# Modulation of Emotional Face Processing by Visual Attentional Flexibility and ADHD Symptoms in ASD: Results from the ABC-CT Feasibility Study

Developmental Electrophysiology Laboratory
Yale Child Study Center

M. R. Altschuler, A. Naples, B. Lewis, G. Dawson, R. Bernier, S. Jeste, C. A. Nelson, K. Chawarska, S. J. Webb, F. Shic, Q. Wang, M. Murias, C. Sugar, & J. McPartland

ABC·CT Autism Biomarkers Consortium for Clinical Trials

## Background and Objective

- Face processing difficulties are common in autism spectrum disorder (ASD).
- In addition to social deficits, children with ASD often show impaired executive function (EF), the ability to manage complex or conflicting information in the service of attaining a goal.
- Atypical face processing and impaired EF are also evident in attention deficit/hyperactivity disorder (ADHD), which often co-occurs in ASD.
- It is not yet known whether ADHD and visual attentional flexibility (VAF)—a type of EF that involves shifting, engaging, and disengaging visual-spatial attention—modulate event-related potentials (ERPs) to emotional faces in ASD.
- Our objective was to use electroencephalography (EEG) and eye-tracking (ET) to examine whether ADHD and VAF modulate ERPs to emotional faces in children with ASD versus typical development (TD).

## Method

**Participants:**

| Group | N | Mean (*SD*) Age in Years | Mean (*SD*) FSIQ | Mean (*SD*) ADOS-2 Severity |
|---|---|---|---|---|
| ASD | 19 | 8.53 (2.03) | 93.84 (16.49) | 7.95 (1.55) |
| TD | 26 | 6.60 (1.98) | 114.08 (9.34) | 1.19 (0.40) |

**Face Processing EEG Data Acquisition and Paradigm:**

- EEG was recorded at 1000 Hz with a 128-channel Hydrocel Geodesic net. Participants viewed neutral and fearful faces (see Fig. 1).
- ERPs (P100, N170) were extracted from occipitotemporal electrodes in the left hemisphere (LH) and right hemisphere (RH) (see Fig. 2). Difference scores (neutral – fear) were calculated.

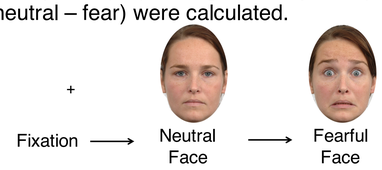


**Figure 1.** EEG task.

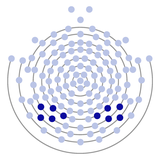

**Figure 2.** Electrodes.

**Visual Attentional Flexibility ET Data Acquisition and Paradigm:**

- ET was collected using a SR Eyelink 1000+ binocular eye-tracker at 500 Hz.
- Participants completed a gap-overlap task. A central stimulus (CS) was displayed, followed by a peripheral stimulus (PS), with 3 conditions (see Fig. 3):
  - Baseline: PS was displayed concurrent with CS disappearance.
  - Gap: PS was displayed 200 ms after CS disappeared.
  - Overlap: PS was displayed while CS remained screen.

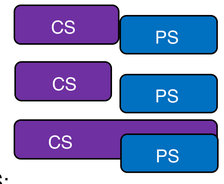


**Figure 3.** ET task.

- VAF effects were calculated from reaction time (RT) to PS:
  - Disengagement (overlap – baseline).
  - Facilitation (baseline – gap).
  - Gap (overlap – gap).

**ADHD Symptoms Questionnaire:**

- *Childhood and Adolescent Symptom Inventory-5* measured two types of ADHD symptoms dimensionally:
  - Inattention (CASI-I).
  - Hyperactivity/impulsivity (CASI-H).

## Results

**Group and Condition:**

- Main effects of group were identified for gap-overlap RTs (*p*<.05) but not ERPs (*p*>.05; see Fig. 4). RTs were faster in ASD for gap-overlap. Main effects of condition were identified for N170 and P100 amplitudes (*p*<.05; see Fig. 4) and gap-overlap RTs (*p*<.01).

**IQ and Age:**

- IQ was not correlated with ERPs in ASD or TD. In ASD, age was not correlated with ERPs. In TD, age was correlated with N170 and P100 amplitude and latency to fearful and neutral faces (*p*<.05).

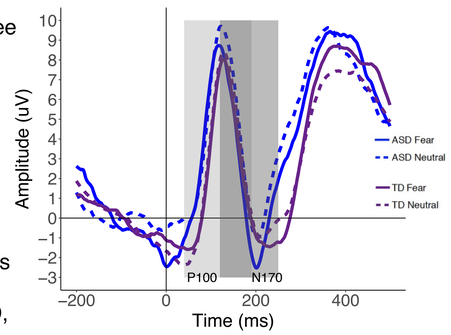


**Figure 4.** Neural response to fearful and neutral faces.

**Do ADHD Symptoms Relate to ERPs to Fearful and Neutral Faces?**

- In ASD, greater inattention (CASI-I) related to slower LH P100 to fearful faces (*r*=.69, *p*<.01), and greater hyperactivity/impulsivity (CASI-H) related to slower LH N170 to fearful faces (*r*=.59, *p*<.05; see Fig. 5).
- In TD, greater inattention (CASI-I) related to faster LH N170 to fearful faces (*r*=-.46, *p*<.05; see Fig 6).

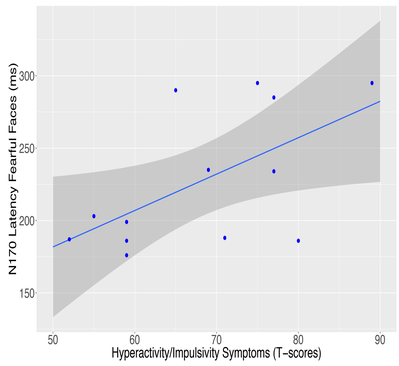


**Figure 5**. N170 latency and ADHD symptoms in ASD.

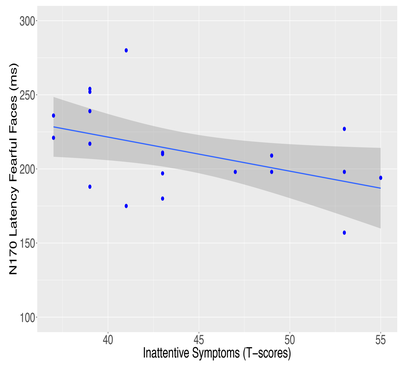


**Figure 6**. N170 latency and ADHD symptoms in TD.

- In ASD, greater hyperactivity/impulsivity (CASI-H) related to slower LH N170 to fearful relative to neutral faces (*r*=-.64, *p*<.05; see Fig 7).
- In ASD, greater inattention (CASI-I) related to slower LH P100 to fearful relative to neutral faces (*r*=-.56, *p*<.05; see Fig 8).

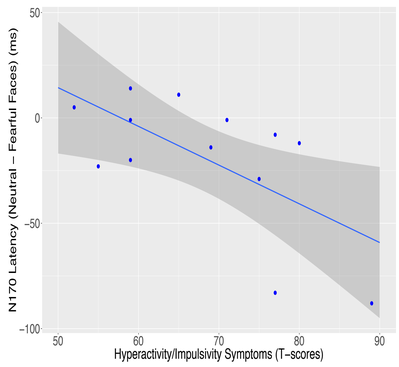


**Figure 7**. N170 latency and ADHD symptoms in ASD.

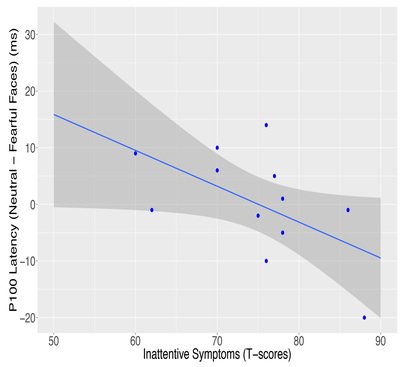


**Figure 8**. P100 latency and ADHD symptoms in ASD.

## Results

**Does VAF Relate to ERPs to Fearful and Neutral Faces?**

- Greater facilitation effect (more orienting-based attentional flexibility) related to slower RH N170 to fearful relative to neutral faces (*r*=-.60, *p*<.05; see Fig 9) in ASD.
- Greater gap effect (more processing-based attentional flexibility) related to faster RH N170 to fearful relative to neutral faces (*r*=.47, *p*<.05; see Fig 10) in TD.

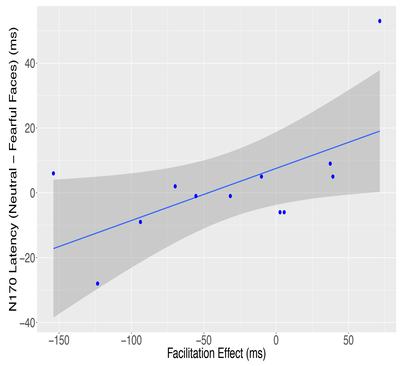


**Figure 9**. N170 latency and facilitation effect in ASD.

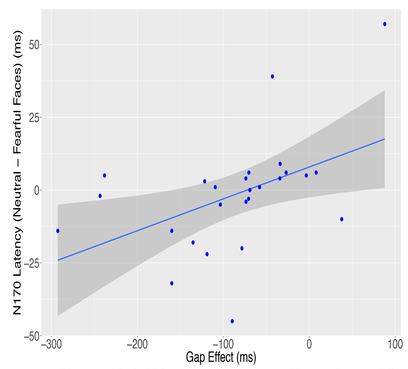


**Figure 10**. N170 latency and gap effect effect in TD.

## Discussion

- Variability in EF-related ADHD symptoms and VAF modulate neural response to faces differently in ASD versus TD.
- Children with ASD with more ADHD symptoms showed slower neural responses to faces, whereas TD children showed the opposite pattern.
- When comparing emotional faces, children with ASD with more ADHD symptoms showed slower neural responses to fearful versus neutral faces.
- Greater facilitation predicted slower neural response to fearful versus neutral faces in ASD, while greater gap effect in TD predicted the reverse.
- Although ERPs were not associated with age or IQ in ASD, future research should replicate these results with groups matched on these demographic variables.
- Brain response to faces may be modulated by orienting efficiency in ASD but by processing efficiency in TD, suggesting distinct relationships among EF and social perception in ASD versus TD.
- These results may relate to differences in processing style in ASD and TD. Future research should examine how differences in processing emotional faces may relate to individual differences in gestalt versus detail-related processing.
- In addition, these results suggest separate pathways for neural recognition of faces in ASD compared to TD. Future neuroimaging research should examine this possibility to specify the neural mechanisms impaired in ASD that may be potential targets for intervention.

## References

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ABC-CT
abc-ct@yale.edu
medicine.yale.edu/ycci/researchers/autism/

McPartland Lab
mcp-lab.org
mcp.lab@yale.edu

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