The Impact of Breathlessness on the Intelligibility of Speech

Louise Thompson, B.A., Emily Lin, PhD., and Michael Robb, PhD
Department of Communication Disorders, University of Canterbury, Christchurch, New Zealand

Abstract

The aim of this study is to determine how deterioration of voice quality, such as breathlessness, may impact on the intelligibility of speech. Acoustic analysis was conducted on sustained vowel phonation as well as discrete segments taken from recorded sentences, retrieved from a database of voice disordered speech. Measurements made included: frequency of the first two formants (F1, F2), singing power ratio, the amplitude difference between the first two harmonics (H1-H2 amplitude difference), voice onset time, and energy ratio between consonant and vowel (CV ratio). A series of two-way (glottal closure x vowel) repeated measures analyses of variance showed a significant effect of glottal closure (complete vs. incomplete) or glottal closure by vowel interaction effect for the F2 frequency, H1-H2 amplitude difference, and singing power ratio. Based on findings in literature that reported a dominant first harmonic as a useful goal of breathiness, the measure of H1-H2 amplitude difference was selected as a factor for investigating the impact of voice quality on the perception of vowel intelligibility and clarity. Fixed-length vowel segments at five levels of H1-H2 amplitude difference were presented to 10 male and 10 female inexperienced listeners between the ages of 19 and 34 years. It was expected that the tokens with a dominant first harmonic, indicative of a more breathy voice, would be judged as being less intelligible. Results of the study: the finding of a change of the perceptual ratings as a function of H1-H2 amplitude difference will demonstrate the effect of voice quality on vowel intelligibility.

Introduction

Voice quality refers to the perceived auditory characteristics that mark an individual's speech (Gerratt & Kreiman, 2004). Voice quality such as breathiness, hoarseness, roughness, strain, weakness, and anochea is typically considered to be one of the problems of voice disorders (Papstein & Rudy, 2009). Pathological voice quality is associated with disorders resulting from mass or non-mass lesions, neurological problems, or functional problems (Papstein & Rudy, 2009). Voice quality is what most commonly characterizes voice disorders (Kreiman, Gerratt, Kempster, Erman, & Berke, 1993). Voice patients seek treatment because they do not sound normal, and judge the success of treatment on whether their voices are heard as “normal.” If the babbles produced at 90 dB SPL were significantly different from the glottal closure (complete vs. incomplete) or glottal closure by vowel interaction effect for the F2 frequency, H1-H2 amplitude difference, and singing power ratio. Based on findings in literature that reported a dominant first harmonic as a useful goal of breathiness, the measure of H1-H2 amplitude difference was selected as a factor for investigating the impact of voice quality on the perception of vowel intelligibility and clarity. Fixed-length vowel segments at five levels of H1-H2 amplitude difference were presented to 10 male and 10 female inexperienced listeners between the ages of 19 and 34 years. It was expected that the tokens with a dominant first harmonic, indicative of a more breathy voice, would be judged as being less intelligible. Results of the study: the finding of a change of the perceptual ratings as a function of H1-H2 amplitude difference will demonstrate the effect of voice quality on vowel intelligibility.

Methods

Stage One: Acoustic Analysis

Acoustic parameters from voice samples were measured for analysis. The voice samples consisted of segments taken from running speech and sustained vowels obtained from a database of voice recordings of individuals with varying degrees of voice pathology, classified according to whether they achieved complete or incomplete glottal closure during videobronchoscopic examinations on the day of voice recording.

Voice Recordings

Voice recordings were previously recorded from voice patients seen in the voice clinic of the University of Canterbury. The 16 patients were selected from a cohort of 26 patients with voice disorders. The 16 patients included 13 males and 3 females ranging in age from 19 to 77 years. Each patient had undergone videolaryngostroboscopy with recording of an estimated laryngeal adduction time of at least 0.5 s. Voice samples were selected to represent a range of voice characteristics, including patients with dysphonia as well as patients with normal voice. Each voice sample was divided into three segments, providing a total of 48 samples for analysis. The segments were recorded at a sampling rate of 16 kHz, with a digitization resolution of 16 bits, and stored in a digital format.

Stage Two: Perceptual Study

Participants and Participant’s Task

The participants were 10 male and 10 female adult native English speakers between 19 and 34 years with normal hearing and normal speech, language, and production skills. Participants were required to perform two forced-choice tasks based on their perception of the stimuli. The 50 ms segments were selected from sentence readings (“sustained vowels”, “sentences”, and “words”), with vowel quality manipulated to achieve complete and incomplete glottal closure. The samples were selected to represent a range of voice characteristics, including patients with dysphonia as well as patients with normal voice. Each voice sample was divided into three segments, providing a total of 48 samples for analysis. The segments were recorded at a sampling rate of 16 kHz, with a digitization resolution of 16 bits, and stored in a digital format.

Results

The acoustic study results indicated that the F2 frequency, H1-H2 amplitude difference measures were significantly higher for voice patients with incomplete glottal closure associated with breathy voices. The perceptual study results require closer analysis at this point in time.

The findings of this study may contribute to determining how deterioration of voice quality, such as breathlessness, impacts on the intelligibility of speech.

Conclusion

The acoustic study results indicated that the F2 frequency, H1-H2 amplitude difference measures were significantly higher for voice patients with incomplete glottal closure associated with breathy voices. The perceptual study results require closer analysis at this point in time. The findings of this study may contribute to determining how deterioration of voice quality, such as breathlessness, impacts on the intelligibility of speech.

Acknowledgments

This project was funded by the University of Canterbury's Library and Learning Support Services. The authors would like to thank all the participants for their time and effort.

References


