Right- and Left-brain-damaged Subject Performance on a Test of Reading Comprehension: The Nelson Reading Test Revisited

Marie T. Rau, Ute Kongsbak, Mary Gordon, and Donna J. Graville

The ability to infer implied meaning from contextual cues is universally recognized as an important cognitive skill. This capacity allows us to "step beyond the face value of immediate sensory input and arrive at a meaning that is more than the sum of the given parts" (Myers, 1990). Myers (1990) also suggested the term "inference failure" to describe how brain damage can disrupt the ability to infer intended meaning. Investigators have examined inferential reasoning abilities in a variety of clinical populations, including aphasic adults (Nicholas & Brookshire, 1987; Tompkins & Mateer, 1984), mildly to moderately demented subjects (Graville & Rau, 1990), and persons with right hemisphere brain damage (Mackisack, Myers, & Duffy, 1987; Myers, Linebaugh, & Mackisack, 1985; Tompkins & Mateer, 1984). Results suggest that inferencing abilities are deficient in all of these clinical populations compared to non-brain-damaged controls, and that right-brain-damaged persons consistently show reduced capacity to infer intended meaning when compared with left-brain-damaged individuals.

The ability to infer information from paragraph-length reading material has been studied in aphasic and demented persons and compared to non-brain-damaged elderly adults. Nicholas and Brookshire (1987) found that both aphasic and non-brain-damaged subjects performed more poorly on reading questions involving high levels of inference than they did on questions requiring no inference or those requiring simple inferences. The aphasic subjects performed more poorly than the non-brain-damaged group at all levels of inference. Using the same test instrument—the Nelson Reading Skills Test (Hanna, Schell, & Schreiner, 1977)—Graville and

Rau (1990) obtained different results when they compared the inferential reading abilities of mildly and moderately demented persons with those of non-brain-damaged elderly controls. They found no difference in performance across levels of inference for either group of subjects, although expected differences in overall performance were found across the three subject groups. One methodological difference between the Nicholas and Brookshire (1987) study and the work of Graville and Rau (1990) was that the latter researchers had subjects read the stimuli aloud prior to answering the reading-comprehension questions, whereas the Nicholas and Brookshire subjects only read the stimuli silently.

In an effort to explore the different results obtained by these two studies, and to replicate Graville and Rau (1990) with a different clinical sample, this investigation examined the performances of right- and left-brain-damaged persons on the Nelson Reading Skills Test, utilizing the methods of Graville and Rau (1990). The following questions were posed:

1. Does the performance of aphasic and right hemisphere damaged adults differ significantly on a multiple sentence reading task requiring different levels of inference?
2. Do right hemisphere damaged persons perform less accurately on reading-comprehension tasks requiring a high degree of inference compared to tasks requiring minimal to moderate ability to infer information?
3. Is the Nelson Reading Skills Test an adequate measure of inferential reading ability in brain damaged adults?

METHOD

Subjects

The sample was drawn from the patient population of a large VA medical center and its associated care units and clinics. It consisted of two subject groups: 16 aphasic individuals with evidence of a single left hemisphere cerebrovascular accident (CVA) (LBD subjects); and 16 individuals with evidence of a single right hemisphere CVA (RBD subjects). All subjects were at least four months post-onset of CVA, right handed, and native English speakers. Other inclusion criteria were adequate vision to read large print; premorbid reading skills at the seventh-grade level or higher according to education level achieved, occupation, and subject self-report; a score of 10 or higher on each item of subtest VII of the PICA (Porch, 1981) and a SPICA overall mean score (DiSimoni, Keith, Holt, & Darley, 1975; DiSimoni, Keith, & Darley, 1980) at or above the 65th percentile, in order to

screen out those individuals with moderate and severe language impairments. Descriptive characteristics of the subjects are summarized in Table 1.

A series of *t* tests revealed that the two subject groups did not differ in terms of age, time post-CVA, or education level. There was, however, a significant difference between the groups in overall communicative efficiency as measured by performance on the *SPICA* and on a measure of metaphorical language comprehension, the Metaphorical Language Test (MLT) (Burns, Halper, & Mogil, 1985). The RBD group performed significantly better on both of these measures than did the aphasic subjects.

Diagnostic Instruments

1. SPICA. The short version of the PICA consists of four subtests and has been found to accurately predict overall PICA score (DiSimoni et al., 1975, 1980). It was used as a screening instrument in this study to determine overall communicative efficiency.
2. Metaphorical Language Test (MLT). This measure is a subtest of the RIC Evaluation of Communication Problems in Right Hemisphere Dysfunction (RICE) (Burns, Halper, & Mogil, 1985), and consists of a series of 10 proverbs, which the subject is asked to explain. According to the authors, RBD individuals frequently provide literal or personal interpretations of proverbs or idioms. The MLT was included as a clinical descriptor of ability to grasp implied meaning.
3. Nelson Reading Skills Test (NRST). Form 4 of Level B of the NRST was used to assess subjects' reading comprehension skills and was our primary dependent measure. The NRST has been described in detail elsewhere (Nicholas & Brookshire, 1987; Graville & Rau, 1990). It consists of a total of five paragraphs, each of which is followed by five to eight multiple-choice questions. A total of 33 questions in all are included 11 questions requiring a high level of inference; 12 requiring a moderate level of inference (referred to as "translational" questions); and 10 requiring no inferencing ability, as the answers are found directly in the text material (referred to as "literal" questions).

Experimental Procedures

Screening instruments and the NRST were administered to each subject individually, in a clinic room or the subject's home. Subjects were instructed to read aloud each passage and the applicable questions and then to indicate the correct answer from four choices. Aphasic subjects who were

TABLE 1. DESCRIPTIVE CHARACTERISTICS OF LEFT- AND RIGHT-BRAIN-DAMAGED (LBD AND RBD) SUBJECTS

Subject	Age (years)	Education (years)	Time post-CVA (months)	SPICA (mean)	Metaphorical Language Test (mean)
LBD					
1	52	8	37	12.13	7
2	57	12	288	12.23	9
3	57	14	29	13.05	4
4	60	14	27	13.78	7
5	61	14	31	12.90	10
6	61	17	18	13.60	6
7	61	10	134	14.05	5
8	62	14	10	14.00	3
9	63	12	24	12.45	8
10	63	11	4	12.60	6
11	68	9	31	12.45	1
12	68	13	119	14.13	7
13	68	12	50	14.55	10
14	74	14	41	12.40	9
15	79	14	54	13.30	5
16	62	8	40	12.16	10
Mean	63.50	12.25	58.56	13.11	6.68
SD	6.65	2.52	70.60	0.81	2.65
RBD					
17	50	12	6	14.00	7
18	51	14	143	14.93	8
19	55	8	12	14.95	10
20	58	8	32	14.30	9
21	62	10	132	15.05	9
22	63	14	24	14.85	10
23	65	14	16	14.53	10
24	66	14	15	14.50	9
25	66	12	45	14.78	10
26	69	9	120	13.53	4
27	71	11	168	13.10	8
28	72	10	31	14.88	10
29	73	18	13	14.83	10
30	75	12	35	14.13	10
31	80	12	18	14.58	8
32	73	9	132	14.25	10
Mean	65.56	11.68	58.87	14.45	8.87
SD	8.69	2.70	57.40	0.55	1.63

unable to read aloud were instructed to follow along while the examiner read the paragraph to them. Subjects were informed that they could reread the passage and the questions silently if they chose. Subjects were allowed as much time as needed to complete the task. Responses were recorded on-line and scored by the examiner.

RESULTS

Data were analyzed using the SYSTAT computer-based statistical package (Wilkinson, 1986), which incorporates Tukey's HSD correction factor (Tukey, 1977) when performing multiple t test comparisons. A t test comparison of the mean NRST scores of the two groups revealed that the RBD subjects performed significantly better ($p = <.028$) than the LBD subjects on the NRST ($t = -2.31$; $df = 1, 30$). At different levels of inference, RBD subjects performed better on translational items ($t = -2.764$; $df = 1, 30$; $p = <.01$), but the two groups did not differ in performance on literal and high inference level items. The two groups' performance on the high inference level items approached significance, however, with the RBD subjects performing better ($t = -2.024$; $df = 1, 30$; $p = <.052$).

To determine whether there were performance differences across levels of inference within the RBD and LBD groups, a repeated-measures ANOVA (Wilkinson, 1986; Winer, 1971) was used. Because the total numbers of questions requiring literal, translational, and high level inference were not equal, raw scores for each type of question were converted to percent-correct scores before the ANOVA was performed. No significant main effect for level of inference was observed within either subject group (see Table 2).

TABLE 2. SUMMARY OF THE ANALYSIS OF VARIANCE BY QUESTION TYPE WITHIN AND BETWEEN GROUPS

	SS	DF	MS	F	Probability
LBD TOTAL SCORE					
between	258.380	2	129.19	1.286	0.291
within	3014.233	30	100.474		
RBD TOTAL SCORE					
between	382.853	2	191.426	1.3	0.287
within	4417.954	30	147.265		

SS = Sum of Squares DF = Degrees of Freedom
MS = Mean Squares   ($p < .05$)

DISCUSSION AND CONCLUSIONS

It was anticipated that both RBD and LBD subjects would perform better answering questions that required literal interpretation of information contained in a multiple-sentence reading task than when answering those that required what the authors of the NRST describe as a high level of inference. Aphasic subjects in the Nicholas and Brookshire (1987) study showed such a pattern, and it was expected that the RBD subjects in this study would have relatively more difficulty inferring information not explicitly stated in the text. Instead, subjects performed similarly to the demented and non-brain-damaged elderly subjects of Graville and Rau (1990), showing consistency of performance across NRST inference levels.

What are possible explanations for the discrepancy of these findings? One explanation might be that brain damaged persons don't actually have more relative difficulty with tasks requiring a higher level of inferencing ability. The weight of research evidence, however, and the hypothesis' lack of face validity requires its rejection.

Another explanation is that differences in characteristics of the clinical samples employed could account for the discrepant results. Although no statistical measures were applied, casually inspecting the means and standard deviations of the demographic characteristics in the Nicholas and Brookshire (1987) samples and our samples (Graville & Rau 1990) suggests that differences in age, education, and months post-onset are quite small.

A third possible explanation is that the dependent measure employed, the NRST, was designed for children and is not robust enough to demonstrate differences across levels of inference in adults. Nicholas and Brookshire, however, did find that the NRST demonstrated differences in subject performance across levels of inference for both non-brain-damaged and aphasic adults. Because their results are consistent with other inference ability research in brain-damaged populations and are in line with predicted outcomes, it appears that the NRST does measure differences in degree of inference difficulty.

The most plausible explanation for the different results obtained by the Nicholas and Brookshire (1987), Graville and Rau (1990), and the present study appears to be methodological. If having subjects read the stimulus paragraphs aloud allocated subjects' attention away from the stimuli content, one might predict that subjects would do no better on the literal questions than on those requiring a high degree of inference. The advantage of directly available information would be eliminated. In fact, inspection of the data suggests just that: It's not that our subjects did as *well* on the high inference level items as they might have been expected to do on the literal items, but rather that they did as *poorly* on the literal items as they might have been expected to do on the high inference level items.

In conclusion, the results of this study suggest using caution when comparing the results of tasks that may require different degrees of attention allocation. Reading aloud for comprehension may allocate attention in quite different ways than reading silently does. Future research efforts could examine this question by having the same subjects read equivalent forms of the NRST silently *and* aloud.

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