question type (Within text versus Outside text). A significant F was found (Hotellings value .810, $p < .000$). Univariate analyses were then employed. Results indicated a significant main effect for group, $F(1,28) = 22.18$, $p < .001$, and a significant main effect for type of inference question, $F(1,28) = 7.9$, $p < .01$. There was no significant interaction between group and inference question type, $F(1,28) = 1.44$, $p > .05$. Individual subject performance and percentage of questions accurate for each group can be found in Table 4.

Post hoc t -tests showed the normal group performed significantly better than the RHD group on within-text inference questions (72.7% vs.

TABLE 3. INDIVIDUAL AND GROUP PERFORMANCE FOR RIGHT-HEMISPHERE-DAMAGED (RHD) AND NORMAL (NORM) SUBJECTS ON EXPLICIT AND INFERENCE QUESTIONS

<i>Sub</i>	<i>Explicit</i>		<i>Inference</i>	
	RHD	NORM	RHD	NORM
1	20	20	14	20
2	10	17	9	17
3	20	16	15	12
4	15	20	10	16
5	15	17	14	16
6	13	20	8	20
7	6	16	7	19
8	7	13	12	14
9	12	16	5	10
10	17	21	17	18
11	15	17	16	17
12	15	21	10	22
13	11	22	9	21
14	17	22	15	22
15	7	19	9	19
mean	13.3a	18.5c	11.3b	17.5c

Pairs with different subscripts are significantly different from each other ($p < .05$).

40.2%) and outside-text inference questions (78.2% vs. 53.8%). The RHD group performed significantly better on outside-text inferences compared to within-text inferences (40.2% vs. 53.8%). There was no difference between question type for the normal group.

CONCLUSION

One question we addressed was whether, relative to neurologically normal subjects, RHD subjects could use general world knowledge in drawing appropriate situation specific inferences. Contrary to what we expected, our results did not support Gardner's hypothesis that RHD subjects have difficulty using or applying their general world knowledge to comprehend a particular story. *Outside text* inferences were easier for all subjects, right hemisphere damaged and normals. Our RHD subjects performed better on inference questions when they could rely on their general world knowledge. They found that questions relying primarily on the text's integrating information were more difficult.

TABLE 4. INDIVIDUAL AND GROUP PERFORMANCE FOR RIGHT-HEMISPHERE-DAMAGED (RHD) AND NORMAL (NORM) SUBJECTS ON WITHIN- AND OUTSIDE-TEXT INFERENCE QUESTIONS

<i>Sub</i>	<i>Within</i>		<i>Outside</i>	
	RHD	NORM	RHD	NORM
1	75	88	53	87
2	25	75	47	73
3	75	25	60	67
4	50	63	40	73
5	50	63	60	73
6	38	88	33	87
7	13	75	40	87
8	25	50	67	67
9	13	38	27	47
10	75	75	80	80
11	50	75	80	73
12	50	100	40	93
13	13	88	53	93
14	25	100	80	93
15	25	88	47	80
mean	40.2a	72.7c	53.8b	78.2c

Pairs with different subscripts are significantly different from each other ($p < .05$).

It is important to note that although subjects performed better on *outside inferences* they performed poorly overall on both types of inference questions. RHD subjects achieved only 40% accuracy on inferences drawn solely from the text compared to 54% on inferences that could be aided by general world knowledge. Normal subjects achieved 73% and 78% accuracy, respectively, on these inferences.

A second question concerned performance on explicit versus inferential questions. Explicit questions were easier for both RHD and normal subjects. RHD subject overall performance was significantly poorer than normal subjects'. The fact that both types of information were affected in RHD performance contradicts the hypothesis that RHD adults have difficulty processing only certain types of information.

It may be argued that deficient performance on both explicit and inference questions was due to lack of retention and/or comprehension of the story. However, this argument should be considered in relation to models for story grammar, as we are indeed talking about recall and comprehension of a logical story. Story grammar reflects the regularities in the internal structure of a story that guide an individual's recall and comprehension of

the logical relationships between people and events. Thus, it could be argued that poor performance of the RHD subjects on both the explicit and inferential questions may be due to inefficient use of, or degradation of, adequate story grammar knowledge.

Another explanation may be that an artificial distinction between explicit and inferential information was created. In normal text processing, individuals comprehend the text as a whole. Distinctions between explicit and implicit information are not consciously made. On-line text comprehension involves a blend of explicit and implicit information strongly influenced by contextual factors and pre-existing schemata. From this perspective, it is not surprising that the difference between RHD subjects' performance on explicit and inferential questions was smaller than originally expected.

Future research should address the issues of retention and the integration of explicit and implicit information in the context of a story task. Individual subject characteristics need to be explicitly defined and the influence of other variables such as severity of deficit, visual perception, memory and other cognitive factors should be controlled to clarify the nature of the apparent deficit in RHD subjects' ability to comprehend complex linguistic material.

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