Using AI-driven platform to Detect Negative Symptoms of Schizophrenia Through Facial and Acoustic Analysis

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METHODOLOGICAL QUESTION

- The automatic analysis of facial and acoustic expressions is an evolving field that finds some clinical applications. One of these applications is the study of facial and speech productions in individuals with schizophrenia, which is a major indication of negative symptoms of this illness. One feature of Negative symptoms is the reduction of facial movements and emotional facial expressions and is a transdiagnostic feature of schizophrenia.
- Current methods of assessing negative symptoms depend on verbal report from patients and/or caregivers and a clinical interview. These interviews can be insensitive to change in treatment, subjective, requires extensive training and subject to cultural disparities.
- Facial and speech changes in negative symptom may be difficult to track and quantify with only interview methods. With passive (real-world) data collection, combined with patented algorithms and machine learning, we are starting to see examples of machine biosensors that can predict early signs of diseases in advance of an actual event. Similarly, digital therapeutics platforms can be used to supplement clinical interviews for more objective and precise measurements.
- Would a novel artificial intelligence (AI) system analyzing facial and acoustic features improve measurement of negative symptoms in schizophrenia?

AIMS

- **Aim 1:** To investigate whether negative symptoms can be meaningfully measured using AI-enabled vocal and facial analysis software called Neurological and Mental Health Screening Instrument (NEMSI) by comparing speech metrics (e.g., prosody, rate, intelligibility, pauses duration etc.) and video metrics (e.g., specific facial and head movements) to clinician-rated psychometric assessments for negative symptoms.
- **Aim 2:** To investigate the feasibility and user experience (patient) of NEMSI through system acceptability, usability, engagement, and benefits; and to identify if participants’ negative symptoms, and levels of persecutory ideation would impact their use of the system.

METHOD

- **Experimental Approach:** At the first visit, the following instruments are administered: sociodemographic and clinical questionnaire, PANSS, BNSS, CDSS, CGI-S, AIMS, SAAS, BARS and NEMSI. The second visit occurs within a one-week period and is done by the same clinician to assess for test-retest reliability and intra-rater reliability. The second visit includes the same instruments in addition to the CGI-I (severity of illness, improvement, and degree of change). Healthy controls only performed the NEMSI.
- **Patient Eligibility:** Inpatients with diagnosis of schizophrenia, age 18 - 60, English speaking, WRAT-IV Reading Score ≥ 8th grade, Negative symptoms as evidenced by score of ≥ 18 on PANSS Marder Negative Symptom Factor
- **Healthy Control Eligibility:** Individuals with no prior history of mental illness, age 18 - 60, English speaking.
- **Analyses:** Reliability (ICC), concurrent, convergent, divergent and discriminative validity of NEMSI speech and facial metrics to the BNSS, PANSS Marder Negative factor and the CDSS

RESULTS: SPEECH AND VOCAL METRICS

- **Speech Articulation** is how clearly the speaker pronounces words. When some sounds are slurred together or dropped out of a word, the word may not be understood.
- Speech Intelligibility (SIT) refers to how well someone can be understood when they’re speaking.
- Articulation Rate and Loudness (AMR) assesses repetitive movements of oral articulators.

RESULTS: FACIAL EXPRESSION AND GESTURES

- **Facial Features**
  - Jaw velocity (mean and maximum speed of the jaw) was negative correlated with PANSS Negative symptoms and BNSS Total Score
  - Total Mouth Surface area and eyebrow movement was also negatively correlated with PANSS Negative Symptoms, the BNSS Total Score and Blunted Affect
  - Lip Aperture was negatively correlated with PANSS Negative Symptoms, BNSS total and Anhedonia

RESULTS: RELIABILITY AND VALIDITY

- Reliability NEMSI AI (Time 1 and Time 2): ICC = 0.981
- Reliability PANSS Marder Negative Symptoms (Time 1 and Time 2): ICC = 0.954
- Reliability BNSS Total Score (Time 1 and Time 2): ICC = 0.954
- Validity of NEMSI with 1. BNSS Total Score = 0.804, 2. PANSS Marder Negative Symptom = 0.893, BNSS Alogia = 0.812, BNSS Avolition = 0.844
- Internal Consistency of NEMSI: 0.877 Test ReTest Reliability NEMSI: p < 0.01

CONCLUSIONS

- Speech and facial AI technology could aid in negative symptoms assessments
- NEMSI showed adequate reliability, validity, and internal consistency
- Additional testing on larger sample sizes, reproducibility, and generalizability of the software is warranted.