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].
- Traditional behavioral therapies for hypophonia, such as **LSVT-LOUD®**[2] or **SPEAK OUT!®**[3], often fail to bridge the gap between clinical practice and real-world situations due to cognitive demand and other factors[4].
- **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[5-11].
- The **efficacy of such devices can vary significantly**, necessitating a deeper understanding of their acoustic and perceptual profiles and clinical implications.

Purpose

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

Methodology

Amplified Recordings:
- Recordings were from ten individuals with Parkinson's disease (PD) and hypophonia.
- Prerecorded speech was calibrated to 72 dB and rerecorded at a distance of 30 centimeters.
- Amplified recordings from devices 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 has been shown to correlate to intelligibility[12-14].
- Results were obtained using linear mixed effects models.

Amplification Devices

Figure 1

Results

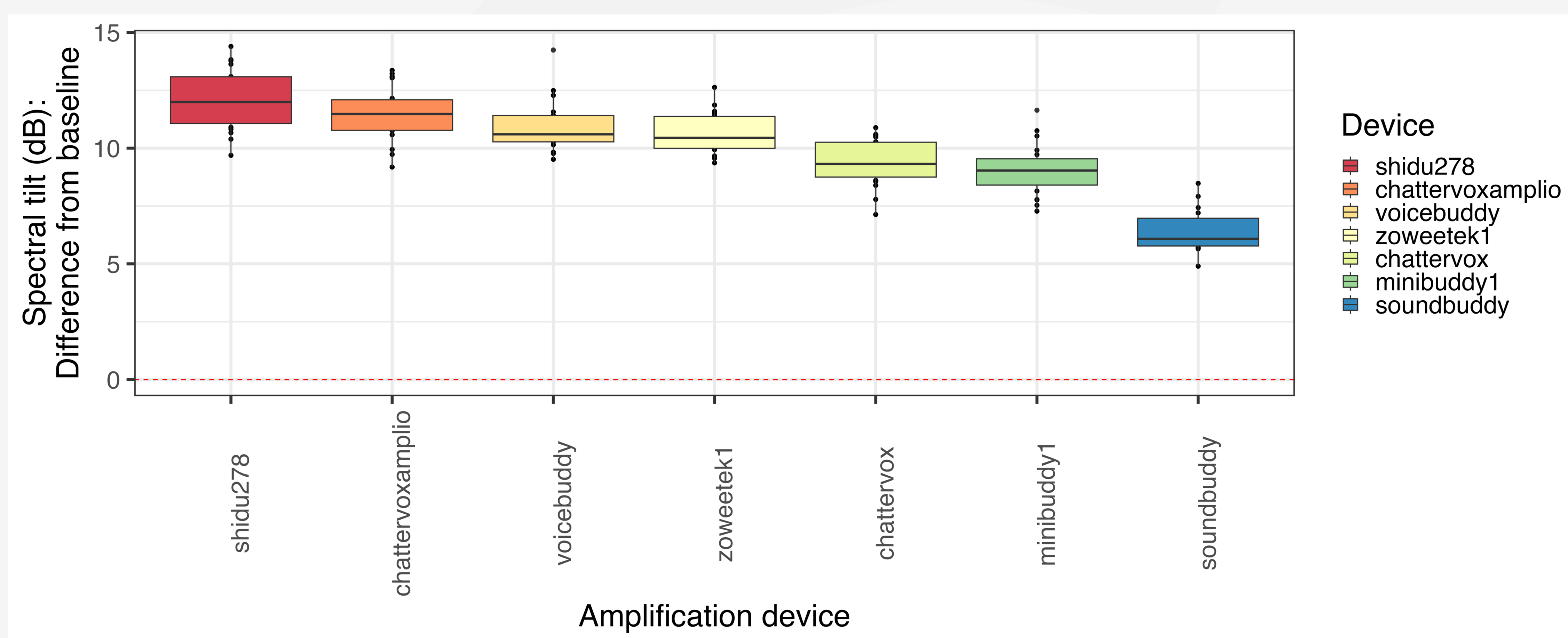

Figure 2

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.

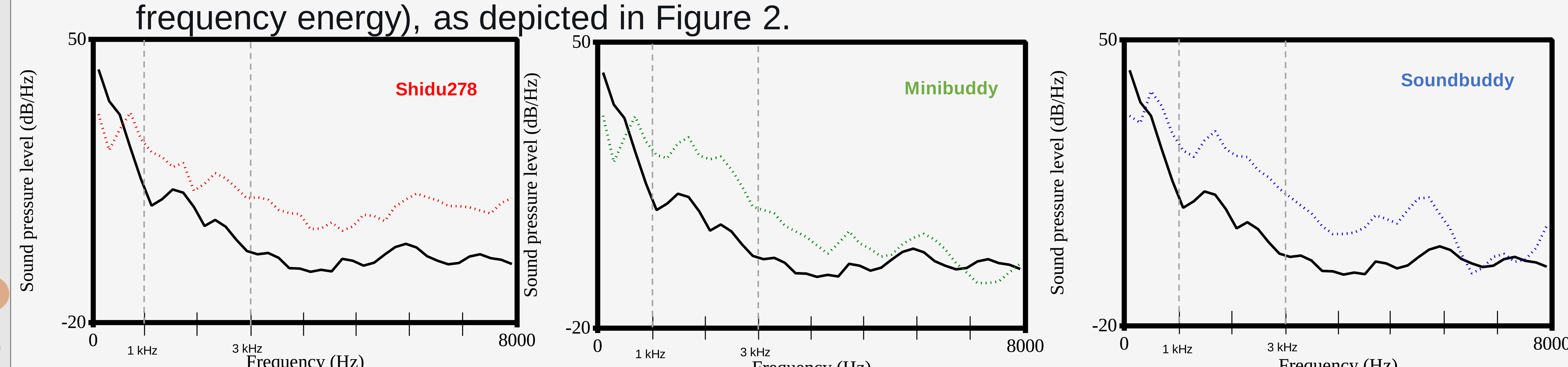

Figure 3

Discussion

- There is a coherent trend in spectral alterations across all devices, showing a **decrease in low-frequency** energy and an **increase in mid- and high-frequency** energy when amplifying audio signals.
- **Significant diversity in the extent of acoustic modification among the devices.**
- 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

Understanding the subjective experience of amplified speech and optimizing clarity through identifying key acoustic features is vital, alongside integrating amplification devices with behavioral strategies and customizing them with adaptive algorithms based on individual voice traits for enhanced effectiveness.

Contact & References

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