A Comparison of the Communication Skills of Patients with Cortical or Subcortical Right Hemisphere Damage

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INTRODUCTION

Left hemisphere or dominant cortical areas are responsible for propositional, analytic, serial, or linear processing of information. In contrast, right hemisphere or nondominant cortical areas are responsible for appositional, holistic, synthetic, simultaneous, or gestalt processing of information (Bever, 1975). Adamovich and Brooks (1981) reported auditory comprehension, verbal expression and reading comprehension deficits as a result of their investigation of right hemisphere damaged subjects. These investigators indicated the need for further research with regard to the communication deficits of patients with specific lesion sites within the right hemisphere.

Limited information is available with regard to specialized right hemisphere cortical linguistic functions which differ from right hemisphere subcortical linguistic functions. Lesions in cortical areas are thought to contribute to decreased divergent though (Gazzaniga, 1977; Galin, 1974). Right parietal lesions can result in neglect (Meyers, 1978; Hacaen, 1962) and prosopagnosia (Joynt and Goldstein, 1975). Right temporal lesions can result in decreased memory for spatial and nonverbal material and tonal patterns (Milner; 1964, 1974). Occipital lobe lesions can result in decreased visual perception (DeRenzi and Spinnler, 1966).

With regard to right hemisphere subcortical structures, lesions in the right subcortical white matter lateral to the splenium of the corpus callosum can result in decreased naming abilities. Right ventrolateral thalamic lesions cause decreased storage and recall of verbal and visual information, along with decreased recognition, decreased learning and overall deterioration of verbal performance (Perrelt <u>et al.</u>, 1969; Asso <u>et al.</u>, 1969; Shapiro <u>et al.</u>, 1973). The purpose of this investigation was to compare the communicative capabilities of patients with cortical versus subcortical right hemisphere lesions.

SUBJECTS

Two experimental subject groups were selected. The first group consisted of three subjects (two females and one male) who sustained cortical right hemisphere damage from a single cerebrovascular accident. The group mean age was 64 years with a range of 46-81 years. The mean educational level was 10 years. The second group consisted of two subjects (one female and one male) who sustained subcortical damage from a single cerebrovascular accident. The group mean age was 59.5 years; one subject was 53 years and one subject was 66 years old. The mean education level was 9 years. Two non-brain-injured controls were also examined. Their mean age was 62 years; one subject was 67 years and one subject was 55 years old. The mean educational level for this group was 12 years. Only those subjects who displayed unilateral damage based on CT scan and neurological examination were selected for inclusion in the experimental groups. Other experimental group requirements included at least six months post cerebrovascular accident, right handed, and English speaking only.

METHODS

Each subject was tested in two one-hour sessions. The following tests were administered: 1) portions of the Boston Diagnostic Aphasia Examination including:

Auditory Comprehension Subtests: "Commands," in which motor planning and motor control, auditory retention, auditory sequencing, and selective attention are necessary to carry out verbally presented information. "Body Part Identification" in which subjects are required to point to body parts named by the examiner and to display right-left discrimination. Motor control, motor planning, selective attention and auditory retention are also necessary for this task. "Complex Ideational Material" in which subjects are required to attend to and retain verbal stimuli of increasing length and complexity.

Verbal Expression Subtests: "Automatic Sequences" in which the subject is required to name the days of the week, months, numbers and letters in sequence. "Repetition of Words," "Repetition of Phrases," and "Responsive Naming," in which the subject is required to name items described verbally by the examiner.

Reading Comprehension Subtest: "Sentence and Paragraph Comprehension" in which subjects are required to visually perceive and comprehend sentences and paragraphs of increasing length and complexity.

2) Hooper Visual Organization Test in which subjects are asked to name pictures of objects which are fragmented.

3) Borkowski, Benton and Spreen Word Fluency Task in which subjects are given one minute per letter to name words beginning with the letters S, T, P and C.

4) The last fifty items of the Boston Naming Test in which subjects are asked to name pictures of objects.

5) Subtests of the Detroit Test of Learning Aptitude including: "Verbal Absurdities," in which subjects are required to tell what is absurd about statements such as, "If I am in a hurry I get a horse because an automobile is too slow." Portions of "Verbal Opposites" subtest. Portions of the "likenesses and differences" subtest, in which subjects are required to describe the ways in which two items are most alike and most different.

6) Informal Linguistic/Cognitive Assessment Tests included a non-standardized assessment of: Verbal Sequencing Skills, in which subjects are asked to tell the steps necessary to make a telephone call from a phone booth.

Verbal Problem Solving, in which subjects are asked to describe three possible solutions to the problem of locking keys in a car.

Linguistic Visual Closure, in which subjects are required to name the word which would be made if missing letters were filled in.

Linguistic Visual Reorganization, in which subjects are required to name the word which would be made by unscrambling a group of letters presented visually.

Immediate and Short Term Memory for Related and Unrelated Words, in which subjects are asked to repeat increasingly longer sets of word strings under no delay and 30-second delay conditions.

RESULTS

A one-way Analysis of Variance (ANOVA) and a Duncan Multiple Comparison Test were conducted to determine if there were relationships between group mean test scores (percentages) of subjects with right hemisphere cortical lesions, subjects with right hemisphere subcortical lesions and non-brain-injured subjects. The ANOVA yielded F-ratios which were significantly different for 5 of the 19 test variables between subject groups. In addition to these 5 test variables, the Duncan Multiple Comparison Test revealed a significant difference between subject groups on the Linguistic Visual Closure Test. Specific test variables which differed significantly between groups are summarized in Table 1.

Table 1. A summary of the test variables which differed significantly between experimental groups. KEY: Group 1 = non-brain injured; Group 2 = cortical damage; Group 3 = subcortical damage.

	Significant Difference Between Experimental Groups		
Experimental Tests	Group 1 vs Groups 2 & 3	Group 1 vs Group 2 vs Group 3	Groups 1 & 2 vs Group 3
Boston Naming Test	.05		
Verbal Opposites	.01		
Likenesses & Differences	.05	.05	
Hooper Visual Organization Test	.001		
Linguistic Visual Closure Test	.05	.05	
Commands			.01

DISCUSSION

Analysis of the responses of the experimental groups revealed the following similarities and differences between groups:

The brain-injured groups made significantly more errors than the non-brain-injured group on the Hooper Test of Visual Organization. There was no significant difference between the two brain-injured groups with regard to numbers of errors. The two brain-injured groups were similar to each other with regard to type of error. Both brain-injured groups assigned a name to each of the pieces of the object rather than synthesizing the pieces in order to correctly name the object.

The brain-injured groups made significantly more errors than did the non-brain-injured group on the Boston Naming Test. There was no significant difference between the two brain-injured groups with regard to number of errors. These two groups were also similar to each other in regard to type of error. Both groups displayed errors which were either visually similar to the stimulus, i.e. "telescope" in response to a picture of a "hoze nozzle" or similar to the circumlocution errors made by aphasic patients, i.e. subjects described the function of objects which they could not name.

On the "Verbal Opposites" subtest of the Detroit Test of Learning Aptitude, both brain-injured groups made significantly more errors than did the non-brain-injured group. There was no significant difference between the two brain-injured groups with regard to number of errors. These two groups were again similar to each other in regard to type of errors. The groups both exhibited response delays and error responses characterized by the provision of synonyms, i.e. "slow" in response to "gradual" when antonyms were required, i.e. "sudden" in response to "gradual." Experimental subjects also made syntactic errors, such as providing an adjective, i.e. "true" when a noun, "truth" was required.

On the Linguistic Visual Closure Test all groups differed significantly with regard to number of errors. The non-brain-injured group made the least number of errors and the cortically damaged group made the greatest number of errors. Both brain-injured groups appeared to have difficulty in this task for similar reasons. These subjects seemed to have difficulty in "switching sets" once a response was made. For example, if the response "TUB" was given in response to the visual stimulus "T_B_," a subject might be unable to produce an alternate response even when the error was pointed out and the subject was instructed that he needed a word with one more letter. Further inspection of the error patterns on this subtest revealed that both cortically and subcortically damaged subjects either treated individual letters as abbreviations, i.e. "post script" for "P_S_" or as initial letters of syllables, i.e. "healthy" for "H_T." These errors reflect shifts in cognitive style which are typical for patients with right hemisphere damage.

On the "Likenessess and Differences" subtest of the Detroit Test of Learning Aptitude, all groups differed significantly with regard to number of errors. The non-brain-injured group had the least errors and the subcortically damaged group had the most errors. The error patterns of the two experimental groups on this test were different. Patients with cortical damage had more difficulty than did subcortically damaged patients in explaining how two items were most different. Patients with subcortical damage had more difficulty in explaining the way in which two items were most alike. For example, when responding to the question: "How are running and walking most alike and most different?" a cortically damaged patient replied, "Both are forms of movement, but you have to like to run, walking is an everyday movement." In contrast, a subcortically damaged patient responded: "Both result in a lack of wind, but walking is slower than running." A tendency was noted for both experimental groups to provide somewhat trivial similarities or differences. For example, when describing how wire and thread were most alike, both experimental groups stated that they were "both slender" instead of stating that they were "both used for binding things together."

The difficulty which cortically damaged patients displayed in describing item differences could be attributed to decreased visual imagery. This conclusion is in agreement with Caramazza's (1976) theory that right hemisphere damage disrupts verbal problem solving due to decreased visual imagery skills. However, Caramazza did not control for cortical versus subcortical right hemisphere damage, and the subcortically damaged patients in the present study displayed a different error pattern than the cortically damaged patients. Specifically, subcortically damaged patients displayed more difficulty in describing how two items were most alike. We hypothesize that, during the description of likenesses and differences, subcortically damaged patients were capable of the visual imagery skills necessary to describe how two items are different; yet they were unable to retain these images long enough to describe item similarity. This hypothesis is again based on Muma's (1978) theory which states that the description of the similarities between two items requires the mental listing of the critical features of both items followed by the selection of the similar item from each list.

Further support for the thoery of retention deficits in subcortically damaged patients was also seen in the group's performance on the "Commands" subtest of the Boston Diagnostic Aphasia Examination. Subcortically damaged patients made significantly more errors on this subtest than did the other two groups. The non-brain-injured group and the cortically damaged patients made no errors on this test. The subcortically damaged patients made errors which could be attributed to auditory retention deficits and/or inattention to detail. For example, subcortically damaged patients tended to tap each shoulder more than two times when specifically requested to "tap each shoulder twice." It appeared that verbally presented information could not be retained long enough to enable the patients in this group to complete complex commands.

SUMMARY

An investigation of the communicative capabilities and limitations of patients with cortical or subcortical right hemisphere damage was conducted. All experimental subjects made significantly more errors than non-brain-injured controls on a test battery designed to assess communicative skills. Similar performances were displayed by both experimental groups with regard to number and type of errors on the Hooper Test of Visual Organization, Boston Naming Test, and on the "Verbal Opposites" subtest of the Detroit Test of Learning Aptitude. Experimental groups differed from each other with regard to number and/or type of errors on the Linguistic Visual Closure Test, "Likenesses and Differences" subtest of the Detroit Test of Learning Aptitude and the "Commands" subtest of the Boston Diagnostic Aphasia Examination.

Behaviors exhibited by both groups of patients with right hemisphere damage included response latency, difficulty "switching sets," difficulty identifying the salient features of stimuli, naming difficulties, and decreased verbal reasoning because of difficulty with simultaneous or gestalt processing of linguistic information. It appeared that the communication deficits exhibited by the two experimental groups stemmed from breakdowns in different underlying processes. The cortically damaged patients appeared to have visual processing deficits. The subcortically damaged patients exhibited attention or retention deficits.

Future research should include (1) a comparison of left hemisphere damaged subjects' performance to right hemisphere damaged subjects'

performance on this test battery, and (2) a comparison of the performance of subjects with specific right hemisphere cortical lesions on this test battery.

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DISCUSSION

Q: I see a lot of the behaviors you described when I work with closed head injury patients. Do you see similiarities in these populations?

A: Yes. A lot of the battery that we put together for the right hemisphere damaged patients came from observing the similiarities in behavior between right hemisphere damaged patients and closed head injury patients. Portions of the battery that we use with right hemisphere damaged patients came from our evaluation protocol for closed head injury patients.