A psychometric evaluation of digital speech-based markers of negative symptom severity in schizophrenia spectrum disorders

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Methodological Issue Being Addressed This work addresses the psychometric evaluation of digital speech-based measures of negative symptom severity in schizophrenia spectrum disorders to advance the clinical validation of these measures for use in clinical trials.

Introduction Digital assessment technologies have the potential to enhance the assessment of negative symptoms in schizophrenia spectrum disorders (SSD). For example, automated speech analysis has been used to quantify the speech and language changes associated with negative symptom severity in SSD. However, the large number of available speech features and variability in results across studies make it difficult to determine the features with the greatest clinical utility. The goal of the current analysis was to identify the most robust speech-based markers of negative symptom severity by evaluating their reliability and validity in a sample of participants with SSD.

Methods Data were analyzed from 62 inpatient participants with a SSD who completed a longitudinal cohort study of acute psychosis, including a baseline visit during inpatient admission and a follow-up visit upon discharge. Clinical assessments included the Scale for the Assessment of Negative Symptoms (SANS), Brief Psychiatric Rating Scale (BPRS), and Extrapyramidal Symptom Rating Scale (ESRS). Speech was recorded while participants completed several tasks using the Winterlight Labs iOS app—tasks included in this analysis were two picture description and two journaling tasks. A set of 38 speech features relevant to negative symptoms based on the research literature and quantifying the acoustic and linguistic properties of speech were extracted for each participant from speech recordings and their transcripts. Speech features were evaluated for: 1) associations with negative symptom severity (SANS Total) at the baseline visit (Spearman partial correlations adjusted for age and biological sex); 2) acceptable or higher test-retest reliability when comparing the two stimuli within tasks at the baseline visit (intraclass correlation [ICC] ≥ 0.50); 3) replicability of significant associations with negative symptoms and within-visit test-retest reliability at the follow-up visit; 4) convergent validity (association with BPRS Negative symptoms score), discriminant validity (no association with BPRS Positive symptoms score), and specificity for negative symptom severity (no association with BPRS Total score); 5) relationships with potential clinical confounds (antipsychotic dose and extrapyramidal symptoms [ESRS akathisia and parkinsonism scores]) and participant demographic characteristics (age, sex, education); and 6) interrelationships among identified speech features.

Results Of the evaluated speech features, four features from the picture description task (mean

pause duration, speech proportion, speech rate, unfilled pauses) and three features from the journaling task (speech proportion, speech rate, unfilled pauses) consistently demonstrated significant correlations with SANS Total (rho = |0.30-0.50|) and adequate or better test-retest reliability between administrations (ICC = 0.55-0.89) at baseline and follow-up visits. These features were significantly correlated with negative symptom severity when rated with the BPRS; however, only speech rate consistently demonstrated convergent validity across tasks and visits(rho = -0.37 to -0.51). None of the four features were significantly correlated with BPRS Positive (supporting discriminant validity), BPRS Total (supporting specificity for negative symptoms), or potential clinical confounds (antipsychotic dose and extrapyramidal symptoms). Regarding the influence of participant demographic characteristics, the identified speech features were most consistently associated with biological sex and were inconsistently associated with level of education, and the speech feature relationships with negative symptoms held when additionally controlling for level of education. The four features were significantly intercorrelated, with consistently strong correlations between speech proportion and mean pause duration.

Conclusion This analysis identified three speech features that were reliably measured and consistently associated with negative symptom severity across speech tasks and visits: speech proportion, speech rate, and unfilled pauses. These features reflect the amount, rate, and pause characteristics of speech and therefore have high face validity with the vocal characteristics that clinicians attend to in the evaluation of patient negative symptom severity. Of these, speech rate further consistently demonstrated convergent validity, discriminant validity, and specificity to negative symptom severity, and none of the features were associated with potential clinical confounds. Results suggest that speech rate may serve as a robust and objective speech-based marker of negative symptom severity to complement existing measures in SSD. Additional work is needed to examine the sensitivity of the identified speech features to longitudinal change in negative symptoms.

Co-Authors

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