

Coordinated Studies of a Syndrome of Impairment in Somesthetic Perception and Motor Function

This group of studies represents part of a comprehensive examination by many investigators¹ of a 16-year old female, (E), with highly deficient somesthetic perception and motor function, including speech of very limited intelligibility.

I. Phonetic Studies

Several studies of the phonetic characteristics of the patient's speech behavior were carried out using tape recordings made at NIDR facilities in Bethesda, Maryland.

A test was devised consisting of a set of 146 of the patient's worst isolated-word utterances and presented to the patient and to two phoneticians for judgment as to the identity of the initial consonant of each item. Twenty consonants were represented and only those items were chosen in which the identification was in doubt. The purpose of this test was to see whether some linguistic information at the sub-phonemic or component level was not being transmitted at greater-than-chance frequency despite the virtually complete absence of phoneme-and-word intelligibility of any item. An analysis of the results was made in terms of a traditional "place," "manner" and "voicing" classification, and included several alternatives possible within this framework, viz., three-place, four-place, four-manner and five-manner classifications, respectively. Frequencies substantially greater than chance did occur for several of the

judges, and for several of the categories. The patient's scores were noticeably poorer than those for either of the phoneticians². The four-place categorization yielded no better than chance results for any of the judges, but the three-category place, and the two manner categories did, with but one exception, yield frequencies greater than chance. The amount of agreement between judges was also determined, with the result that agreement between patient and either phonetician was shown to be close to the calculated expected value, but that agreement between phoneticians was in all cases substantially above the expected value. The findings of this study are regarded as a first-order approximation whose chief value is to point up the probable existence of a persistent transmission of linguistic information at the sub-phonemic level, despite a complete lack of proper coding at the phoneme or higher level. A number of conditions in the data collection, and in design and presentation of this test combined to attenuate the findings. It would, therefore, appear reasonable to interpret the results obtained as conservative. The test also revealed requirements and restrictions needed in future work of this sort, if the data are to be kept simple enough to be credibly interpreted.

A second study was made, this time by a single investigator to determine the presence of any large scale regularities in the patient's production of syllable-initial consonants. A nonsense syllable frame "ə'CV" was chosen in which one of 16 consonants was followed by one of four vowels. The unstressed schwa vowel of the first syllable was included to provide some control over the initial articulatory starting point of the following consonant. The set of 64 utterances was repeated eight times. The order of C's and V's was not random, but was varied in four ways. Each utterance was elicited by a printed card. Her utterances were then transcribed by the investigator.

From this work it appears that the patient exhibits different and somewhat overlapping ranges of variability in producing particular consonants and consonant classes. Most striking was her production of voiceless as compared to voiced stops. In all cases voiceless plosives were well within the requirements for correct phonemic identification, albeit with minor anomalies, but each voiced plosive showed characteristic deviations: for /b/, place and manner information were preserved but de-voicing occurred throughout; for /d/, manner was largely preserved, but place and voice information fluctuated widely; for /g/, voicing was preserved, with manner and place information showing variability. /g/ also appeared to be affected by phonetic context to a greater extent than the others. Each of the other consonant groups -- nasals, voiced fricatives, voiceless fricatives, and /w r l y/ -- showed characteristic but less striking deviations. In syllabification the patient showed abnormally long separation between syllables, presumably due to efforts at proper tongue placement for the following consonant. She showed no such difficulty at other times in rapidly repeating a series of schwa-like vowels clearly separated from one another by silence, though here, too, her repetition rate was below normal. Other details including data pertinent to further interpretation of the materials reported here are to be published in an expanded report.

At the time recordings were made, advantage was taken of a dual track provision to record signals from a throat pickup as well as from the air microphone. Subsequently both tracks were high and low pass filtered and printed out oscillographically using a Honeywell 1508 Visicorder. The purpose of the oscillograms was to determine if any regularities in pulmonic and laryngeal function could be established, and what relation these bore to upper-tract activity. This question was motivated

by the phonetic data, which show an inverse relation between place and voicing information not only with respect to the plosives, as seen above, but also -- though not so easily discerned -- in the production of fricatives as well. While it is recognized that laryngeal vibration and friction noise do not comprise all the acoustic cues that serve the "voiced/voiceless" phonemic contrast, the oscillograms do, in fact, reveal these acoustic parameters to be quite abnormal and irregular for the patient's syllable-initial consonant. Following the lead of earlier work at Haskins (Lisker & Abramson, 1964) measurements were made of the time interval between burst and voicing onset in the patient's speech. These yielded mean values for voicing lag that were definitely larger than normal. Significant measurements were more difficult to obtain for intended "voiced" plosives, since the plosive burst was not always apparent. This was particularly the case for /g/, for which bursts were the exception. A variety of other abnormalities are often present, among them: extremely heavy aspiration and a mode of voicing that attenuates harmonics of the fundamental above F1, leaving only noise-filled higher formants until midway into the syllable nucleus. Pitch and voicing breaks, after voicing is fully initiated, are rare.

II. Electromyography and Cineradiography

In order to describe the muscle activity of her speech articulators, E's utterances were recorded electromyographically. The data thus obtained were compared with those recorded from normal subjects. Electromyograms were recorded from the upper lip, tongue tip, and tongue blade of E and a normal control subject during repeated productions of 20 monosyllables and disyllables of varied phonemic structure. A cineradiographic film obtained by Dr. James F. Bosma was also studied. It was found that many aspects of E's motor function were within

normal limits, including the form of the raw muscle potentials, bilateral symmetry of muscle action, and voltage levels reached during an utterance. However, the patterns of voltage recorded during speech revealed a marked and comparatively general deficit in spatial and temporal differentiation of muscle action. This was evidenced by an inability to contract a given muscle without contracting nearby muscles and an inability to make quick changes in contraction of a given muscle. These findings, together with those of gross deficits in complex somesthetic perception observed by R.A. Chase and others, and the comparatively minor deficits in speech perception presented in Section III led to a general description of E's deficit as an inability to process somesthetic information necessary for the structuring of efficient voluntary movements.

III. Perception Testing

A third phase of the exploration of the patient's speech and linguistic behavior involved the use of some of the speech perception tests already developed at Haskins Laboratories and for which a body of normal responses had been obtained. Owing to practical limitations, it was not possible to select or design tests beforehand that were known to be especially appropriate to the patient's phonetic behavior; nor was it possible to administer the full schedule of each test given. Despite these difficulties, the results did show certain deviations from the normal and provide useful profile information.

Seven tests or test groups were administered to the patient in this phase of the investigation. All of them had been or were currently being used in other research at Haskins Laboratories. They were:

1) OVE II consonant identification and discrimination: /b d g/

responses;

2) OVE II vowel identification and discrimination: /ɪ, I, ε /

responses;

3) DOE/TOE identification (synthetic Pattern Playback patterns with cutback of first formant varied and asking for /d/ or /t/ responses);

4) RAPID/RABID identification (synthetic Pattern Playback patterns with silent interval of intervocalic stop varied, and calling for /p/ and /b/ responses);

5) RUPEE/RUBY identification (spoken utterances with silent interval of intervocalic stop varied by tape cutting, and calling for /p/ or /b/ responses);

6) SLIT/SPLIT identification (spoken word "slit" with variable silent interval introduced by tape cutting between elements of the consonant cluster, and calling for 'slit' or 'split' responses);

7) /dubɛ:/duwɛ/ identification (synthetic Pattern Playback patterns with length of intervocalic transition varied, and calling for /b/ or /w/ response).

Compared to normal responses a decrease in overall level of performance was characteristic of the patient on most tests. In the OVE II identification tasks, the consonant results showed closer to normal appearance than those for the vowels. In the discrimination task, patient showed a marked lowering relative to normal in discrimination of the vowel stimuli having high second formant corresponding to the 'i' and 'ɪ' region, and of consonant stimuli having medium to low F2 transition corresponding roughly to the 'b' and 'd' region. In the identification tests, identification crossovers occurred at the correct points in time, with the only variable being the degree of sharpness. Crossover was sharp for two tests: SLIT/SPLIT and RUPEE/RUBY; somewhat attenuated or flattened for

RAPID/RABID; and not clearly normal or sub-normal for DOE/TOE. Results for the /dubɛ:/duwɛ/ were completely random. Despite the considerable limitations placed on test selection and administration, these results, taken in conjunction with the other data on the patient's speech production, do suggest test designs that might serve to point up inter-relations between aspects of speech production and speech perception.

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Footnotes

1. The facilities of the National Institute of Dental Research at Bethesda, Maryland were made available to the Haskins Laboratories' investigators through the generosity of Dr. James F. Bosma who has been coordinating the investigations of this patient.
2. Although the necessarily "broad" transcription she was forced to use, and unfavorable conditions in which she took the test undoubtedly lowered her score.

Reference

Leigh Lisker and Arthur S. Abramson, Word XX, 3, Dec. 1964, 384-422.