Do motor symptoms and antipsychotic medications influence the digital speech assessment of negative symptoms in schizophrenia spectrum disorders?

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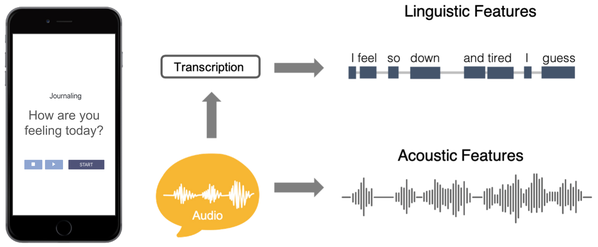
Background

- Computational speech analysis may help provide a quantitative assessment of negative symptoms in schizophrenia and overcome limitations of traditional symptom scales.
- However, the influence of potential confounding clinical variables (e.g., comorbid motor symptoms) has not yet been systematically ruled out, which is necessary for the clinical validation of computational speech metrics.
- ***This study examined whether motor symptoms and antipsychotic medication were associated with speech markers of negative symptoms in participants with schizophrenia spectrum disorders (SSD).***

Methods

- **Participants:** 43 inpatients with SSD
- **Clinical Assessments:** Negative symptoms (Scale for the Assessment of Negative Symptoms; SANS); motor symptoms (Extrapyramidal Symptom Rating Scale; ESRS).
- **Speech tasks (from the Winterlight assessment app):** Journaling (x2), Picture Description (x3), Phonemic Fluency, Semantic Fluency, Paragraph Reading.
- **Quantitative speech features:** 8 acoustic and 10 timing variables extracted for each participant from transcribed speech recordings.

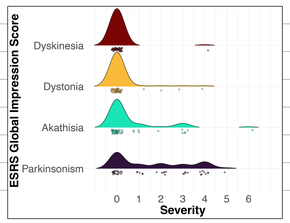


- **Analyses:** Associations (age- and sex-adjusted partial Kendall rank correlations) were evaluated between quantitative speech features and the following: negative symptoms (SANS), motor symptoms (ESRS global impression scores), and antipsychotic medication dose (chlorpromazine equivalent; CPZE).
- Statistical significance: set at $p < .05$, FDR-corrected within task.
- Bayesian analyses were used to further evaluate evidence for the absence of associations between speech and motor symptoms or antipsychotic medication dose.

Participant characteristics

Age (years)	26.16 (5.08)
Sex	14 female, 29 male
Race/Ethnicity	21% Asian, 47% Black, 16% White-not Hispanic, 9% Multiple, 7% Other
Education (years)	14.19 (1.97)
Diagnosis	3 bipolar disorder w/ psychosis, 11 schizoaffective, 20 schizophrenia, 1 schizophreniform , 8 unspecified psychotic disorder
BPRS Total	48.47 (11.58)
SANS Total	26.58 (9.98)
ESRS Parkinsonism	1.53 (1.67)
ESRS Akathisia	0.56 (1.26)
ESRS Dystonia	0.23 (0.81)
ESRS Dyskinesia	0.09 (0.61)
CPZE dose	289.66 (220.54)

Note. Means and standard deviations are reported where relevant.

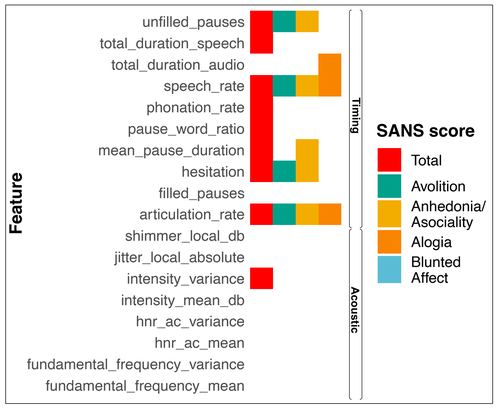


Highlights

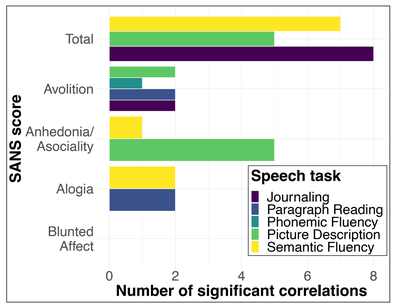
Quantitative speech features are sensitive to negative symptom severity in schizophrenia spectrum disorders and do not appear to be confounded by motor symptoms or antipsychotic medications.

Results: Speech and negative symptoms

Features significantly associated with SANS symptoms on at least one task



Number of significant correlations between speech features and negative symptom scores in each task



- The majority of significant feature correlations were for timing features, with most associations present across multiple tasks.
- Association strength was in the small-to-medium range for positive (Kendall's tau = 0.21 to 0.31) and negative (Kendall's tau = -0.37 to -0.20) correlations.

Results: Speech, motor sx, and antipsychotics

- No significant correlations between speech features and parkinsonism, akathisia, or CPZE dose after FDR correction.
- Bayesian analyses indicated no more than anecdotal support for the alternative hypothesis for all but one feature: mean fundamental frequency (with akathisia; moderate support; BF_{10} = 3.56), which was not associated with negative symptoms.
- Bayes factors otherwise indicated moderate support ($BF_{01} > 3$) for the absence of an association between speech and motor symptoms or CPZE dose for most features.

Bayesian tests for correlations with relevant speech features

Feature	ESRS Akathisia		ESRS Parkinsonism		CPZE dose	
Unfilled pauses[a] (picture description)	BF_{10} = 0.2 BF_{01} = 5.01	data I H1 data I H0	BF_{10} = 0.205 BF_{01} = 4.876	data I H1 data I H0	BF_{10} = 0.291 BF_{01} = 3.434	data I H1 data I H0
Total duration speech[a] (semantic fluency)	BF_{10} = 0.407 BF_{01} = 2.456	data I H1 data I H0	BF_{10} = 0.201 BF_{01} = 4.979	data I H1 data I H0	BF_{10} = 0.162 BF_{01} = 6.154	data I H1 data I H0
Total duration audio[a] (paragraph reading)	BF_{10} = 0.459 BF_{01} = 2.176	data I H1 data I H0	BF_{10} = 0.272 BF_{01} = 3.676	data I H1 data I H0	BF_{10} = 0.268 BF_{01} = 3.737	data I H1 data I H0
Speech rate (semantic fluency)	BF_{10} = 0.234 BF_{01} = 4.273	data I H1 data I H0	BF_{10} = 0.21 BF_{01} = 4.76	data I H1 data I H0	BF_{10} = 0.335 BF_{01} = 2.988	data I H1 data I H0
Phonation rate[a] (semantic fluency)	BF_{10} = 0.407 BF_{01} = 2.456	data I H1 data I H0	BF_{10} = 0.201 BF_{01} = 4.979	data I H1 data I H0	BF_{10} = 0.162 BF_{01} = 6.154	data I H1 data I H0
Pause word ratio (journaling)	BF_{10} = 0.206 BF_{01} = 4.856	data I H1 data I H0	BF_{10} = 0.206 BF_{01} = 4.856	data I H1 data I H0	BF_{10} = 0.177 BF_{01} = 5.648	data I H1 data I H0
Mean pause duration[a] (journaling)	BF_{10} = 0.562 BF_{01} = 1.778	data I H1 data I H0	BF_{10} = 0.684 BF_{01} = 1.462	data I H1 data I H0	BF_{10} = 0.307 BF_{01} = 3.255	data I H1 data I H0
Hesitation[a] (semantic fluency)	BF_{10} = 0.338 BF_{01} = 2.96	data I H1 data I H0	BF_{10} = 1.86 BF_{01} = 0.538	data I H1 data I H0	BF_{10} = 0.264 BF_{01} = 3.787	data I H1 data I H0
Articulation rate[a] (picture description)	BF_{10} = 0.198 BF_{01} = 5.06	data I H1 data I H0	BF_{10} = 0.198 BF_{01} = 5.06	data I H1 data I H0	BF_{10} = 0.161 BF_{01} = 6.22	data I H1 data I H0
Intensity variance (semantic fluency)	BF_{10} = 0.303 BF_{01} = 3.3	data I H1 data I H0	BF_{10} = 0.203 BF_{01} = 4.93	data I H1 data I H0	BF_{10} = 0.173 BF_{01} = 5.793	data I H1 data I H0

Note. Bayesian tests are reported for speech from the task demonstrating the strongest association with SANS Total score (or subscore when the correlation with Total score was not significant).

BF_{01} = Bayes factor for the null hypothesis; BF_{10} = Bayes factor for the alternative hypothesis.

Bayes Factor (BF) interpretation: 1-3 = anecdotal support; 3-10 = moderate support; > 10 = strong support.

[a]Features that showed a significant (*pFDR* < .05) correlation with negative symptoms and a significant (uncorrected $p < .05$) correlation with motor symptoms or CPZE dose.

Conclusions

- Speech features are sensitive to negative symptom severity in SSD and do not appear to be confounded by motor symptoms or antipsychotic dose.
- Additional research in samples with more severe motor symptoms and that examines other factors influencing speech (e.g., culture) will help to further validate computational speech-based assessment of negative symptoms.

Presented at the 2023 Congress of the Schizophrenia International Research Society

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