Comparing longitudinal changes in speech-based digital measures in cognitively healthy, possible cognitive impairment, and MCI/AD individuals

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Background

- In Alzheimer's disease (AD), changes to speech and language differentiate individuals with AD from healthy controls and may precede clinical diagnosis[1,2,3,4]
- Speech-based digital biomarkers may be able to detect early signs of mild cognitive impairment (MCI) using a brief, naturalistic and objective speech assessment
- Speech-based digital biomarkers may offer more sensitive tools for tracking disease progression in MCI and AD
- The objectives of this study are to determine:
  - If speech-based digital measures can distinguish cognitively healthy older adults from those with possible cognitive impairment based on cognitive screening measures, and those with diagnoses of MCI or AD
  - How well speech-based digital measures can measure change over time in these groups

Methods

- 130 community-dwelling older adults were recruited for this study
- Participants completed a tablet-based speech assessment and the Montreal Cognitive Assessment (MoCA)[5] at Baseline and 6 months
- Participants were divided into three groups:
  - Cognitively healthy (MoCA ≥ 26 at baseline and at 6 months; n = 18, mean age = 66.2 yrs, 61.1% female)
  - Possible cognitive impairment group (MoCA < 26 at both timepoints; n = 19, mean age = 79.6 yrs, 78.9% female)
  - MCI/AD group (clinician dx; n = 17, mean age = 77.0 yrs, 47% female)
- Speech samples were recorded, transcribed and analyzed to produce 8 aggregate scores pertaining to different aspects of speech and language, chosen for their previous association to AD[3]
- Two-way mixed ANOVAs were used to compare language scores across groups and assess change over time
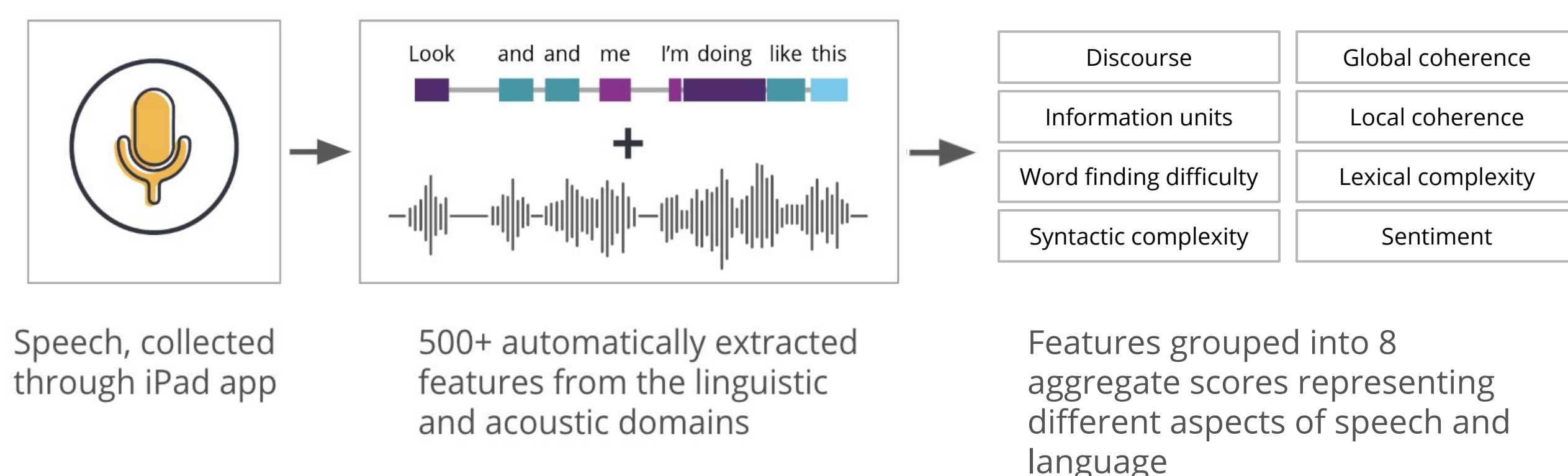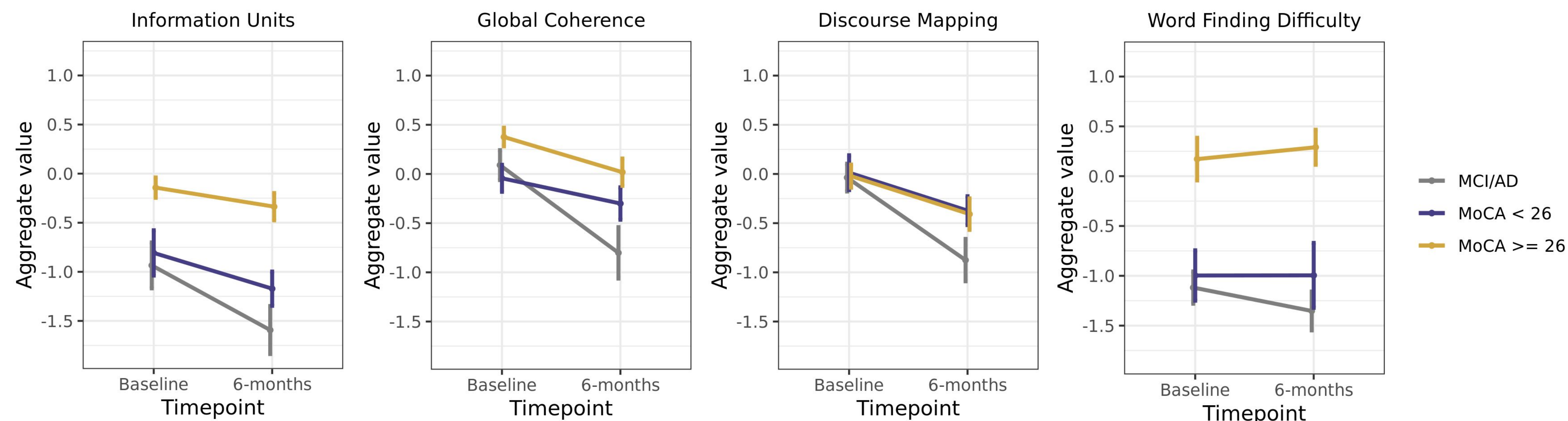

Speech, collected through iPad app — 500+ automatically extracted features from the linguistic and acoustic domains — Features grouped into 8 aggregate scores representing different aspects of speech and language

Figure 1: Group differences and change over 6 months in selected speech aggregates

Results

Speech Aggregate	Effect of group (p-value)	Effect of time (p-value)	Interaction of group x time (p-value)
Information Units	< 0.001	< 0.001	0.15
Global Coherence	0.02	< 0.001	0.06
Discourse Mapping	0.27	< 0.001	0.20
Word Finding Difficulty	< 0.001	0.74	0.46
Local Coherence	0.03	0.07	0.27
Lexical Complexity	0.02	< 0.001	0.21
Syntactic Complexity	< 0.001	0.03	0.07
Sentiment	< 0.001	< 0.001	0.23
MoCA Scores	< 0.001	0.56	0.36

- Seven of the eight speech aggregate scores showed significant effects of group, suggesting that the groups can be distinguished based on multiple aspects of speech and language
- For all aggregates except sentiment, the cognitively healthy (MoCA > 25) group had the highest scores, consistent with predictions
- Six of the eight speech aggregates showed significant effects of time, with three (information units, global coherence, discourse mapping) showing declines in scores over 6 months
- No language composite had a significant interaction of group x time, though several showed trends of steeper decline in MCI/AD
- There was no significant effect of time or group x time interaction on MoCA scores

Conclusions

- This study demonstrates that speech-based biomarkers are sensitive to detect differences in individuals based on cognitive status and MCI/AD diagnosis
- A number of speech aggregates showed significant decline over a 6-month period, unlike MoCA scores
- Scores reflecting information content and coherence of speech both differentiated the groups and showed decline in a 6 month period
- No speech measure had a significant interaction between group and time, which may be due to the timescale of follow up or the small sample sizes
- Ongoing work with larger samples and longer study periods will continue to examine which aspects of speech and language are most sensitive to cognitive status and disease progression and validate novel digital biomarkers
- Digital speech assessments represent promising tools for characterizing early cognitive decline and monitoring change over time

References

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