Voice Quality Analysis Of Children With Cerebral Palsy During Sustained Phonation And Story Retell

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INTRODUCTION

Children with Cerebral Palsy Have Voice Quality Changes

- Cerebral Palsy (CP) is a group of disorders caused by perinatal damage to the central nervous system resulting in movement, sensory, communication, and cognitive impairments (American Academy of Cerebral Palsy and Developmental Medicine, 2013).
- Over 50% of children with CP have communication disorders, including dysarthria (Bax, AbboS, & Lohmander, 2016; Von Fricken & Sundareshwar, 2016; Himmelmann et al., 2017). Hendler et al., 2013; Nation et al., 2014) and associated voice quality changes (e.g., evert & Kent, 2013; Miller et al., 2015; Nip, 2017).

Quantifying Voice Quality

- Voice quality differences are typically captured via rating scales; e.g., CAPE-V (Green et al., 2006)
- Voice ratings are mildly correlated with intelligibility in children with CP; however more fine-grained measures of voice quality may provide a better basis for documenting therapeutic changes (Nip et al., 2018).
- Psychoacoustic measures of the voice source are associated with changes in voice quality perception and articulatory origins (Hillenbrand et al., 2018).
- H1*-A2* is a spectral tilt measure relating the amplitude of the harmonic F2 to the amplitude of the first harmonic, corrected for vowel formants (allowing for cross-vowel comparisons).
- Cepstral peak prominence (CPP), which measures the relative ratio of harmonic and inharmonic acoustic energy, has a strong relationship with breathing (Hillenbrand et al., 2018).
- Speaking task differences do not impact psychoacoustic measures of the voice source in healthy talkers (Green et al., 2016).
- It is unclear if psychoacoustic measures of voice are affected by speaking tasks in children with CP though acoustic measures of speech production in children with CP (e.g., intensity, F0) are (Green et al., 2016).
- Characterizing the voice quality difference between children with CP and their health peers using fine-grained acoustic measures are needed to understand the long-term impairments causing the voice quality changes.

Research Questions

- How do acoustic measures in voice quality differ between children with CP and their typically-developing age- and sex-matched peers in both isolated vowels and in a story re-tell task?

METHOD

Participants

- 8 children with CP (2F, 7M) and 8 age- and sex-matched typically developing peers (TD; 2F, 7M), aged 4 to 15 years.
- All participants passed a hearing screening (Audiologic Screening of Children; ASHA, 1997), and were free of upper respiratory infections. (5), 994–1001.
- Intelligibility measured with the Test of Children’s Speech 1 (TCS-1) (Stamm et al., 2000).

Speaking Tasks

- 10 repetitions of the vowels /i, o, u/ in isolation.
- /i, o, u/ in connected speech through a story re-tell task (Bars, Beets, Boots; Green et al., 2016).

Data Collection

- Audio recording (16-bit, 44.1 KHz) using a head-mounted microphone.

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RESULTS

Children with CP have Lower Spectral Tilt and Lower CPP Values than their TD Peers

- H1*-A2* values were significantly lower, indicating a more constricted voice quality for children with CP than TD peers for [o, i].
- Smaller CPP values for the CP group indicate greater noise (e.g., breathiness, roughness, or voice irregularity) at the laryngeal level.
- The combination of lower H1*-A2* and CPP suggest that children with CP have creaker, more irregular phonations.
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Vowels differed in Spectral Tilt and CPP Values for Both Groups

- For both H1*-A2* and CPP, [o] had the highest values whereas [u] had the lowest.
- Results hold for children with CP and their TD peers.

Task Differences between Isolated Vowels and Story Retell

- Unlike previous findings in adults (e.g., Coster et al., 2008), both groups demonstrated task differences between isolated vowels and vowels produced during story retell.
- More noisy vocal fold vibration for isolated vowels than in stories suggests more difficulty producing modal phonation in sustained vowels, which are longer and louder.
- Evaluating psychoacoustic measures of voice quality in children should include sampling the voice source in isolated vowels and connected speech.

REFERENCES


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