Error-Related Negativity and Task Performance in Young Adults with Generalized Anxiety Disorder

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Introduction

35% of college students are diagnosed with an anxiety disorder[1].

Generalized Anxiety Disorder (GAD) is the most common anxiety disorder encountered in primary care settings[2,3].

Error-Related Negativity (ERN) is a critical electrophysiological marker derived from EEG representing the brain's response to mistakes.

Hypothesis: (1) Enhanced ERN in GAD participants compared to controls. (2) Enhanced ERN correlates with higher anxiety severity. (3) Worse behavioral performance in GAD participants compared to controls.

GAD patients have shown a **larger ERN**[4], indicating an overemphasized error-monitoring process in anxiety.
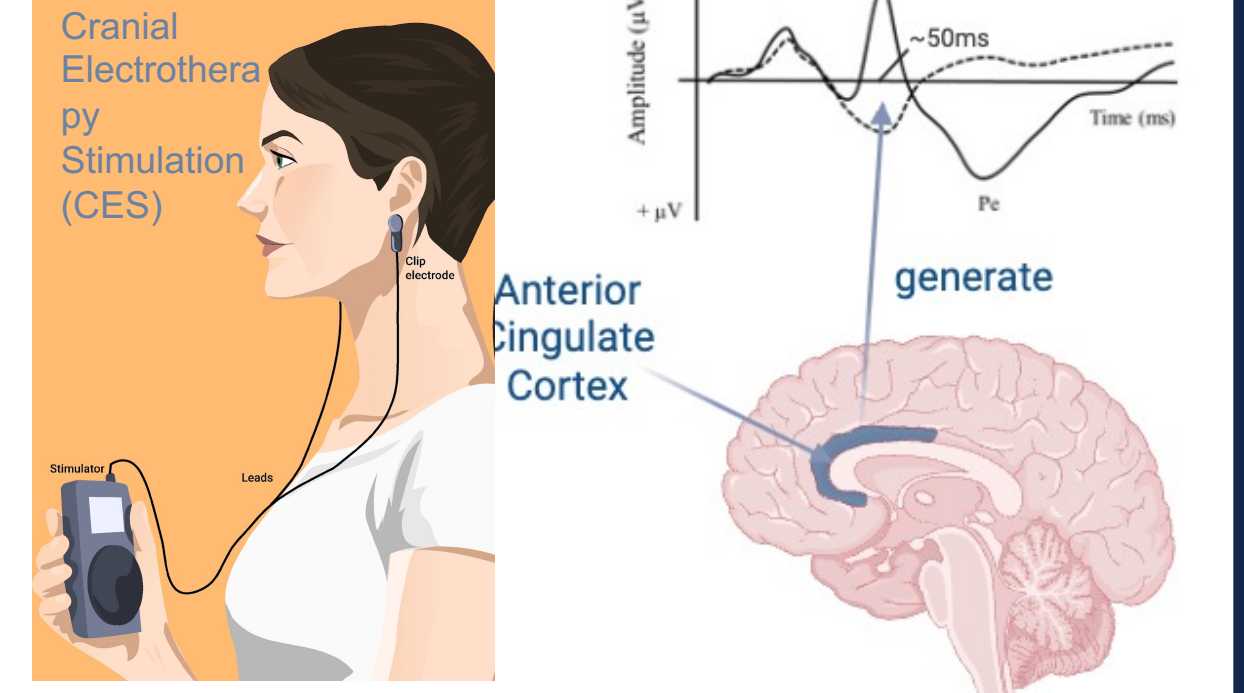

Methods

Participants & Task Design: The GAD Group (N=12, 19.7 ± 0.98 years) was assessed with GAD-7, HAM-A, and BAI, while the Control Group (N=7, 22.1 ± 2.34 years) served as a comparison. Participants underwent a single session wearing high-density EEG while doing the arrow version flanker test.
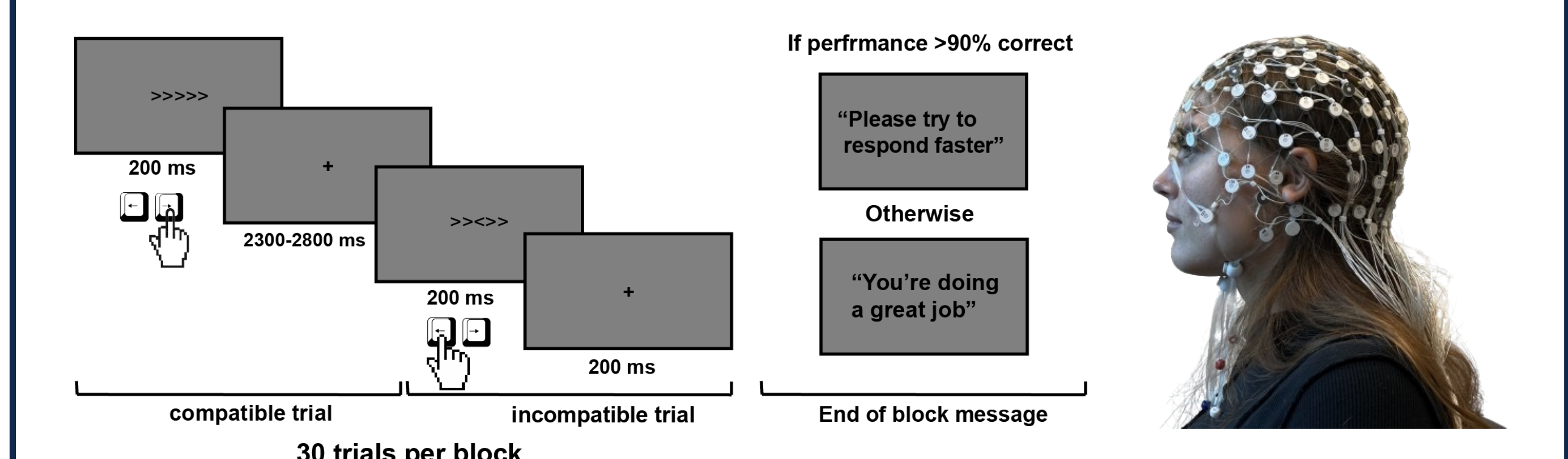
EEG Data Processing: A single high-density EEG session involved participants completing 330 trials across 11 blocks in an arrow Flanker test, recording error/correct response-related neural activity and behavioral metrics like reaction time and accuracy.

Data was preprocessed and segmented into trial-specific epochs with baseline correction, average at Fz, FCz, and Cz electrodes within 100 ms post-response.
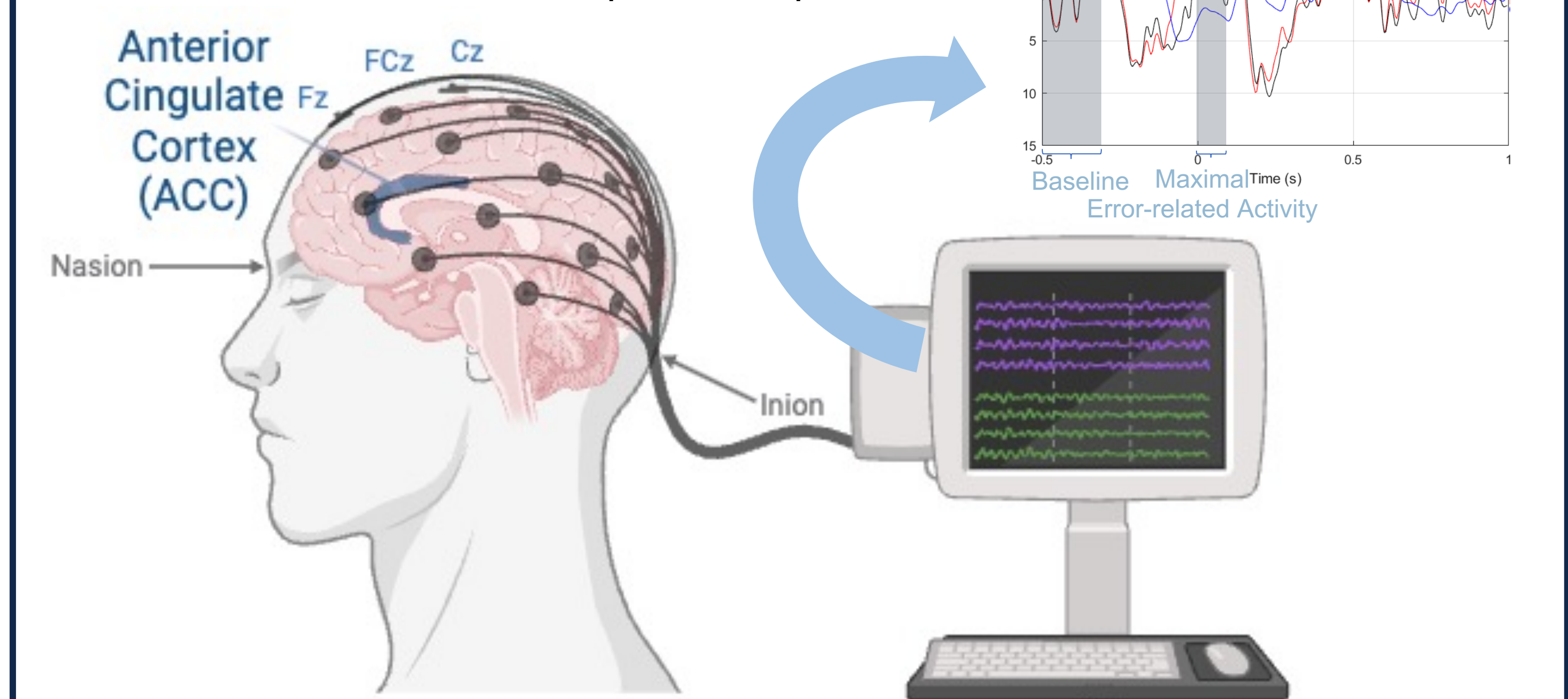
Results

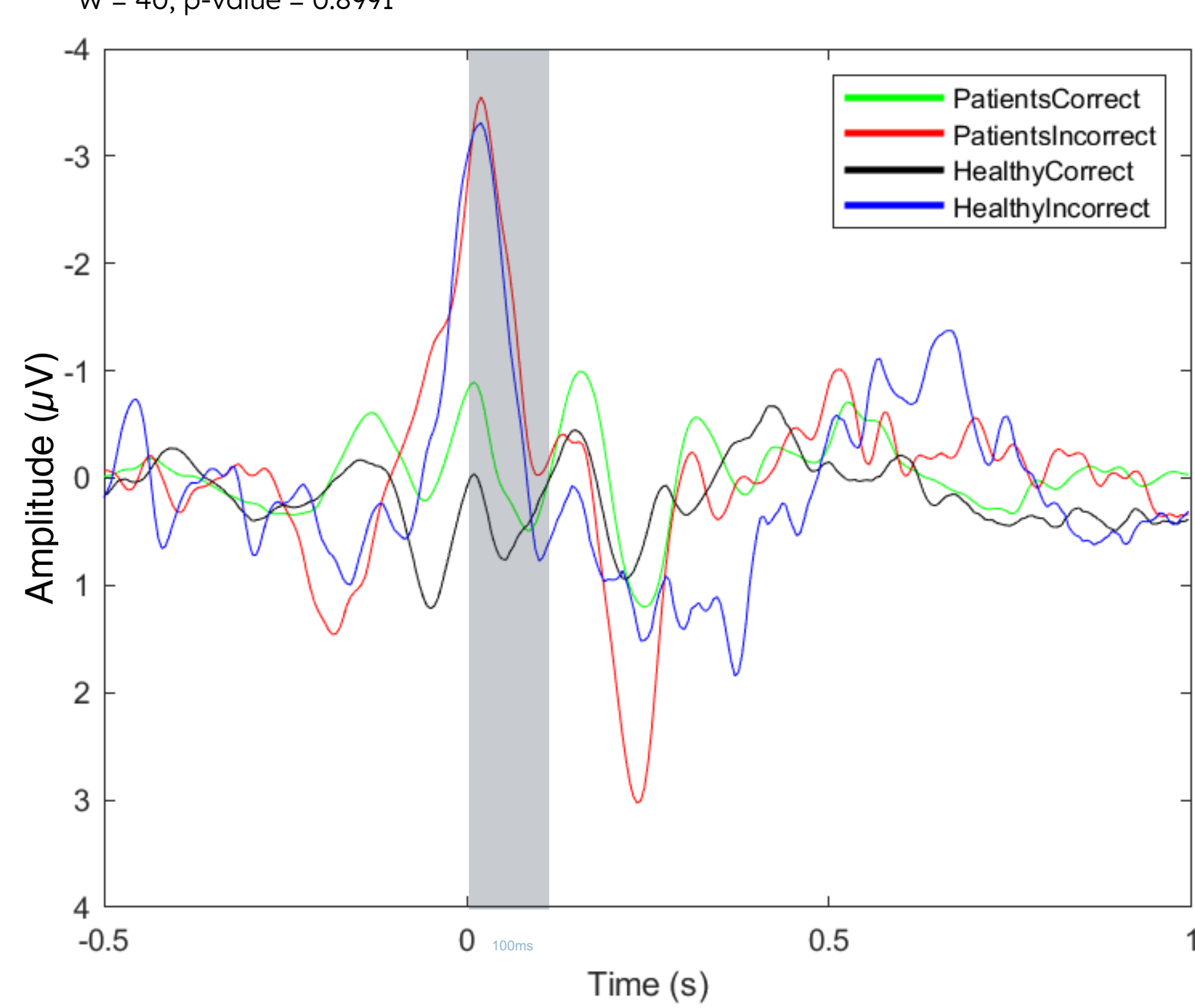### No significantly enhanced ERN in GAD participants

W = 40, p-value = 0.8991

Fig 1. Grand Average of Response-locked ERP Waveforms for both GAD and HC by Conditions

ERPs(μV)	GAD (N = 12)	HC (N = 7)
ERN	-2.132	-1.833
CRN	-0.137	0.367

ΔERN is not significantly different between GAD and HC Group

W = 41, p-value = 0.9663

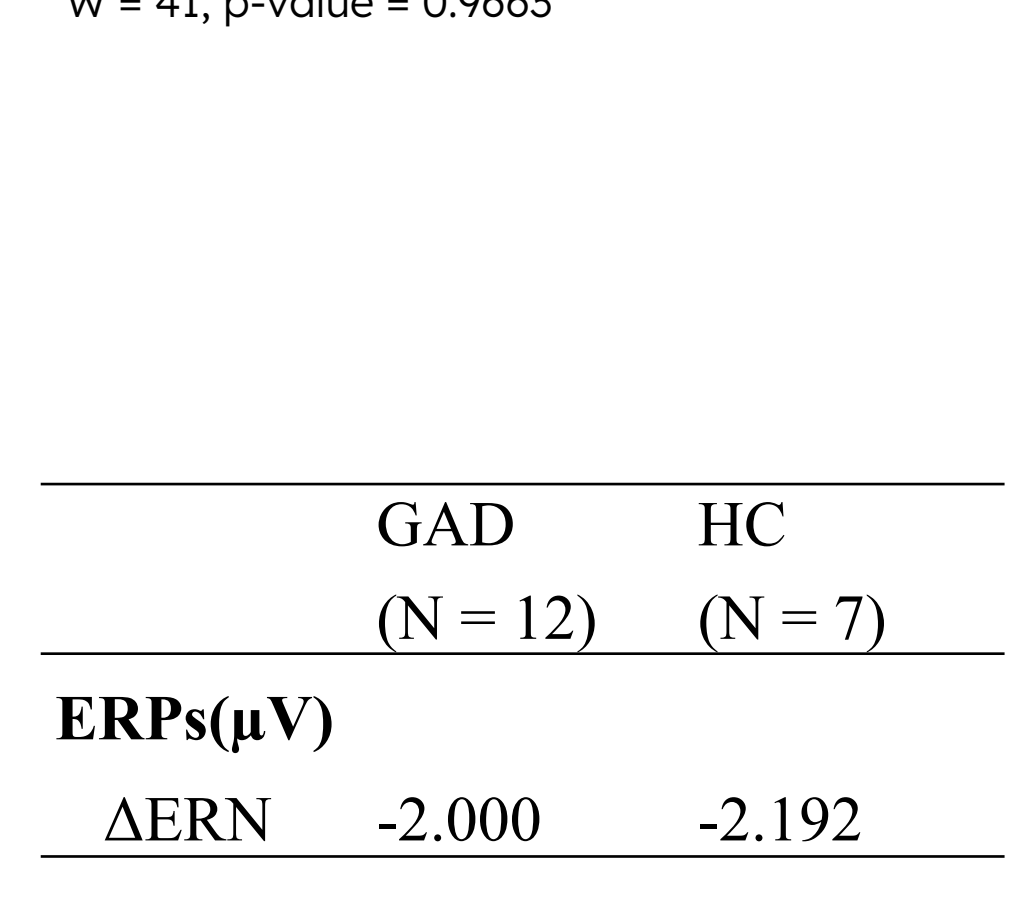| ERPs(μV)	GAD (N = 12)	HC (N = 7)
ΔERN	-2.000	-2.192

Fig 2. Grand Average of ΔERN Waveforms for GAD and HC groups

ERN was significantly more negative than CRN V= 0, p < 0.001 x
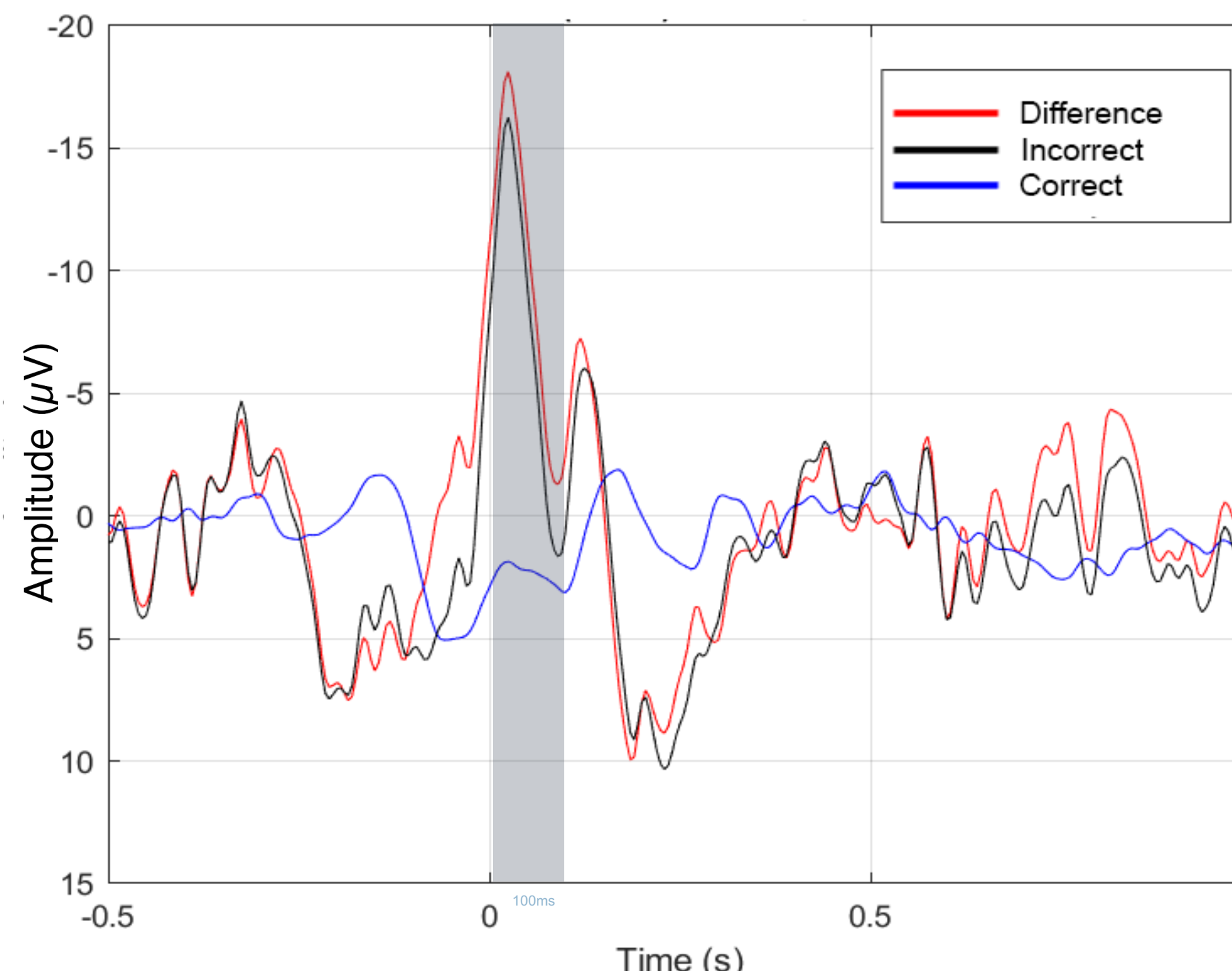

Fig 3. Example ERP Waveform from One Participant

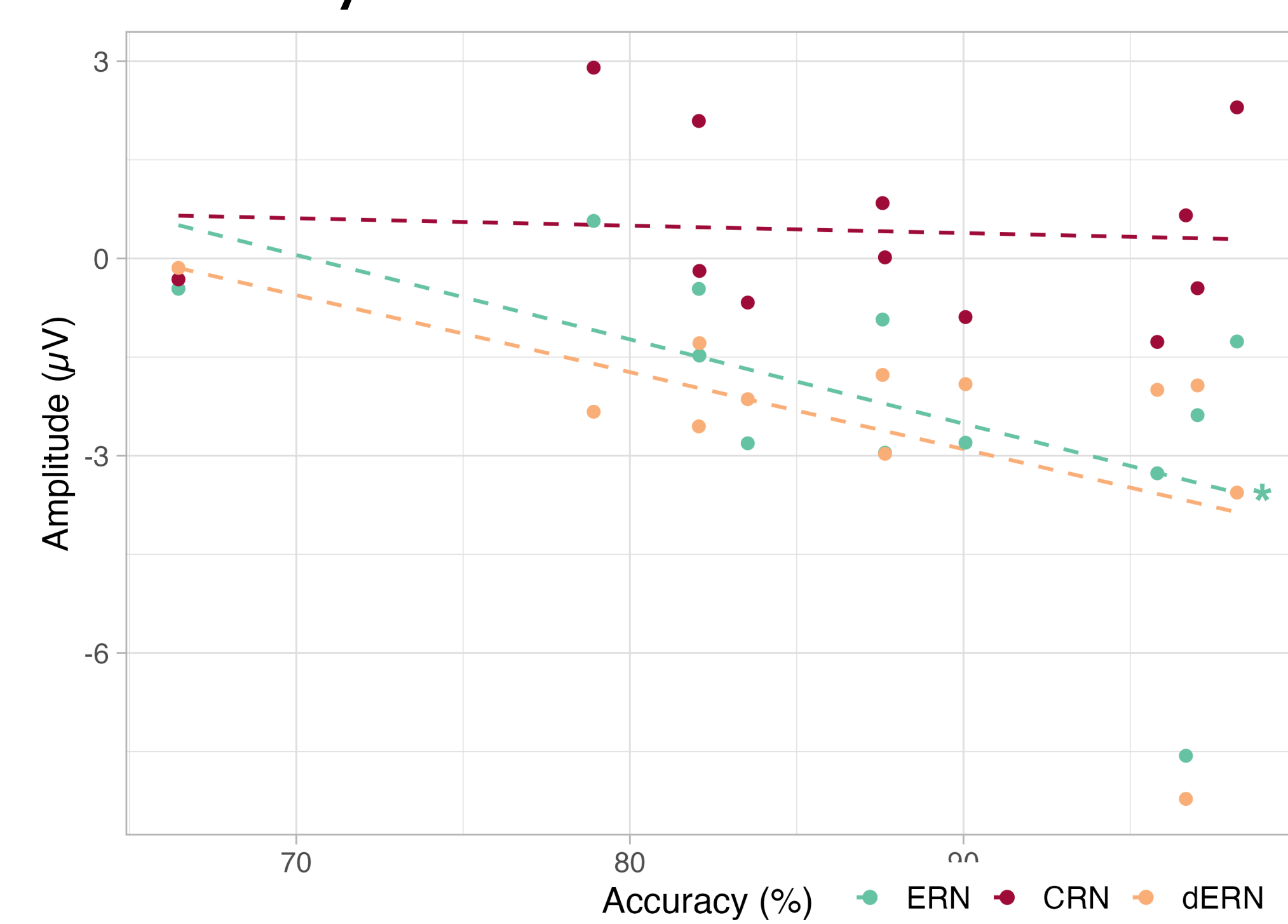### More Negative ERN Related to Higher Accuracy in GAD * ρ = -0.62, p < 0.05

Fig 4. Correlation between Neural Correlates and Accuracy in GAD group

Longer Reaction time in the GAD group on error trials

Table 1. Mean Reaction Time Measures for Both Groups

Reaction time(s)	GAD (N = 12)	Healthy Control (N = 7)
Correct trials	.405 (.0984)	.400 (.0581)
Incorrect trials	.438 (.0502)	.353 (.0506) ** W = 73, p < 0.01

Exploratory: Comorbidity Effect

*Current Depression Episode, current Social Anxiety Disorder or current Obsessive-Compulsive Disorder
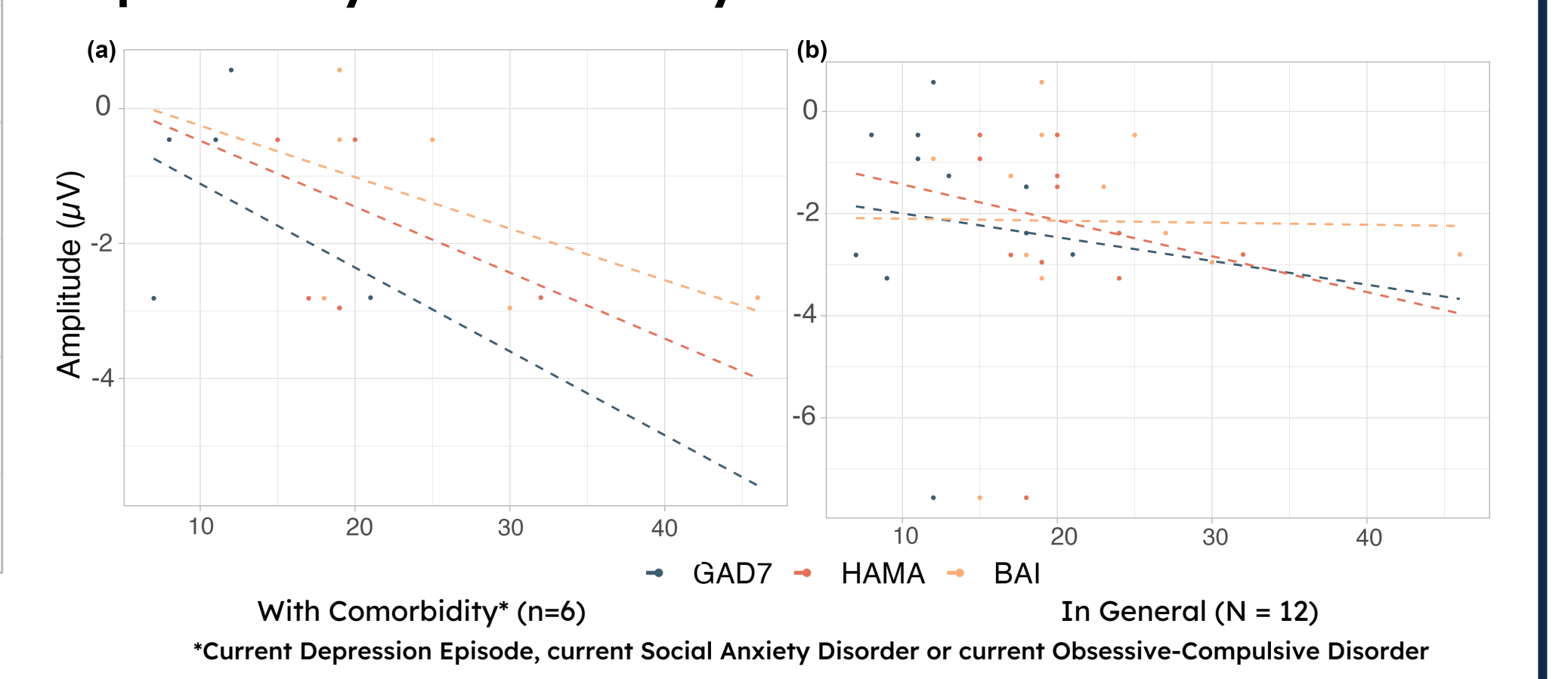
Fig 5. Correlation between ERN and anxiety scores by comorbidity

Discussion

No Enhanced ERN in GAD Participants compared to controls.
- Small N & Choice of HC group
- ERN heterogeneity
- Enhanced ERN may develop in later adulthood for GAD[5].

No significant correlations between neural correlates and anxiety measures.
- The complexity of mapping specific brain activity patterns to anxiety
  - Interfering factors
  - Other anxiety measures(PSWQ)

Behaviorally, Enhanced ERN is associated with higher performance accuracy in young adults with GAD.
- Compensatory adaptation

- Correspond with closer monitoring of one's behavior and greater sensitivity to errors[5].

Longer reaction times in young adults with GAD upon making errors.
- Heightened anticipation of errors
- Preoccupation could slow their responses as they may take more time to respond in an attempt to avoid errors.

Future Directions
- Individual ERN Change after Treatment
- Time-Frequency Decomposition
- Additional Neurophysiological Measures
- Studying Interacting Effects due to Comorbidity

References

1. Tan GXD, Soh XC, Hartanto A, Goh AYH, Majeed NM (2023) Prevalence of anxiety in college and university students: An umbrella review. Journal of Affective Disorders Reports 14:100658.
2. Ormel J, VonKorff M, Ustun TB, Pini S, Korten A, Oldehinkel T (1994) Common mental disorders and disability across cultures. Results from the WHO Collaborative Study on Psychological Problems in General Health Care. JAMA 272:1741–1748.
3. Wittchen H-U (2002) Generalized anxiety disorder: prevalence, burden, and cost to society. Depress Anxiety 16:162–171.
4. Wittchen H-U (2002) Generalized anxiety disorder: prevalence, burden, and cost to society. Depress Anxiety 16:162–171.
5. Kujawa A, Weinberg A, Bunford N, Fitzgerald KD, Hanna GL, Monk CS, Kennedy AE, Klumpp H, Hajcak G, Phan KL (2016) Error-related brain activity in youth and young adults before and after treatment for generalized or social anxiety disorder. Prog Neuropsychopharmacol Biol Psychiatry 71:162–168.

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