

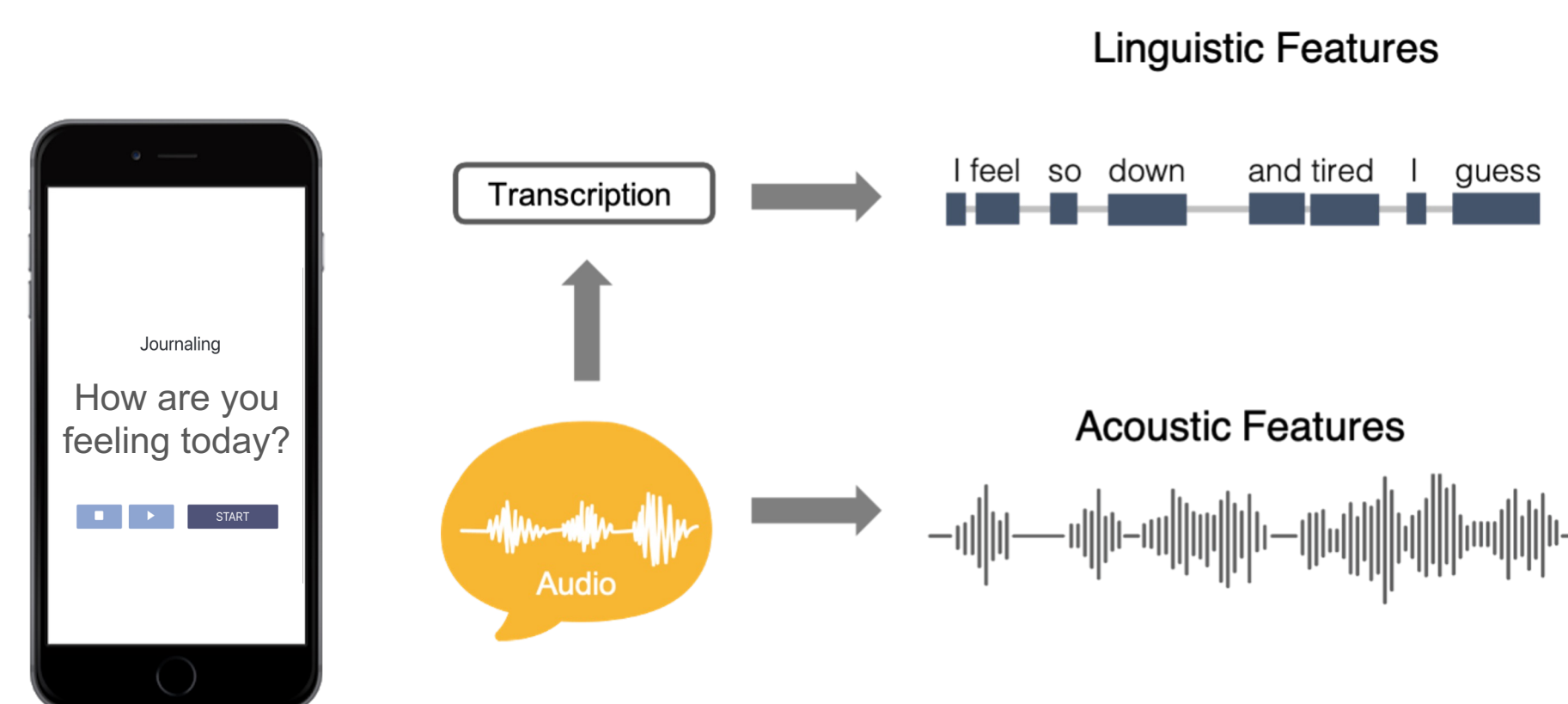
Background

- Computational speech and natural language processing analysis may improve objective symptom assessment to help diagnose and monitor psychiatric disorders.
- However, there is limited research applying this approach in non-Western languages.
- **In the current study, we examined the ability of computational speech analysis to index symptom severity and track symptom change in Arabic-speaking patients with schizophrenia.**

Methods

Participant characteristics	Algeria	Jordan	Saudi Arabia
n	14	27	16
Age (years)	33.7 (12)	34.7 (11.3)	34.3 (10.9)
Gender	4 F / 10 M	15 F / 12 M	2 F / 14 M
Education (% post-secondary completed)	42.9%	96.3%	62.5%
PANSS Total	37.9 (8.7)	57.5 (16.3)	89.8 (25.5)
PANSS Positive	9.1 (4.6)	12.4 (5.6)	20.0 (5.5)
PANSS Negative	10.2 (4.9)	15.0 (6.9)	26.6 (9.4)
PANSS General	18.6 (2.8)	30.1 (9.2)	43.2 (15.2)

- **Participants:** 57 outpatients diagnosed with schizophrenia, from three clinical sites in the Middle East and North Africa.
- **Study design:** Longitudinal design with seven monthly visits
- **Clinical assessment:** Positive and Negative Syndrome Scale (PANSS).
- **Speech tasks (from the Winterlight assessment app):** Journaling, Picture Description, Phonemic Fluency, Semantic Fluency, Paragraph Reading and Recall.
- **Speech processing:** Participant audio recordings were transcribed and translated into Modern Standard Arabic, and then analyzed with signal and natural language processing (NLP) to extract features capturing different properties of speech: acoustic, timing, lexical, morphological, syntactic, semantic coherence, and discourse.



Acknowledgements

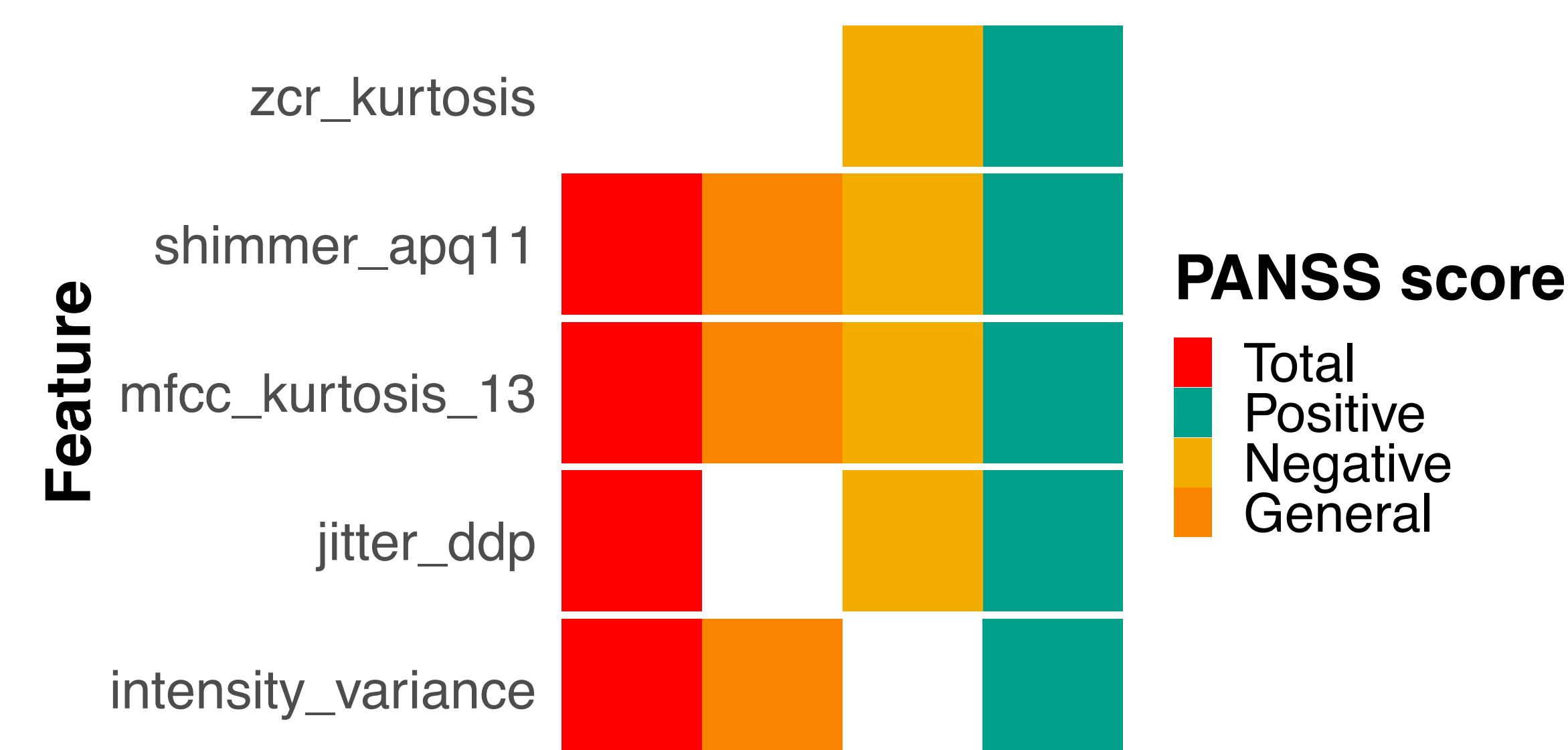
We would like to thank and acknowledge the efforts of patients and their families as well as local investigators: Pr. Mohand Tayeb Benatmane and Dr. Nazima Djili (Mustapha University Hospital Center, Algeria), Dr. Falah Al Tamimi, Alaa Hazayed & Rita Asad (Mental Health Hub, Jordan), and Dr. Nawaf Alharthi (Jeddah Psychiatric Hospital, KSA) for their collaboration. We would also like to thank our colleagues at Hikma Pharmaceuticals: Amal I. Altabba, Ruba A. Jaber and Faisal A. AlHusry for their effort and collaboration on this project.

Methods, continued

- **Analyses:** Associations between PANSS severity (Positive, Negative, General, Total) and speech features from each task were examined using Spearman correlations pooling all visits, and significant correlations ($p < .05$, FDR-corrected within tasks) were validated with Spearman partial correlations adjusted for age, sex, education, and study site.
- Associations between longitudinal change in identified speech features and change in symptom severity were examined with partial Spearman correlations performed on change scores from adjacent visits and evaluated for statistical significance at $p < .05$, FDR-corrected within tasks.

Results: associations with symptom change

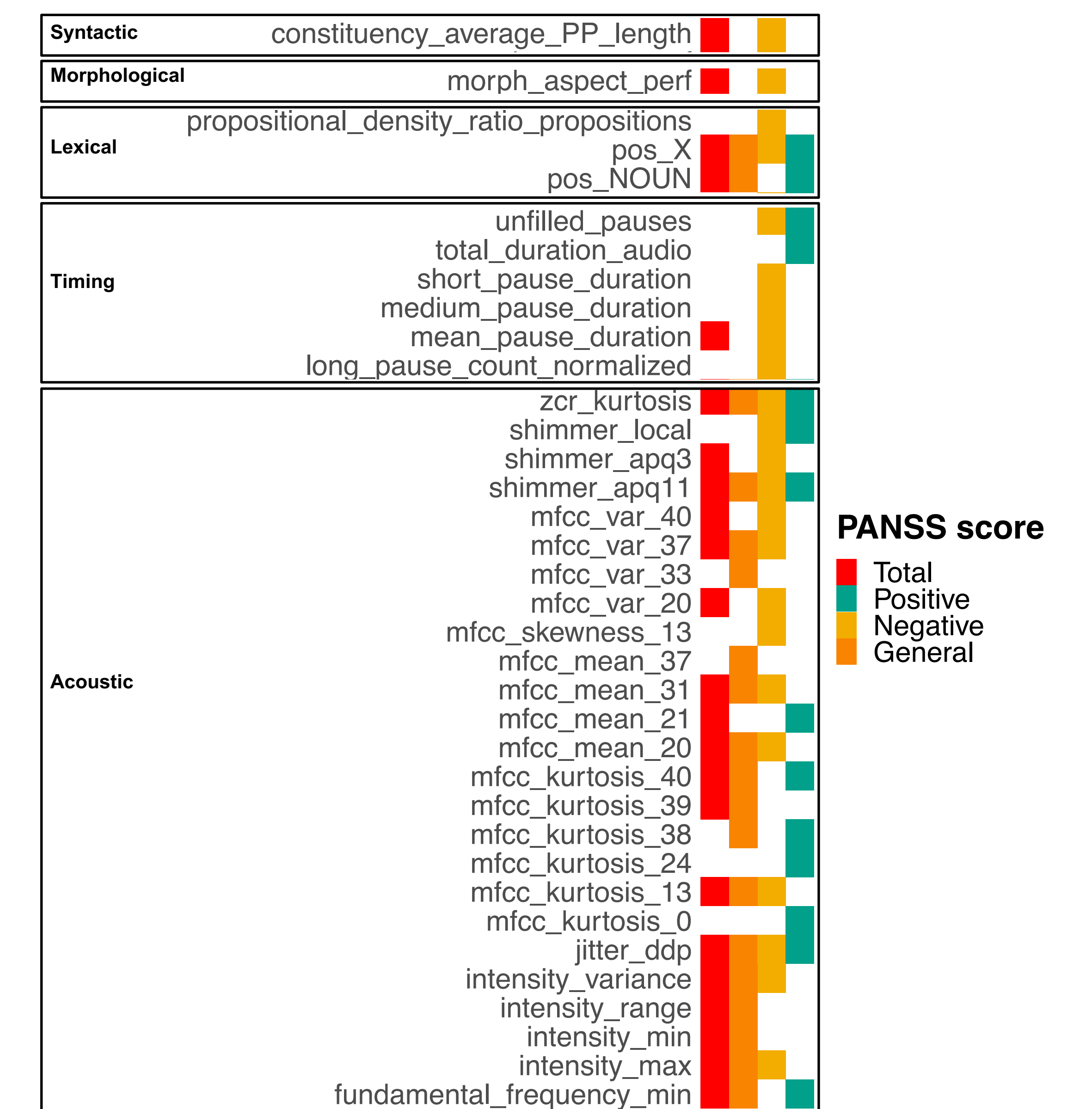
Speech features that significantly tracked longitudinal symptom change



- 25 significant correlations spanning 5 unique acoustic features
- Features with correlations present on multiple tasks:
 - Decreasing intensity variance was associated with increasing PANSS Total and General from one visit to the next
 - Increasing shimmer was associated with an increase in all symptoms from one visit to the next
- Most associations were present for multiple symptom domains
- Association strength was in the small range after adjusting for demographic variables and study site ($\rho = -0.26$ to -0.18 and 0.16 to 0.23).

Results: speech markers of symptom severity

Features significantly associated with symptom severity on at least one task



- 116 significant correlations spanning 36 unique features
- Features with correlations present on more than one task:
 - **Lexical:** noun use
 - **Timing:** medium pause duration
 - **Acoustic:** intensity variance, minimum fundamental frequency, zero-crossing rate, shimmer, jitter, MFCCs
- Most associations were present for multiple symptom domains
- Associations were small to medium for bivariate correlations and decreased to small after adjusting for demographic variables and study site ($\rho = -0.19$ to -0.11 and 0.11 to 0.24).

Conclusions

- Computational speech and analysis can identify features associated with symptom severity and symptom change in Arabic-speaking schizophrenia participants, suggesting the cross-linguistic utility of this approach.
- Identified speech features may serve as novel digital markers to facilitate screening and symptom monitoring in clinical trials.