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Short communication

Intranasal oxytocin and the neural correlates of infant face processing in non-parent women

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ABSTRACT

Event-related potentials (ERPs) have been widely employed to identify different stages of face processing, with recent research probing the neural dynamics of adult's processing of infant faces. Infant faces represent a salient category of visual stimuli, especially in parents, likely prioritized for processing through activity of the oxytocinergic system. Here we employed a randomized, double-blind, and within-subject crossover study of 24 non-parent women to examine the impact of intranasal oxytocin administration, relative to placebo, on processing infant and adult faces. Our main finding was that, relative to placebo, the P300 ERP elicited by infant faces was greater than the P300 elicited by adult faces in the oxytocin condition. Therefore, oxytocin administration may enhance the allocation of attention towards infant cues, even in non-parent women.

1. Introduction

Accumulating research has evidenced the inherent salience of infant socio-emotional signals to women during their transition to motherhood (Feldman, 2015). Activity of the oxytocinergic system may be one mechanism through which these infant cues become more salient to mothers (Feldman, 2015; Ferrey et al., 2016). Oxytocin administration in non-parent females listening to infant cries was associated with decreased activity in neural circuits implicated in processing aversion, and increased activity in neural circuits implicated in empathy and bonding (Riem et al., 2011). Another study reported oxytocin administration increased self-reported preference for infant, relative to adult, faces (Marsh et al., 2012), further supporting the proposal that the oxytocinergic system modulates responding to infant cues (Feldman, 2015; Ferrey et al., 2016). However, additional research is needed to identify the stages of infant cue processing modulated by oxytocin, beginning with non-parent women to interrogate the oxytocinergic system prior to any biological or environmental factors associated with pregnancy and parturition.

Many aspects of parent responding to infant cues are thought to be rapid and intuitive (Papousek, 2000; Rutherford & Mayes, 2011); therefore, employing temporally-sensitive techniques that can disentangle oxytocin modulation of perceptual, attentional, and cognitive processing of infant cues are warranted. Given their excellent temporal resolution, event-related potentials (ERPs) elicited by infant stimuli have been employed to understand variation in the stages of infant cue processing in parents and non-parents (Maupin, Hayes, Mayes, & Rutherford, 2015; Young et al., 2016). The N170 is associated with structural encoding of faces (Bentin, Allison, Puce, Perez, & McCarthy, 1996), and may be modulated by infant emotional expression and parental status of participants (Proverbio, Brignone, Matarazzo, Del Zotto, & Zani, 2006; Rodrigo et al., 2011). The P300 indicates attention allocation to salient stimuli (Luck, 2005; Ritter & Ruchkin, 1992), and may be enhanced by infant affect and familiarity (Bick, Dozier, Bernard, Grasso, & Simons, 2013; Doi & Shinohara, 2012; Proverbio et al., 2006). Finally, the late positive potential (LPP) evidences sustained and in-depth processing of emotionally- and motivationally-relevant stimuli (Schupp et al., 2000; Schupp et al., 2004): LPP amplitudes are larger when elicited by emotional, as compared to neutral, infant faces (Malak, Crowley, Mayes, & Rutherford, 2015; Rodrigo et al., 2011).

We employed a randomized, double-blind, within-subject crossover design to examine whether oxytocin administration, relative to placebo, would modulate the N170, P300, and LPP elicited by neutral and distress infant and adult faces. We hypothesized that relative to placebo, oxytocin administration would (1) enhance ERPs elicited by infant as compared to adult faces, and (2) differentially affect ERPs elicited by infant distress as compared to infant neutral faces, given prior work evidencing oxytocin modulation of neural responses to infant cries (Riem et al., 2011).

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2. Methods

2.1. Participants

The Human Investigations Committee at Yale School of Medicine approved all procedures (www.clinicaltrials.gov NCT02238379). Twenty-four non-parent women participated (18–31 years, M = 23, SD = 3; 23 single, 1 married; M weight 134lb, SD = 22lb). Exclusion criteria included pregnancy, hormonal birth control usage, and clinically significant medical or psychiatric illnesses. Participants gave informed consent and were compensated $160.

2.2. Apparatus and stimuli

Net Station 4.2.1 recorded EEG (250 Hz sampling rate; Cz reference) with high impedance amplifiers (Net Amps 200, 0.1 Hz high-pass, 100 Hz low-pass). An EGI 128 Hydrocel Ag/AgCl electrode sensor net was soaked in a warm potassium chloride solution, fitted per manufacturer specifications. Impedances were < 40 kΩ.

Stimuli (8.68 cm by 7.84 cm; viewing distance 74 cm; visual offset 19 ms) were grayscale photographs of 12 unique infant faces (Strathearn & McClure, 2002), 12 unique adult faces (Tottenham et al., 2009), and 24 unique houses, randomly selected, and presented on a black background. Within each face set (infants, adults), half expressed distress (6) and half were neutral (6), with identity held constant. Although face stimuli were rated within their respective databases, 20 non-parent women re-rated these faces using the Self-Assessment Manikin (Lang, Bradley, & Cuthbert, 2008) to confirm valence ("1"-"very happy, pleased, good" to "9"–"very unhappy, scared, sad". Adult distress (M = 6.77, SD = 1.08) was rated higher than adult neutral (M = 5.11, SD = 0.41) faces, t(19) = 6.50, p < 0.001. Similarly, infant distress (M = 7.39, SD = 0.80) was rated higher than infant neutral (M = 3.84, SD = 0.94) faces, t(19) = 12.50, p < 0.001.

2.3. Procedure

Two study visits (commencing 1200 h–1500 h) were scheduled four weeks apart. Prior to the visit, participants were instructed not to: exercise or drink alcohol for 24 h, drink caffeinated beverages for 12 h, and to refrain from smoking (applied to one participant) and eating for 2 h. Participants completed a urine toxicology, pregnancy test, and nasal congestion screen (www.nwentallergy.com). For safety monitoring, blood pressure, heart rate, and temperature were measured routinely.

In this randomized double-blind, within-subject crossover design, participants received oxytocin (24 IU) or placebo (i.e., saline) from identical nasal sprays prepared by the Investigational Pharmacy at Yale-New Haven Hospital, using United States Pharmacopeia oxytocin powder. After priming the spray, participants administered four puffs, alternating nostrils, with 15 s between puffs. After 45 min, participants completed the ERP task: one trial consisted of central fixation (jittered 400–600 ms), stimulus presentation (1000 ms), and blank screen (1000 ms). After 9 practice trials, there were 4 blocks of 108 experimental trials. Within each block, 48 face (50% infant; 50% distress) and 48 house stimuli were presented (12 non-ERP catch trials were included, requiring a response to a red stimulus, M accuracy = 99.96%). House trial frequency matched face trial frequency to avoid oddball effects. Houses were included to ascertain whether oxytocin uniquely affected face processing. T-tests comparing the house-elicited P300 and LPP were unaffected by oxytocin versus placebo (p's > 0.17). Comparing the house-elicited N170 across left and right hemispheres with a repeated measures ANOVA also evidenced no modulation by spray type (p's > 0.98). The task took approximately 25 min.

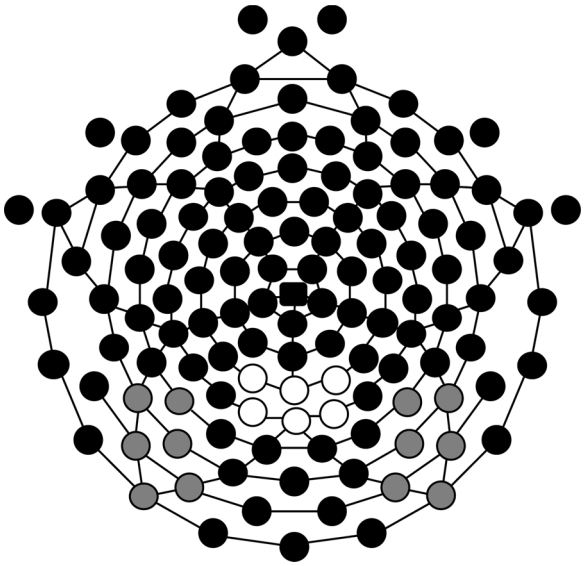

Fig. 1. Electrode layout for the 128 Hydrocel Ag/AgCl electrode sensor net (EGI; Tucker, 1993). Electrodes used in the N170 analysis are shaded in gray and electrodes used in the P300 and LPP analyses are shaded in white.

2.4. Analysis

Analyses were performed blind to spray type. EEG data was preprocessed with Net Station 4.5.7. Data was 30 Hz low-pass filtered and segmented into 1-s epochs, −100 ms to 900 ms post-stimulus onset. Bad channels (> 200 μV; where > 40% of trials were affected) were replaced through spline interpolation. Ocular Artifact Removal (Gratton, Coles, & Donchin, 1983), using a blink slope threshold = 14 μV/ms, was applied. Eye-blink and movement thresholds were 150 μV. Remaining channels with artifacts in > 40% of trials were replaced with spline interpolation. EEG data were re-referenced to the average reference, baseline-corrected, and averaged within each condition (M face trials per stimulus = 44/48; M house trials = 174/192).

N170 amplitude (149–225 ms) was averaged in left (58,59,64,65,68, and 69) and right (89,90,91,94,95, and 96) lateral posterior electrodes; P300 (200–400 ms) and LPP (500–900 ms) amplitudes were averaged over central scalp electrodes (61, 62, 67, 72, 77, 78; Fig. 1) (Malak et al., 2015; Noll, Mayes, & Rutherford, 2012). ERPs were visually inspected and confirmed for each participant. All ANOVAs were conducted with Condition (Oxytocin, Placebo), Face Age (Infant, Adult), and Expression (Neutral, Distress) as within-subject factors, and additionally Hemisphere (Left, Right) for the N170.

3. Results

3.1. N170

Infant Faces elicited a larger N170 than Adult Faces, F(1,23) = 5.11, p = 0.03, $\eta^2_{partial}$ = 0.18. Distress Faces elicited a greater N170 than Neutral Faces, F(1,23) = 11.38, p = 0.003, $\eta^2_{partial}$ = 0.33. There was no main effect of Condition, F(1,23) = 1.06, p = 0.31, $\eta^2_{partial}$ = 0.04, and Condition did not interact with the other variables, p's > 0.16 (Fig. 2).

3.2. P300

Infant Faces elicited a larger P300 than Adult Faces, F(1,23) = 5.21, p = 0.03, $\eta^2_{partial}$ = 0.19, which was qualified by a Face Age by Condition interaction, F(1,23) = 5.20, p = 0.03, $\eta^2_{partial}$ = 0.18. Paired-sample *t*-tests evidenced the Infant Face P300 was greater than the Adult Face P300 following Oxytocin, t(23) = 3.89, p < 0.001,