

Vowel production under masking noise in individuals with and without Parkinson's disease

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Introduction. When communicating in noisy environments, speakers tend to increase vocal intensity and modify their articulation to maintain intelligibility (i.e., the Lombard effect; first described by Etienne Lombard in 1911). Acoustically, these changes can be reflected in lengthened vowel durations [1] and shifts in vowel formant frequencies [1]. While the effect of masking noise on speech acoustics has been extensively studied in typical speakers, its acoustic–phonetic characteristics in Parkinson's disease (PD) remain less well understood. Speech problems are common in PD and often involve both phonatory and articulatory impairments [2], which also result in decreased intelligibility [3]. Prior studies have shown that articulatory impairments are reflected in reduced acoustic contrasts between vowels [4], which can be improved with speech therapy targeting a voluntary increase in speech loudness [5]. However, it remains unclear how speakers with PD adjust their vowel production under masking noise, as this induces largely involuntary changes in speech production. This study, therefore, investigated the effects of auditory masking on vowel duration and the first and second formant frequencies (F_1 and F_2) in speakers with PD and typical speakers.

Methods. Acoustic data were collected from 34 native Dutch speakers with PD and 29 control speakers as part of a larger study. Preliminary analysis includes 14 speakers with PD (six female) and 15 age-matched control speakers (nine female). Participants produced two minimal word pairs containing the target vowels / ϵ / and / u /: *dekken* /'d ϵ .kən/, *doeken* /'du.kən/ and *bekken* /'b ϵ .kən/, *boeken* /'bu.kən/. Speech was elicited with and without masking noise. During postprocessing, we manually segmented all target vowels in Praat [6] and measured vowel durations and the first and second formant frequencies at vowel midpoints. Statistical analyses were conducted using linear mixed-effects models, with duration, F_1 , and F_2 as the dependent variables and group (PD, control), masking (masked, unmasked), vowel (/ u /, / ϵ /), and sex (male, female) as fixed effects. We also included random intercepts per word and subject, including vowel and masking as (significant) random slopes per speaker.

Results. There were no group differences between speakers with PD and control speakers in vowel duration ($\beta = 0.005$, $p = 0.39$) or F_1 ($\beta = -1.96$, $p = 0.86$). For F_2 there was a significant interaction between group and sex ($p = 0.01$; see Fig. 1). Pairwise comparisons revealed that female control speakers had lower F_2 values than female PD speakers ($\Delta_{\text{control,PD}} = -82$ Hz, $p = 0.02$), whereas no significant difference was observed between male control and male PD speakers ($\Delta_{\text{control,PD}} = 38$ Hz, $p = 0.25$). Overall, there were no significant interactions between group and masking for any measure. A small but significant main effect of masking was observed for vowel duration ($\beta = -0.004$, $p < 0.001$) and F_1 ($\beta = -26.83$, $p < .001$), but not for F_2 ($\beta = 10.18$, $p = .354$).

Discussion. The present findings indicate that speakers with PD and controls showed similar patterns of adjustment under masking noise, with increased vowel duration and higher F_1 values, consistent with increased articulatory effort typical for typical Lombard speech. Further analyses will focus on more vowel contrast pairs, and adding additional intensity measures to more clearly determine when speaking under masking noise has a positive effect for speakers with PD. This would in turn highlight the potential usefulness of including auditory masking exercises in speech therapy.

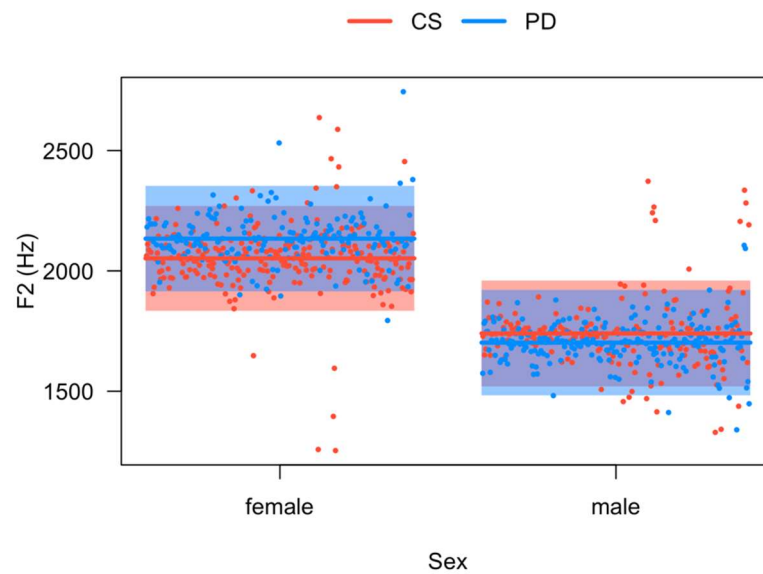


Fig. 1. Model-predicted F_2 values by sex and group (PD: Parkinson's disease; CS: control speakers).

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