Perceptual characteristics of clear speech in Parkinson disease

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INTRODUCTION

Perceptual characteristics of speech often correlate to objective measures, and psychophysical scales reveal fairly predictable relationships between what listeners perceive and what an instrument can measure (Shorey, 2003). Clear speech production involves modulation of the speech system to enhance intelligibility. A substantial literature has examined the physiological, acoustic, and perceptual characteristics of clear speech production. Under clear speech conditions, it is hypothesized that the neuro-motor drive of the entire speech production system is increased, including slower, louder, and more precisely-articulated speech (Perliski Zandipour, Matthews, & Lane, 2002; Searl & Evitts, 2013). A number of measures have been used to examine the perceptual correlates of clear speech, including direct ratings of speech clarity using a visual-analogue continuum (e.g., Searl & Evitts, 2013; Tassio & Greibok, 2010), scaled speech intelligibility ratings (e.g., Tjaden, Sussman, & Wilding, 2014), and intelligibility measures calculated from transcribed responses (e.g., Lam & Tjaden, 2013; Smigielski & Brodow, 2005).

Individuals with Parkinson disease have been shown to exhibit decreased speech clarity and intelligibility in habitual speech. However, use of clear speech strategies have shown to improve both perceptual measures of speech clarity and intelligibility. Recent work using acoustic measures suggests that individuals with PD exhibit an increase in articulation rate over the course of a reading passage when using clear speech (Dikema, Scherer, Gieberman, & Whitfield, 2016). This may suggest that the intelligibility benefit of the clear cue may fade over the course of the reading passage. However, an accelerating speech rate has also been observed in the habitual speech of individuals with PD. Therefore, more data are needed to confirm the existence of clear speech cues fade in this population. The aim of the current investigation was to examine listener clarity ratings of clear and habitual speech samples produced by individuals with and without PD at various points in a reading passage.

METHODS

Speakers. Habitual and clear reading samples (The Caterpillar Passage; Patel et al., 2013) produced by 16 individuals with idiopathic Parkinson's disease (PD) including 10 males, Mean age=61, Range: 53-76, and 6 females, Mean age=64, Range: 57-77, and 16 older-adult control-speakers (OA) including 8 males, Mean age=66, Range: 52-80, and 8 females, Mean age=65, Range: 48-81, were recorded onto a digital recorder using a table top microphone.

Speaking Task. The reading passage was divided into five segments, each having an equal number of syllables. Different speech segments, ranging from 7 to 15 syllables in length, were extracted from each of the five segments of the passage for each group. These samples were extracted from both the habitual and clear speech samples, and were distributed approximately equal intervals within each of the five segments of the passage. This yielded ten total speech samples for each speaker, five habitual and five clear, and 80 total speech samples for each speaker group. The samples were normalized to a level of 70DB.

Listening Task. Thus far, perceptual data have been collected from 12 listeners who have received graduate-level training in motor speech and voice disorders. Each listener was randomly assigned as one of the four groups. Each group rated the clarity of speech samples produced by 8 speakers, 4 with PD and 4 without. For the perceptual task, listeners rated the clarity of each speech run using module-free direct magnitude estimation (DME) to obtain scaled clarity ratings. A total of 100 speech samples (20 repeated samples to measure intra-rater reliability) were presented to listeners in a sound treated booth at 60 dBA using E-Prime. The samples were quasi-randomized such that the listener did not hear the same speaker two times in a row. The DME protocol involved instructing listeners to create a scale, rating the first speech sample as an integer value, then to assign ratings that reflect the proportional difference in perceived speech clarity between each sample and the previous rating.

Analysis. Each rating was divided by the first rating to create a scaled clarity rating. For each speaker, partition, and condition, the scaled clarity ratio was averaged across the listeners. Descriptive Statistics, along with linear mixed model analyses were conducted to examine differences between groups, conditions, and across the passage. The initial syllable number was used as a covariate in the model to examine changes in the scaled clarity rating across the passage.

RESULTS

Fixed effect parameter estimates from the linear mixed model suggest:

- Scaled clarity rating for the PD group was on average less clear than the control speakers in the habitual condition. However, this difference was not statistically significant, $Est = -0.27$, $p=0.18$.

- Control speakers exhibited a significant increase in scaled clarity ratings from the clear as compared to the habitual condition, $Est = 0.43$, $p<0.001$.

- Speakers with PD exhibited a lesser degree of clarity-related increase in scaled clarity rating than control speakers, but this difference was not statistically different from the control speakers, $Est = -0.10$, $p=0.56$, $p=0.58$.

Random effects estimates suggested that there was significant between-speaker variation in clear speech effect for the scaled clarity rating, $\sigma^2=35.5$, $p<0.01$.

CONCLUSIONS

These preliminary data suggest:

- The speech of individuals with PD was perceived to be on average less clear than the speech of healthy control speakers.

- The clear condition was associated with higher scaled clarity rating for both groups; however, individual trends suggest that this was not the case for every speaker.

- Visual inspection of the scaled clarity ratings across the reading passage suggests that speakers with PD may experience clear speech cue fade, as the scaled clarity ratings for the clear speech condition decreased over the course of the passage.

Data collection for this project is still ongoing and the current results need to be replicated in a larger number of listeners. Additionally, acoustic measures of speech articulation should be examined to determine which aspects of the speech signal contribute to the loss of clarity across the passage.

Clinical implications:

- Clear speech cue fade is an important notion that should be considered in treatment.

- Due to the nature of motor deficits in PD, cue fade may result from aberrant re-energization of the speech motor system during connected speech.

- Reminding speakers with PD to maintain clear speech behavior over the course of a speech utterance is potentially just as important as cueing the desired changes to speech clarity.

REFERENCES


