

Differential speech and language characteristics across neurodegenerative disorders

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Background

Speech and language changes have been reported to occur across a range of neurodegenerative disorders, including Alzheimer's Disease (AD), Frontotemporal Dementia (FTD) and Parkinson's Disease (PD).^{1,2} Digital technologies allow for remote capture of speech recordings, which could be used to non-invasively detect and monitor signs of neurodegenerative disorders. In order to determine the specificity of speech and language changes, it is important to compare speech and language changes across different neurological conditions. In this study, we pool data across studies of speech in AD, FTD and PD populations, and compare them to healthy older adults, to identify disease-specific and disease-general characteristics of speech and language.

Methods

- In this cross-study comparison, we pooled data from normative studies of healthy older adults (HC, N = 260), and studies of individuals with a clinical diagnosis of AD (N = 115), FTD (N = 36) or PD (N = 42). In some cases, participants provided multiple speech samples over longitudinal assessments.
- In all studies, speech was recorded from an open-ended, naturalistic picture description task, in which participants were shown a line drawing of a scene and asked to describe everything they saw in the picture.
- Speech samples were transcribed and analyzed, producing >500 acoustic and linguistic variables describing the characteristics of the speech sound and content.
- Speech variables were compared across groups using linear mixed models testing for group differences and including factors of age, sex, and picture stimulus.
- Significant group effects ($p < 0.05$) were further examined with pairwise group comparisons.

Winterlight Speech Analysis Pipeline

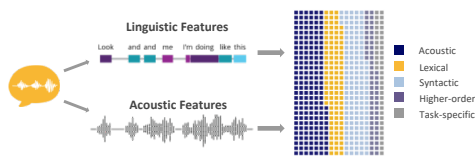


Figure 1: Selected speech variables with differential group patterns in AD, FTD and PD

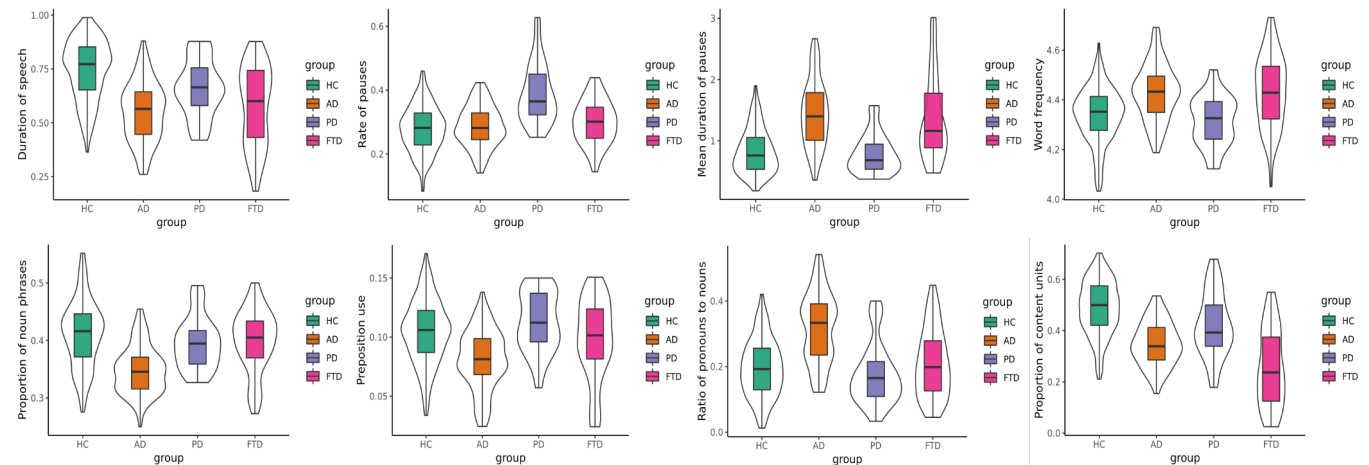


Table 1: Significant group differences in selected speech variables

| Speech feature | AD vs. HC | PD vs. HC | FTD vs. HC | AD vs. PD | AD vs. FTD | PD vs. FTD |
|-----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Duration of speech | $p < 0.001$ | n.s. | $p < 0.001$ | $p < 0.001$ | $p < 0.01$ | $p < 0.001$ |
| Rate of pauses | n.s. | $p < 0.001$ | $p < 0.05$ | $p < 0.001$ | $p < 0.05$ | $p < 0.001$ |
| Mean duration of pauses | $p < 0.001$ | $p < 0.05$ | $p < 0.001$ | $p < 0.001$ | $p < 0.05$ | $p < 0.001$ |
| Word frequency | $p < 0.01$ | $p < 0.05$ | $p < 0.001$ | $p < 0.001$ | n.s. | $p < 0.001$ |
| Proportion of noun phrases | n.s. | $p < 0.001$ | $p < 0.001$ | $p < 0.001$ | $p < 0.001$ | $p < 0.001$ |
| Preposition use | $p < 0.01$ | $p < 0.05$ | $p < 0.05$ | $p < 0.001$ | n.s. | $p < 0.01$ |
| Ratio of pronouns to nouns | $p < 0.001$ | $p < 0.01$ | n.s. | $p < 0.001$ | $p < 0.05$ | $p < 0.01$ |
| Proportion of content units | $p < 0.001$ | n.s. | $p < 0.001$ | $p < 0.001$ | $p < 0.001$ | $p < 0.001$ |

Conclusions

This study indicates that speech and language characteristics, derived from a picture description task, were differentially affected in AD, FTD, and PD. The rate and duration of pauses, as well as the types of words used differentiated the different neurodegenerative disorders from one another and from healthy controls.

- Specifically, individuals with AD and FTD had reduced speech output and longer pause durations. In contrast, individuals with PD had notably higher rates of pauses.
- Individuals with AD and FTD used more frequent words and produced descriptions with reduced content. Content reductions were the most extreme in FTD.
- Individuals with AD produced a lower proportion of noun phrases, used fewer prepositions and increased pronouns, consistent with previous studies.³ These patterns were less evident in FTD and PD.

Further work is needed to develop classification models based on speech and language patterns for the differential diagnosis of neurodegenerative disorders.

References

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