# Speech Perception Among Patients Demonstrating Apraxia of Speech, Aphasia, and Both Disorders

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The underlying basis of apraxia of speech has yet to be resolved. Martin (1974) suggested that the speech perceptual abilities of apractic speakers has not been adequately investigated. Thus, it has been premature to designate this disorder as a motoric impairment rather than a phonological disorder. Similarly, Lesser (1978) concluded her review of apraxia of speech by stating that the case for the disorder being "...specifically of linguistic encoding without consequences for speech perception has not yet been refuted" (pp 181-182).

The purpose of this investigation was to study the auditory and speech perceptual abilities of apractic speakers at various linguistic levels in four major areas: (1) auditory and speech sequencing; (2) speech discrimination given an auditory model; (3) speech recognition/discrimination and sequencing abilities; and (4) internal speech discrimination.

## METHOD

### Subjects

Four groups of subjects were studied: (1) pure apractic subjects (n=4); (2) aphasic subjects without apraxia (n=10); (3) aphasic subjects with apraxia (n=10); and (4) normal subjects (n=11). The four subjects of the pure apractic group were judged to be free of aphasia as measured by performances on the PICA, the Token Test, and modified sentences devised by Keenan and Brassell (1972). The subjects from the two aphasic groups demonstrated moderate aphasic impairment as measured by the PICA, Token Test, and Wechesler digit span. In addition, mean levels of impairment on each test were approximately the same in both of these groups.

### Procedures

Fourteen tests of auditory and speech perceptual abilities were administered in four major areas. A brief description of each follows.

#### Auditory and Speech Sequencing Tasks

Task I. Sequencing Two Complex Tones

This task was modelled after that of Efron (1963). Two complex tones,

one high in frequency (center frequency, 2300 Hz) and one low in frequency (center frequency, 250 Hz) were presented in pairs. The pairs were separated by ISIs of 600, 500, 400, 300, 200, 100 and 0 msec. A total of 130 stimuli were used. Subjects were to report which sound came first, the high or the low.

Task II. Recognition of Errors of Phoneme Sequencing in Familiar Polysyllabic Words

Twenty-eight highly familiar polysyllabic words were presented auditorily. Half were spoken correctly and half contained errors of sequencing (ɛfələnt). Subjects were to report whether the words were spoken correctly or incorrectly.

Speech Discrimination Tasks

Task III. Discrimination of Consonants in CV, VC, and CVC Nonsense Syllables

A total of 210 pairs of stimuli were presented. Half of the pairs of stimuli were the same and half were different in that one member of the pair contained a consonant change within either the feature of place, voice, or manner. The subjects were to report whether members of the pair were the same or different.

Task IV. Discrimination of Consonants in CV, VC, and CVC Words

The task consisted of 158 items and was exactly the same as Task III with the exception that all stimuli were real words (e.g., /ek/ - /et/).

Task V. Discrimination of Initial Consonant Clusters in Nonsense Words

Pairs of nonsense stimuli initiated by consonant clusters were administered. The task consisted of 100 items, with 50 pairs being the same and 50 different. In the 50 differing pairs, the consonant clusters were varied systematically in one of five ways: (1) insertion of schwa; (2) omission of the second consonant in the cluster; (3) omission of the first consonant; (4) transposition of one cluster member with the final C; and (5) substitution for one of the consonants in the cluster. Subjects were to report whether the pairs were the same or different.

Task VI. Discrimination of Initial Consonant Clusters in Stimuli Based Upon Real Words

This task was the same as Task V, but stimuli were based upon real words (e.g., /slip - səlip/).

Task VII. Discrimination of Final Consonant Clusters in Pairs of Nonsense Words

This task was exactly the same as the two preceding tasks but final consonant clusters were tested. In addition, each final cluster represented one of three linguistic categories: (1) those which only follow the phonological rules of the language; (2) those which may be morphologically constraining; and (3) those which are always morphologically constraining.

Task VIII. Discrimination of Final Consonant Clusters in Pairs of Stimuli Based Upon Real Words

This task was the same as Task VII, with the exception that stimuli were based upon real words (e.g., hænd - hænt; mæts - mæt).

Task IX. Recognition of Sound Substitutions in Familiar Polysyllabic Words

The task consisted of 72 items, half spoken correctly and half containing one consonant substitution in the feature categories of either place, voice, or manner. Subjects were to report whether the word was spoken correctly or incorrectly.

## Recognition and Sequencing Tasks

Task X. Recognition and Location of a Syllabic Unit in Nonsense Trisyllabic Stimuli

The task consisted of 91 trisyllabic nonsense words, 49 containing target syllables to be recognized and 56 containing syllabic foils. Subjects were to report whether the target syllable they were to be listening for (one of seven for each series of 13 items) occurred in the nonsense word, and if so, the location of the syllable, i.e., first, second or third syllable (e.g., Do you hear /æk/ in /lumiæk/? If so, where did it occur?).

Task XI. Recognition and Location of a Syllabic Unit in Trisyllabic Words

This task was exactly the same as the preceding task. However, real words were used (e.g., Do you hear /faɪ/ in "fireplace"? If so, where does it occur?).

## Internal Speech Discrimination Tasks

Tasks XII, XIII and XIV

Each of these tasks consisted of ten items. For each item, an array of five objects was placed in front of the subject. The tasks were to choose: (1) the two items beginning with the same sound (Task XII); (2) the two items ending with the same sound (Task XIII); or (3) the two items with names which rhymed (Task XIV). All subjects were familiarized with the names of the objects before testing and each achieved 100% recognition of the object names as a prerequisite preceding task administration.

Preparation and Administration of Stimuli

Tasks I through XI were prerecorded using high quality audio equipment. The stimuli for Task I were generated using a computer timing system. Tasks II through XI used real speech. The stimuli were spoken by an adult male speaker (F.L.D.) after rigorous practice to ensure correct phonetic pronunciation. Two random series of each task were constructed, the second series being copied from the first generation series to ensure exact phonetic representation. Two random series of the 14 tasks were used and were administered to the 35 subjects in a random order. In addition, test-retest reliability was established for each subject on most tasks.

All auditory tasks were administered in a sound field in a distraction-free environment at a comfortable listening level.

## RESULTS

Preliminary Analyses. Non-parametric procedures were used initially for two reasons: (1) the small number of subjects in Group I, and (2) a lack of homogeneity of variance among the groups. Results of the Mann-Whitney Rank Sum Tests indicated that the performances of the pure apractic (Group I) and normal subjects (Group IV) were not significantly different on any of the dependent measures tested. Similarly, performances of the aphasic (Group II) and the aphasic-apractic subjects (Group III) were not significantly different on any of the dependent measures with the exception of Task II and Task IX. In both cases the subjects with aphasia performed less well than did the aphasic-apractic subjects.

The pure apractic subjects performed significantly better than the aphasic subjects (Group II) on all dependent measures and better than the aphasic-apractic subjects (Group III) on all dependent measures with the exceptions of Tasks II, VII and VIII. The normal subjects performed significantly better than the aphasic and aphasic-apractic subjects on all major variables. In addition, performances of the normal and aphasic-apractic subjects did not differ significantly on Task IX.

Parametric Analyses. Results of the Mann-Whitney Rank Sum Tests indicated that patients with pure apraxia of speech and no aphasia are normal in their abilities to process the types of auditory and speech information included within this protocol. Thus, the subjects of Group I (pure apractic) and Group IV (normal) were combined to form a new group of 15 Ss.

All data were adjusted logarithmically to correct for heterogeneity of variance. In addition, in all ensuing analyses, the independent variables of age and hearing were controlled statistically.

The data from the three groups were subjected to 70 Analyses of Covariance, 14 representing the major dependent variables, and 56 representing subvariables. On all major dependent measures except one, performances of the normal/pure apractic subjects were significantly superior to those of the aphasic and aphasic-apractic subjects. The exception was Task IX. Performances of the aphasic-apractic subjects did not differ significantly from those of normal/pure apractic subjects for the ability to recognize errors of substitution in polysyllabic words. Subjects with aphasia only, however, performed significantly more poorly than normal/pure apractic subjects. Performances of subjects from aphasic and aphasic-apractic groups, however, did not differ significantly.

Aphasic and aphasic-apractic subjects performed similarly on all variables with the exception of two tasks. On Task II, which required the recognition of errors of phoneme ordering in polysyllabic words, subjects with aphasia only performed significantly more poorly than the aphasic-apractic subjects. On Task IV, the performance of subjects with aphasia only was superior to that of aphasic-apractic subjects. However, statistical differences were obtained on Task IV due to the aberrantly high error rate of one subject from the aphasic-apractic group.

## CONCLUSIONS

Viewed comprehensively, the results of the data analyses comparing the performances of the groups led to three major conclusions:

1. Subjects with apraxia of speech only process auditory stimuli similarly to subjects with no neurological deficits when such processing requires temporal ordering, phonological discrimination with an auditory model, both of these skills combined, and internal speech discrimination.

2. Subjects with aphasia, whether found in combination with apraxia of speech or not, demonstrated, for the most part, performances which were significantly inferior to those of normal and pure apractic subjects with regard to the auditory processing skills mentioned above.

3. Aphasic and aphasic-apractic subjects demonstrated, for the most part, auditory processing skills which did not differ significantly.

## DISCUSSION

Results of this investigation indicated that anomalies in auditory and speech processing do not constitute the basis of apraxia of speech. First, pure apractic subjects demonstrated no impairments in these areas and, second, subjects with aphasia plus apraxia of speech performed similarly to subjects with aphasia only. Furthermore, results of this investigation indicated that the underlying basis for auditory and speech perceptual disorders in subjects with acquired left hemisphere disorders is aphasia. In fact, among subjects with aphasia only, speech perceptual processing may be somewhat more deviant than in subjects with aphasia and apraxia of speech. On Task II, the former group of subjects had significantly more difficulty recognizing speech errors of sequencing in polysyllabic words. A possible explanation for this may reside in the fact that more aphasic subjects had lesions directly involving the temporal lobe.[1] Luria (1966) and Blumstein et al. (1977) have previously reported that lesions affecting the temporal lobe, may, in fact, result in deficits of phonemic sequencing.

Although the performances of the aphasic and aphasic-apractic subjects did not differ significantly on Task IX, the aphasic subjects performed significantly more poorly than normal/pure apractic subjects while the aphasic-apractic subjects did not. On this task, which required the recognition of substitutions in familiar polysyllabic words, aphasic subjects either may have had more difficulty evoking clear and correct internal phonological representations of the intended words, since no external referent was provided, or may have been cuing into the meaningfulness of an item. If meaning was conjured then semanticity may have over-ridden the necessity for precise analysis of phonetic structure.

In summary, the results of this study strongly indicated that auditory and speech processing deficits do not constitute the basis nor do they coexist with the disorder of apraxia of speech. Further, evidence has been presented which indicates that aphasia and apraxia of speech are distinct and mutually exclusive disorders.

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[1] Sites of lesion were confirmed in all Ss by CT scan, EEG, and/or surgical reports as well as by confirmatory behavioral symptomatology.

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