4aSCb13. The correlation between perceptual saliency and acoustic parameters of dysarthrias
Emily Q. Wang* and Leo Verhagen

*Corresponding author's address: Communication Disorders and Sciences, Rush University Medical Center, 1611 West Harrison Street, Chicago, Illinois 60612, emily_wang@rush.edu

Dysarthria is a group of speech disorders resulting from neurological disturbances in central or peripheral systems. There are six single types of dysarthria and all present with deviations at both segmental and suprasegmental level. However, it is unclear what matters more to the listener: the deficits at the segmental or suprasegmental level. In this study, reading samples were collected from subjects with any of the three types of dysarthria: scanning speech of ataxic dysarthria, spastic dysarthria and hypokinetic dysarthria. All had slow speaking rate, monopitch and monoloudness. Acoustic analyses were used to examine changes at both segmental and suprasegmental level. At the segmental level, parameters obtained include word and syllable per minute, vowel F1 and F2, syllable, word, sentence, and pause duration, mean F0 and vF0 at sentence and paragraph level. Peak F0 and vowel duration of stressed and unstressed vowels were also obtained. Perception experiment was conducted. Pitch contours were extracted and tested separately from those un-manipulated stimuli. Listeners made forced choice for rate and speech naturalness for the former and for overall speech intelligibility, speech rate and speech naturalness for the latter. Effective size was used to determine the contributions of parameters at the segmental and suprasegmental level.

Published by the Acoustical Society of America through the American Institute of Physics
INTRODUCTION

Dysarthria is a group of speech disorders resulting from neurological disturbances in central or peripheral systems which lead to abnormal changes in speech musculature or speech movement patterns (Duffy, 2005, 2013). Dysarthria has been classified into six single types of dysarthria based on perceptual deviations from normal speech at both segmental and suprasegmental level (Darley, Aronson & Brown, 1969a, 1969b, 1975, Duffy, 2005, 2013). The relationship between the perceptually defined dysarthria types and the neurological diseases that cause them is not linear. That is, a neurological disease may lead to different types of dysarthria in different individuals or at different stage of the disease progression in the same individual. On the other hand, several single types of dysarthria may result from a single neurological disorder. It has been proposed to use sets of acoustic measures to correlate global speech dimensions such as speech intelligibility, prosody and voice quality (Kent and Kim, 2003). This paper describes our first attempt to explore this possibility.

METHOD

Material

Multiple reading samples were collected from 3 participants who were diagnosed with one of the three types of dysarthria: scanning speech of ataxic dysarthria, spastic dysarthria and hypokinetic dysarthria. The types of dysarthria were perceptually defined at the time of evaluation. However, other information such as etiology, site of lesion and non-speech confirmation signs was also used in assisting the dysarthria diagnosis (Duffy, 2005, 2013). The three participants each had a different neurodegenerative disease. The participant who was diagnosed with spastic dysarthria was female and the other two were male. There were three shared and dominant perceptual characteristics of their speech: slow rate, monopitch and monoloudness.

Analysis

Acoustic analyses were used to examine changes at both segmental and suprasegmental level. Praat was used for data recording and analysis (Boersm, 2001). At the segmental level, parameters obtained include speaking rate measured at word level (word/s) and syllable level (syllable/s), vowel F1 and F2, syllable, word, sentence, and pause duration, mean F0 and vF0 at sentence and paragraph level. Peak F0 and vowel duration of stressed and unstressed vowels were also obtained. Perception experiment was conducted. Pitch contours were extracted and tested separately from those un-manipulated stimuli. Listeners made forced choice for rate and speech naturalness for the former and for overall speech intelligibility, speech rate and speech naturalness for the latter. Effective size was used to determine the contributions of parameters at the segmental and suprasegmental level.

RESULTS AND BRIEF DISCUSSION

In this short version of the paper, we only report three measures: Speaking rate measured at word level (word/s) (Figure 1) and syllable level (syllable/s) (Figure 2), and mean speaking fundamental frequency (f0 Hz) averaged over the entire reading passage and mean standard deviation (Figure 3). For speaking rate, although all three types of dysarthria were perceived as similarly slow rate, when keeping the sentence duration constant for the two different calculations, word spoken per second (Figure 1) vs. syllable spoken per second (Figure 2), the word/s measure seems to be almost consistent across the three types of dysarthria. Interestingly, with the syllable/s measure it used, the scanning ataxic type of dysarthria was actually faster than the other two types. Since they were all perceived similarly slow, it seems that the perceived slow rate may correspond to the word level information rather than the syllable level information. As for the speaking fundamental frequency, it seems that although listeners identified all three types of dysarthria as being monopitch and monoloudness, the scanning ataxic type and the spastic type of dysarthria may in fact less variable in pitch when comparing to the hypokinetic type as shown by their smaller standard deviations (vF0). However, given the small sample here, this conclusion could not be drawn until all samples are analyzed and reported. Nonetheless, the acoustic parameters revealed by the analysis may not be the salient perceptual characteristics identified and used by listeners in judging the types and severity level of dysarthrias.
FIGURE 1. Comparison of speaking rate at sentence level calculated at word/s across the three types of dysarthria.

FIGURE 2. Comparison of speaking rate at sentence level calculated at syllable/s across the three types of dysarthria.

FIGURE 3. Comparison of speaking Fundamental Frequency (F0 Hz) over the entire reading sample across the three types of dysarthria.
REFERENCES