

ASSESSING DYSPARTHRIA USING VARIABILITY MEASURES FROM AUDIO RECORDINGS

Frits van Brenk, Anja Lowit

University of Strathclyde, Glasgow, United Kingdom

Classification and characterization of motor speech disorders (MSDs) is important from the viewpoint of diagnosis and treatment. Clinical diagnosis is primarily based on auditory-perceptual characteristics of perceived speech abnormalities, but is subject to unreliable clinical judgement and quantification, and difficult to relate to the underlying pathophysiology. In this study we investigate whether it is possible to diagnose dysarthria based on measures of speech variability by using Functional Data Analysis (FDA) (Ramsay et al., 1996). A reliable quantification of variability in speech can potentially reveal underlying motor control problems, enable early detection of sub-clinical speech abnormalities, and provide sensitive and quantifiable outcome measures that aid treatment strategies. FDA has been shown to be successful in investigating variability of kinematic movements obtained by lip displacement tracking, but may also be applied to other dimensions of speech, including amplitude envelopes and pitch and formant tracks. Anderson et al. (2008) used FDA to calculate spatial and temporal variability of amplitude envelopes of sentence repetitions produced by patients with hypokinetic and ataxic dysarthria and demonstrated that variability characteristics were influenced by dysarthria type.

In the current study, we aim to extend these findings by employing a wider range of speaking conditions and speech variables, and including a standardized acoustic clinical assessment of dysarthria. Participant groups included five patients with mild to moderate hypokinetic dysarthria due to Parkinson's disease; five patients with mild to severe ataxic dysarthria due to various underlying neuropathologies, and ten control participants without a speech disorder. The phrase "Tony knew you were lying in bed" was repeated around twenty times during six speaking conditions: at habitual, slow and fast speech rate, and at habitual rate with increased sentence length with and without increased syntactic complexity, and whilst performing a simultaneous drawing task. The amplitude envelope, fundamental frequency, first and second formant tracks were extracted, filtered and normalized. The tracks were then non-linearly stretched using FDA, allowing a separate calculation of spatial and temporal variability. For the acoustic speech assessment, a series of diadochokinetic tasks, a vowel prolongation task and a reading task were employed. Rate, regularity and accuracy of syllable repetitions, maximum phonation time and pitch and intensity ranges were measured to evaluate motor control performance and speed, flexibility and regularity of articulatory movements. The measures of speech variability were compared across speaker groups, and correlated to the results of the acoustic speech assessment.

References

- Ramsay, J. O., Munhall, K. G., Gracco, V. L., and Ostry, D. J. (1996). Functional data analyses of lip motion. *Journal of the Acoustical Society of America*, 99(6):3718–3727.
- Anderson, A., Lowit, A., & Howell, P. (2008). Temporal and spatial variability in speakers with Parkinson's Disease and Friedreich's Ataxia. *Journal of Medical Speech - Language Pathology*, 16(4), 173–180.