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Effect of Oxytocin Administration on Mirror Neuron Activation

Mackenzie Hepker
mhepker@pugetsound.edu

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Mackenzie Hepker & David Andresen
University of Puget Sound

Introduction

- **Mirror neurons** are a class of neurons that activate both when performing an action or experiencing a sensation ***and*** when observing another doing so (Rizzolatti and Craighero, 2004).
- **Oxytocin**, commonly known as the "love" or "cuddle" hormone, is naturally produced in brain and has been shown to mediate similar **social perceptions and behaviors** as the mirror neuron system (MNS)—including **empathy, trust, generosity, emotion recognition, social cognition, and intergroup perception** (i.e. in-group favoritism and out-group derogation).
- Thus, ***oxytocin is heavily implicated in the function of the MNS.*** Perry et al. (2010) found that oxytocin administration increases human Mu wave suppression (indicative of mirror neuron activity) while perceiving biological motion. Oxytocin also increases emotion recognition and social cognition in autistic individuals.
- **This is only the second study** attempting to conclusively link oxytocin to MNS activity, in which we hypothesize the hormone plays a critical role, **and the first to do so while perceiving social gestures, and in an intergroup context**.

Question

- **Does oxytocin play an influential role in the function of the mirror neuron system?**
- **Does oxytocin influence mirror neuron activation in an intergroup context?**

Methods

Participants

- 13 participants analyzed*; all male
- all Puget Sound undergraduate students

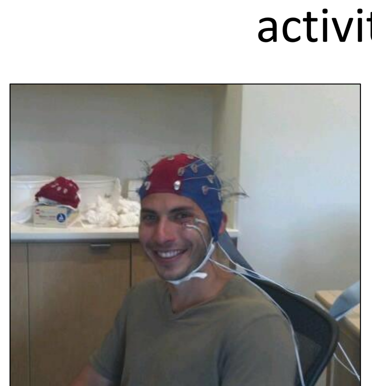
*note: as of May 2014, 19 subjects have been analyzed

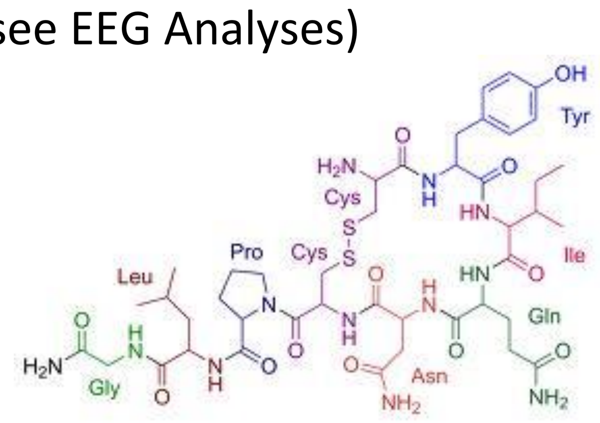
Oxytocin Administration

- Each participant had one session with oxytocin and one session with placebo (order unknown to participant)
- 40 IU oxytocin (1 ml) administered via intranasal spray (18-40 IU typical for most studies); placebo spray administered accordingly

Electroencephalography (EEG; Biosemi)

- 32 electrodes spanning entire scalp, attached with gel through a cap
- EEG converts electrical activity from cortical neurons into "brain waves" associated with various types of neural activity (see EEG Analyses)





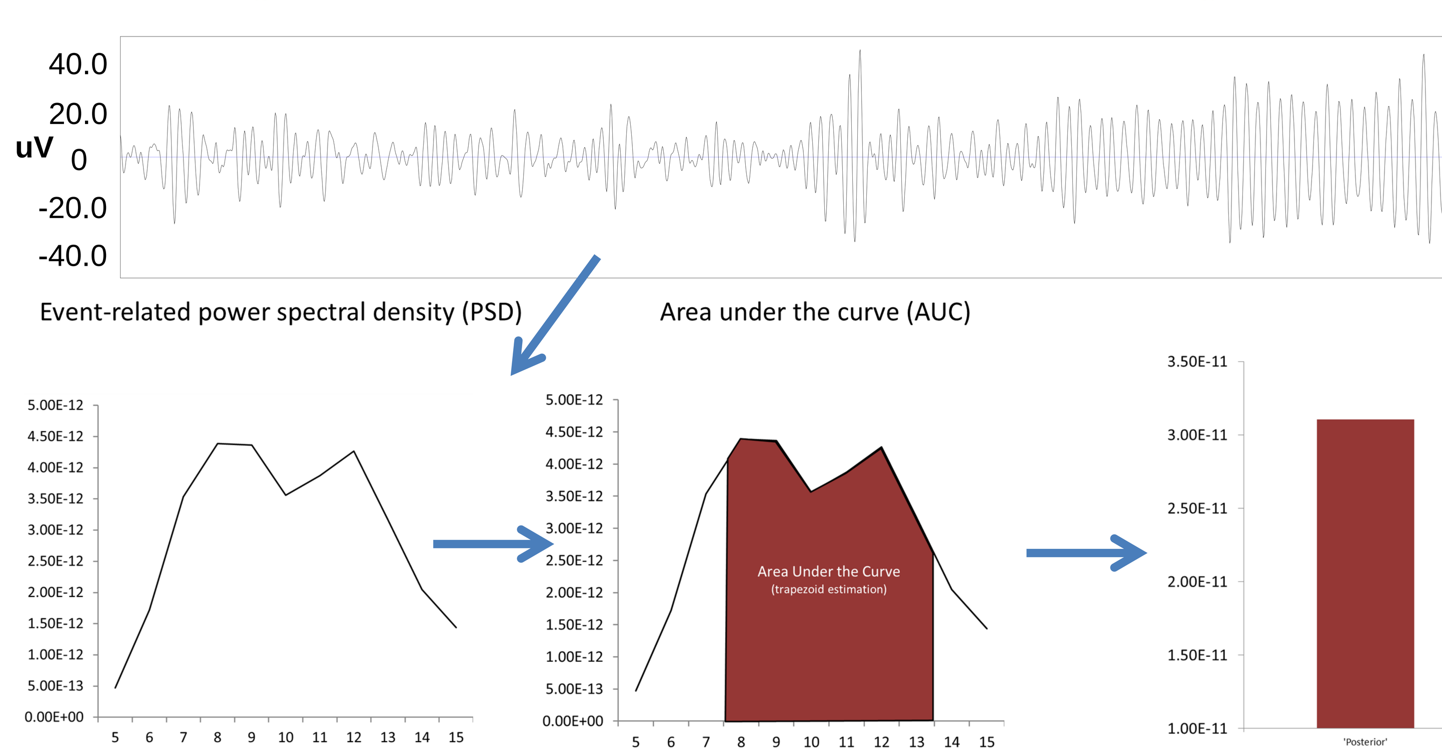
EEG Task – Gesture Recognition

- Ten-second movies of two White (in-group) and two Black (out-group) individuals making social hand gestures, half male and half female
  - social processing engages the MNS.
- Half familiar gestures (e.g., thumbs up), and half unfamiliar (American Sign Language)
- Cover task: Participants determined whether each gesture was familiar or unfamiliar and pressed one of two keys after the movie was over

•*Two EEG sessions**: One with oxytocin administration and one with placebo*
*per subject

EEG Analyses

- Mirror neuron activity has been shown to be significantly correlated with "Mu wave suppression," or reduced energy in oscillatory electrophysiologial activity in the **Mu wave band** occurring in the **8-12 Hz frequency range** (Oberman et al., 2005).
- Mu-waves indicate that the MNS is "idling;" the **suppression** of these waves indicates synchronized neuron activation
- Spectral power curve indicates amount of neuron activity at various frequencies
- We expected that Mu-wave suppression would be higher for White actors than Black actors in conjunction with past studies, and that oxytocin would increase Mu suppression and potentially affect this relationship



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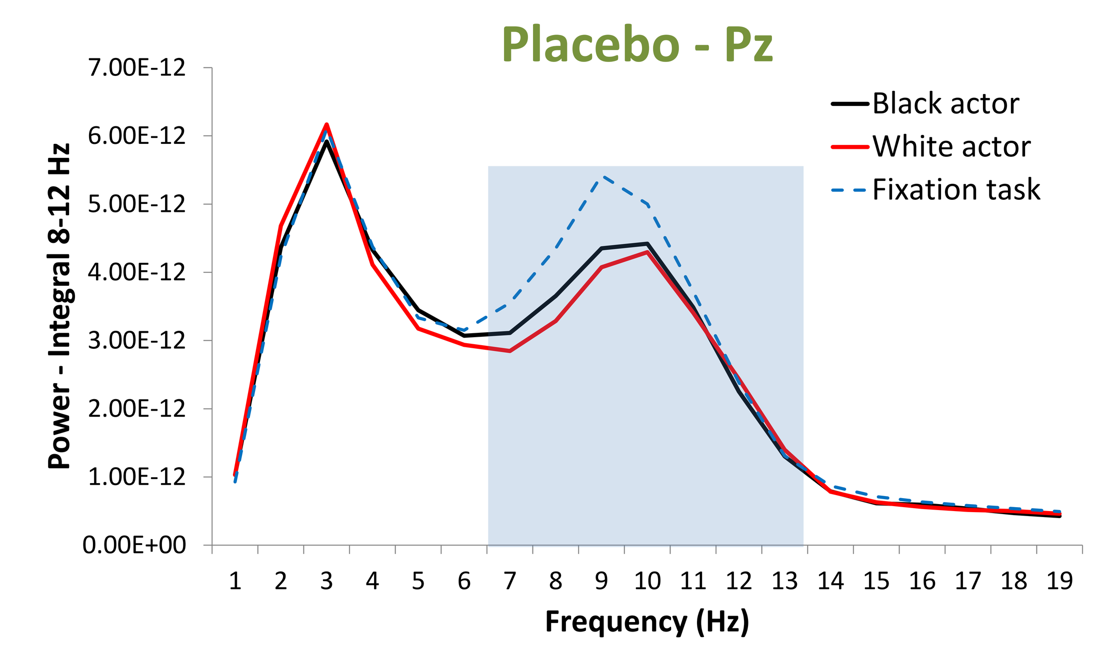
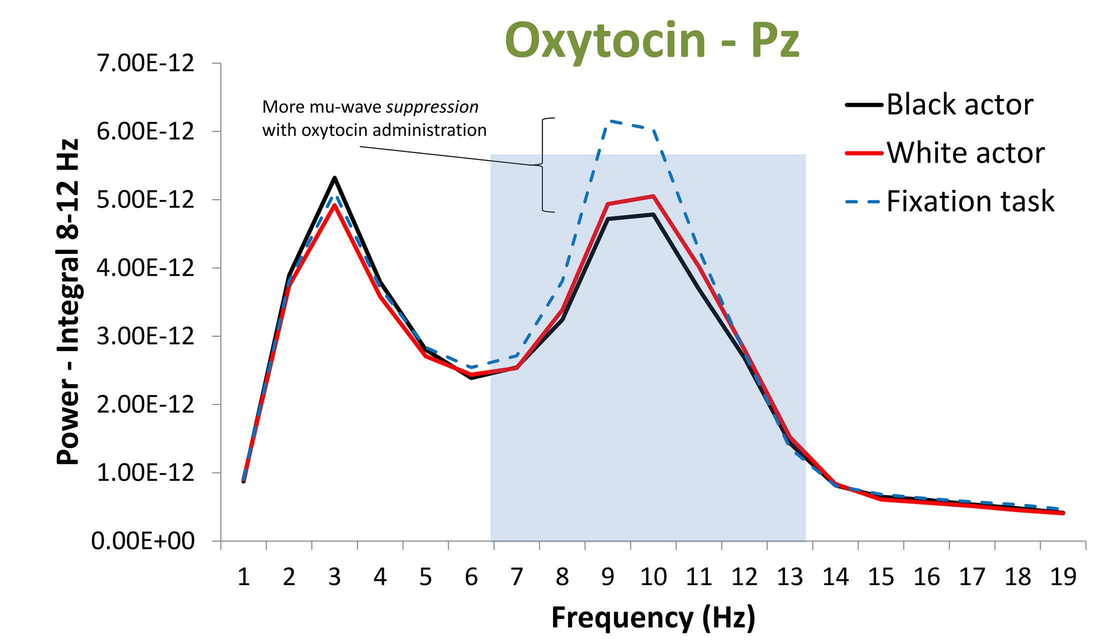
Results : Spectral Power





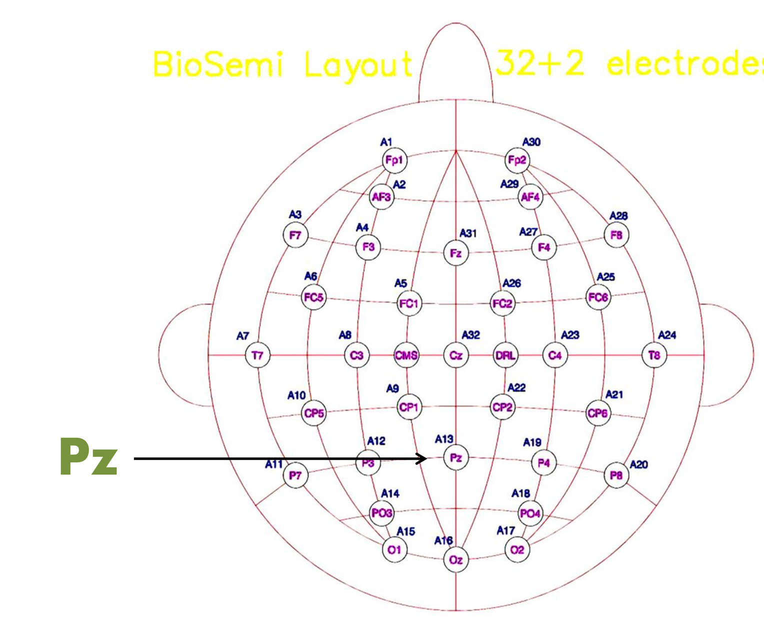
- All figures contain data averaged across all 13 participants.
- **Pz** = central parietal electrode (region most associated with MNS activation

Less is more!

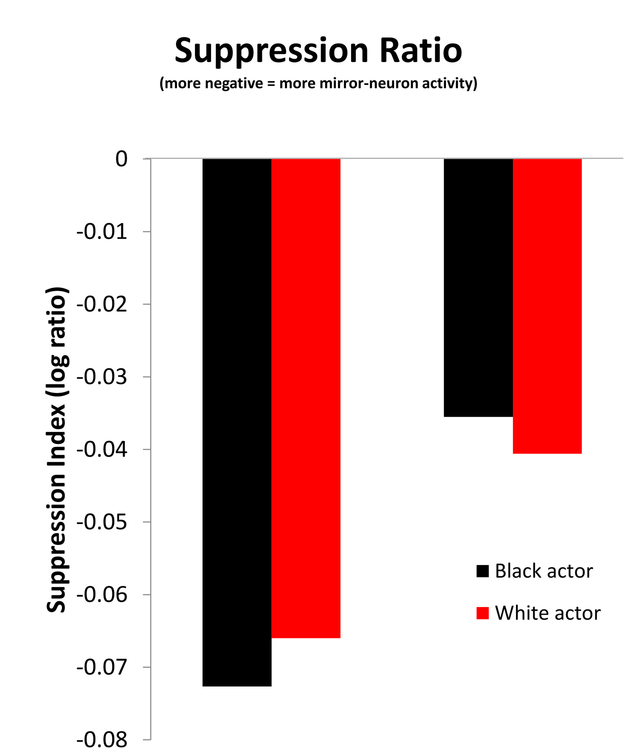
Suppression of the 8-13 Hz Mu wave (blue region) indicates greater mirror neuron activation. Here, less spectral power (in microvolts) in the Mu range indicates greater mirror neuron activity.

Two main findings:

- Greater Mu suppression (more mirror neuron activity) when observing individuals than fixation point control
- Greater overall Mu suppression while perceiving both white and black actors relative to the control when given oxytocin than when given placebo



Results : Suppression Index



Less area under curve = more mu suppression (mirror neuron activation).
Suppression Index: log of the mu-activity for black actors/white actors divided by fixation.

$$\log \frac{Black\ or\ White}{Fixation}$$

Zero indicates same amount of mu activity for both fixation task and task of interest; **negative values show mu-suppression.**

Main Effect of Oxytocin on MNS:

- Subjects exhibited **more mirror-neuron activity towards both black and white individuals when given oxytocin** than when given placebo (**p = 0.06**, n = 13).
- There may be an interaction between ethnicity, oxytocin and mirror neuron activity, but it is not yet significant (p = 0.35).

- This figure contains averaged data from all electrodes across all participants.

Conclusions

- A nearly significant positive effect of oxytocin on mirror neuron activity, even with such a small sample size, indicates that **oxytocin influences mirror neuron activation and may play a role in regulating social perception via the MNS.**
- **Oxytocin *may* influence intergroup perception via the MNS;** increasing the sample size will shed more light on this possibility.

Further research is needed to conclude the role of oxytocin in normal MNS function and intergroup perception, such as the use of antagonists, measuring oxytocin levels in serum given various social stimuli, and expanded experimentation. It would also be beneficial to see if the MNS is equally responsive in negative, positive and neutral contexts (all of which are enhanced by oxytocin). More data for this study will be collected Fall 2013.

Acknowledgements

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