**INTRODUCTION**

- The slope of second formant (F2) frequency transitions is an acoustic measure of the rate of change of vocal tract configuration (Kim et al., 2009).
- Previous research indicated reduced F2 slopes for speakers with dysphonia vs healthy controls, and strong correlations of F2 slope and speech intelligibility, indicating that F2 slope has potential to serve as an index of speech severity (Yunusova et al., 2012; Martel-Sauvageau & Tjaden, 2017).
- Acoustic measures usually include averaged transition duration, transition extent, and slope, but thus far no studies have considered the variability of F2 transitions over repeated productions.
- Variability indices obtained from repeated sentence-length productions have found to be promising indicators of speech motor involvement:
  - Higher measures of variability in dysarthria compared to typical speech (van Brenk & Lowit, 2012).
  - Higher measures of variability in dysarthria associated with decreased intelligibility (Cummins et al., 2014).
- Sensitive to different speaking demands, including changes in articulation rates (Tjaden & Weismer, 1998), with previous findings reporting increased variability in speech produced at fast rate (McHenry, 2003).

**PURPOSE**

The aim of this study was to investigate whether the quantification of variability of F2 transition metrics could be used to characterize dysarthria. Particularly, we investigated whether these repetition-to-repetition variability measures showed similar sensitivity compared to averaged F2 transition measures at habitual and fast speaking rates, and whether they could potentially reveal aspects of speech motor control deficits in dysarthria not fully captured by averaged measures.

**METHODS**

**PARTICIPANTS**

- 23 speakers with Parkinson’s Disease and mild-moderate hypokinetic dysarthria (HD): 18 male, 5 female, age 40-81. M = 66.6, SD = 10.6
- 9 speakers with various neurological diseases and mild-severe ataxic / ataxic-spastic dysarthria (AD): 6 male, 3 female, age 37-70, M = 57.4, SD = 13.9
- 26 age-matched control speakers (CON): 15 male, 11 female, age 35-80, M = 57.1, SD = 14.1

**SPEECH TASK: F2 SLOPE MEASURES**

- Repeat the phrase “Tony knew you were lying in bed” as similar as possible, approximately 20 times at habitual and fast speech rates
- The rising F2 transition portion of the dipthong /ai/ in ‘lying’ was used; onsets and offsets determined by the 20/20 rule (Weismer et al., 1988)
- F2 data were obtained at 5ms increments in Praat, with outliers manually corrected
- Slopes with a minimum duration of 40ms were included
- Measures of interest were mean and coefficient of variance (CoV) of:
  - Transition Duration (TD; in ms)
  - Transition Extension (TE; in Hz)
  - Global Slope (GS; in Hz/ms)

**SPEECH TASK: INTELLIGIBILITY MEASURES**

- Engage in a monologue
- Perceptual judgements (averaged Likert-scaled ratings of intelligibility and listening effort) by 15 undergraduate SLP students; some experience in listening to speech of individuals with dysarthria

**EXTRCTION AND ALIGNMENT**

- Extraction, alignment, and overlay of twenty F2 transitions. Blue shaded area: 95% CI.

**RESULTS: SLOPE MEASURES**

**Transition Duration**

- Overall: AD = HD > CON; Hab > Fast
  - Group comparisons: Hab: AD > HD > CON
    - Task comparisons: AD: HD, CON: Hab > Fast

**Transition Extension**

- Overall: AD = HD > CON; Hab > Fast
  - Group comparisons: AD > HD
    - Task comparisons: AD: HD, CON: Hab > Fast

**Global Slope**

- Overall: AD = HD = CON; Hab > Fast
  - Group comparisons: Hab: AD > HD > CON
    - Task comparisons: AD: HD, CON: Hab > Fast

**SUMMARY AND CONCLUSION**

- Averaged slope measures:
  - No group differences for transition duration
  - Reduced transition extensions in AD and HD
  - Global slope higher in CON vs HD: speakers with hypokinetic dysarthria produced slower F2 slopes (see also Kim et al., 2009)
- Variability of slope measures:
  - Higher variability of transition durations and extensions in HD and AD vs CON group (see van Brenk et al., 2012)
  - Higher global slope variability in AD vs HD and CON groups
  - Overall higher variability measures in AD vs HD; possibly due to dysarthria type and/or higher overall severity
  - Effects of rate on averaged or variability in slope measures were limited
- Notable correlations were found between slope measures and intelligibility for speakers with hypokinetic dysarthria, and were most prominently found during habitual rate:
  - Higher mean transition extension associated with higher intelligibility
  - Higher variability in transition extension and global slope associated with lower intelligibility (see Cummins et al., 2014)
- Overall results suggest added value of F2 variability measures in evaluating motor speech involvement, but only for hypokinetic dysarthria, and only at habitual speech rate

**REFERENCES**