Characterizing Depressive Symptom Fluctuations using Automated Speech Assessment: A Remote Feasibility Study

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Background

Mood symptoms are highly heterogeneous between individuals and are known to fluctuate over time. Previous research has demonstrated that individuals with major depressive disorder can be separated into distinct classes based on how their symptoms fluctuate [1]. The degree to which mood symptoms fluctuate has also been linked to global functioning and quality of life measures, with high fluctuating individuals having significantly poorer outcomes [2]. One barrier to understanding fluctuating symptoms is that repeated clinical assessments are not always feasible and can be burdensome for patients to complete. There has been a growing interest in the use of automated speech and language assessment to objectively characterize mood symptoms in psychiatric disorders [3]. Speech assessments can be completed remotely, at high-frequency, and are low patient burden. The goal of the current study was to determine the feasibility of collecting daily speech and mood data and to characterize daily speech fluctuations relative to depression symptoms over a one month period.

Methods

Daily assessments of speech and mood were completed remotely for 30 days. Audio recordings in response to an open-ended prompt asking how participants were feeling that day (Figure 1A) were obtained using a speech app and analyzed using signal and natural language processing (NLP) to derive >500 acoustic and linguistic measures (Figure 1B). Daily depression symptoms were separately collected using a 9-item electronic questionnaire based on items from the Patient Health Questionnaire-9, with total daily scores ranging from 0 (no symptoms) to 55 (severe symptoms).

Within-subject variations in daily depression were characterized by plotting mean residual scores (Figure 2). Spearman correlations (r_s) between speech and depression measures were assessed using data pooled across 26 time points (short day assessments) (Figure 3), and repeated measures correlations investigated within-individual associations (Figure 4).

Results

Sixteen individuals (5 M, 11 F, mean age ± SD= 30.8 ± 9.3, mean daily depression score ± SD= 13.1 ± 9.4) participated in the study. Participants provided ~380 audio samples and 400 depression scores (79% and 83% of scheduled assessments, respectively), indicating high study adherence.

We are thankful to the study participants for taking part in this research. One or more authors report potential conflicts which are described in the program.

Acknowledgements

This study supports the feasibility of high-frequency remote speech assessment as a means to understand fluctuating depression symptoms. The results indicate that speech measures could be used to monitor daily fluctuations of depression symptoms and that measures of particular relevance include sentiment valence, sentiment dominance, and speech rate.

Discussion

Sentiment analysis involves the use of NLP to identify and quantify affective states through linguistic analysis. Sentiment valence informs the use of positive, negative or neutral words, with lower scores indicating the use of more negative words (e.g., unhappy). Sentiment dominance describes feelings of power, with lower scores indicating words that denote feeling less power (e.g., controlled). Lower sentiment valence and dominance were associated with higher depression scores when examining pooled and intra-individual data. Consistent with the literature [3, 4], higher depression was also associated with slower speech rates when examining pooled data, but not intra-individually.

Taken together high-frequency remote speech assessment to monitor depression symptoms may have clinical utility particularly with growing interest in telehealth and digital health interventions. However, future studies on larger clinical samples are warranted to determine specifically how speech may inform symptom fluctuations in the context of symptom remission and/or relapse.

References