Generalizability of digital speech and language assessments in MCI/mild AD across four non-English languages

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Objectives

Neurodegenerative diseases frequently impair speech and language production. Research examining speech patterns in individuals with Mild Cognitive Impairment (MCI) and Alzheimer's disease (AD) has identified various acoustic and linguistic alterations, including increased pausing and reduced noun usage[1,2]. However, most of the research has been in an English-speaking population, leaving a gap in the research of how findings apply across other languages.

The current analysis of baseline data from the phase 2b VIVIAD[3] clinical trial sought to examine the associations between speech features in 242 patients with MCI and AD in four different languages (Danish, Dutch, German, Spanish). We also explored the relationship between the speech features and a standardized measure of cognitive function: the Mini Mental State Examination (MMSE).

Sample characteristics

Table 1. Sample Demographics

Language	Total Participants	Age (Mean±SD)	Sex (M:F)	Education			MMSE (Mean)
				High	Middle	Low	
Danish	84	68.7±6.8	45:39	28	47	9	24.5
Dutch	40	66±7.4	18:22	20	15	5	24.4
German	57	66.7±8.4	28:29	20	35	2	24.7
Spanish	61	71.3±6.1	27:34	12	24	25	24.3

SD = Standard Deviation; M:F= number of males and females

Methods

A picture description task was administered to all patients using instructions in their respective languages. We analyzed the speech recordings from the picture description tasks using the Winterlight speech processing pipeline. Five speech features including number of picture objects described, number of nouns, speech rate, pronoun-to-noun ratio and average word length were chosen based on previous analyses of speech patterns in MCI/AD, and a composite score was calculated combining the five measures.

Task description

In the picture description task, participants were presented with a picture (Figure 1) depicting an everyday scene and were instructed to describe everything they saw in the picture. Participants described the picture in their own words, with no time limit, and their responses were recorded.

Figure 1. Family in kitchen scene

Analysis

A series of correlation analyses examined: 1) the interrelationships among the speech features in each language (Figure 2); 2) whether the speech features were related to the MMSE (Table 2).

References
[1]Robin, J., Xu, M., Balagopalan, A., Novikova, J., Kahn, L., Oday, A., ... & Teng, E. (2023). Automated detection of progressive speech changes in early Alzheimer's disease. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring, 15(2), e12445
[2]Spilka, M. J., Xu, M., Robin, J., Simpson, W. (2023). Robustness and generalizability of a speech-based composite score for measuring disease progression in AD. Clinical Trials on Alzheimer's Disease (CTAD) Conference.
[3]Vijverberg E.G.B., Axelsen T.M., Bihlet A.R., Henriksen K., Weber F., Fuchs K., Harrison J.E., Kühn-Wache K., Alexandersen P., Prins N.D., Scheltens P. (2021). Rationale and study design of a randomized, placebo-controlled, double-blind phase 2b trial to evaluate efficacy, safety, and tolerability of an oral glutaminyl cyclase inhibitor varoglutamstat (PQ912) in study participants with MCI and mild AD-VIVIAD. Alzheimers Res Ther. 2021 Aug 23;13(1):142.

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Results

Figure 2. Correlations and distributions of speech features in the four languages

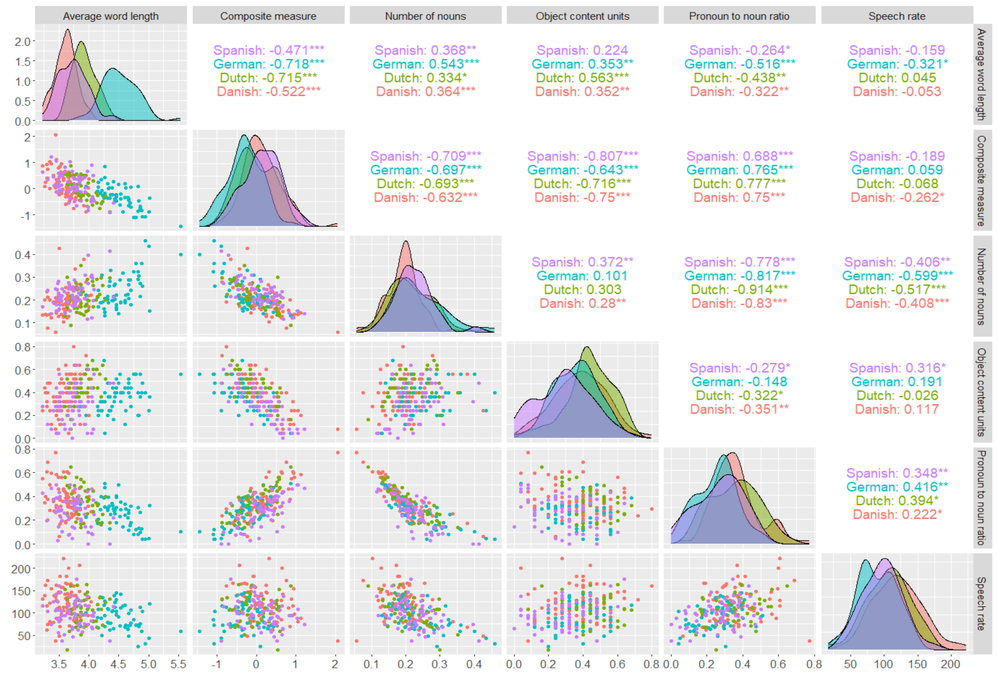

Table 2. Correlations between the MMSE and the speech features

Speech Feature	Spanish	German	Dutch	Danish
Average Word Length	**r = 0.28***	**r = 0.30***	r = 0.08 n.s.	**r = 0.29****
Composite Measure	**r = -0.47*****	**r = -0.31***	**r = -0.41****	**r = -0.39*****
Number of Nouns	r = 0.18 n.s.	r = 0.11 n.s.	r = 0.30 n.s.	**r = 0.21***
Object Content Unit	**r = 0.42*****	**r = 0.28***	**r = 0.32***	**r = 0.27***
Pronoun to Noun Ratio	r = -0.23 n.s.	r = -0.13 n.s.	**r = -0.36***	**r = -0.25***
Speech Rate	r = 0.22 n.s.	r = 0.09 n.s.	r = 0.04 n.s.	r = 0.15 n.s.

n.s. = not significant; p<0.05 *; p<0.01 **; p<0.001 ***

Conclusions

- In the four languages the directions of the associations among the speech features were generally consistent. There was variation in the magnitudes of the correlations, with German showing the most consistent pattern of significant correlations (ranging from moderate to high).
- In all four languages examined, significant correlations with the MMSE were found for both the composite score ($-0.47 \leq r \leq -0.26$) and the object content unit score ($0.27 \leq r \leq 0.42$).
- Speech and language digital biomarkers for MCI/AD demonstrate cross-linguistic validity and correlate with broader cognitive functioning, with the combined multi-feature composite score and the object content unit score showing greater sensitivity to cognitive decline than other single speech features.
- This research addresses validating digital endpoint measures across diverse linguistic populations in global trials.
- Further research is needed to examine other aspects of speech and language, and to further probe the relationship between speech features and measures of cognition.