Conscious and Nonconscious Emotional Processing and Level of Autistic Traits

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BACKGROUND

- Autism spectrum disorder (ASD) is a neurodevelopmental disorder involving a wide range of socio-emotional difficulties.
- Emotional processing is affected in ASD, and aberrant neural activity in response to emotional faces has been observed (Dawson et al., 2005).
  - When viewing faces, individuals with ASD show decreased neural efficiency (McPartland et al., 2004).
- Previous studies of face processing in ASD have largely utilized consciously presented stimuli that are likely processed through cortical areas (e.g., fusiform face area).
  - Studies on the neural basis of nonconscious (e.g. stimuli presented too quickly to be consciously perceived) processing suggest that, even without conscious awareness of stimuli, emotion processing brain areas are activated (Morris et al., 1998).
  - Emotional faces presented too briefly to enter conscious awareness are thought to be processed by the amygdala and related limbic structures through a direct pathway from the thalamus (Morris et al., 1998).
- Few studies have explored nonconscious emotion processing in ASD.
  - Investigating nonconscious emotion processing in ASD can provide important information about whether subcortical face processing differentiates individuals with ASD compared to their TD peers (similar to cortical face processing).
  - Relative to TD controls, individuals with ASD have attenuated fMRI response to faces presented for less than 30 milliseconds (Kleinhans et al., 2011).
- While a diagnosis of ASD is categorical, autistic traits are continuously distributed in TD individuals (Constantino & Todd, 2003).
- The current study aimed to explore the neural correlates of conscious and nonconscious perception of emotional faces as a function of level of autistic traits.

METHODS

Present Study

- The present study investigated three event-related potential (ERP) components. The P100 is thought to index low-level sensory processing. The N170 is thought to represent early face processing. The P300 is thought to represent attention and stimulus salience.

Participants

- 25 typically developing (TD) right-handed adults (Age: M = 22.68 yrs, SD = 1.67; Sex: 13 females)

Self-Report Behavioral Measures

- The Autism Quotient (AQ) (Baron-Cohen et al., 2001)
  - 50 item forced choice self-report
- Participants divided into two groups (high/low AQ score) based on median split

Data Acquisition and Extraction

- 360 trials in six conditions (fearful nonconscious, fearful conscious, neutral nonconscious, neutral conscious, sad nonconscious, and sad conscious)
- EEG recorded continuously at 500 Hz using 128-channel Hydrocel Geodesic Sensor Nets.
- ERPs segmented to 100 ms pre-stimulus baseline, 600 ms post-stimulus, and average referenced.
- Peak amplitude and latency for the P100 and N170 were extracted from occipitotemporal sites over right and left hemisphere. Peak amplitude and latency for the P300 was extracted from central-parietal electrode sites, (Figure 1).

Statistical Analysis

- Peak amplitude and latency were analyzed using separate repeated measures ANOVAs

P100 and N170

- 3 within-subjects factors
  - Emotion (fearful/neutral/sad)
  - Stimulus Type (conscious/nonconscious)
  - Hemisphere (left/right)
- 1 between-subjects factor
  - AQ score (high/low; calculated with median split)

P300

- 2 within-subjects factors
  - Emotion (fearful/neutral/sad)
  - Stimulus Type (conscious/nonconscious)
- 1 between-subjects factor
  - AQ score (high/low)

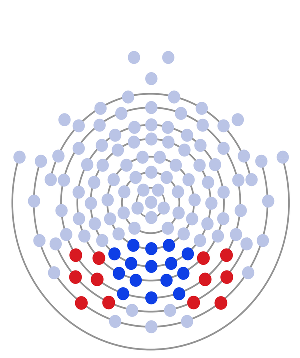

Figure 1. **Red:** Bi-lateral occipitotemporal electrode sites used to analyze the P100 and N170
Blue: Central-Parietal electrode sites used to measure the P300

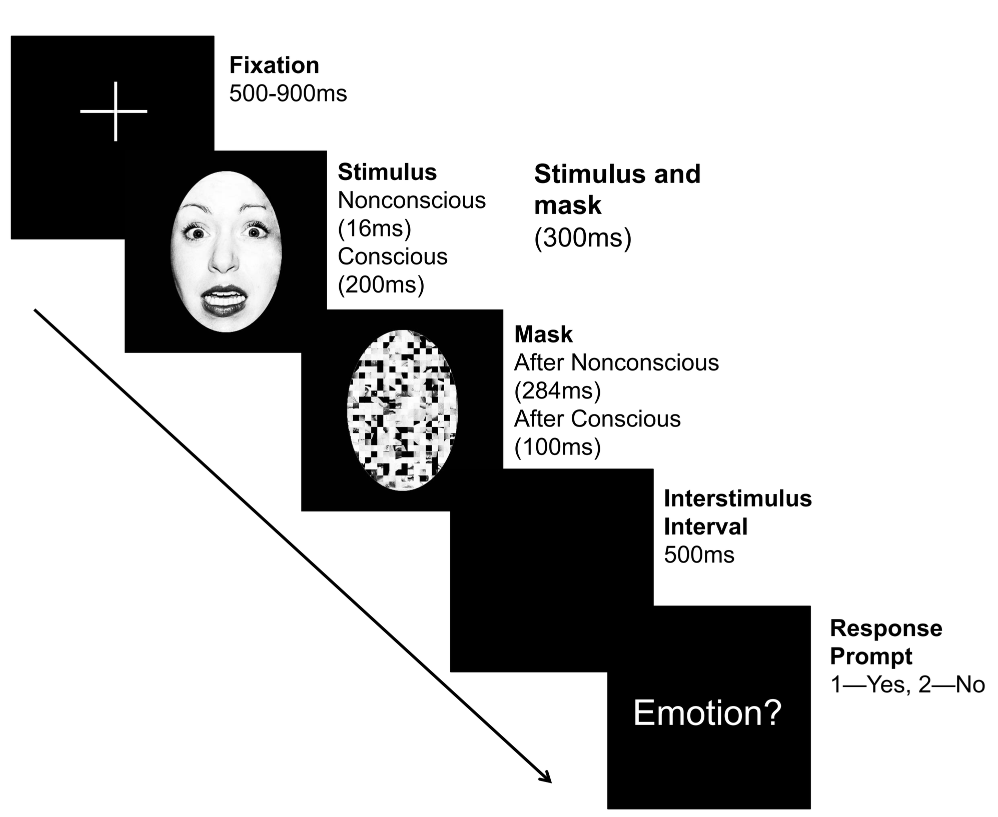

Figure 2. Schematic and timing of the paradigm. Note that the total duration of the stimulus and mask was always 300ms (regardless of whether the trial was conscious or nonconscious).

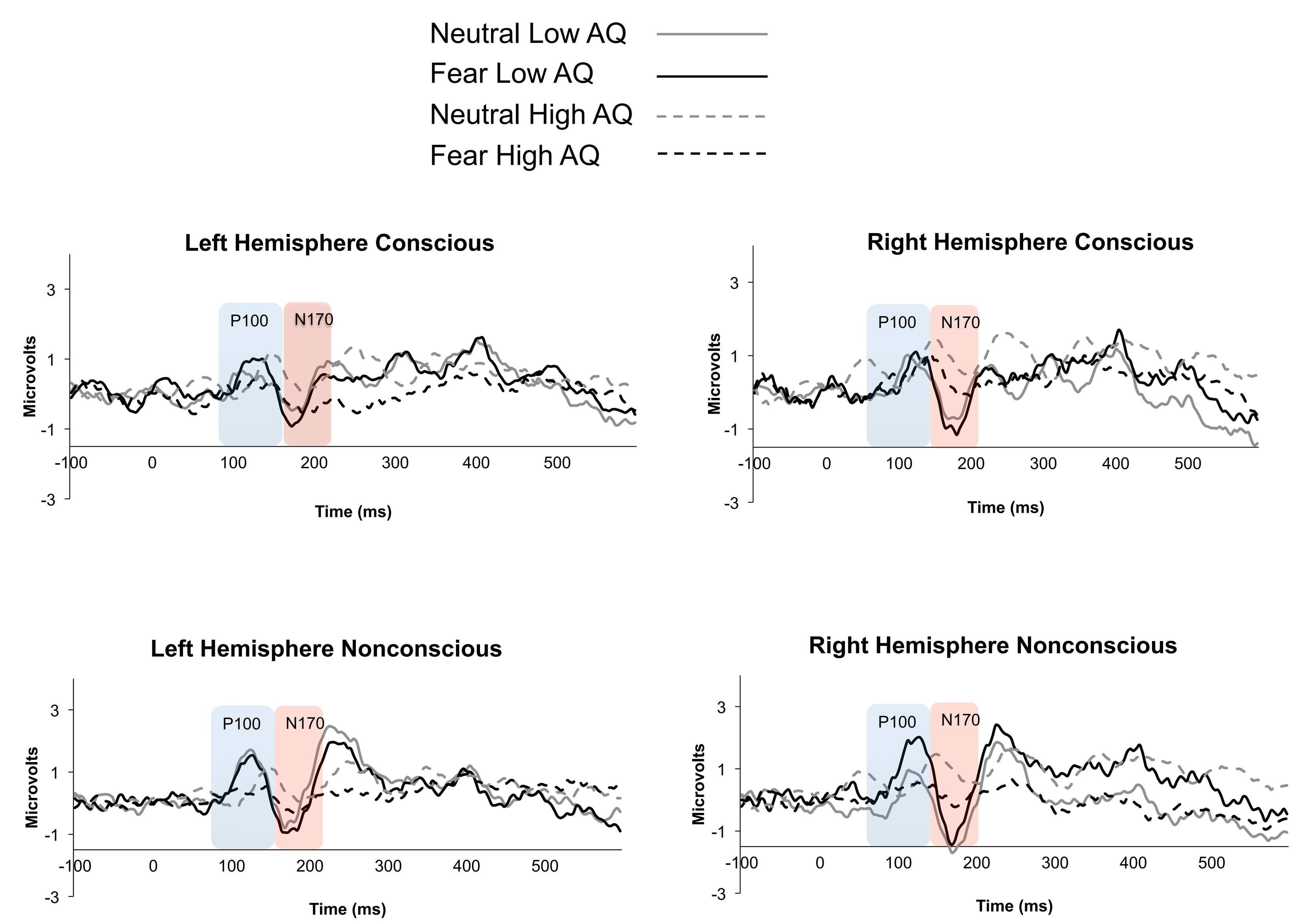

Figure 3. *(AQ: Autism Quotient)*. Grand averaged waveforms for the P100 (shaded in blue) and N170 (shaded in red) components in response to neutral and fearful faces. ERP responses to nonconscious faces are depicted on the bottom row, and conscious faces on the top. The shaded area represents the area utilized for statistical analysis.

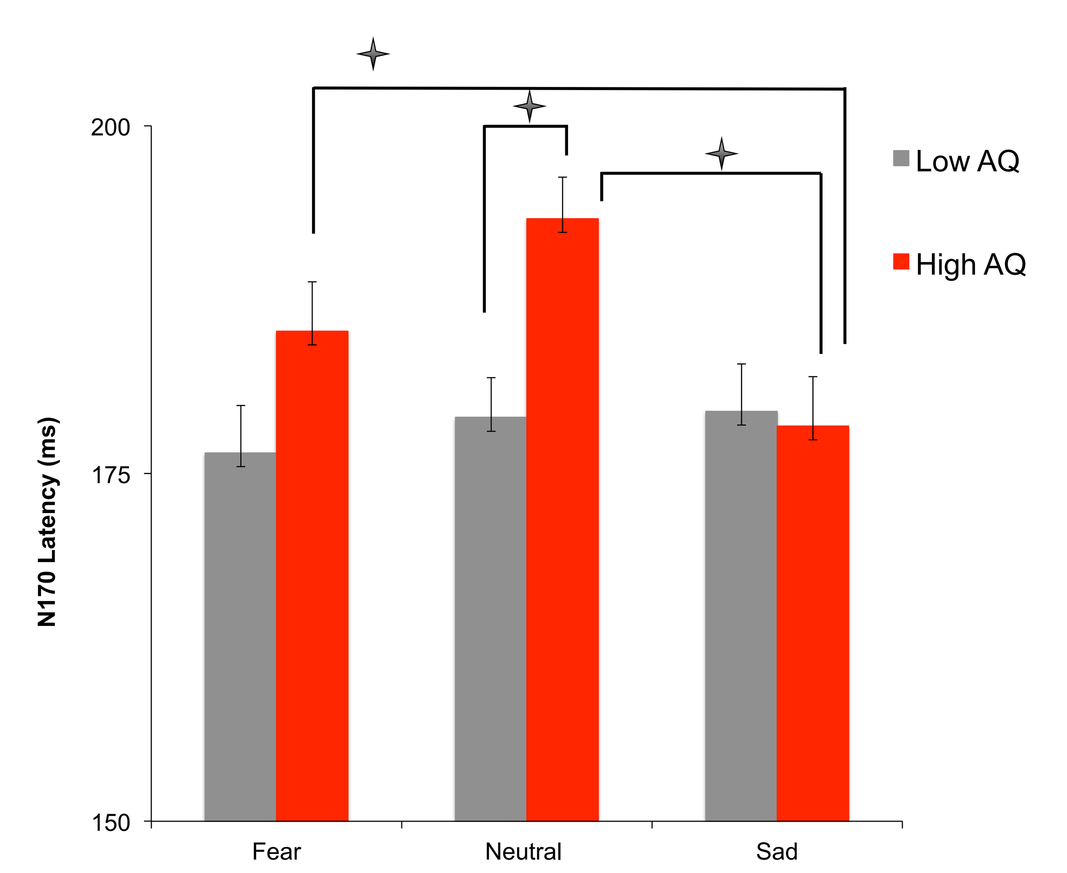

Figure 4. Latency to N170 in response to emotional faces (regardless of whether faces were presented consciously or nonconsciously) in individuals with high versus low AQ (Autism Quotient) scores. Individuals with low AQ scores are depicted in grey, and those with high AQ scores are depicted in red. ✦ ≤ .05

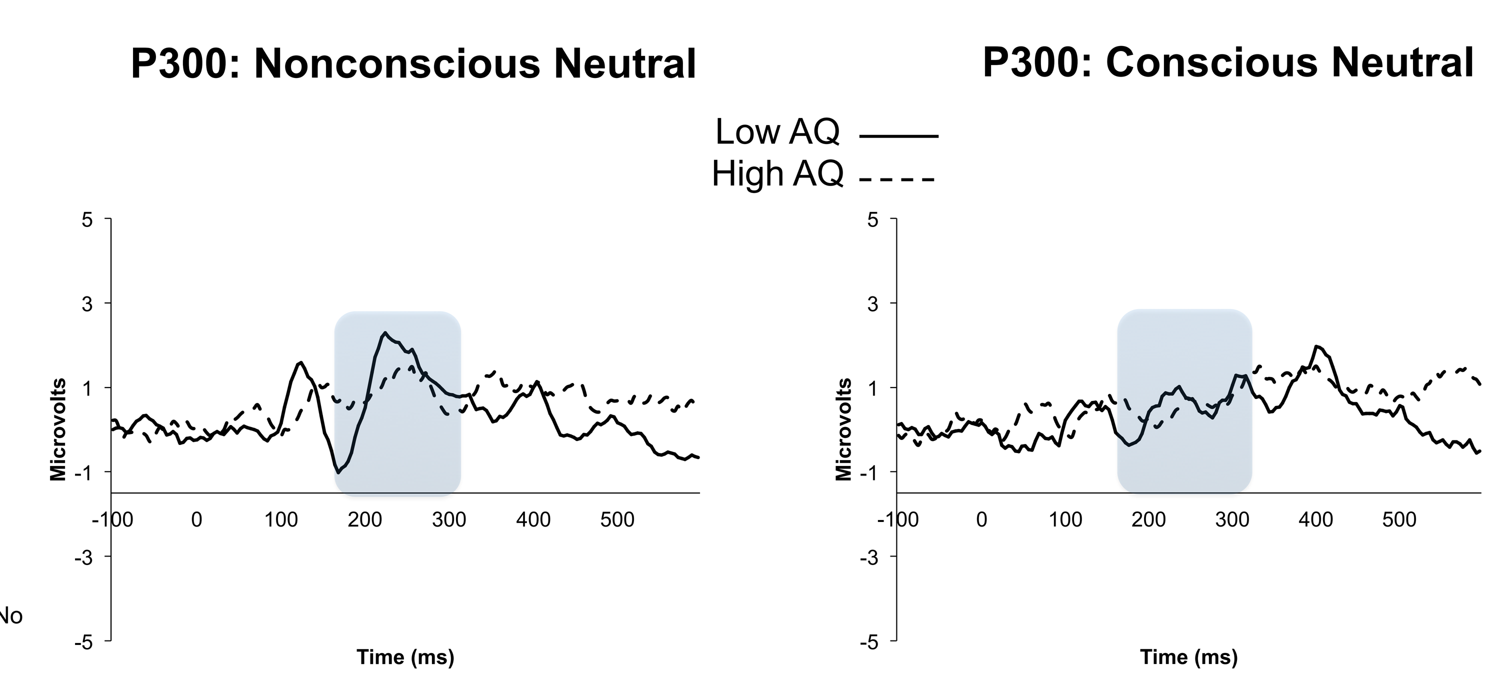

Figure 5. Grand averaged waveforms for the P300 in response to neutral faces for individuals with both low and high AQ (Autism Quotient) scores. P300 response to nonconscious neutral faces is shown on the left, and P300 response to conscious neutral faces is shown on the right. Shaded area represents the area utilized for statistical analysis.

PRELIMINARY RESULTS

ERP Results:

P100: Amplitude

- Grand averaged waveforms of the P100 and N170 components for individuals with both high and low AQ scores are shown in Figure 3.
- Main effect of Stimulus type, $F(1,23) = 14.91$, $p < .01$ such that nonconsciously presented faces elicited larger P100s vs. consciously presented faces.
- Significant Emotion * Hemisphere interaction, $F(2,22) = 4.73$, $p = .019$ such that the P100 was larger for fearful faces in the right vs. left hemisphere ($p = .031$).
- Significant Emotion * Stimulus type *Hemisphere * AQ score interaction, $F(2,22) = 5.95$, $p = .009$.
  - In individuals with low AQ scores, larger P100s in the right hemisphere to nonconsciously presented vs. consciously presented fearful faces ($p = .006$).
  - In individuals with low AQ scores, larger P100s were elicited in the left hemisphere to nonconsciously presented neutral faces vs. consciously presented neutral faces ($p = .007$).
  - In individuals with high AQ scores, larger P100s elicited in the right hemisphere for nonconsciously presented neutral faces vs. consciously presented neutral faces ($p = .015$).

P100: Latency

- Significant effect of AQ score, $F(1,23) = 6.28$, $p = .02$ such that individuals with high AQ scores had longer P100 latency than those with low AQ scores.

N170: Amplitude

- No significant main effects or interactions (all ps > .1).

N170: Latency

- Significant interaction between Emotion * AQ score, $F(2,22) = 4.81$, $p = .018$.
  - Pairwise comparisons revealed that individuals with low AQ scores had significantly faster N170s versus those with high AQ scores to neutral faces ($p = .002$) and marginally faster N170s to fearful faces (.087). No differences between groups were present for sad faces.
  - Individuals with high AQ scores had significantly faster N170s to sad faces vs. neutral ($p = .001$) and fearful ($p = .052$) faces, whereas individuals with low AQ scores did not have significant differences in latency between emotions (Figure 4).
- Marginally significant effect of AQ score, $F(1,24) = 3.64$, $p = .064$ such that individuals with low AQ scores had faster N170 latency vs. those with high AQ scores.

P300: Amplitude

- Main effect of Stimulus type, $F(1.23) = 7.80$, $p = .01$ such that nonconsciously presented faces elicited larger P300 vs. consciously presented faces.

P300: Latency

- Emotion * AQ score interaction, $F(2,22) = 3.60$, $p = .044$.
  - Pairwise comparisons revealed individuals with high AQ scores had marginally longer P300 latency to neutral faces vs. those with low AQ scores ($p = .099$; Figure 5).

CONCLUSIONS

- Increased latency to emotional faces in individuals with high levels of autistic traits is consistent with previous findings in individuals with ASD (O'Connor et al., 2005; McPartland et al., 2004).
- Individuals with high levels of autistic traits evidence inefficient face processing (as indexed by P100 and N170 latency).

IMPLICATIONS

- The current study suggests that inefficient face processing is not only present in individuals with ASD but is also observed in TD individuals with high levels of autistic traits.
- Like the ASD phenotype, face processing is highly heterogeneous, and efficiency of face processing exists on a continuum spanning both typical and atypical development.
- Future studies should examine levels of autistic traits in control groups to understand relationships among subthreshold autistic symptomatology and the neural substrates of social perception.

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