Assessing & monitoring clinical severity in depressive disorders using automated speech analysis

Michael J. Spilka[1,2], Mengdan Xu[1,2], Sunny X. Tang[3,4], Leily Behbehani[3], Jessica Robin[1,2] , & William Simpson[1,2]

[1]Winterlight Labs, Toronto, ON, Canada. [2]Cambridge Cognition, Cambridge, UK. [3]Institute of Behavioral Science, Feinstein Institutes for Medical Research, Northwell Health, Glen Oaks, New York, USA. [4]Zucker Hillside Hospital, Northwell Health, Glen Oaks, New York, USA.

Contact: michael.spilka@camcog.com

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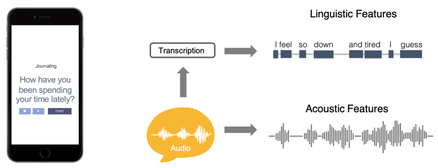
Background

- Novel digital technologies, including computational speech analysis, may help provide objective and low-burden markers of symptom severity in depressive disorders, which in turn may facilitate more efficient clinical assessment and monitoring.
- However, most prior research has been cross-sectional, which limits conclusions about the sensitivity of speech to longitudinal changes in depression.
- ***Objective:*** *In the current study, we examined associations between speech and clinical severity in a longitudinal observational study of major depressive disorder.*

Methods

- **Participants:** 133 outpatient participants with a primary DSM-5 diagnosis of Major Depressive Disorder
- **Study design:** Longitudinal observational study with assessments at baseline, and at 1-, 2-, and 3-month follow-up.
- **Clinical self-report measures:** Patient Health Questionnaire-9; PHQ-9; depression severity), Generalized Anxiety Disorder-7 (GAD-7; anxiety severity), Sheehan Disability Scale (SDS; functional impairment).
- **Speech assessments (Winterlight Assesment App):** Picture Description (describing the contents of a complex scene), Journaling (describing how the participant has been spending their time), Positive Fluency (listing all positive events the participant expects to experience in the next week in 1 minute), Phonemic Fluency (listing all words the participant can think of that begin with a specific letter in 1 minute).
- **Speech features:** 72 core acoustic and linguistic features computed using signal analysis of speech recordings and natural language process (NLP) of speech transcripts.
- **Analyses:** Associations between speech features and severity of depression, anxiety, and functional impairment were examined with linear mixed-effects models controlling for demographic variables (age, sex, education). Within these models, both between-subject associations (using participants' subject-level mean across visits) and within-subject associations over time (using participants' visit-specific deviations from their subject-level mean) were examined.



Participant characteristics at baseline

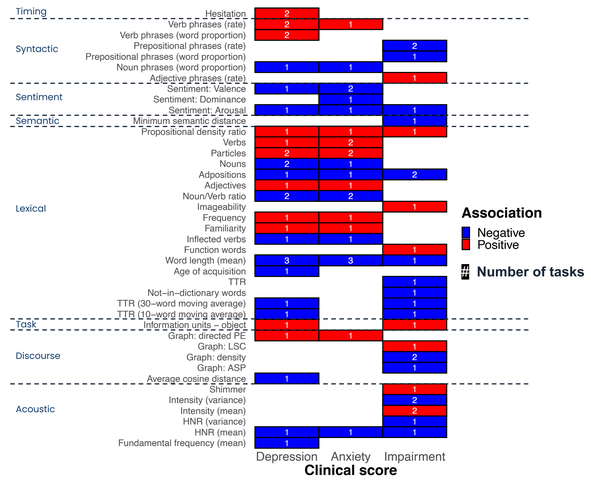
Age (*M*, *SD*)	28.5 (9.7)
Sex (*n*)	91 female, 42 male
Years of education (*M*, *SD*)	15.3 (1.9)
PHQ-9 (*M*, *SD*)	13.4 (6.8)
GAD-7 (*M*, *SD*)	11.1 (5.7)
SDS (*M*, *SD*)	16.4 (7.0)

Highlights & Conclusions

- Several acoustic and linguistic speech features were robust markers of clinical severity in major depressive disorder, showing associations with clinical severity both between and within participants.
- Results indicate the potential utility of digital speech assessment and analysis as an objective and low-burden tool for symptom monitoring in clinical trials.

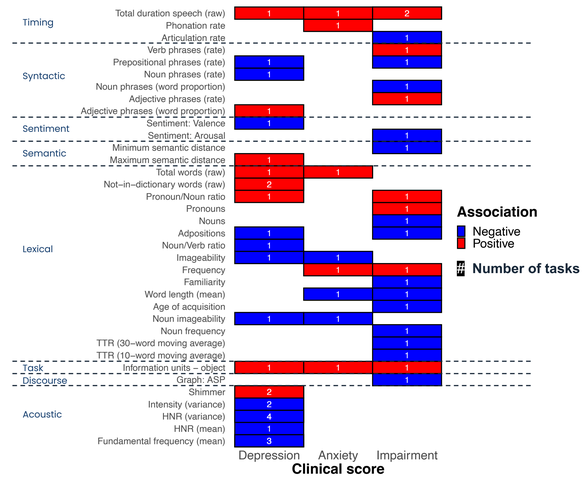
Results: Between-subject associations

- Significant speech features associated with overall severity differences between participants included:
- 25 features associated with *depression*
- 18 features associated with *anxiety*
- 23 features associated with *functional impairment*



Results: Within-subject associations

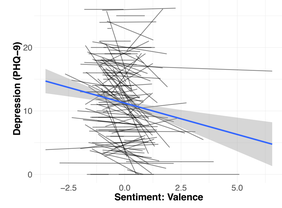
- Significant speech features associated with clinical severity changes within participants over time included:
- 19 features associated with *depression*
- 8 features associated with *anxiety*
- 21 features associated with *functional impairment*



Results: consistent between- & within-subject associations

Speech feature	Clinical domain
↓ fundamental frequency	Depression
↓ harmonic-to-noise-ratio	Depression
↓ word sentiment valence rating	Depression
↑ picture description information units	Depression, Functional impairment
↓ word length	Anxiety
↓ minimum semantic distance	Functional impairment
↓ word sentiment arousal rating	Functional impairment
↓ use of prepositional phrases	Functional impairment
↓ use of adpositions	Functional impairment

Plot for the relationship between depression severity and word sentiment valence (picture description task)



Longitudinal within-subject associations (using deviations from within-subject mean)

Between-subject association (using subject-level mean)

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