Acoustic contrastivity in idiopathic Parkinson's disease before and after therapy

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Abstract

- This study examined change in acoustic contrastivity measures following amplitude treatment (LSVT® LOUD) in eight speakers with idiopathic Parkinson’s disease
- Automated acoustic analysis routines measured pause percentage time, intensity variation, spectral change, and spectral range for recordings of the Sentence Intelligibility Test
- All measures but pause percentage time were significantly higher following treatment, suggesting increased acoustic contrast related to greater articulatory precision

Background

Speech characteristics of hypokinetic dysarthria (HKD) in Parkinson’s disease (PD)
- decreased loudness
- monoloudness
- monopitch
- imprecise articulation
- decreased intelligibility

About LSVT

- Lee Silverman Voice Treatment (LSVT® LOUD) is an intensive treatment program based on increasing vocal loudness
- Previous results of LSVT in PD/HKD include:
  - increased sound pressure level and vocal pitch inflection
  - decreased intelligibility
- Increased sentence-level intelligibility

Quantitative parametric measures of speech in HKD

- Rosen and colleagues reported on measures quantifying acoustic contrastivity in speakers with HKD/PD
- These measures, designed to reflect intensity and spectral contrast, were reduced in patients with HKD/PD compared to healthy controls

Method

Participants

- 8 speakers (3 females, 5 males; mean age = 64.44 years) with IPD and no prior speech therapy

Recordings

- Recorded during 3 pre- and 3 post-LSVT days (total of 6 recording sessions)
- Short form of the Sentence Intelligibility Test
- 11 sentences of 5 to 15 words per sentences (66 sentences total)

Acoustic analysis

- Automated praat® acoustic analysis routines, with measures based on Rosen et al.9

Measure

<table>
<thead>
<tr>
<th>Measure</th>
<th>Interpretation</th>
<th>Calculation</th>
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<tbody>
<tr>
<td>Percentage pause time</td>
<td>PPT</td>
<td>Reflects extreme intensity drops in the speech signal</td>
</tr>
<tr>
<td>Intensity variation</td>
<td>IV</td>
<td>Reflected in precision and articular closure</td>
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<tr>
<td>Spectral change</td>
<td>SC</td>
<td>Indicator of sharp spectral changes at consonant boundaries</td>
</tr>
<tr>
<td>Spectral range</td>
<td>SR</td>
<td>Indicator of acoustic distinction between consonants and vowels</td>
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</tbody>
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Calculation

- PPT and IV were calculated from an RMS intensity contour
- Spectral range and spectral changes were derived from a series of a wideband spectra
  - A 50 mF FFT spectrum (Hamming window) was generated every 10 ms in the acoustic signal
  - The difference between the acoustic energy in adjacent spectra was obtained for each frequency band
  - Median and maximum values of spectral change across the frequency bands were recorded across trials
- SR - Difference between absolute max and absolute min intensity values across frequency band and time point

Results

- Statistical analysis of the acoustic contrastivity measures was completed using a linear mixed effects model
- Fixed effects for Treatment (pre vs. post), Day (1-3), and the interaction
- Random effects for Subject
- Each acoustic measure served as a separate dependent measure

Discussion

- The majority of speakers with PD have increased acoustic contrastivity following amplitude treatment (LSVT), consistent with overall intelligibility gains previously reported in the same speakers
- The results also are consistent with suggestions that LSVT treatment has effects on the acoustic signal above and beyond increased sound pressure level
- Further investigation is needed to examine the relationship between acoustic contrastivity and intelligibility and other perceptual dimensions of speech impairment in people with PD and HKD

References