The current study investigates:

- Empathy for physical pain in TD adults reveals that autistic traits modulated event-related potential (ERP) markers of empathic processing for both physical and social pain.
- Empathy for social pain mentalizing networks (e.g., dorsomedial prefrontal cortex, insula).
- Enhanced activation in affect-encoding regions during observed physical pain is also seen in highly empathic individuals during empathy for social pain.

Our previous work in TD adults revealed that autistic traits modulated event-related potential (ERP) markers of empathic processing for both physical and social pain:

- P300: an index of cognitive appraisal and stimulus categorization.

Neural markers of empathic response to social pain in ASD remain unexplored.

The current study investigates:

- The temporal dynamics of empathy for physical and social pain in ASD versus TD.
- Relations among neural responses to observed social pain, empathic traits, and social function in ASD.

### METHOD

**PARTICIPANTS**

- 14 TD male adults (2 left-handed)
- 7 male adults with ASD (1 left-handed)

<table>
<thead>
<tr>
<th>Table 1. Participant Demographics</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>TD (21) 18-25 27-56 -- --</td>
</tr>
<tr>
<td>EQ Score</td>
<td>122 (3) 19-28 34 (14) 15-54 67 (18) 44-91</td>
</tr>
<tr>
<td>SRS-A-SR Score</td>
<td>M (SD) 22 (3) 19-28 34 (14) 15-54 67 (18) 44-91</td>
</tr>
<tr>
<td></td>
<td>M (SD) 21 (2) 18-25 38 (9) 27-56 -- --</td>
</tr>
</tbody>
</table>

**DATA ACQUISITION AND EXTRACTION**

- *EEG recorded continuously at 250 Hz*
- *HydroCol Geodesic Sensor Net 128*
- *Data segmented to static image (100 ms pre-stimulus baseline, 550 ms post-stimulus) and average-referenced*
- *Peak amplitude and latency for the N110 (90-170 ms) and P300 (300-550 ms) extracted at C3 and C4 sites*

**STATISTICAL ANALYSIS**

- Peak amplitude and latency were analyzed using multivariate repeated measures ANOVA.
- 4 within-subjects factors:
  - Type (Social/Physical)
  - Task (Count/Rate)
  - Pain (Painful/Painless)
  - Hemisphere (Left/Right)
- Between-subjects factors:
  - Diagnosis (ASD/TD)
  - Bivariate correlations were computed among amplitude and latency difference scores and behavioral scores.

**RESULTS: FIGURES**

- **Figure 3. C3 and C4 recording sites**
- **Figure 4a. Waveforms to observe physical and social scenarios (painful and painless) in TD**
- **Figure 4b. Waveforms to observe physical and social scenarios (painful and painless) in ASD**

### EXPERIMENTAL DESIGN

- Three experimental manipulations:
  - *Type of stimuli (Social/Physical)*
  - *Pain depicted in stimuli (Painful/Painless)*
  - *Task (Count/Rate)*
- *Task manipulated attention:*
  - Count the bracelets on actors’ wrists (1-4)
  - Rate distress to observed pain (1-4)
- *Four blocks, counterbalanced for sequence:*
  - 60 trials per block (30 painful, 30 painless trials randomized within block)
  - Each trial included a video and a static image depicting the video’s final frame.

### RESULTS: SUMMARY

**ERPs RESULTS**

- *N110 Amplitude: Interaction between Diagnosis and Pain [F(1,19)=9.413, p<.005]*
  - N110 amplitude to painless scenarios in ASD>TD [t(19)=4.038, p<.001]
- *P300 Latency: Interaction of Diagnosis, Type, and Hemisphere [*F(11,39)=9.425, p=.006]*
  - P300 latency to social scenarios longer than to physical scenarios in ASD [t(39)=-2.327, p =.059] but not in TD [t(39)>1, p =.188] in the right hemisphere.
  - Right-hemisphere P300 latency to physical actions in TD>ASD [t(19)>2.791, p=.012]

**ERPs-Behavioral correlations**

- EQ scores correlate with the difference in P300 amplitude between observed physical and social pain in the right hemisphere across diagnostic categories [r = -.641, p = .002]
  - Higher trait empathy is associated with greater amplitude to social versus physical pain.
- EQ scores correlate with the difference in P300 amplitude between observed socially painful and painless scenarios in the right hemisphere across diagnostic categories [r = .573, p = .007]
  - Higher trait empathy is associated with greater amplitude to socially painful versus painless scenarios.
- SRS-A-SR scores in ASD correlate with N110 amplitude difference between observed physical and social pain during the rating task [r = -.815, p = .030]
  - Higher social function in ASD is associated with greater empathy to social relative to non-social pain in the left hemisphere.

### CONCLUSIONS

- ERPs revealed disruption of brain mechanisms regulating affective response to observed pain/lack of pain, as indexed by the N110 component, in ASD.
- During affective stages of empathic processing, enhanced sensitivity to social pain at the N110 was associated with greater overall social functioning in ASD.
- ERPs indicated delayed neural processing of social actions and faster processing of physical actions, as indexed by the P300 component, at cognitive stages of empathic processing in ASD.
- During cognitive stages of empathic processing, self-reported empathy was associated with greater sensitivity to social pain at the P300 component in TD and ASD.

### IMPLICATIONS

- The neural response to observed social pain is closely associated with empathic functioning in both typical and atypical development.
- Early emotional response to others’ pain may serve as an indicator for treatment selection and a metric of outcome for social skills interventions in ASD.
- Research in progress in our lab explores the modifiability of this response in children and adults with ASD.

### REFERENCES