IDENTIFICATION OF APRAXIA OF SPEECH FROM PICA VERBAL TESTS AND SELECTED ORAL-VERBAL APRAXIA TESTS

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Our review of 228 cases of apraxia of speech (Wertz, Rosenbek, and Deal, 1970) revealed that apraxia of speech occurs more frequently than is indicated by the number of cases reported in the literature, and the disorder most commonly coexists with aphasia and/or dysarthria. Based on the latter observation, we suggested the need for systematic testing to determine the presence of apraxia of speech in brain injured adults. Otherwise, its presence may be masked by the other two disorders.

Previous reports on apraxia of speech have been theoretical or definitional (Canter, 1969; Darley, 1964). Some have presented in-depth phonemic analyses (Johns and Darley, 1970). Others (LaPointe and Wertz, 1969) have applied specific criteria for differentiating apraxia of speech from aphasia and dysarthria. Yet others (Denny-Brown, 1965) have presented individual cases in an attempt to localize lesions resulting in apraxia of speech. To date, only one investigation has asked clinicians to judge the presence of apraxia of speech, differentiate it from coexisting aphasia and/or dysarthria, and rate its severity (Rosenbek, 1970).

Since apraxia of speech is a motor speech disorder requiring a different therapeutic approach than one would use with the language disturbance seen in aphasia or the motor speech problems demonstrated by the patient with dysarthria, it is essential that the clinician be able to appraise and diagnose the presence of apraxia of speech in brain injured adults. Consequently, we selected two groups of patients--one group demonstrating aphasia and no apraxia of speech and one group demonstrating aphasia with coexisting apraxia of speech--and asked clinicians to judge the presence or absence of apraxia of speech in each patient, and, if present, to rate the severity of apraxia of speech on a seven-point scale.

Definition of Terms

In order to differentiate aphasia from apraxia of speech, it is necessary to develop useful definitions for the two disorders. We have used Darley's (1969) definitions for both disorders. We defined the oral expressive manifestations of aphasia as follows:

> Slowed vocabulary retrieval, substitution of words, use of wrong words, circumlocution, omission of connectors or modifiers, telegraphic constructions, altered word order, reduced fluency, supernormal fluency, neologisms, jargon, perseveration.

The definition for apraxia of speech was as follows:

> An articulatory disorder resulting from impairment, as a result of brain damage, of the capacity to program the positioning of speech musculature and the sequencing of muscle movements for the volitional production of phonemes. The speech musculature does not show significant signs of weakness, slowness, or incoordination when used for reflex and automatic acts.

In addition, previous research has been quite consistent in identifying the characteristics of apraxia of speech. Darley (1969) has summarized these results, and they are shown in Table 1. The patient with apraxia of speech presents some

TABLE 1. Characteristics of apraxia of speech. (From Darley, 1969)

Prominent phonemic errors: omissions, substitutions, distortions, additions, repetitions
Some errors are perseverative, others anticipatory
Errors are off-target approximations of desired production
Errors are highly inconsistent
Errors vary with the complexity of articulatory adjustment
Errors increase as words increase in length
Automatic-reactive speech is better than volitional-purposive speech
Imitative responses are particularly poor
Speaker is usually aware of his errors but typically cannot anticipate or correct them
Anticipation of errors leads to prosodic disturbances: slowed rate, even stress, even spacing
Oral apraxia often, but not always, accompanies apraxia of speech

combination of the characteristics listed in the Table--prominent phonemic errors, anticipatory and perseverative errors, off-target approximations of the desired production, inconsistent errors, errors which vary with articulatory complexity, an increase in errors as words increase in length, islands of error-free production, poor imitative responses, awareness of errors but inability to anticipate or correct them, prosodic problems when the patient attempts to anticipate his errors, and the frequent co-occurrence of oral apraxia.

Plan of the Study

Two groups of patients were selected: one group of ten aphasic patients who demonstrated no apraxia of speech and one group of ten patients with both aphasia and apraxia of speech. All subjects received the Porch Index of Communicative Ability (PICA) (Porch, 1967) and the Oral-Verbal Apraxia Battery (OVAB) (Wertz and Rosenbek, 1971). If any question arose regarding the presence or absence of apraxia of speech in a patient, additional tests were administered or previous tests were repeated. If diagnosis was still equivocal after additional testing, the patient was not used in the study.

Subjects

Table 2 shows the descriptive data for the two groups of patients. The aphasic group had a mean age of approximately 50 years and the apraxia of speech group had a mean age of approximately 53 years. Both groups revealed slightly over 12 years of education. The aphasics showed a mean post-onset of 14 and one-half months and the apraxia of speech group showed a mean of approximately 28 months. Severity of apraxia of speech, rated on a seven-point scale, ranged from 1 (extremely mild) to 6 (quite severe) with a mean of 3.

The aphasic group displayed greater mean involvement on the PICA for overall, gestural, and graphic scores than the apraxia of speech group. However, the mean aphasic group verbal score was slightly better than the mean verbal score obtained by the apraxic group. The range of severity on the PICA was greater for the aphasic group on all scores except the verbal score. Figure 1 shows subtest mean modality response scores for both groups. Again, it can be seen that the apraxia of speech group was superior to the aphasic group on all but the four verbal tests.

Tests

A diagnosis of apraxia of speech is typically made following a clinical evaluation that employs either the PICA and OVAB or similar speech and language tests. Therefore, the clinician bases his diagnosis of apraxia of speech on the verbal subtests

TABLE 2. Patient descriptive data.

DESCRIPTIVE	GROUPS					
	Aphasic			Apraxia of Speech		
	Mean	Range	S.D.	Mean	Range	S.D.
Age In Years	50.1	14 - 74	17.55	52.8	38 - 78	11.12
Education In Years	12.3	7 - 17	2.59	12.4	8 - 16	2.27
Months Post-onset	14.5	1 - 50	17.87	28.1	11 - 72	18.13
Severity of Apraxia of Speech (On Seven-point Scale)				3.0	1 - 6	1.49
PICA Scores						
Overall	11.74	8.63-13.52	1.56	13.04	10.90-14.60	1.41
Gestural	12.99	10.29-14.20	1.11	14.06	13.36-14.94	0.53
Verbal	12.25	10.53-14.02	1.27	12.01	5.38-14.53	2.89
Graphic	9.83	5.15-13.73	3.14	12.38	7.92-14.78	2.26

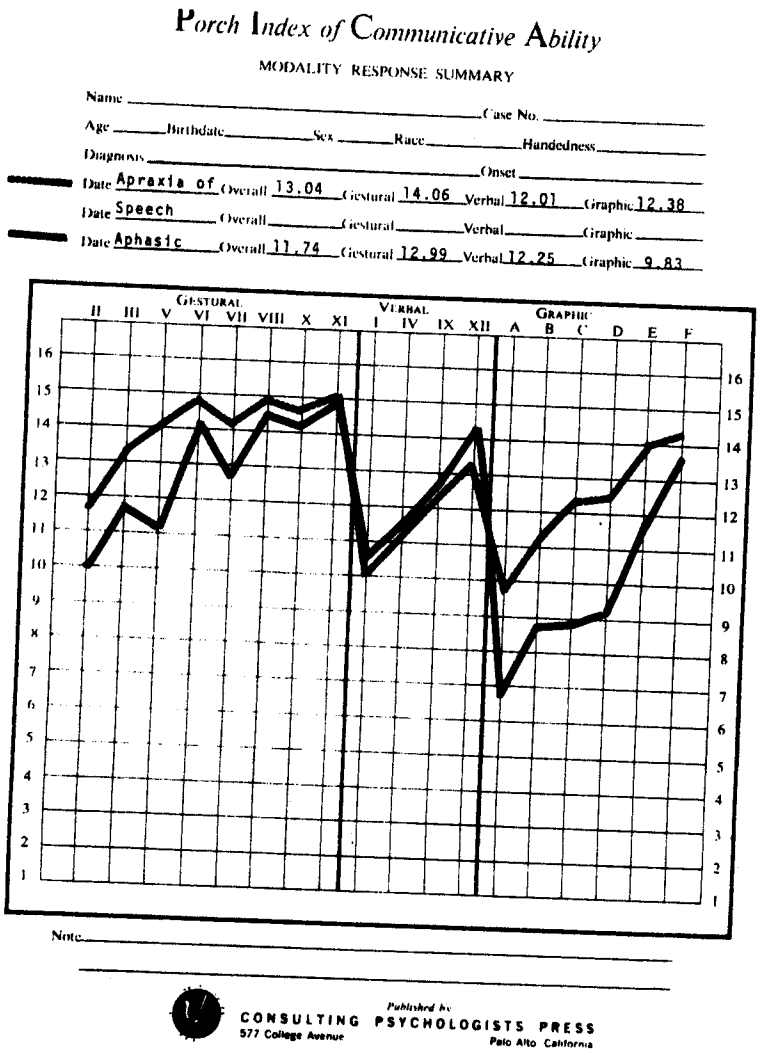

FIGURE 1. Subtest mean modality response scores for the aphasic and apraxia of speech groups.

comprising his clinical battery. Accordingly, we selected the four PICA verbal subtests and four tests from the OVAB for presentation to judges. Selection of the four OVAB subtests was based on the results of Rosenbek and Merson's work (1971) which identified the types of speech tasks most useful in determining the severity of apraxia of speech.

Table 3 shows the tests used in our listening tasks. Task 1 was comprised of listening to the four PICA verbal subtests for each of the 20 subjects. Task 2 was comprised of listening to four tests selected from the OVAB for each subject. And, Task 3 was comprised of listening to each individual PICA subtest and each individual OVAB subtest. Patients were randomized on Tasks 1 and 2, and patients and subtests were randomized on Task 3. The judges, therefore, listened to three

TABLE 3. Tests used in listening tasks.

TEST	DESCRIPTION OF TASK
PICA VERBAL TESTS	
Subtest I	Describe the function of common objects
Subtest IV	Name common objects
Subtest IX	Complete sentences by saying the names of objects
Subtest XII	Repeat the names of objects
ORAL - VERBAL APRAXIA BATTERY	
Diadochokinesis	Repeat monosyllables (p,t,k) and combined monosyllables (p-t-k)
Multisyllabic Words	Repeat multisyllabic words (e.g. snowman, impossibility)
Sentences	Repeat sentences (e.g. The shipwreck washed up on the shore)
Counting	Count from one to twenty

tape recordings. Their task was to determine the presence or absence of apraxia of speech on each subject's tape recorded samples. In all cases where a judge decided a patient was apraxic, he was asked to rate the severity of apraxia on a seven-point scale where 1 was minimal and 7 was severe. In

addition, if a judge could not decide on the presence or absence of apraxia of speech, we permitted him to list "undecided." Seven judges participated in the study. Judges were not trained for the listening tasks. All were working with brain injured adults, and all were making the kinds of diagnoses required by the listening tasks in an everyday clinical setting.

It is not an unusual clinical observation that aphasic patients will, at times, display "apraxic like" behavior and patients with apraxia of speech will not demonstrate the disorder on every verbal test. Table 4 confirms this observation. Initially, we diagnosed each patient using his overall behavior. Next, we determined the presence or absence of

TABLE 4. Group performance on individual tests based on initial diagnosis.

TESTS	GROUPS					
	Aphasic (N = 10)			Apraxia of Speech (N = 10)		
	Yes	No	Undetermined	Yes	No	Undetermined
PICA Subtest I		10		7	1	2
PICA Subtest IV		10		3	5	2
PICA Subtest IX		10		4	5	1
PICA Subtest XII		10		4	5	1
Diadochokinesis	1	8	1	8	1	1
Multisyllabic Words		10		9	1	
Sentences		7	3	7	1	2
Counting		10		3	6	1

apraxia of speech in each patient on each of the eight subtests. As seen in the Table, aphasic patients are much more consistent across tests than patients with apraxia of speech. Only two subtests show scatter--diadochokinesis and sentences. Not one test, however, was able to demonstrate the presence of apraxia of speech in all ten apraxic patients. In one sense, these data demonstrate a characteristic of apraxia of speech--extreme variability.

Results

Table 5 shows the percent correct judge agreement with the diagnosis on the three listening tasks. Judges agreed with

TABLE 5. Percent correct judge agreement on three listening tasks.

TASK	PERCENT CORRECT		
	Mean	Range	S.D.
PICA Verbal Combined	74.29	45 - 100	16.69
OVAB Combined	72.86	60 - 100	14.09
Individual Tests	70.42	43 - 89	16.03

the diagnosis 74 percent of the time using the PICA verbal subtests combined, approximately 73 percent of the time using the four OVAB subtests combined, and 70 percent of the time using individual subtests. Although the judges missed the diagnosis 26 to 30 percent of the time, as indicated in Table 5, Table 6 shows that correlation coefficients between judge's diagnoses and the correct diagnoses were significant for all three tasks at the .01 level. The magnitude of the correlation

TABLE 6. Correlation among judge's diagnoses and initial diagnoses.

TASK	CORRELATION COEFFICIENTS		
	Mean	Range	S.D.
PICA Verbal Combined	.61**	.29 - 1.00	.21
OVAB Combined	.58**	.40 - 1.00	.21
Individual Tests	.54**	.24 - .81	.17

** Significant at the .01 level of confidence

is greatest for the PICA verbal tests combined followed by OVAB tests combined and individual tests.

Table 7 shows the percent correct judge agreement with the diagnosis on the individual tests. Best agreement (82 percent) was obtained on the multisyllabic words test. This is followed by PICA subtest XII (74 percent), PICA subtest I (72 percent), diadochokinesis (71 percent), PICA subtest IX (69 percent), PICA subtest IV and counting both (66 percent), and sentences (64 percent). One individual subtest, therefore,

TABLE 7. Percent correct judgment on individual tests.

TESTS	MEAN PERCENT CORRECT
PICA VERBAL TESTS	
Subtest I	72
Subtest IV	66
Subtest IX	69
Subtest XII	74
ORAL-VERBAL APRAXIA BATTERY	
Diadochokinesis	71
Multisyllabic Words	82
Sentences	64
Counting	66

multisyllabic words, showed better judge agreement with the correct diagnoses than any of the three major listening tasks. Further, another individual test, PICA XII, was equal to judge agreement with the initial diagnoses on one of the general listening tasks and better than the other two general tasks.

Table 8 shows the correlations between judged severity and diagnosed severity. Severity correlations were all significant at the .01 level. Actually, judges were better at rating severity than they were at making a diagnosis. However, the correlations reflect diagnostic choices. They indicate that judges tended to be very close to the diagnosed severity in apraxia of speech patients they diagnosed as demonstrating apraxia of speech, that judges rated aphasic patients misdiagnosed as demonstrating apraxia of speech as having a very mild apraxia, and misdiagnosed very mild apraxia of speech patients as being aphasic.

TABLE 8. Correlations among Judge's ratings of severity and diagnosed severity.

TASK	MEAN CORRELATION WITH DIAGNOSED SEVERITY
PICA Verbal Combined	.92**
OVAB Combined	.93**
Individual Tests	.83**

** Significant at the .01 level of confidence

Table 9 shows reliability coefficients for two judges who judged the three tasks twice. It can be seen that reliability is better for severity ratings than for diagnostic judgements. Further, reliability was better for diagnosis on the PICA followed by the OVAB and individual tests. However, reliability for severity ratings was better on the OVAB followed by the PICA and individual tests. All reliability coefficients were significant at the .01 level of confidence. Essentially, reliability across the three tasks mirrors the total judges' performance.

Table 10 shows the correctness of judges' diagnoses on the ten aphasic patients. It is obvious that the judges were more correct in judgements made using the PICA verbal tests than in judgements made using the OVAB. Using group consensus, one aphasic patient would have been misdiagnosed on the basis of PICA results, and perhaps four aphasic patients would have been misdiagnosed using the OVAB. On the other hand, Table 11 shows an opposite effect for apraxia of speech patients. Judges were more correct in judgements made using the OVAB than in judgements using the PICA. Again, using group consensus, one patient would have been misdiagnosed using the OVAB and two patients would have been misdiagnosed using the PICA.

Discussion

This kind of study results in a tremendous amount of data; much of which we have not analyzed or presented in this paper. A logical next step, for example, would involve an attempt to explain why judges made errors. It may be a function of the phonemic content of a patient's speech, or it may be related to how auditory input deficits affect a patient's speech.

TABLE 9. Reliability coefficients for two judges

JUDGE	TASKS					
	PICA Verbal Combined		OVAB Combined		Individual Tests	
	Diagnosis	Rating	Diagnosis	Rating	Diagnosis	Rating
1	.66**	.82**	.59**	.97**	.60**	.68**
2	1.00**	.98**	1.00**	.94**	.89**	.83**
Combined	.83**	.90**	.79**	.96**	.75**	.76**

** Significant at the .01 level of confidence

TABLE 10. Correctness of judges' diagnoses for aphasic patients.

PATIENT	JUDGES' DIAGNOSES (N = 7)					
	PICA Verbal Combined			OVAB Combined		
	Correct	Incorrect	Undecided Incorrect	Correct	Incorrect	Undecided Incorrect
1	6	1	0	6	1	0
2	6	1	0	5	1	1
3	7	0	0	7	0	0
4	2	2	3	6	1	0
5	4	2	1	1	3	3
6	4	0	3	4	3	0
7	5	1	1	1	5	1
8	6	1	0	6	1	0
9	5	1	1	2	4	1
10	6	1	0	3	3	1
Percent	73	14	13	59	31	10

TABLE 11. Correctness of judges' diagnoses for apraxia of speech patients.

PATIENT	JUDGES' DIAGNOSES (N = 7)					
	PICA Verbal Combined			OVAB Combined		
	Correct	Incorrect	Undecided Incorrect	Correct	Incorrect	Undecided Incorrect
1	7	0	0	7	0	0
2	1	6	0	6	0	1
3	4	2	1	3	4	0
4	6	1	0	6	1	0
5	5	2	0	6	1	0
6	7	0	0	7	0	0
7	7	0	0	7	0	0
8	5	0	2	6	0	1
9	2	2	3	7	0	0
10	6	0	1	5	1	1
Percent	71	19	10	86	10	4

Based on our present results, we can conclude that the PICA or the OVAB will permit correct identification of patients demonstrating apraxia of speech in over 70 percent of the cases. Further, the two tests used as a battery will permit correct identification of apraxia of speech in almost 100 percent of the cases. The two patients misdiagnosed on the PICA were picked up on the OVAB, and the one patient misdiagnosed on the OVAB was identified by four of the seven judges on the PICA.

The use of both measures for diagnosing aphasic patients presents some problems. The PICA correctly rules out apraxia of speech in 73 percent of the cases; however, the OVAB falsely identifies aphasic patients as demonstrating apraxia of speech in 31 percent of the cases. Using the two tests as a battery does not help resolve the misdiagnoses.

Tests that contribute the greatest amount of error in diagnosis are PICA subtest IV, OVAB sentences, and OVAB counting. This may indicate that the name finding difficulty demonstrated by some aphasic patients on PICA subtest IV is identified as trial-and-error groping behavior characteristic of apraxia of speech. The kinds of errors demonstrated by aphasic patients on the sentence repetition task may be influenced by the lengthy auditory stimuli. And, counting, being a serial speech task, may not demonstrate the kinds of phonemic errors characteristic of apraxia of speech. All of these assumptions require further research.

The short repetition tasks were particularly useful in making a diagnosis. PICA subtest XII and OVAB tests of diadochokinesis and multisyllabic words resulted in correct diagnosis in over 70 percent of the cases. This does not indicate that patients with apraxia of speech demonstrate particular difficulty on imitative tasks, but it does indicate that imitative tasks are especially useful in reaching a diagnosis.

Finally, it is distressing to note the lack of reliability within judges. Even though both severity and diagnostic reliability coefficients were significant at the .01 level on all three tasks, judges changed their diagnoses on up to 25 percent of the cases in one listening task and their rating on up to 24 percent of the cases in another listening task. This is not influenced by patient variability since the ratings and diagnoses were done using the same recorded sample. However, the bulk of intra-judge variance was due to "undecided" errors rather than a change in diagnosis. No direction--more or less severe--was noted in the lack of reliability in severity ratings.

While judges' diagnoses and severity ratings are significantly correlated with the correct diagnoses and severity ratings at the .01 level, greater precision is

necessary in the clinical setting. There is a need to identify what contributes to incorrect diagnoses and severity ratings and apply the findings in everyday clinical practice.

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