Oxytocin modulates processing efficiency of socially salient visual information

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BACKGROUND

- The social motivation hypothesis suggests that social dysfunction in ASD, such as deficits in face processing, derive from atypical processing of socially rewarding stimuli during development.
- Oxytocin (OT) influences social behavior and is hypothesized to enhance social salience by (a) reducing anxiety and/or (b) increasing reward sensitivity (Bethlehem et al., 2014).
- Functional neuroimaging in healthy adults suggests that intranasally administered OT enhances activity in brain regions involved in face processing.

Study Aims

- To apply event-related potentials (ERPs) to investigate the temporal dynamics of oxytocin's influence on the neural substrates of face perception.
- To examine the relationship between autistic and anxious traits on the impact of oxytocin during face perception.

We predicted that OT would enhance the efficiency of face perception, as reflected in shorter latency to face-sensitive ERP components and that these effects would be modulated by individual differences.

PARTICIPANTS & METHODS

Table 1: Participant Demographics: 21 TD male adults (4 left-handed).

Age		STAI Trait Score		SRS-A-SR Score	
M (SD)	Range	M (SD)	Range	M (SD)	Range
25.3 (3.7)	19-32	30.8 (7.13)	20-47	36.5 (16.5)	3-70

Self-Report Behavioral Measures

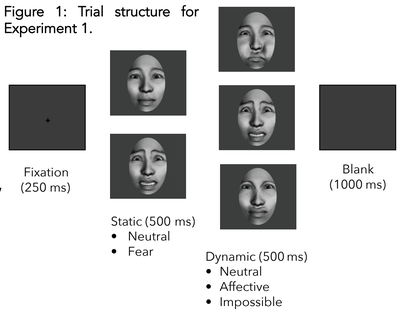
- The State-Trait Anxiety Inventory (STAI)
- 65-item measure of social functioning in adults
- The Social Responsiveness Scale; Adult Self-Report (SRS-A-SR)
- 20-item measure of trait anxiety in adults

Data Acquisition and Extraction

- 146 trials in experiment 1 (73 neutral, 73 fear), 156 trials in experiment 2 (52 eyes, 52 nose, 52 mouth).
- EEG recorded continuously at 500 Hz using 128-channel Hydrocel Geodesic Sensor Nets.
- ERPs segmented to 100 ms pre-stimulus baseline, 500 ms post-stimulus, and average referenced.
- Peak amplitude and latency for the P100, N170, and N250 were extracted from occipitotemporal sites over right and left hemisphere.

Experiment 1: Affective Face Processing

Figure 1: Trial structure for Experiment 1.



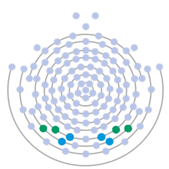
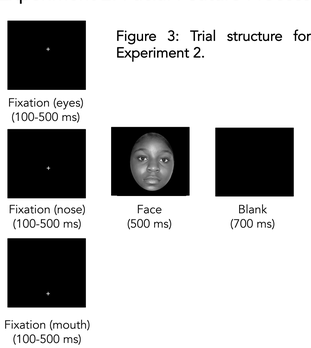


Figure 2: N170 recording sites for Experiment 1: 64, 65, 90, 95
Recording sites for Experiment 2: 69, 70, 83, 89

Experiment 2: Facial Feature Processing

Figure 3: Trial structure for Experiment 2.



Statistical Analysis

- Peak amplitude and latency were analyzed using separate repeated measures ANOVAs:
- 3 within-subjects factors
  - Treatment (Oxytocin/Placebo)
  - Condition (Neutral/Fearful in Experiment 1 & Eyes/Not eyes in Experiment 2)
  - Hemisphere (Left/Right)
- Correlations examined between behavioral measures and change in fear sensitivity indexed by OT-associated change in affective face processing.
  - Operationalized by component (N170, N250) amplitude and latency difference scores between treatments; e.g., (fear – neutral for oxytocin) – (fear – neutral for placebo).

Experiment 1: Affective Face Processing

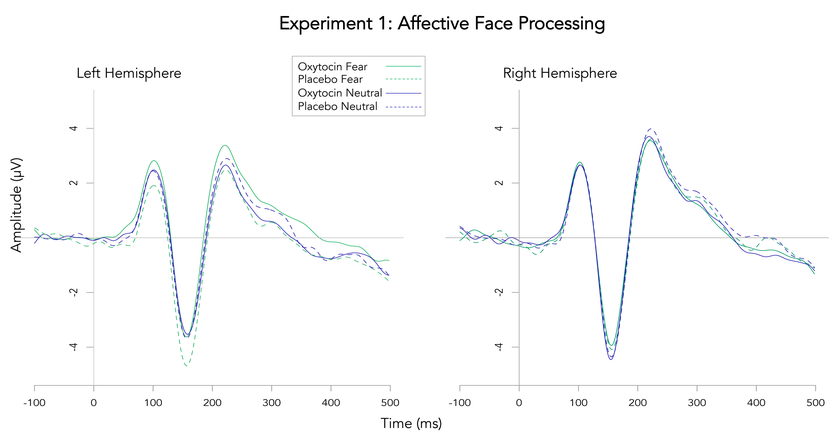


Figure 4: Waveforms depicting brain response to fearful and neutral faces in the left and right hemisphere.

Experiment 2: Facial Feature Processing

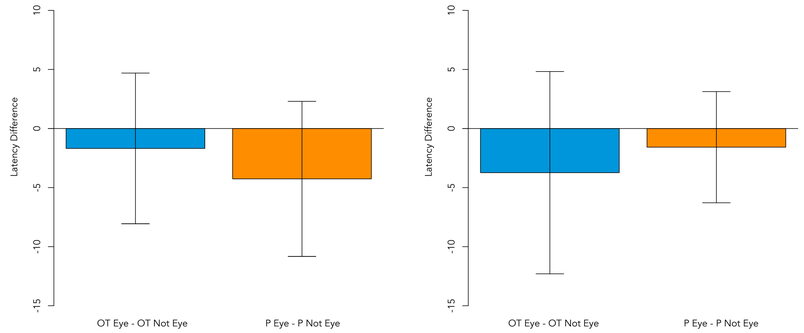


Figure 5: N170 latency difference scores between oxytocin and placebo conditions (eye region vs. facial features) in left and right hemisphere.

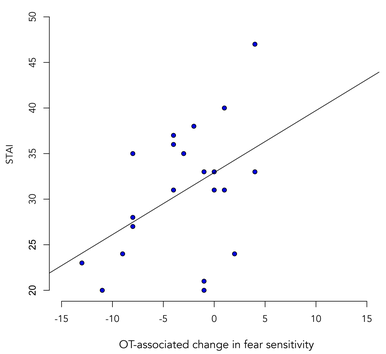


Figure 6: Correlation of STAI scores with a neural index of OT-associated change in N170 latency between fearful and neutral faces in left hemisphere.

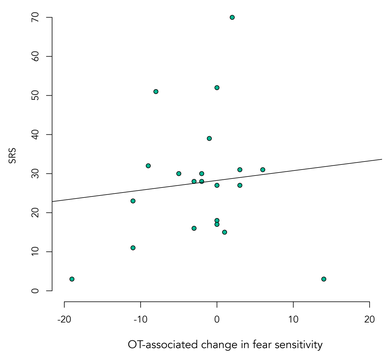


Figure 7: Correlation of SRS scores with a neural index of OT-associated change in N170 latency between fearful and neutral faces in left hemisphere.

RESULTS

Affective Face Processing:

P100

- No statistically significant effects in amplitude or latency for the P100.

N170

- Fearful faces elicited N170 with greater amplitude than neutral faces.
  - Main effect of condition [$F(1, 20) = 7.32$, $p < 0.05$].
- Latency to fearful faces was shorter during OT administration compared to placebo.
  - Interaction between treatment and condition [$F(1, 20) = 4.85$, $p < 0.05$]; [$t(1, 20) = -2.406$, $p < 0.05$]; post-hoc: [$t(1, 20) = -2.406$, $p < 0.05$].
- OT attenuated N170 amplitude to fearful faces in left hemisphere.
  - Interaction between treatment, condition, and hemisphere [$F(1, 20) = 5.19$, $p < 0.05$]; post-hoc: [$t(20) = 2.725$, $p < 0.05$].

N250

- OT increased N250 amplitude difference between fearful and neutral faces in left hemisphere.
  - Interaction between treatment, condition, and hemisphere [$F(1, 20) = 5.19$, $p < 0.05$]; post-hoc: [$t(20) = 2.127$, $p < 0.05$].

Facial Feature Processing:

P100 & N250

- No statistically significant effects in amplitude or latency for the P100 or for the N250.

N170

- Latency to eye region was shorter compared to other facial features.
  - Main effect of condition [$F(1,18) = 12.16$, $p < 0.05$].
- OT administration reduced latency difference between eyes and other facial features in the left hemisphere.
  - Interaction between treatment, condition, and hemisphere [$F(1,18) = 6.46$, $p < 0.05$].

ERP-Behavior Correlations

- In the left hemisphere, the OT-associated change in fear sensitivity between fearful and neutral faces was positively correlated with trait anxiety and with level of autistic traits.
  - STAI ($r = 0.538$, $p = 0.012$)
  - SRS ($r = 0.460$, $p = 0.036$)

CONCLUSIONS

- Consistent with prior research, fearful expressions and fixations to the eyes modulated neural response to faces.
- OT administration modulated perception of socially salient information:
  - OT enhanced efficiency of processing emotional faces at early perceptual stages reflecting structural encoding (N170).
  - OT decreased amplitude of a component reflective of emotion decoding (N250), consistent with reduction in anxiety to aversive social stimuli.
  - OT attenuated activity contralateral to face processing regions for fearful faces.
  - OT reduced differential N170 latency evoked by eyes versus other facial regions, increasing latency to eyes and decreasing latency to other facial regions in left hemisphere.
- Effects of OT were associated with individual differences in anxiety and level of autistic traits.

IMPLICATIONS

- Findings align with theoretical accounts that involve both decreased processing of social threats and increased perceptual salience of social cues as mechanisms underlying OT's effect on social behavior.
- Behavioral correlations suggest intranasal OT induces greater changes in neural correlates of structural face encoding for individuals with higher anxiety and higher autistic traits.
- Results emphasize the importance of applying temporally sensitive imaging methods to examine treatment-associated changes in processing efficiency and add to evidence supporting the potential utility of oxytocin to ameliorate autistic symptomatology.
- Research in progress in our lab explores the modifiability of this response in adults with ASD.

REFERENCES

Bethlehem, R. A. I, Baron-Cohen, S., van Honk, J., Auyeung, B., & Bos, P. A. (2014). The oxytocin paradox. *Frontiers in Behavioral Neuroscience, 48* (8), 1-5.

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