Acoustic Profiles of Speech Amplification Devices on Speech in Parkinson's Disease

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Background

Hypophonia, a prevalent symptom of Parkinson's Disease (PD), presents considerable challenges in communication. Marked by diminished vocal loudness and clarity, hypophonia significantly impacts the quality of life for individuals affected by PD[1]. Among the various interventions to manage hypophonia, speech amplification devices have emerged as a promising augmentative treatment. These devices aim to enhance the intelligibility and audibility of speech, thus improving communication effectiveness for individuals with PD and hypophonia[2-8]. However, the efficacy of such devices can vary significantly, necessitating a deeper understanding of their acoustic profiles and clinical implications.

Purpose

The purpose of this study is to quantify the acoustic profiles of speech amplification devices on hypophonic speech.

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Methodology

Amplified Recordings:
- Recordings were from ten individuals with Parkinson's disease (PD) and hypophonia.
- All recordings were taken at 1 meter and adjusted to 72 dB SPL.
- These were compared to a flat-frequency response speaker's control signal.

Stimuli:
- The stimuli comprised pink noise, sustained phonation, and a reading passage.

Acoustic Measures:
- Analyses included spectral tilt and energy amplitude in three frequency bands: 0-1 kHz, 1-3 kHz, and 3-8 kHz.
- Spectral tilt reflects frequency resolution and intelligibility[9-11].
- Results were obtained using linear mixed effects models.

Amplification Devices

Figure 1

Results

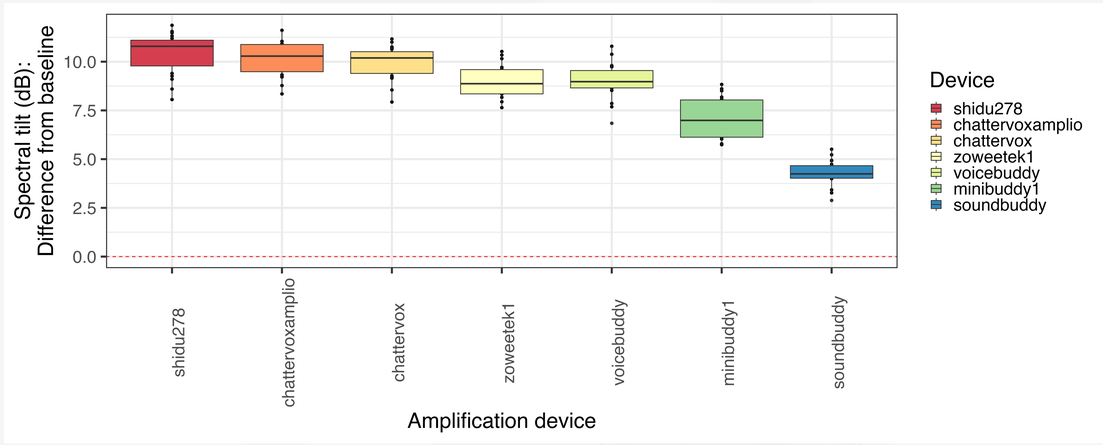

Figure 2

Compared to the baseline:
- **Low frequency energy:** Most (4/7) devices significantly attenuated low frequency energy between 0 - 1 kHz. There was no significant effect for the Shidu, Soundbuddy, or Voicebuddy.
- **Mid & high frequency energy:** All devices significantly amplified mid frequency energy between 1 - 3 kHz and 3 - 8 kHz, though a wide range in the magnitude of amplification was observed.
- **Spectral tilt:** All devices increased spectral tilt (the difference in mid-high versus low frequency energy), as depicted in Figure 2.

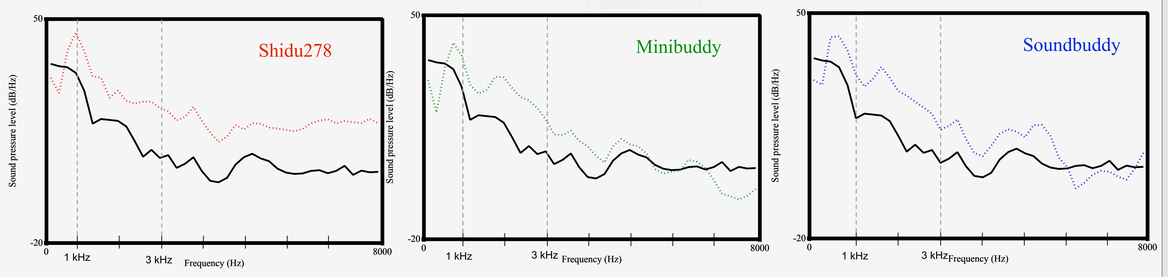

Figure 3

Discussion

The results demonstrate consistent patterns of spectral change across devices, characterized by decreases in low-frequency energy and increases in mid- and high-frequency energy when amplifying audio stimuli. While this overall pattern was consistent across stimuli, substantial variability in the magnitude of acoustic change was observed across the devices. This variability suggests the importance of considering how individual voice characteristics are affected by amplification when selecting an appropriate amplification device to ensure optimal treatment efficacy.

Future Directions

Examining auditory perceptual aspects will enhance our grasp of amplified speech's subjective experience and identify the acoustic features that optimize clarity. Understanding how amplification devices complement behavioral strategies is vital for improving treatments, while exploring adjustments, such as adaptive algorithms based on individual voice traits, can enhance device customization and effectiveness.

References