DEVELOPING A MULTIMODAL DIGITAL PHENOTYPING PARANOIA MEASURE: COMPREHENSIVE PSYCHOMETRIC EVALUATION

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INTRODUCTION

Natural Language Processing (NLP) has been applied to measure paranoia for over 50 years but has yet to show sufficient psychometric support for deployment in clinical trials.

We developed a digital phenotyping (DP) solution for tracking paranoia, emphasizing:

- ***Interpretability*** – using only 3 features closely tied to the operational definition of paranoia.
- ***Multimodality*** – using context (e.g., geolocation) for optimization

NLP METHODS

Figure 1. Study rational and methods: Description of the three key features and moderators developed and evaluated in this study, and the psychometric evaluation plan.

Feature 1: Sentiment

Sentiment analysis objectifies affective tone of text based on keyword and phrase search, with scores ranging from -1 (extremely negative) to 0 (neutral) to 1 (extremely positive). This feature is the sentiment value for the entire language sample.

Feature 2: Self-Other Dependencies

Open Information Extraction identifies relational triples including a subject, object, and their relationship. For this project, we were interested in dependencies that included a "Self" and a "Other" in the subject-object pair. This feature is the number of Self-Other dependencies.

	Subject	Relationship	Object
Dependency 1	I	Am worried	Things
Dependency 2	The government	Harm	Me

Feature 3: Self-Other Sentiment

Sentiment analysis was conducted on the Self-Other dependencies. This feature is the most negative sentiment value of the independent Self-Other dependencies from the language sample.

Moderating Variables:

Three moderating variables were expected to exacerbate paranoia, and intensify the paranoia-related features

1. *Being Away from home*: Evaluated using the geolocation stamp while speaking. Values greater than 50 meters from home were counted as being outside the home.
2. *Being With Strangers*: Evaluated based on self-report just prior to speaking.
3. *Being Alone*: Evaluated based on self-report just prior to speaking.

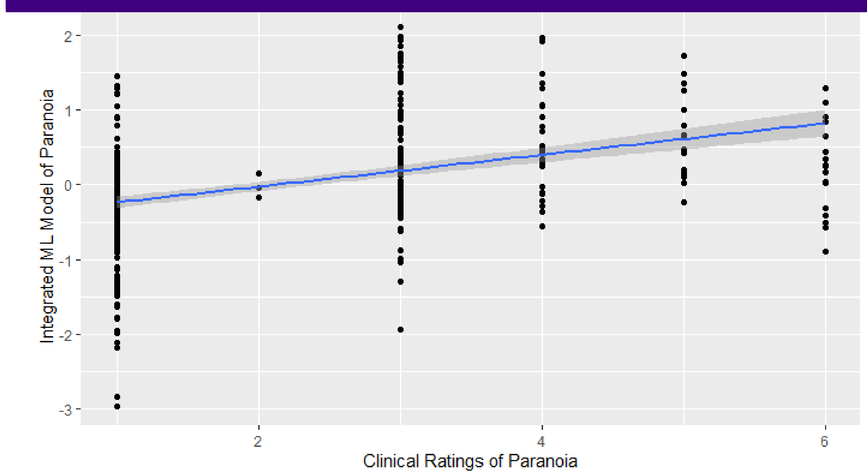
METHODS OVERVIEW

35 people with SMI were given smart phones; providing 477 video "diaries" over a week.

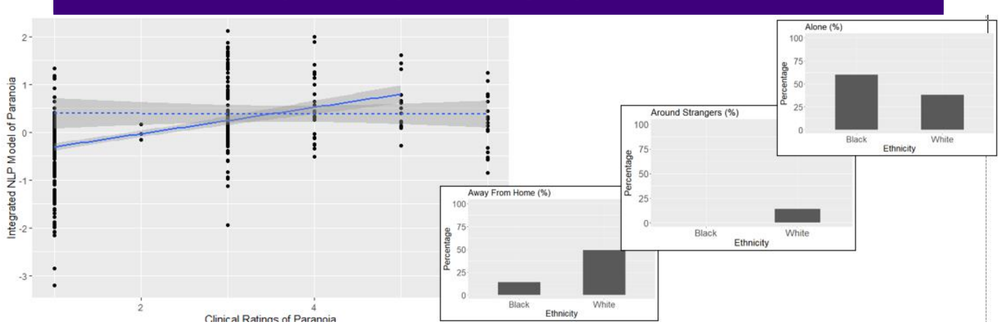
Regularized regression of 3 key NLP features, interacting with 3 key moderators, was used to model clinically-rated paranoia.

Criterion measure: CRO Paranoia (PANSS; Opler & Lewis, 1987)
Convergent measures: PRO Paranoia; concurrent with video recording
Divergent validity measures: CRO and PRO Depression, Anxiety

Convergence with Clinical Ratings



Unpacking Demographic Biases



RESULTS

Is our measure reliable over time? Yes, all ICC values exceeded 0.75, and most exceeded 0.90 over a week.

Is our measure sensitive to paranoia? Good convergence was seen with our measure and clinical ratings of paranoia..

Is our measure specific to paranoia? Yes. Minimal convergence with CRO or PRO ratings of depression/anxiety were seen.

Is our measure demographically biased? Yes. Sensitivity was much higher for the 25 White participants than the 10 Black participants.

What is the nature of these biases? White participants were much more likely to provide data when away from their home and around strangers – situations that might elicit paranoia.

CONCLUSIONS

Our approach, employing novel and highly sophisticated NLP solutions with multimodal integration, showed good reliability and validity.

It also showed demographic bias – an issue rarely examined in DP studies to date.

Our approach allowed us to directly understand these biases. Future research will help mitigate these biases to improve generalizability to diverse populations.

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