CHAPTER

30

Quantitative and Qualitative Comparisons of Auditory Comprehension and Reading in Aphasia

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It is generally accepted that aphasic language deficits may be unevenly distributed among the expressive and receptive modalities. The most obvious example of this uneven distribution of the language deficit in aphasia is provided by the disparities observed in the language output of Broca and Wernicke aphasic patients. The relative degrees of impairment between the receptive modalities are not so clear-cut, however. Most studies comparing auditory and reading comprehension have indicated that most aphasic patients present impairments of approximately equal severity in these two modalities. In a study of 78 aphasic patients, Smith (1971, p. 187) observed that "the incidence of severe reading defects increased systematically with the severity of [auditory] comprehension defects." Based on ratings of severity of communicative impairment performed on a seven-point, equal-appearing interval scale, Duffy and Ulrich (1976) reported that 37 of their 44 aphasic subjects presented auditory comprehension and reading deficits that fell within one scale point of one another. The severity of six subjects' auditory comprehension and reading deficits differed by two scale points and one subject's by three scale points.

Studies by Gardner, Denes, and Zurif (1975) and Gardner and Zurif (1976) have also produced results that indicate that most aphasic patients present auditory and reading comprehension deficits of similar severity. Gardner and colleagues (1975) reported no significant difference between the auditory and visual modalities in aphasic patients' judgments regarding which of two sentences was correct. Gardner and Zurif (1976) reported that aphasic subjects with significant comprehension deficits made more errors on tasks requiring single word and phrase reading than did subjects with mild auditory comprehension deficits. Kertesz (1979) also provided data supporting a strong relationship between the severity of auditory comprehension deficits and that of reading deficits. Based on the test results of 225 aphasic patients, Kertesz obtained correlation coefficients of .70 between auditory comprehension and sentence reading and .76 between auditory comprehension and following printed commands. Finally, Webb and Love (1983) reported a correlation coefficient of $-.638$ between the number of errors their 35 aphasic subjects made on a battery of 12 reading tasks and the subjects' mean scores on subtests VI and X of the Porch Index of Communicative Ability (Porch, 1973). This result indicated that subjects with lower scores on these tests of auditory comprehension made more reading errors than did subjects with higher scores.

Two studies of Broca aphasic subjects, however, suggest that substantial discrepancies between auditory comprehension and reading may occur among aphasic patients on a more regular basis than suggested by the studies described above. Benson (1977) reported that 51 of 61 Broca aphasic patients, most of whom had relatively intact auditory comprehen-

sion, presented a significant reading impairment. Gallaher and Canter (1982) observed that their 10 Broca aphasic subjects made significantly more errors in selecting which of four pictures best matched a simple active declarative sentence in reading than when the sentence was presented auditorily. Furthermore, only Gardner and colleagues (1975) and Gallaher and Canter (1982) used linguistically identical stimuli when testing both auditory comprehension and reading. Failure to use homogeneous stimuli may have resulted in a failure to appreciate significant performance differences in the other studies reviewed. Finally, except for Gallaher and Canter (1982), the aforementioned studies used only quantitative analyses, with no qualitative analyses directed at discerning variations in performance related to specific linguistic variables having been conducted.

The purpose of the present investigation was to examine the auditory and reading comprehension of a heterogeneous group of aphasic patients using a standardized test of auditory comprehension and a reading version of that test with the same linguistic and pictorial stimuli. The results of this study provide directly comparable data regarding the severity and nature of the auditory comprehension and reading impairments of aphasic individuals.

METHOD

SUBJECTS

The subjects for this study were 13 aphasic individuals, eight males and five females. The subjects' mean age was 62.9 years, with a range of 46 to 84 years. Their mean number of years of formal education was 13.9, with a range of 12 to 20. Mean time post-onset was 38.9 months, with a range of 3 to 132 months. Seven of the subjects were classified as presenting a fluent aphasia, six as nonfluent. No subject had any auditory or visual acuity impairment or any visual field cut that might have interfered with performance of the experimental tasks.

PROCEDURE

All of the subjects were administered four tests as follows:

Test 1. Auditory Comprehension Test for Sentences (ACTS) (Shewan, 1979): The ACTS is a standardized test of auditory comprehension consisting of four example stimulus sentences and 21 test sentences. The sentences vary in terms

of length, vocabulary frequency, and syntactic complexity. Three levels of each of these variables are represented among the stimuli. Subjects respond to the auditorily presented sentences by pointing to one of four pictures. The four pictures include the target picture and three foils, each of which differs from the target by one critical attribute. Two tape-recorded versions of the ACTS were used in this study, one employing the standard order of administration and one using a different random order of the 21 test sentences.

Test 2. Reading Version of the ACTS, Standard Order: In this test, the ACTS stimuli were presented, in standard order, on 5 × 7 inch cards. The sentences were printed in pica type enlarged to an average letter height of 4 mm. The stimulus card was left in the subject's view until he or she had responded by pointing to a picture.

Test 3. Reading Version of the ACTS, Randomized Order: This test was identical to test 2 except that the test stimuli were presented in a different randomized order.

Test 4. Subtest IV — Sentence-Picture of the Reading Comprehension Battery for Aphasia (RCBA) (LaPointe and Horner, 1979): This test consists of 10 items in which the subject points to which of three pictures best matches a printed sentence.

The auditory version and the two reading versions of the ACTS were scored using both plus/minus scoring and the weighted scores described by Shewan (1979). For the reading versions, a latency of 10 seconds was permitted for a "prompt correct response," rather than a latency of 3 seconds in the auditory version. Order of administration was counterbalanced across subjects with one test being administered during each of four testing sessions. Testing sessions occurred at least 4 days apart and with a total elapsed time of no more than 21 days over the four sessions.

RESULTS

Individual subject and mean scores for plus/minus and weighted scoring of the three versions of the ACTS and subtest VI of the RCBA are presented in Table 30-1. The scores for the first administration of a reading version of the ACTS (either test 2 or test 3) are listed under ACTS-Reading/1, and those for the second administration of a reading version of the ACTS are

TABLE 30-1. INDIVIDUAL AND MEAN SCORES FOR THE THREE ADMINISTRATIONS OF THE ACTS AND SUBTEST VI OF THE RCBA

	Auditory		*ACTS-Reading/1*		*ACTS-Reading/2*		
Subject	*+/−*	*Weighted*	*+/−*	*Weighted*	*+/−*	*Weighted*	*RCBA-VI*
1	18	88	20	100	21	100	10
2	18	91	17	82	18	78	10
3	17	87	19	85	16	83	10
4	10	72	10	69	11	73	8
5	10	67	11	66	10	62	8
6	17	86	13	71	14	74	10
7	18	90	17	80	16	88	9
8	18	88	19	88	19	84	10
9	16	83	17	87	15	81	9
10	17	83	15	73	18	79	10
11	14	77	13	70	13	68	9
12	14	74	12	66	13	74	9
13	19	93	17	85	18	79	10
$\bar{X}$	15.8	83.0	15.4	78.6	15.5	78.7	9.4
SD	2.99	8.07	3.28	10.35	3.26	9.41	—

presented under ACTS-Reading/2. Therefore, ACTS-Reading/1 scores may be viewed as first test scores and ACTS-Reading/2 scores as re-test scores.

Pearson product-moment correlation coefficients were computed for selected pairs of ACTS results. The correlation coefficient for the ACTS and ACTS-Reading/1 scores using plus/minus scoring was .84 ($p < .001$). The correlation coefficient for these two administrations using weighted scores was .73 ($p < .002$). The correlation coefficients for the ACTS-Reading-1 and ACTS-Reading/2 scores were .88 ($p < .001$) using plus/minus scoring and .87 ($p < .001$) using weighted scores.

Group error distribution patterns across the variables of length, vocabulary, and syntax for the ACTS, ACTS-Reading/1 and ACTS-Reading/2 are presented in Table 30-2. These results show that error distributions were similar for all three tests, with the number of errors increasing with the level of complexity. On all three tests, the subjects made nearly equal numbers of length and vocabulary errors and slightly fewer syntax errors.

Comparisons were also conducted of which items were failed and which error responses were chosen. Comparing the ACTS and the ACTS-Reading/1, it was found that 53.7 percent of the items that the subjects failed on the ACTS were also failed on the ACTS-Reading/1. Of the 36 items that were failed on both tests, subjects chose the same error response on 61.1 percent. Of the 73 items failed on the ACTS-Reading/1, 54.7 percent were also failed on the ACTS-Reading/2. Subjects chose the same error response on 85.0 percent of the 40 items that subjects failed on both reading administrations.

TABLE 30-2. NUMBER OF ERRORS OCCURRING ON STIMULI OF EACH LEVEL OF COMPLEXITY ON THE ACTS, ACTS-READING/1, AND ACTS-READING/2

	ACTS	*ACTS-Reading/1*	*ACTS-Reading/2*
Length			
L1	3	5	5
L2	4	6	10
L3	20	15	14
Vocabulary			
V1	3	5	5
V2	9	10	7
V3	15	14	16
Syntax			
S1	3	5	5
S2	6	6	7
S3	10	14	12

In addition to the group quantitative analyses reported above, qualitative error analyses were performed. These analyses were carried out using the qualitative error analysis designed for use with the ACTS. This analysis uses subjects' error responses to classify errors according to position in the stimulus (first segment versus second segment), grammatical form class (noun versus verb versus adjective versus pronoun), syntax (negative), and linguistic constituent (noun phrase versus verb phrase versus prepositional phrase). The results of these analyses were used to compare error distributions on the ACTS and ACTS-Reading/1.

As can be seen in Table 30-3, the subjects distributed their errors essentially equally between the first and second segments of the stimuli on both the ACTS and ACTS-Reading/1. Regarding grammatical form class, subjects made more errors on nouns than verbs on the ACTS and more errors on verbs than nouns on the ACTS-Reading/1. Subjects made 10 errors involving negatives on the ACTS and 17 on the ACTS-Reading/1. Results of the linguistic constituent analysis revealed that on both the ACTS and ACTS-Reading/1, subjects distributed their noun errors essentially equally between noun phrases and prepositional phrases.

Individual subject's error distributions were also analyzed. Eight of the subjects, five fluent and three nonfluent, distributed their errors in similar patterns on both the ACTS and ACTS-Reading/1. The remaining five subjects, two fluent and three nonfluent, showed substantially different error distributions between the ACTS and ACTS-Reading/1. The criterion for identifying error distributions as dissimilar was 30 percent or greater dif-

TABLE 30-3. PERCENTAGES OF ERRORS OF EACH TYPE ON THE QUALITATIVE ERROR ANALYSIS FOR THE ACTS AND ACTS-READING/1

Errors	*ACTS*	*ACTS-Reading/1*
Position of error		
First segment	51	50
Second segment	49	50
Grammatical form class		
Noun	60	41
Verb	35	51
Adjective	4	7
Pronoun	2	2
Negative	10	17
Linguistic constituent		
Noun phrase	20	22
Verb phrase	45	62
Prepositional phrase	25	16

ference in the number of errors falling in any two complementary error categories.

Of the two fluent subjects distributing their errors differently between the ACTS and the ACTS-Reading/1, one made 72 percent of his errors on the ACTS on nouns and 14 percent of his errors on verbs. On ACTS-Reading/1, he made 22 percent of his errors on nouns and 67 percent of his errors on verbs. On the ACTS, his noun errors occurred mostly on the longest stimuli and were distributed equally between noun phrases and prepositional phrases. His verb errors on ACTS-Reading/1 occurred mostly on stimuli that were longer and contained less frequently occurring vocabulary. The other fluent aphasic subject showing different error distributions between the ACTS and ACTS-Reading/1 made all of her errors on the second segments of stimuli on the ACTS and on the first segments of stimuli on the ACTS-Reading/1. Two-thirds of this subject's errors on the ACTS occurred in phrases containing a locative preposition.

All three of the nonfluent subjects distributing their errors differently between the ACTS and the ACTS-Reading/1 did so relative to grammatical form class. One subject made 75 percent of his errors on nouns and 25 percent on adjectives on the ACTS. Two-thirds of his noun errors were on the objects of locative prepositions. On ACTS-Reading/1, he made 33 percent of his errors on nouns, 50 percent on verbs, and 17 percent on pronouns. A second of these nonfluent subjects divided her errors equally between nouns and verbs on the ACTS. On ACTS-Reading/1, she made 20 percent of her errors on nouns and 80 percent of her errors on verbs. Of her verb errors on both tests, all but one was on less frequently occurring vocabulary. The third nonfluent subject showed a noun-verb distribution similar to that of the second. On the ACTS, 67 percent of his errors were on nouns and 33 percent on verbs. On ACTS-Reading/1, 14 percent of his errors were on nouns and 72 percent on verbs.

The first nonfluent subject also distributed his errors differently relative to the segment of the stimulus in which the error occurred. He divided his errors equally between the first and second segments of the stimuli on the ACTS, while making all of his errors on ACTS-Reading/1 on the second segments of stimuli. No pattern of error distribution regarding the length, vocabulary, or syntactic complexity of the stimuli on which his errors occurred could be discerned. Finally, the second nonfluent subject also showed different error distributions on stimuli containing negatives. She made three errors involving negation on ACTS-Reading/1, while making none on the ACTS. All three of these errors were in passive sentences.

DISCUSSION

Results of the quantitative analyses conducted in this study are, for the most part, compatible with the results of previous studies comparing the

auditory comprehension and reading deficits of aphasic individuals. The correlation coefficients obtained between the ACTS and ACTS-Reading/1 exceeded those reported by Kertesz (1979) and by Webb and Love (1983). These higher correlations may reflect the use of linguistically identical stimuli in the present study.

The current results also paralleled those of Smith (1971) and Duffy and Ulrich (1976). The mean difference between ACTS and ACTS-Reading/1 plus/minus scores was 1.5. Only one of the subjects in this study achieved a plus/minus score on the ACTS that differed from his score on ACTS-Reading/1 by more than two accurate responses. In addition, the largest weighted score difference obtained was 15, with a mean difference of only 6.8, where the maximum possible difference was 63 when subjects responded appropriately to all stimuli.

Results of the qualitative analyses performed, however, indicate that one cannot rely on quantitative results alone when comparing the auditory and reading comprehension deficits of aphasic patients. Five of the 13 subjects in this study presented marked qualitative differences between their auditory and reading comprehension performances, in spite of differences between their ACTS and ACTS-Reading/1 plus/minus scores of 0, 1, 2, 2, and 4. Thus, even when the severity of auditory and reading comprehension impairments may appear essentially equal, the nature of these deficits may be quite different.

Based on the results of Benson (1977) and Gallaher and Canter (1982), one might expect that the qualitative differences observed could be largely attributed to the nonfluent aphasic subjects in this study. This was not the case, however. Of the five subjects presenting qualitative differences, two were fluent and three nonfluent. The current results are more consistent with those of Gardner and colleagues (1975) and Gardner and Zurif (1976), who reported no significant differences between their anterior and posterior lesion groups.

Examination of the specific qualitative differences observed revealed that one fluent and one nonfluent subject distributed their errors differently between the first and second segments of the stimuli. The nonfluent subject distributed his auditory errors equally between first and second segments, while making all of his reading errors on the second segment. This may suggest a limitation in working memory capacity that occurred randomly under the immediate processing demands of auditory comprehension but manifested itself on the second segment in reading, wherein working memory capacity may have been filled by first-segment information. The fluent subject made all of her auditory comprehension errors on the second segments of stimuli. Two-thirds of these errors occurred on the objects of locative prepositional phrases. This may reflect a particular difficulty with prepositions consistent with that reported by Gardner and Zurif (1976). All of this subject's reading errors occurred on first

segments, possibly indicating a deficit in her ability to retain first-segment information while processing second-segment information.

Four subjects, two fluent and two nonfluent, also distributed their errors differently between nouns and verbs. In every case, the difference was in the direction of more noun than verb errors in auditory comprehension and more verb than noun errors in reading. In one case, noun errors in auditory comprehension occurred predominantly on the objects of prepositional phrases, but the other three subjects distributed their noun errors nearly equally between sentence subjects and objects of prepositions. No other explanatory pattern for this difference could be discerned from the data.

One nonfluent subject made three errors involving negation in reading, but none in auditory comprehension. All three of these errors occurred on passive sentences. The processing demands of passive negative sentences requiring syntactic decoding of two transformations are greater than those of active negative sentences requiring decoding of only one transformation. Why the greater syntactic complexity of passive negative sentences should manifest itself in reading and not auditory comprehension remains unclear, however.

Two areas of future investigation clearly emerge from this study. No comparisons were made between the performances of the fluent and nonfluent groups because of the heterogeneity of the language impairments observed within each group. Larger groups of aphasic subjects need to be studied to identify commonalities among those patients presenting either highly similar or markedly dissimilar auditory comprehension and reading impairments. In addition, individual patients need to be studied meticulously to determine the precise nature of their processing deficits. The second area of investigation involves the treatment of these patients. In particular, patients presenting similar auditory comprehension and reading impairments should be studied for cross-modality generalization of treatment effects.

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DISCUSSION

Q = question; A = answer; C = comments.

Q. I think it's helpful to dig into normal theories of auditory comprehension and reading comprehension and the differences and similarities between the two processes possibly as other sources of prediction and possible explanaton. You discussed a working memory concept and used that a little bit in discussing your results. I'm wondering if there was a problem with passive negatives in reading but not in auditory comprehension?

A. Yes, but that's not where I invoked the concept of working memory.

Q. Right but it could be invoked in reading. Especially persons having difficulty reading might involve more auditory recoding in the reading process. Therefore, the number of processes crowding for space in working memory just accumulates so much that at the top end of complexity they may fall out in reading where it may not fall out in auditory processing which has its own demands. I'm wondering whether or not there are any special differences between reading and auditory comprehension which would cause the difference in working memory that you discussed? I think problems with one half of a sentence in one modality and problems with the other half in the other modality does seem to be kind of an incomprehensible result.

A. Your point is well taken. The reason I feel we need to start looking at individual patients very closely is to provide a better basis from

which to seek explanations in normal theory, but I think we may need to do that, at least at this stage of the game, on a more individual basis. As we accumulate a more detailed data base on a greater number of subjects, we may be able to develop explanations based on theories on normal reading and auditory comprehension which generalize across groups of patients.

Q. In terms of the disparity between some of the auditory and reading skills, did you look at the writing generative skills of some of those aphasic patients, and can you tell me how intact that was or not? Do you think that would give you any information on their underlying reading capabilities?

A. That's a good question, and unfortunately the answer is going to have to take an impressionistic form. I have not looked specifically at these patients' writing, but what I can tell you is that there is a wide range within the group. There are a couple of those patients who can't write a lick, and there are others at the high end who have pretty functional writing.