Acoustic Variability in Dysarthria: Effects of Articulation Rate and its Relationship with Intelligibility

Frits van Brenk1,2, Anja Lowit2 & Kris Tjaden1

1Department of Communicative Disorders and Sciences, University at Buffalo, USA 2Department of Speech and Language Therapy, University of Strathclyde, Glasgow, UK

Introduction

- Rate reduction is a popular management strategy in treatment of hypokinetic dysarthria (Yorkston et al., 2007).
- However, not all speakers with dysarthria exhibit improved speech intelligibility when slowing rate (Tjaden et al., 2014).
- Research on the effects of rate changes on stability of sentence-length speech motor movements in dysarthria is sparse and contradictory, with findings of:
  - increased variability at slow rate (Kleinow et al., 2001).
  - increased variability at fast rate (McHenry, 2003).
- Most speech variability research is based on linear measures extracted with Functional Data Analysis:

Methods

Participants

- 23 speakers with PD 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=74, SD=13.9)
- 27 age-matched control speakers (CON) (16 male, 11 female, age 35-80, M=74, SD=13.9)

Speech Tasks: Variability Measures

- Repeat the phrase "Tony knew you were lying in bed" as similar as possible, around 20 times
- Three speaking conditions:
  - Habitual speech rate (Hab)
  - Slow speech rate
  - Fast speech rate
- Acoustic properties of interest:
  - Sound pressure level (SPL)
  - Fundamental Frequency (F0)
  - First Formant (F1)
- Measures extracted with Functional Data Analysis:
  - Spatial Variability
  - Temporal Variability

Speech Tasks: Intelligibility Measures

- Engage in a monologue.
- Perceptual judgements (Likert-scaled ratings of intelligibility and listening effort) by 15 undergraduate SLP students, some experience in listening to dysarthric speech

Results: Groups & Tasks

- Conventional linear measures (SPL, F0, F1)
- Linear Mixed Model analyses
- Group and Task fixed factors
- Subject as random factor
- Sentence duration as covariate
- Correlations between variability and intelligibility

Data Analysis (example: SPL contours)

Results: Correlation Results

- Speech variability generally higher in dysarthria compared to controls
- Higher severity in AD group reflected in higher variability
- Rate differences dependent on group, task, speech parameter under investigation. Trends:
  - Deviating from habitual rate increases variability
  - AD: slow rate more impact on variability
  - Increased variability correlated with lower intelligibility ratings; shows potential as acoustic measure of severity
- Group differences of variability not always reflected in significant intelligibility-variability correlations
- Complicated relationship acoustic variability - intelligibility: associations largely dependent on dysarthria type and speech parameter

Summary & Conclusion

- Variability generally higher in dysarthria compared to controls
- Higher severity in AD group reflected in higher variability
- Rate differences dependent on group, task, speech parameter under investigation. Trends:
  - Deviating from habitual rate increases variability
  - AD: slow rate more impact on variability
  - Increased variability correlated with lower intelligibility ratings; shows potential as acoustic measure of severity
- Group differences of variability not always reflected in significant intelligibility-variability correlations
- Complicated relationship acoustic variability - intelligibility: associations largely dependent on dysarthria type and speech parameter

References


www.buffalo.edu