Title: Sex-specific differences in young children's speech production: An acoustic evaluation

It is well accepted that the acoustic characteristics of speech vary systematically as a function of the sex of a speaker. These differences are in part the consequence of physical attributes typically exhibited by adult male and female speakers. The anatomical dimensions of vocal tract size and shape, as well as vocal fold length, are important factors in determining the acoustic characteristics of an individual's speech. For instance, the generally lower fundamental frequency of typical adult male speakers is in part associated with greater vocal fold length. In addition, the dissimilarities in vowel formant patterns between male and female speakers can be linked to differences in vocal tract size and shape.

Despite the strong association between an adult speaker's physical attributes and the acoustic differences of their speech, sex-specific variation cannot be entirely explained by anatomical differences alone, especially in pre-pubescent children where vocal tract dimorphism is limited. Recent morphometric data from large-scale MRI studies have indicated that although the vocal tract anatomy of prepubescent children undergoes periods of growth acceleration, vocal tract dimorphism for most children occurs after 12 years of age (Vorperian et al., 2005, 2009).

Interestingly, despite the lack of significant anatomical vocal tract variation in prepubescent children, listeners are still able to perceptually identify the sex of an unknown speaker from their speech at a moderately high rate. It may be the ability to identify the sex of younger speakers is facilitated by differences in speech acoustics. Production studies involving children have found sex-specific differences in formant frequency patterns (Lee et al., 1999; Perry et al., 2001; Whiteside, 2001), as well as the use of voice onset time (Whiteside & Marshall, 2001).

Thus the purpose of this presentation is to report on additional investigations into the speech production patterns of typically developing prepubescent children. Obstruent productions (stop and fricative) from children 3 to 5 years of age were analyzed using spectral moments analysis. This type of analysis examines the spectral characteristics of discrete time segments of the speech signal in terms of multiple statistical moments (i.e., mean, variance, skewness, and kurtosis). By linking these "statistical snapshots" of perceptually important segments of the speech waveform, spectral moments analysis can be used to detect discrete patterns of acoustic energy.

Results from the young children's obstruent productions indicated sex-related speech differences in a number of individual acoustic and spectral characteristics. Specifically, sex-specific differences were found in the spectral mean, slope, and skewness of voiceless stop and fricative productions. In addition, a discriminant analysis revealed systematic differences between the speech of boys and girls in combinations of spectral characteristics for the fricative productions, but such differences were not found for the stop consonant productions.

Considering that sexual dimorphism of the vocal tract has likely not occurred in children of this age, such acoustic and spectral differences cannot be fully explained by anatomical differences. Therefore it is reasonable to hypothesize that speech development may be influenced by factors that follow cultural or social expectations for male and female speakers. Sex-specific differences in the speech patterns of young children may be associated with learned or behavioral factors, such as patterns of obstruent articulation, that correspond to a male-female archetype (Sachs et al., 1973).

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