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Louder Speech Leads to Greater Intelligibility Improvements than Amplification of Habitual Speech in Parkinson Disease

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Louder speech leads to greater intelligibility improvements than amplification of habitual speech in Parkinson disease [1]

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QUESTION

How do speaking loudly and amplification compare in improving the perceived intelligibility and word transcription scores of speakers with Parkinson disease?

METHODS

Design: The two experiments reported in this article used a repeated measures design which compared intelligibility ratings and transcription scores across three experimental conditions.

Allocation: All 5 speakers with Parkinson disease read the same sentences and word lists. In the first experiment, 11 students provided perceptual judgments of intelligibility for all of the sentences from the three conditions in random order, one speaker at a time. Twenty different

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students transcribed the words from a single assigned speaker (four listeners for each speaker) in the second experiment. The listeners used the same rating or transcription approach for all of the stimuli they heard.

Blinding: Unblinded; the author does not report whether the student listeners were blind to the purposes of the study.

Study duration: The speakers recorded the sentences and words in a single session. The two listening experiments were each completed in a single session.

Setting: The recordings were made in a quiet room. Stimuli were presented to the listeners via headphones, although the setting is not described.

Participants: Five speakers with Parkinson disease (aged 54 to 76 years) who had received therapy focusing on increased loudness 1-2 years prior to the study were recruited to record the sentences and words. Although they failed a hearing screening at higher frequencies, they were able to follow the experimenter's instructions. The two groups of listeners (11 for the first experiment, 20 for the second) were undergraduate and graduate students in speech and hearing sciences with no history of disordered communication; they had little or no experience with dysarthric speakers.

Intervention: The speakers with Parkinson disease read sentences and word lists using the loud speech techniques they had learned in therapy, and then they read the same stimuli in their habitual speech mode. The experimenter adjusted the amplitude of a duplicate copy of the habitual stimuli to match the mean intensity of the loud speech. The listeners then heard the three randomly sequenced sets of stimuli, designated as *loud*, *habitual*, and *amplified*. Eleven listeners rated the perceived intelligibility of the sentences on a 7-point scale, comparing each token against a standard stimulus which had been rated at the scale midpoint of 4 (fair intelligibility) in

pilot work. In the second experiment, 4 listeners were assigned to listen to each of the 5 speakers reading the word lists. Open-set transcription was used instead of a multiple-choice response.

Outcomes: The listeners rated the intelligibility of the sentences on a 7-point scale ranging from 1 (speech is very difficult to understand) to 7 (speech basically sounds normal). The percent intelligibility for the word lists was computed as the number of correctly transcribed words, divided by the total number of words, multiplied by 100. The author extracted a number of acoustic variables from the sentences reflecting both laryngeal and articulatory behavior in order to confirm that the loud speech was acoustically different from the habitual mode speech. These variables included measures of root-mean-square (RMS) intensity, as well as the mean and range of sentence F_0, along with F1 and F2 for selected vowels. Voice onset times, vowel, and fricative durations were measured, as well as statistical moments from the long-term average spectrum.

Intrajudge and interjudge remeasurement data are reported in detail for the acoustic variables, and reveal small mean absolute differences and thus good reliability. The intraclass correlation coefficient of .92 represents good interrater reliability for the sentence intelligibility ratings. The intrajudge reliability for these ratings was modest, with Pearson correlations between .42 and .52 for repeated ratings of the same stimuli.

Attrition: Because each participant took part in a single session, there was no attrition.

MAIN RESULTS

ANOVA and post hoc results from the first experiment revealed that loud sentences (mean = 4.72 on the 7 point scale) were rated as significantly more intelligible than the amplified sentences (mean = 4.11), and that the amplified sentences were also significantly more intelligible than the habitual sentences (mean = 3.82). Individual speakers differed in the degree

to which their intelligibility ratings changed across the three conditions of habitual, amplified, and loud. Acoustic analysis revealed greater changes from habitual to loud speech in laryngeal function (reflected by intensity, F_0, and spectral indexes) than in articulatory behavior (from measures of segment durations and formant frequencies).

Percent word identification scores in the second experiment changed significantly across the three conditions. Identification of loud words was 5.7% higher than for amplified and 10.5% higher than for habitual words. Amplified word scores were 4.9% higher than habitual words. As was the case with sentences, individual speakers varied substantially in the way their scores changed across the conditions. Error analysis revealed that /h/-initial words improved most in the loud condition, where frication noise increased in intensity.

AUTHOR'S CONCLUSIONS

Amplification may be helpful in improving speech intelligibility for some speakers with Parkinson disease. Because the gain used in the present study was limited to the dB increase from habitual to loud speech, it is unclear how performance might increase with higher amplification levels. Increases in the signal to noise ratio in the present study only account for about one third to one half of the intelligibility improvements that accompany loud speech. Thus, loud speech differs from habitual speech in more than just its amplitude. Articulation appears to play a lesser role in these improvements, whereas source spectral changes may be more important. Prosody may also be an important feature to study in the future. Further work is needed to better understand the specific mechanisms underlying intelligibility improvements in loud speech in this population.

Commentary

This article makes an interesting comparison between two contrasting approaches that have been used by speech pathologists to improve the functional communication of individuals with Parkinson disease. The study measured the effects of amplification versus deliberately speaking in a loud voice, rather than evaluating the outcome of a course of therapy. Nevertheless, it sheds important light on the potential benefits of each approach. In this way, it is somewhat similar to a previous study, which compared speaking loudly with deliberately exaggerated articulation (Dromey, 2000) in a single session.

Because the dysarthria associated with Parkinson disease is characterized by laryngeal hypofunction (Adams, 1996; Gentil & Pollak, 1995), treatment options addressing reduced vocal intensity have included electronic amplification and therapy designed to boost vocal loudness. The best known behavioral approach is the Lee Silverman Voice Treatment, or LSVT (Ramig, Countryman, O'Brien, Hoehn, & Thompson, 1996). Amplification requires no special effort from the speaker, whereas the LSVT demands a lasting commitment to increased vocal effort, which must be considered when working with individuals with significant cognitive limitations.

While many studies have reported improvements in communication following the LSVT, and some have directly addressed selected physiologic changes associated with louder speech (Dromey, Ramig, & Johnson, 1995; Ramig & Dromey, 1996; Smith, Ramig, Dromey, Perez, & Samandari, 1995), less is known about the specific mechanisms that may contribute to improved intelligibility. One explanation is that louder speech simply results in an increased signal to noise ratio, and thus speech is easier to understand above ambient noise. Another view is that because loud speech is known to involve higher lung volumes, a flatter harmonic spectrum, and larger articulatory excursions (Dromey & Ramig, 1998; Schulman, 1989; Titze & Sundberg, 1992),

changes in the source spectrum and vocal tract behavior may be responsible for increased intelligibility (Dromey et al., 1995). The valuable contribution made by the present study lies in a carefully designed method that directly evaluates the contribution to intelligibility from increased amplitude alone compared with the additional benefits derived from higher effort speech. The key outcome variable of intelligibility complements previous studies that have focused on vocal tract behavior as reflected by articulatory kinematics (Dromey, 2000) and changes to the acoustic working space (Sapir, Spielman, Ramig, Story, & Fox, 2007; Tjaden & Wilding, 2004).

Beyond the perceptual ratings of sentence intelligibility and the word transcription scores, the present paper provides some intriguing clues about the source of the intelligibility improvements in loud speech via the acoustic measures that the author reports. It appears that adjustments to the source spectrum may contribute more than changes in the segmental timing measures. This notion is consistent with a previous account describing the importance of laryngeal function in speech intelligibility (Ramig, 1992).

This study provides important evidence that there is more to loud speech than amplitude. It could thus be inferred that for individuals with Parkinson disease who are capable of increasing their vocal effort in everyday communication, the benefits of interventions such as the LSVT go beyond an increase in amplitude. Amplification does indeed improve intelligibility, but the present study suggests that it may be less effective than using increased vocal effort to treat disordered communication in this population.

Declaration of interests. The commentary author reports no conflicts of interests and is solely responsible for the content of this structured abstract.

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