Gamma Synchronization During Face Processing is Associated with Social Motivation

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BACKGROUND

Electrophysiological markers of face perception reveal atypical brain activity in ASD.

- Individuals with ASD display a delayed and diminished event-related potential (ERP) response at the face-sensitive N170.
- This atypical response may reflect secondary effects of a primary deficit in social motivation that interferes with the accrual of experience with faces.

This hypothesis is consistent with observed relationships between social motivation and face-related brain activity in typical development.

- Social personality traits (extraversion versus introversion) modulate ERPs to faces.
- Extraverted individuals but not introverted individuals showed a face inversion effect in terms of N170 amplitude.

EEG gamma coherence is a measure of the covariation of two signals in amplitude and oscillatory rhythm. It reflects long-distance interactions and connectivity among neural regions.

- Gamma coherence between scalp regions corresponding to the fusiform gyrus and other brain regions is enhanced 160-260 ms after viewing a face.
- Increased gamma coherence is observed in proportion to emotional valence of faces at 240 ms.

The current study aimed to examine the relationship between gamma coherence and social motivation in individuals with high levels of extraversion or introversion.

We predicted:

- Overall increased gamma coherence between the fusiform gyrus and other brain regions during perception of upright faces relative to inverted faces.
- Increased gamma coherence in extraverted individuals compared to introverted individuals.

METHODS

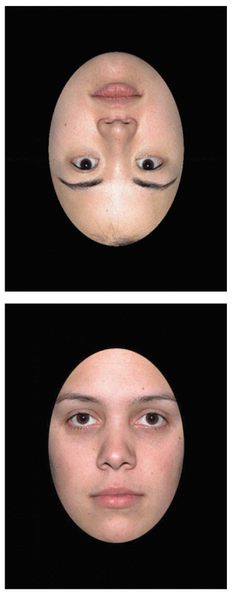


Figure 1. Inverted and upright face stimuli.

Participants

- 96 typically-developing adults (34 male) were pre-screened with the Eysenck Personality Questionnaire Revised Short Scale (EPQ-R) for high or low (+/- 1 SD) scores on the extraversion subscale.
- 34 extreme scorers (19 extraverts, 15 introverts) were invited to participate in the EEG portion of the study.

Stimuli and data acquisition

- Participants viewed 60 trials each of upright faces and inverted faces.
- Each trial was preceded by a central fixation cross for a random period between 500 and 1000 ms.
- This was followed by a randomly selected face stimulus presented for 500 ms and then a 700 ms blank screen.
- EEG was recorded continuously at 250 Hz using a 128-channel EGI Geodesic sensor net.

Data analysis

- Continuous EEG data was filtered, segmented, artifact detected, baseline corrected and averaged for each participant by stimulus category (upright vs. inverted faces) across trials.
- EEG signals were decomposed to the gamma frequency band (30-50 Hz) using wavelet analysis based on 4-6 cycles, a 150 ms window size and 550 ms epochs, including a -25 ms baseline.
- Coherence based on both phase and amplitude was calculated between all channel pairs, excluding pairs involving the 8 eye electrodes. Coherence is measured on a scale between 0 and 1, where 1 indicates two perfectly synchronized signals.
- Average prestimulus baseline coherence was calculated for each subject, for each stimulus category, and subtracted out.
- For these analyses, we focused on averaged time windows spanning 150-250 ms and 250-350 ms.

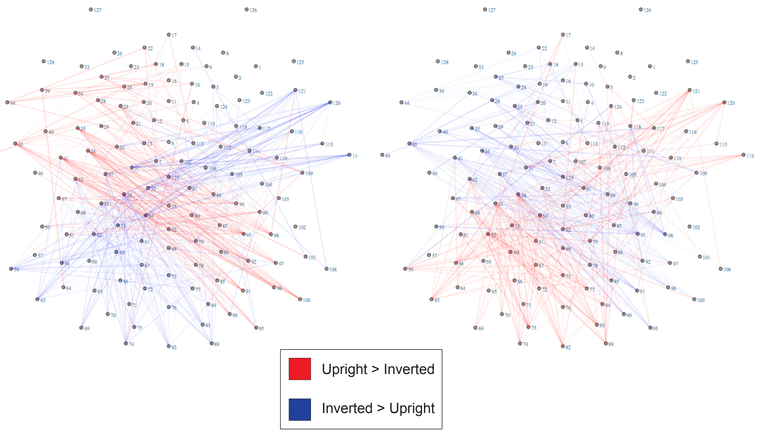
METHODS

Statistical analysis

- For each subject, a difference matrix based on stimulus category was calculated by subtracting coherence associated with inverted faces from coherence associated with upright faces.
- Two-tailed t-tests compared extraverted and introverted groups on this difference matrix to retain only the statistically significant ($p < 0.05$) coherence values between the two groups.

RESULTS

150-250 ms



250-350 ms

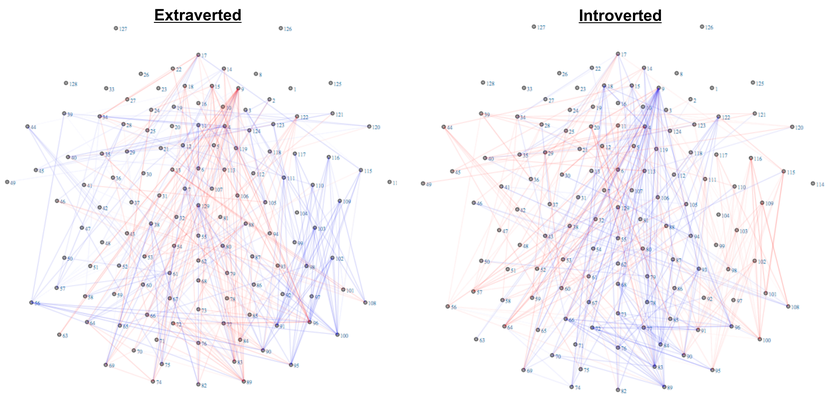


Figure 2. Inter-electrode coherence displaying statistically significant differentiation of coherence during perception of upright versus inverted faces. Red indicates a positive value (i.e. coherence associated with upright faces > coherence associated with inverted faces) while blue indicates a negative value (i.e. coherence associated with inverted faces > coherence associated with upright faces).

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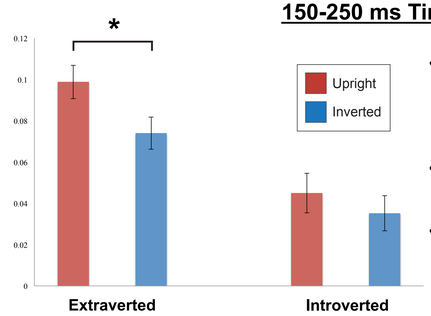
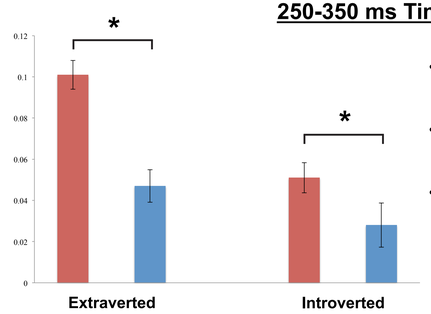
RESULTS

150-250 ms Time Window



- Extraverted individuals exhibited significantly ($p < 0.05$) increased coherence between electrodes over the left prefrontal and right occipitotemporal regions in response to upright faces.
- Extraverted individuals showed overall greater coherence compared to introverted individuals.
- Extraverted individuals showed greater coherence in response to upright faces compared to inverted faces, while introverted individuals showed no significant difference.

250-350 ms Time Window



- Extraverted individuals exhibited significantly ($p < 0.05$) increased frontal/occipital coherence in response to upright faces.
- Extraverted individuals displayed overall greater coherence compared to introverted individuals.
- Both groups showed more coherence in response to upright faces compared to inverted faces during this time window. However, this difference was more pronounced in extraverted individuals than in introverted individuals.

Figure 3. Average significant coherence values (baseline subtracted) for extraverted versus introverted groups with respect to upright and inverted stimuli categories during time windows 150-250 ms and 250-350 ms.

CONCLUSIONS

- Consistent with our hypotheses, increased gamma coherence was positively associated with social motivation.
- Extraverted individuals exhibited higher overall levels of coherence.
- Upright faces elicited enhanced coherence between prefrontal and occipitotemporal regions in extraverted individuals but not in introverted individuals.
- These findings are consistent with prior work demonstrating attenuated ERP face inversion effects in introverted individuals.
- These results support the predictions of the social motivation hypothesis regarding the influence of social drive on the neural bases of face perception.

FUTURE DIRECTIONS

- We are developing methods to statistically correct for multiple comparisons in a coherence difference matrix, such as false discovery rate control, and to select confidence intervals, such as simulation methods.
- Analyses in progress contrast coherence measures for local versus distal connections.
- We are applying these methods to contrast this normative variation in social motivation with that present in clinical populations, such as individuals with ASD.

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