PREMEANINGFUL VOCALIZATIONS OF HEARING-IMPAIRED AND NORMALLY HEARING SUBJECTS

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ABSTRACT
The present study extends the work of Stoel-Gammon [3] by examining longitudinal samples of non-meaningful vocalizations from 10 normally hearing subjects, aged 5-18 months, and 11 hearing-impaired subjects, aged 5-39 months. Consonantal phones in the samples were phonetically transcribed and analyzed in terms of proportional occurrence of place and manner classes. Developmental trends within each group were also examined. The results show the clear group differences in both place and manner of articulation. The hearing-impaired subjects evidenced a higher proportion of labial and alveolar phones. In addition, the inventories of the HI subjects contained a larger proportion of syllabic consonants and a lower proportion of stops than the NH group. Since the study focused exclusively on consonantal inventories (i.e., on consonantal types), it provides only a partial picture of the phonetic characteristics of prelinguistic vocalizations of the two groups. The present study extends the work of Stoel-Gammon [3] by analysing the frequency of occurrence of each consonantal phone (i.e., analysis of consonantal tokens) and determining the proportional use of particular place and manner classes.

1. INTRODUCTION
Recent research has identified several differences between the prelinguistic development of normally hearing (NH) and hearing-impaired (HI) infants. In particular, it has been shown that the onset of canonical babbling, which typically occurs before 9 months in the hearing infant, does not occur until 12 months or later in HI subjects [2] and that the phonetic inventories of NH and HI subjects differ in their size [3]. Methodological procedures are briefly described in the following sections; for more complete descriptions, particularly of the HI subjects, readers are referred to the previous publication.

2. METHODS
The subjects and database for the present study are a subset of those used in the previous study by Stoel-Gammon [3]. Methodological procedures are briefly described in the following sections; for more complete descriptions, particularly of the HI subjects, readers are referred to the previous publication.

2.1 Subjects
The NH group consists of 10 subjects whose prelinguistic development was followed from around 5 months to the onset of meaningful speech, usually around 15-18 months. (These subjects are identified as N1-10 in the previous publication.) None of the HI subjects suffered from recurrent otitis media during the study.

The HI group consists of 11 subjects, aged 5-39 months, with moderate-severe sensorineural hearing loss. These subjects are identified as YH 1.2.5.6.7 and OH 1.2.4.5.6.7 in the previous study [3]. Details regarding hearing sensitivity, age at loss, and identification of loss and amplification are provided in that reference. The HI subjects varied in age at onset and age at identification of hearing loss; for five subjects, data are available in the 5-18 month age range corresponding to the period of data collection for the NH subjects. The remaining six subjects were 19 months or older at the time of data collection.

2.2 Data collection
Half-hour audio recordings were collected in a sound-treated room during which parents and experimenters used eye contact and vocalizations to stimulate vocal output. To be included for analysis, a sample had to contain at least 10 speechlike utterances with a minimum of 20 consonant tokens. The maximum number of speechlike vocalizations for any one sample was set at 60.

Samples were collected from the NH subjects at approximately 6-10 week intervals. The database for this group contains a total of 44 samples with the number of samples per subject ranging from 3-6. The database for the HI group consists of 28 samples. Longitudinal data are available for eight subjects; data for the remaining three consist of a single recorded sample. 12 of the HI samples are from subjects under 18.4 months and thus overlap with the age range of the hearing group.

2.3 Data Analysis
Speechlike vocalizations of each sample were transcribed by a team of trained transcribers who worked independently and then compared analyses. Transcriptions were not changed unless a transcriber felt he or she was mistaken after re-listening to the sample. Correction of 10% of the transcriptions showed that intertranscriber agreement for place, manner and voicing of consonants exceeded 90%. In the present study, the two transcriptions of each sample were analysed independently to determine the number of occurrences of each consonant phone (i.e., analysis of consonantal tokens); the proportional occurrence of consonants according to traditional place and manner classes. The analysis of place of articulation was based on four categories: (1) labial, including labiodental; (2) alveolar, including interdental, and palatal; (3) velar, including uvular and pharyngeal; and (4) glottal. For manner of articulation, consonants were categorized as one of the following: (1) stop; (2) fricative; (3) affricate; (4) nasal; (5) glide; (6) liquid; and (7) flap or trill. The proportion of syllabic consonants, a category which overlapped with some of the manner categories identified above, was also determined. The percentages for each place and manner category obtained from analysis of the independent transcriptions were averaged to yield a single percentage for each place and manner class for each sample.

3. RESULTS AND DISCUSSION
To provide a general picture of the phonetic characteristics of the vocalizations of subjects in each group, the overall performances of NH and HI subjects were compared. The samples were then grouped by age in order to examine developmental trends within each subject population.

3.1 General comparison
Previous studies [2,4] suggested that the vocalization of HI infants is evidence of higher proportion of glottal consonants than those of NH subjects and this was supported by the findings of the present study. Across all samples, the mean proportion of glottals for the NH group was 24.1% (SD14.8) compared with 36.6% (SD28.3) for the HI group. As shown by the large standard deviations, there was a good deal of variance across samples; in fact, although the mean proportion for the HI samples was just over 36%, one sample contained no supraglottal tokens.

Although the proportional use of glottals was higher for the HI group, differences in place and manner of articulation of supraglottal consonants were of an even greater magnitude. Table 1 presents a summary of key differences between the two groups in the use of supraglottal consonants. (Percentages in this table are based on an analysis of supraglottal consonants only, and thus represent a subset of the data.)

In terms of place of articulation, the suggestion by Stoel-Gammon [3] that HI...
subjects produce relatively more labial consonants and fewer alveolar consonants than do HI subjects. Two major differences between the groups emerge from the analyses. First, the HI subjects produce a higher proportion of labial phones. This difference is most likely due to the fact that labials have a highly salient visual component, and thus their articulation can be seen and imitated by babies who have little or no auditory input; alveolar consonants, on the other hand, lack the visual component. Second, the HI subjects produce more nasals and syllabic consonants. It was hypothesized earlier [3] that this preference is due to the fact that these consonants provide more tactile and kinesthetic feedback than do stops which are characterized by rapid movements and short durations.

More research is needed, particularly with HI subjects at younger ages, before the hypotheses proposed here can be confirmed. By documenting phonetic patterns in one set of HI subjects, the present study provides a starting point for such research.

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REFERENCES