

A Comparison of the Language Abilities of Two Aphasic Patients with a Neoplasms in the Dominant Hemisphere: Right-Hemisphere Versus Left-Hemisphere Language Dominance.

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With the advent of computerized axial tomography (CAT, CT, CCT, EMI-Scan, etc.), it is at last possible to describe and classify with extreme specificity the site of lesion in patients with neurological damage. In the next decade, the computerized tomography process should be of enormous help to the neurolinguist and aphasiologist. Depending on the type and amount of language data gathered, it should now be possible to begin to develop more precise neurological models of language function as well as to more effectively evaluate existing neurological language models. This, in turn, should be invaluable in assisting the language therapist to design more efficient treatment approaches and programs to meet the needs of individuals with aphasia.

The present study was undertaken to explore two areas. First, we wanted to add to our present knowledge of the relationship between brain and language functions by describing the speech, reading and writing skills of aphasic patients with precisely localized neoplasms in the cerebral cortex. Second, we wanted to investigate how a patient with aphasia due to a dominant right cerebral lesion differed in his aphasic involvement from an aphasic patient with a dominant left cerebral hemisphere lesion. Concerning this latter issue, Maruszewski (1975) has stated, "...many facts suggest that when the right hemisphere is dominant for language, the degree of dominance is less accentuated than when the left dominates" (p. 83). Hecaen (1969) implies that aphasic patients with a dominant right hemisphere lesion will demonstrate milder and more transitory aphasic symptoms than patients with a dominant left-hemisphere lesion. The ideal experiment to investigate this issue would involve a comparison of language skills of two aphasic patients with lesions in precisely the same location but in different hemispheres. Thus, one would be able to control the variables concerned with the site and extent of the lesion in comparing the language skills of the two patients.

Recently we examined two patients who were aphasic and who had neoplasms in approximately the same location in opposite hemispheres. One patient was found to have a tumor in the right hemisphere and the other patient had a tumor in the left hemisphere. We did not have the ideal or perfect case for comparison, however, because the lesions were not precisely in the same location. However, the subjects were matched closely in several ways such as depth and size of lesion, etiology, duration of symptoms, sex, age and educational background.

After we had identified these two cases, we posed the following questions:

1. What are the speech, reading and writing skills of two aphasic patients with neoplasms in the frontal-parietal and parietal-occipital lobes?
2. In what ways are the aphasic symptoms similar and different for a patient whose language dominance and lesion are in the right hemisphere as compared to those of one whose language dominance and lesion are in the left hemisphere?

Method

The two patients who served as subjects in this study had been diagnosed as aphasic by speech pathology consultants at the Mayo Clinic. Because of their neurological status on admission to the Clinic, both had received an EMI-Scan. These Scans were made with and without contrast and were administered within 24 hours of the time the language battery was administered.

Language Testing

The language assessment battery used to gather the language data in this investigation was designed as part of a larger study concerned with localization of language functions presently being conducted at the Mayo Clinic by Duffy, Darley and Pettit. The language assessment battery consists of 25 subtests, some of which use the 10 objects from the Porch Index of Communicative Ability (PICA). The scoring of responses is based on the PICA 16-point multidimensional scoring system (Porch, 1967). There are, however, a number of differences between the present battery and the PICA. For example, there are tasks on the battery that involve tactile naming and tactile matching; tasks that assess motor speech ability; tasks that assess auditory and visual discrimination, and a subtest to evaluate fluency. Memory span is assessed in three different ways, using a series that increases in difficulty from two to six items (words). In one subtest (12), the patient listens to the words presented auditorily by the experimenter and then has to point to the appropriate objects. In another subtest (15) the patient reads the series aloud from a card and then points to the appropriate objects, and in a third subtest (17) he is asked to listen and merely repeat the series verbally.

Five different subtests involve token test-type commands which require the patient: (1) to describe what the experimenter did with the objects (i.e., "You put the key beside the knife." "You picked up the fork, the pen and the key."), (2) to follow the experimenter's verbal directions in moving the objects, ("Touch the cigarette with the key."), (3) to follow directions after he has read them orally from a card, (4) to describe in writing what was done in manipulating the objects by the experimenter and (5) to merely repeat a command spoken by the experimenter. All reading tasks are scored first according to the accuracy of the patient's oral reading and then again with regard to how well he comprehended what he read.

EMI-Scan Data

These data were analyzed by a neuroradiologist at the Clinic. He measured and recorded the depth, size and locus of lesion, noted the structures involved and outlined the lesion in three different planes.

Subjects

The two male subjects were R.F., a 59 year old, left handed, retired telephone company worker and L.H., a 55 year old, right handed, retired farmer. Both had completed a high-school education. Note that R.F. was the right hemisphere patient and L.H. the left hemisphere patient (R.F. = right; L.H. = left).

Both subjects noted that neurological symptoms began 6 to 7 weeks prior to admission. At the same time they were admitted to the Clinic, they both had trouble in "finding words" and in remembering the names of familiar people and objects. R.F.'s tumor was a grade III Astrocytoma located in the right parietal-occipital lobes. L.H.'s tumor was also a grade III Astrocytoma and located in the frontal-parietal lobes. Figure 1 is a photograph of the EMI-Scan (with contrast) showing the patient's tumor in the left hemisphere.

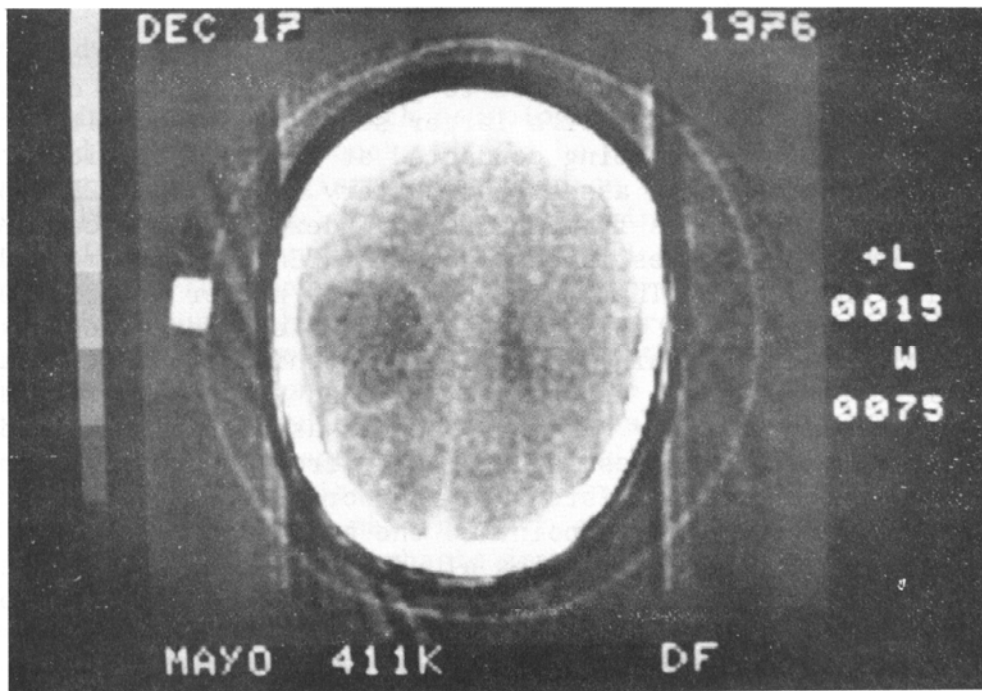


Figure 1.

Figure 2 is a photograph of the EMI-Scan (with contrast) showing the other patient's tumor located in the right hemisphere.

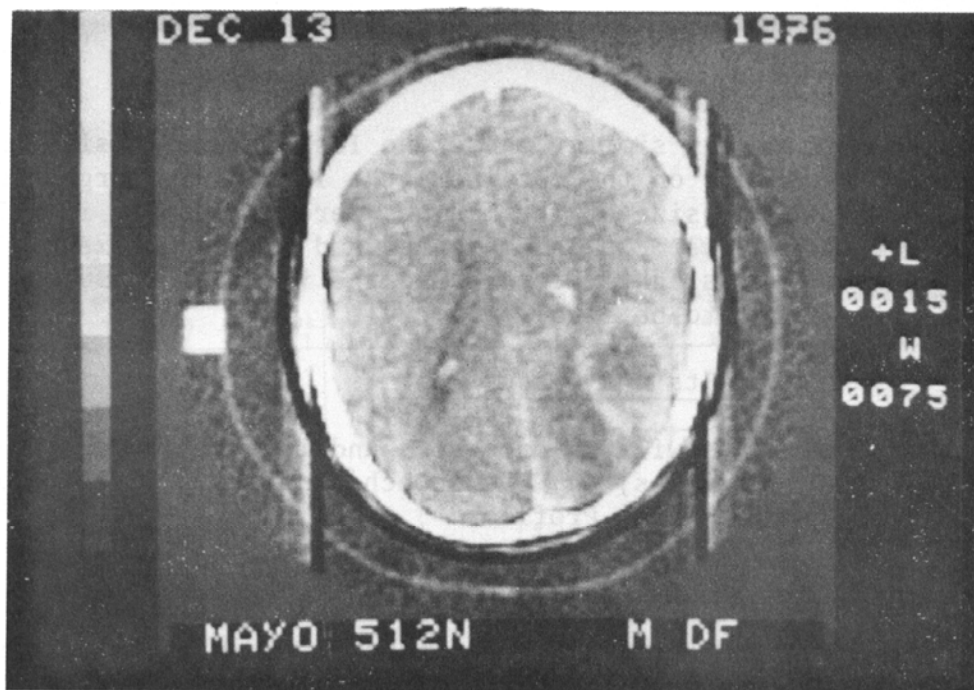


Figure 2.

Figure 3 is a copy of the Neurologic Topographical Sheet which the neuro-radiologist used to draw the lesion based on the series of photographs that are available through the EMI-Scan process. In this drawing the lesions of these two patients can be compared simultaneously in three different views.

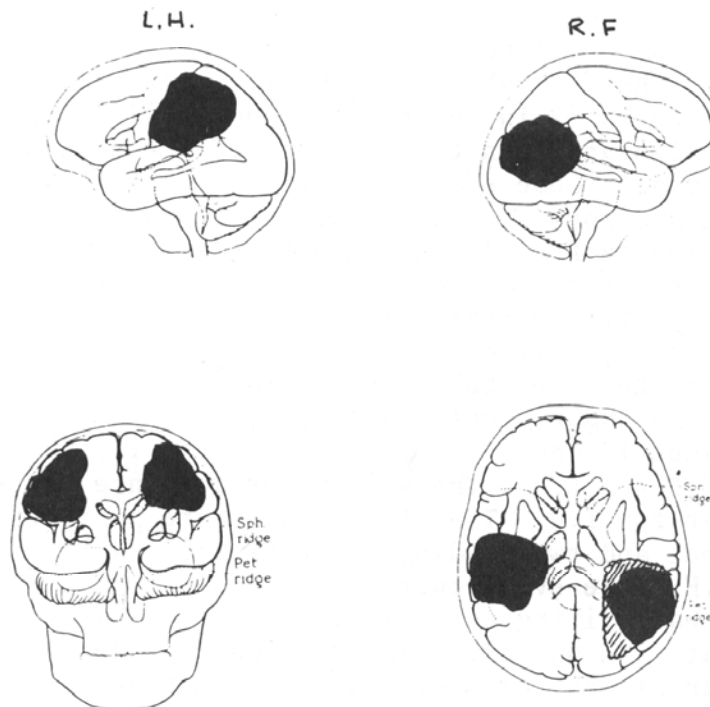


Figure 3.

One can see how remarkably similar these two lesions are in size and shape. Several measurements were made on the cut where the lesion was largest and then were compared. The depth and size of the lesions were comparable in all respects including the fact that they were well demarcated and judged to exert a slight pressure on the thalamus and slightly compressed the internal capsule. No other structures were judged to be involved.

Results and Discussion

Data for the two patients will be presented under four headings: (1) The Complete Language Battery Profiles, (2) The Speech Profiles, (3) The Writing Profiles, and (4) The Comprehension Profiles.

The Complete Language Battery Profiles

To better understand the scope of the complete battery, a brief list of the tasks included in the subtests may be helpful. The following subtests include: 17-repeating a series of words; 18-repeating sentences; 19-repeating single names; 20-motor speech tasks; 4-tactile naming; 6-describing actions; 7-describing functions; 8-naming objects; 3-reading single words; 14-reading sentences; 15-reading a series of words; 16-reading function of objects; 21-copying names; 22-copying letters; 9-writing a description of action; 10-writing names; 2-pointing to object; 11-following commands; 12-pointing to a series of objects; 13-pointing to object by function; 23-auditory discrimination of words; 3-comprehension of single words; 14-comprehension of sentences; 15-comprehension of a series of words; 16-comprehension of object's function; 24-visual discrimination of words; 1-matching object to object; 5-tactile matching.

Figure 4 contains the complete language profiles for the subjects. The average score on six of the 28 tasks on the profile were scored as 15's for L.H. Seven additional tasks (2 in spontaneous speech, 2 in verbal comprehension, 2 in reading comprehension and 1 in tactile matching) were scored between 14 and 15. The average of all these scores was 12.0 with the patient's poorest performance in writing and inconsistently poor performances in two verbal and two reading comprehension tasks. If one were to average the four scores under each of the three speech categories, one would find that L.H. had about the same level of difficulty with imitative (12.5) as with spontaneous speech (12.6) and that his average was highest for reading aloud (13.4).

Note that although the complete language profile for R.F., the patient with the right hemisphere tumor, contains only two average mean scores of 15 and four other scores between 14 and 15, the average for all of his scores was 11.4 as compared to 12.0 for L.H. The writing performance for R.F. was considerably better than it was for L.H. The right hemisphere patient also had difficulty with the same two verbal and two reading comprehension tasks as L.H., except that the scores for R.F. were even lower.

It would appear that writing performance was more severely disturbed for L.H. than R.F. and that with one exception reading comprehension was more severely disturbed for R.F. than it was for L.H. However, what seems remarkable to us was how similar the peaks and valleys of the two profiles are in comparison to one another.

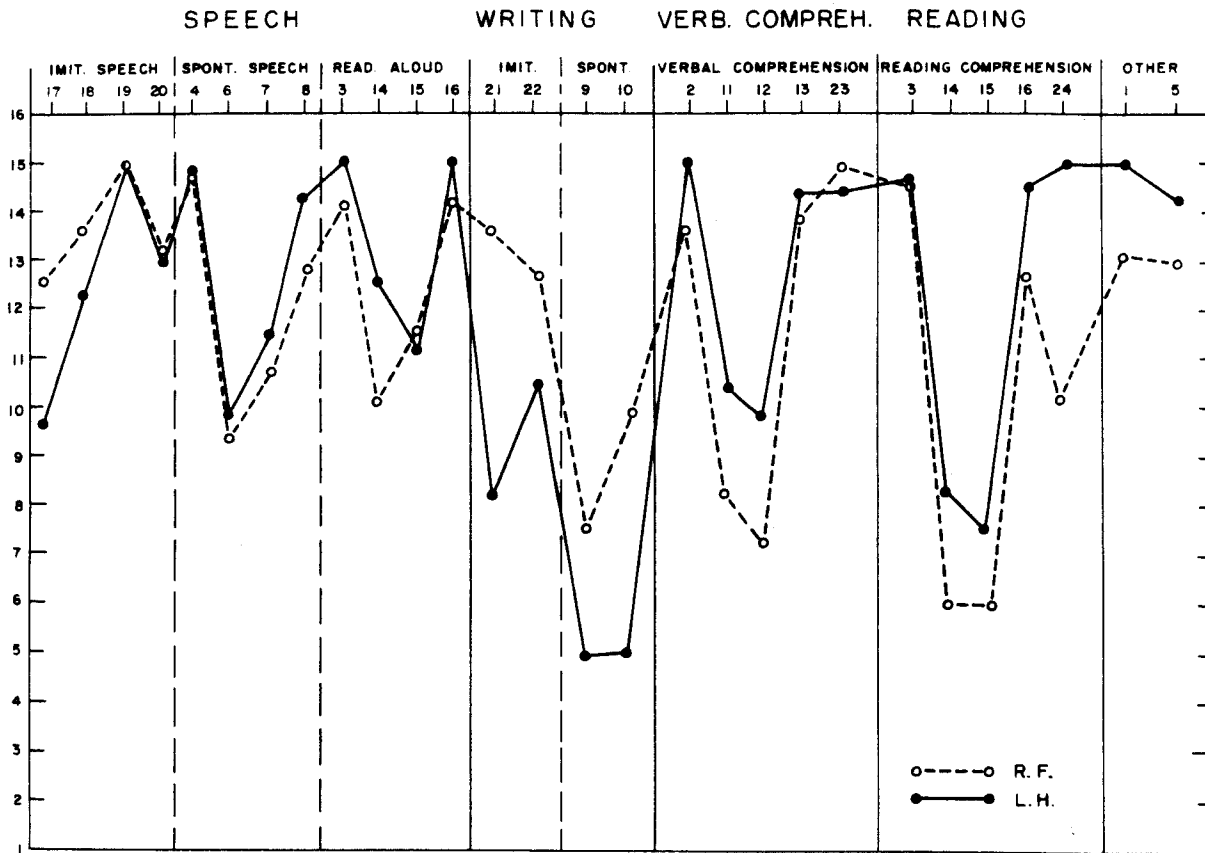


Figure 4. The language battery profiles for L.H. (left hemisphere tumor) and R.F. (right hemisphere tumor).

Speech Profiles. Figure 5 displays the 12 subtests administered under speech; that is, tests of expressive language ability. The average of all 12 subtests for L.H. was 12.8 and for R.F. was 12.7. Notice again in the profiles how well both patients perform on these speech tasks and how similar the peaks and valleys are for each patient.

SPEECH

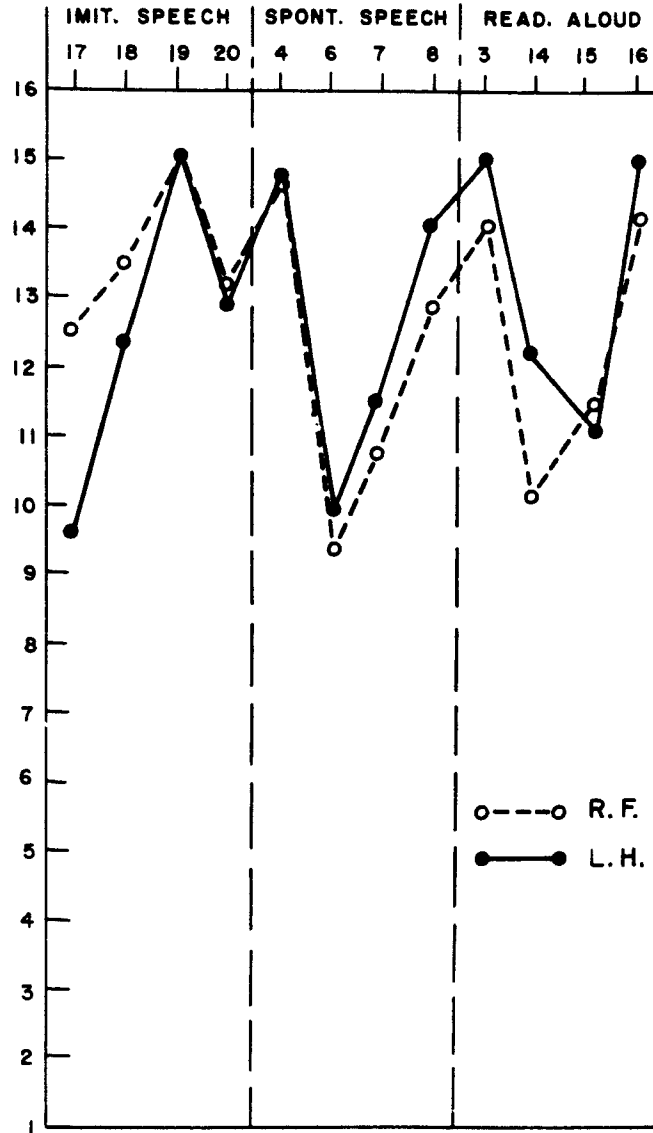


Figure 5. Speech profiles for L.H. (left hemisphere tumor) and R.F. (right hemisphere tumor).

Writing Profiles. The subtests shown in Figure 6 concerned with imitation are those that require the subject to copy names (21) and letters (22). In subtest 9, the patient has to describe in writing what the experimenter did with the objects and in subtest 10, the patient writes the name of the object that the experimenter points to.

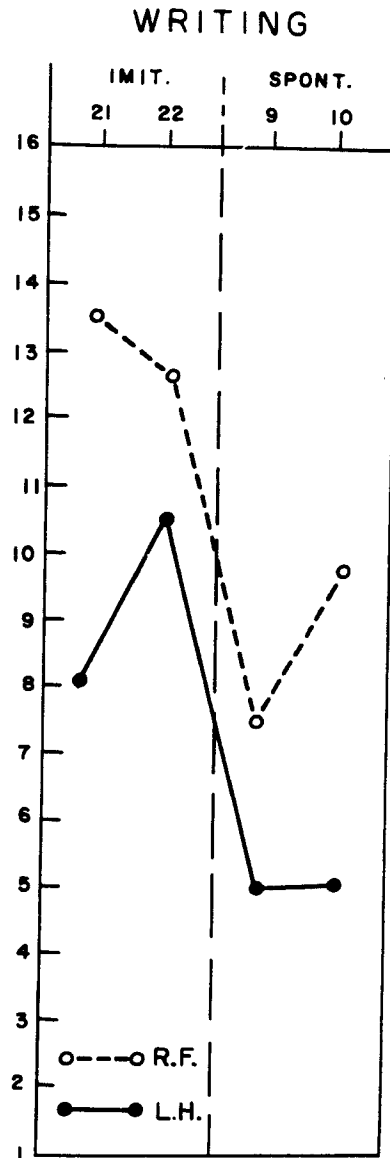


Figure 6. The writing profiles for the two patients, L.H. and R.F.

The average score of these four tasks in writing was 7.2 for L.H. and 10.9 for R.F. It seems clear that L.H. (whose tumor is located more anteriorly than R.F.'s) had considerably more difficulty in writing than R.F. In fact, the left

hemisphere patient (L.H.) refused to do the spontaneous writing subtests 9 and 10, although initially, when asked about his writing, he thought it was "pretty good" and he began the task. He also found copying names considerably more difficult than copying letters.

Note that the writing performance for R.F. was not without error, however. It appears that the parietal lobe involvement (common to both) may account for this poorer performance in writing and that the more anterior the involvement the greater the effect is on the writing performance of a patient.

Comprehension Profiles. Figure 7 compares 5 tests of verbal and 5 tests of reading comprehension. Although a great deal of data are displayed here, we would like to concentrate on only a few points. First, notice once again how similar the profiles are for both patients. Second, notice that verbal comprehension was better (higher mean scores) than reading comprehension for both patients. Third, the overall mean verbal and reading comprehension scores for L.H. were better than for R.F. and the patterns for these two patients on verbal comprehension were strikingly similar to those on reading comprehension.

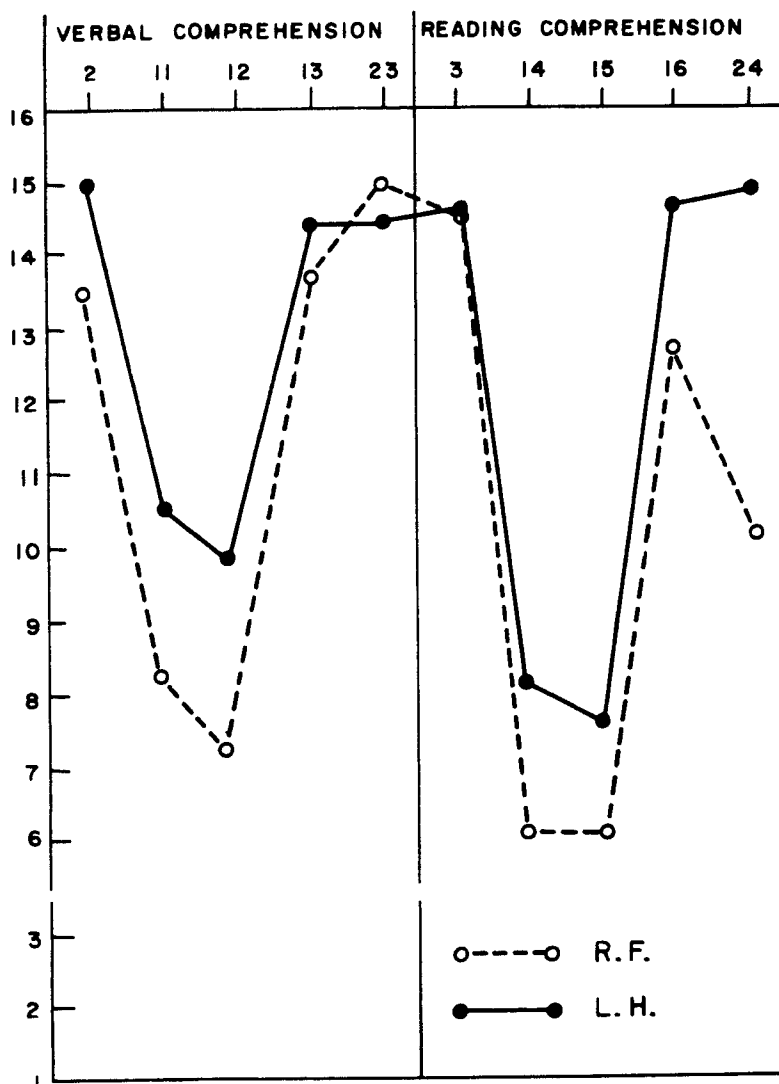


Figure 7. Comprehension profiles for L.H. and R.F.

We should point out that the subtests on verbal comprehension involve the same types of tasks as those for reading comprehension. That is, subtest 2 is similar to subtest 3 in pointing to objects, except that in subtest 2 the subject has to respond to the word spoken by the examiner and in subtest 3 he reads the word himself and then points to the object. Thus, subtest 11 corresponds to 14, 12 to 15, 13 to 16 and 23 to 24. The differences between these tasks is that the stimuli are presented auditorily in verbal comprehension and visually in reading comprehension.

Without belaboring the point, we would conclude that reading comprehension differences favor the left-hemisphere patient. Or to put it another way, the right-hemisphere patient with a more posterior lesion had greater difficulty in reading than the left-hemisphere patient with a more anterior lesion.

Conclusion

What we have attempted to present here are some preliminary results of an approach we feel is extremely promising in exploring localization of language functions in the human brain and its application to the study of right-left hemisphere language dominance.

It does appear that the major differences among the language skills of these two patients lie in reading and writing. It seems consistent with what we know about localization of these functions that the patient with a more anterior lesion (frontal-parietal lobes) is likely to demonstrate difficulties in writing and the patient with a more posterior lesion (parietal-occipital lobes) is likely to demonstrate difficulties in reading as well. Of course, we need to gather more data in this way on a large series of patients before we can make any definitive statements about localization of language functions in the human brain.

In answer to our second question, it appears possible to say that a patient with aphasia following a lesion in a dominant right hemisphere is not substantially different in his aphasic involvement from a patient with aphasia due to a lesion in a dominant left hemisphere. A second point should be made about the nature of aphasic symptoms due to frontal-parietal and parietal-occipital lesions. Our data show that disturbances in language skills occur in all modalities and all major areas of expression and reception. However, note that there are language skills which are relatively intact, given lesions in these lobes, tasks such as repeating names (subtest 19), tactile naming (subtest 4), reading aloud single words (subtest 3), pointing to objects on command (subtest 2), auditory discrimination (subtest 23) and reading comprehension of single words (subtest 3).

Those language skills more severely affected by lesions in the frontal-parietal and parietal-occipital lobes include repeating a series of names (subtest 17), describing the manipulation of objects (subtest 6), reading aloud commands (subtest 14), reading aloud a series of names (subtest 15), following commands (subtest 11) and pointing to a series of objects spoken by an examiner (subtest 12). The most difficult language task other than the writing subtests for both patients was in reading comprehension, which required the reading of a series of names and then pointing to appropriate objects.

In conclusion, we hope that this type of investigation may lead to a better understanding of the differences and/or similarities of language deficits in right and left hemisphere dominant patients. In addition, we hope that data of these kind may lead us to a better understanding of the heuristic value of neurological language models and their applications to prognosis and treatment in aphasia.

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DISCUSSION

- Q: Was it possible to follow these two patients after surgery in order to validate the site of lesion?
- A: Not in the case of the left hemisphere patient, who did not have surgery at the Clinic. Surgery for the patient with the tumor in the right hemisphere did confirm the site, size and extent of the tumor identified through the EMI-Scan process. However, surgery alone may not provide as much specificity concerning site of lesion as the CT-Scan or EMI-Scan process.
- Q: Would you comment about the problems in assessing language deficits in patients with tumors, in view of the widespread effects a tumor is likely to have on immediate and surrounding brain tissue?
- A: The only comment I can make is to agree with the observation that tumors are likely to have more widespread effects on the brain than other lesions. How we hope to be able to examine a large series of patients with different kinds of lesions in the same areas as those described here and perhaps be able to say something more definitive about the similarities and differences that different lesions have on language functions. In fact, we are looking at a large series of lesions in the larger and more extensive study now in progress at the Mayo Clinic.
- Q: How does one answer the question of bilateral representation in these patients?
- A: We really can't answer that question in this study. Certainly there is no evidence of bilateral damage in either case. Preliminary examination of the language skills before and after surgery of the right hemisphere patient demonstrates a significant improvement after surgical intervention. It is my belief that these data would tend to support unilateral right hemisphere dominance in this patient.
- Q: Does the battery you used assess the patient's language skills through gesture?
- A: No.
- Q: Is it possible that the right hemisphere patient's problem in reading merely reflects a result of damage to visual-spatial functions associated with the minor (right) hemisphere?
- A: I think not, since the right hemisphere in question here is the dominant hemisphere for language functions. Therefore, in this case, it is not a matter of damage to the minor hemisphere; but rather, damage to the dominant hemisphere.