BACKGROUND

Deep brain stimulation of the sub-thalamic nucleus (DBS-STN) is a common neurological treatment for individuals with Parkinson's Disease (PD). DBS-STN is hypothesized to increase motor-related cortical activity by disrupting the disease-related inhibition of the cortical-basal ganglia-thalamus motor system. While DBS-STN is prescribed as a means of ameliorating the cardinal motor symptoms in PD, its reported effects on speech intelligibility and acoustic-phonetic characteristics are inconsistent and may produce significant impairments in some individuals (Iulianeli, Adams, & Gow. 2008; Skodda, 2012; Dromey & Bjarnason, 2011). There is evidence to suggest that distinct DBS-STN parameter settings have a major influence on speech intelligibility (Törnqvist, et al., 2005).

Acoustic vowel space and formant slopes are two measures that have been shown to be associated with intelligibility deficits in dysarthria (Weismer, et al., 2012). Vowel space reflects the range of vowel-related articulatory positions while formant transitions reflect the dynamic aspects of articulatory movements. Furthermore, vowel space and formant transition measures have been shown to be susceptible to changes following DBS-STN (Dromey & Bjarnason, 2011).

PURPOSE

The present study examined the effect of specific DBS-STN parameter settings on a) acoustic measures of vowel space and formant transitions and b) intelligibility ratings, and the relationship between these measures.

METHODS

Thirteen individuals with idiopathic PD who had received bilateral DBS-STN were included in the study. Patients produced the sentence "She saw Pattie buy two poppies" during three baseline and five treatment visits. Permutations of the following nine DBS-STN parameter settings were examined: voltage (low, mid, high), frequency (low, mid, high), and pulse width (low, mid, high). Total Electrical Energy Delivered (TEED) was calculated using the following equation:

$$TEED = [(voltage^2 * frequency * pulse\ width)/impedance].$$

Four first-year graduate students in speech-language pathology evaluated the intelligibility of all speech samples on a 10cm visual analogue scale (VAS). Second formant transition extent and slope were calculated in the diphthong /ɑI/. First and second formant peaks were calculated in the corner vowels /i, ɑ, æ, u/.

RESULTS/DISCUSSION

Analyses are ongoing. Preliminary results demonstrate that optimal second formant slope and extent occurred with mid voltage, low frequency, and high pulse width settings. Optimal intelligibility ratings occurred with low voltage, low

frequency, and low pulse width, as well as overall lower TEED. Second formant extent exhibited a significant weak positive correlation with intelligibility. The parameter settings leading to optimal speech measures were highly variable within patients, though lower voltage, frequency and pulse width settings showed a trend towards optimization in the majority of patients. The neurologist's standard clinical adjustments over the five treatment visits led to a final adjustment set to optimize the limb-related cardinal motor symptoms of PD. Eight patients demonstrated a decrease in intelligibility with this final clinical setting.

These preliminary results provide further evidence that the standard DBS-STN settings chosen to reduce limb-related cardinal motor symptoms are generally sub-optimal for speech. These findings highlight the variable effect of DBS-STN on speech and a need for further investigations of individual differences.

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