Exploring Dutch vowel production: development in the first two years

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Keywords
Vowels, Development, Bandfilter Analyses

Abstract

Pure linguistically spoken, infants do not yet produce vowels in the first year of life. Yet, the voiced utterances can elicit a vowel-like perception in the listener. The syllabic nucleus may contain information about physiological changes in the child's oral cavity. For example, the ratio of tongue mass to the size of the oral cavity decreases, thereby allowing more space for the child's tongue to move around. At the same time, the use of the oral space is also driven perceptually, although unclear to what extend. Exploring the vocal tract implies an enormous variability in the quality of vocalic productions in individual children. Analysis of vocalizations from both deaf and hearing infants has already confirmed the presence of a great amount of variability in the individual spectral envelopes.

In acoustic research in vowel acquisition, researchers attempt to estimate formant values with the knowledge about the perceptual quality of segments (e.g., perceived speech sounds) in mind. Obviously, this process allows the measurements to be biased by the investigator's perception. Low sampling rate of the spectrum caused by a high fundamental frequency in young children is another problem.

We have developped a more objective method for analysing children's sound productions that frees us from the need to label the vowel-like segments. Ten measurement points per utterance are selected automatically, thus accounting for articulatory drifting. Per point an acoustic (frequency domain) bandfilter analysis of voiced parts in utterance is done. Instead of formant estimation, a whole spectrum approach (0 – 7 kHz) of the filter output is chosen. Data reduction of all 40 filter outputs is achieved via Principal Component Analysis (PCA). Previous research suggests that the first two principal components are related to the F_1 and F_2 values of vowels.

In the present study, we analysed the sound productions of 5 Dutch boys that participated in a longitudinal research project. Audio recordings were made monthly in a naturalistic home situation. Per month 50 utterances are choosen that met speech motor criteria (phonation, articulation). Per child, the results are presented for the ages of 6, 12, 18, and 24 months. A vocalic reference plane is constructed after a PCA on all two-year-olds'utterances. Each child's contribution for the selected months is mapped unto that plane. Results indicate for example that these Dutch children expand their vowel space along a dimension that corresponds with the first formant.

The data processing can be done quickly and is consistent. Via this approach, important similarities and differences in vowel acquisition patterns in various languages can be uncovered. The results may aid us in identifying elements of a unified theory of vowel acquisitionn that not yet exists. Any progress we can make to map out stages and

processes of vowel acquisition in children will add a new building block towards creating such a theory.

References