Mechanisms of gamma oscillations in relation to face processing in children with autism spectrum disorder: ABC-CT Interim Analysis

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Introduction

- A promising neural marker associated with impaired face processing for individuals with autism spectrum disorder (ASD) is the N170 event-related potential (ERP). Individuals with ASD exhibit longer N170 latencies to faces compared to typically developing (TD) individuals (McPartland *et al*., 2004).
- In addition to face processing deficits, individuals with ASD show increased spontaneous gamma oscillations at rest (Cornew *et al*., 2012; Orekhova *et al*., 2007).
- Synchronization of neuronal firing within the gamma-band (30-70 Hz) reflects regional networks of computationally-coupled inhibitory GABAergic interneurons, regulated by excitatory glutamatergic receptor activation (Sohal *et al*., 2009; Cardin *et al*., 2009).
- While several studies suggest that atypical gamma activity reflects excitatory-inhibitory imbalance, very few electroencephalography (EEG) studies have examined the relationship between this imbalance and face processing computations.

Central Questions

Is temporal processing of upright faces delayed in individuals with ASD?
Do gamma oscillations drive abnormal face processing strategies?

Behavioral Methods

Cognitive assessments were conducted and final diagnosis was determined by licensed psychologists.

Standard Psychometric Measures of Social and Cognitive Functioning

- Autism Diagnostic Observation Schedule, 2nd Edition (ADOS-II)
- Differential Ability Scales, 2nd Edition (DAS-II)
- A Developmental Neuropsychological Assessment (NEPSY-II)

Exclusion Criteria

- Children with sensory or motor impairments, epilepsy, and genetic or neurological conditions
- Children with missing EEG data

Participant Demographics

Clinical Diagnosis	N	Sex (M,F)	Age (*SD*)	IQ (*SD*)	NEPSY-II: Affect Recognition Scaled Score (*SD*)
TD	58	38, 20	8.77 (*1.77*)	115.55 (*13.44*)	11 (*4*)
ASD	113	89, 24	8.90 (*1.61*)	100.05 (*17.42*)	8 (*4*)

Figure 1. Clinical Criteria. Groups were matched on age (p>0.05) but differed significantly on Full-scale IQ and NEPSY-II Affect Recognition scaled scores (p<0.01).

EEG Methods

Experimental Paradigm: Resting State

Objective: Assess brain activity during resting state (eyes open)

- **Acquisition:** EEG was recorded at 1000 Hz with a 128-channel HydroCel Geodesic Sensor Net
- **Design:** 6 x 30 sec videos of non-social dynamic abstract images
- **Inclusion criteria:** > 20 seconds of attended and artifact free EEG segments
- **Primary dependent variable**: Slope of the power spectrum
  - Gamma (γ; 30-50 Hz)

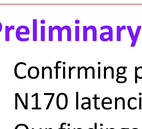


Figure 2. Montage for spectral analysis.

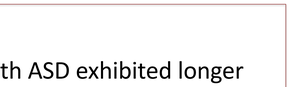


Figure 3. Abstract stimuli used for resting state recording.

Experimental Paradigm: ABC-CT Faces

Objective: Examine neural processing of facial percepts

- **Acquisition:** EEG was recorded at 1000 Hz with a 128-channel HydroCel Geodesic Sensor Net
- **Design:** 216 trials of static images of upright faces, inverted faces, and houses
- **Inclusion criteria:** ≥ 20 artifact-free trials
- **Primary dependent variable**: N170 latency for upright faces and inverted faces

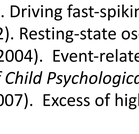


Figure 4. Selection of electrodes for N170 analysis.

Figure 5. Stimuli used for ABC-CT Faces.

Results

Group Comparisons

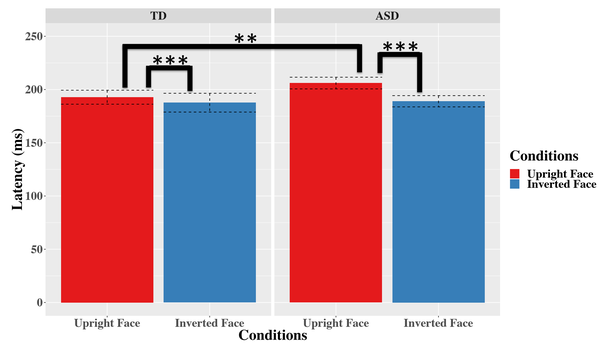
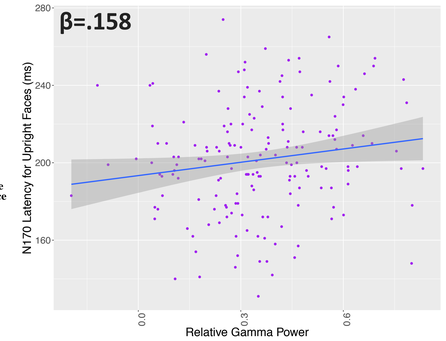


Figure 6. There was a trend toward increased gamma power in individuals with ASD [ASD: 0.38 ± 0.20; TD: 0.32 ± 0.19, p=0.082].

Figure 7. Slower N170 latency for upright faces in individuals with ASD [ASD: 206.08 ± 2.76 ms; TD: 192.79 ± 3.28 ms, p=0.004]. Within groups, inverted faces and upright faces differed significantly (ps<0.0005).

Regression and Correlation Analysis



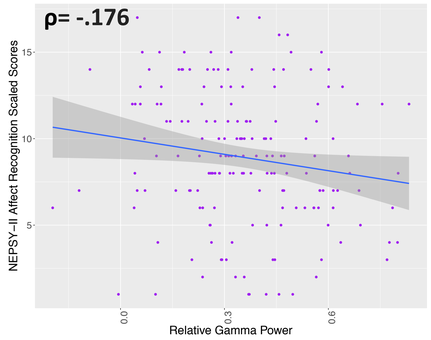


Figure 8. Relative gamma power modestly predicts N170 latency for upright faces in both TD and ASD groups (p=0.04), but not the difference between upright and inverted faces (p>0.05).

Figure 9. Greater relative gamma power was associated with lower NEPSY-II Affect Recognition scores in both diagnostic groups (p=0.021).

Preliminary Conclusions & Future Directions

Preliminary Conclusions

- Confirming previous research, individuals with ASD exhibited longer N170 latencies for upright faces compared to TD participants.
- Our findings suggest that excitatory-inhibitory signaling, as reflected in gamma, influences face processing, which is critical for proper social functioning.

Future Directions

- Ongoing analyses investigate the relationship of visual evoked potentials (VEPs) and the N170.

References

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Acknowledgments

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