

Oxytocin Modulates Neural Circuitry for Social Cognition and Fear in Humans



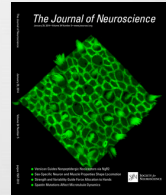
Peter Kirsch¹, Christine Esslinger,¹ Qiang Chen,^{2,4} Daniela Mier,¹ Stefanie Lis,¹ Sarina Siddhanti,^{3,4} Harald Gruppe,¹ Venkata S. Mattay,^{2,4} Bernd Gallhofer,¹ and Andreas Meyer-Lindenberg^{2,3,4} (2006) Oxytocin modulates neural circuitry for social cognition and fear in humans. *J. Neurosci.* 25(40):11489-11493

Glen Francisco
Glen Malaret
Cornell University
BIONB4110

The Journal



- ☞ Published by the Society for Neuroscience
- ☞ Published weekly
- ☞ Impact Factor (2011) 7.115



The Institutions



- ☞ One of the oldest universities in Germany.
- ☞ Founded in 1607 in Gießen



National Institutes of Health

The People



- ☞ Peter Kirsch, PhD
- ☞ PhD University of Wuppertal
- ☞ Head of Clinical Psychology; Central Institute of Mental Health in Mannheim
- ☞ Former Prof. of Psychology Justus-Liebig University



- ☞ Dr. Christine Eißlinger
- ☞ Neurologist
- ☞ Former staff member - Justus-Liebig University Psychiatry

- ☞ Qiang Chen, Ph. D
- ☞ BA & MA Beijing University
- ☞ PhD Industrial Engineering Arizona State University



- ☞ Dr. Daniela Mier
- ☞ Former staff member – Justus-Liebig University Psychology
 - ☞ Head of Social-affective Neuroscience RG - Central Institute of Mental Health in Mannheim



- ☞ Dr. Stefanie Lis
- ☞ MD Justus-Liebig University
 - ☞ Former staff JL University – Psychiatry
 - ☞ Head of Experimental Psychology - Department of Psychosomatic Medicine and Psychotherapy - Central Institute of Mental Health in Mannheim
- ☞ Dr. Harald Gruppe
- ☞ Faculty Researcher Justus-Liebig University – Department of Psychology

- ☞ Venkata S. Mattay, MD
- ☞ MD Andhra University
 - ☞ Residencies:
 - ☞ Neurology UVA Med
 - ☞ Nuclear Medicine George Washington University
 - ☞ Staff Scientist National Institute of Mental Health



- ☞ Prof. Dr. Bernd Gallhofer
- ☞ MD University of Graz
 - ☞ Professor of Psychiatry
 - ☞ Head of Centre for Psychiatry and Psychotherapy Justus-Liebig University School of Medicine



- ☞ Prof. Dr. Andreas Meyer-Lindenberg
- ☞ Medical Director of Department of Psychiatry and Psychotherapy - Central Institute of Mental Health in Mannheim

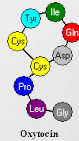


Purpose | Hypothesis

- ☞ **Purpose**
- To see if amygdala function is modulated by oxytocin.
- ☞ **Hypothesis**
- “...that oxytocin would reduce amygdala activation in humans and modulate its participation in functional networks related to fear processing”.

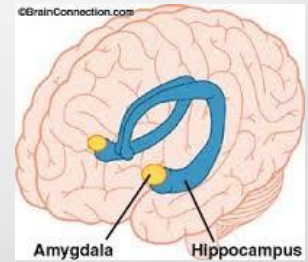
Background

- ☞ Oxytocin - “The Love Hormone”
 - ☞ Neuromodulator
 - ☞ Produced in Posterior Pituitary Gland
 - ☞ Stored in Herring Bodies
- ☞ Associated with:
 - ☞ Lactation
 - ☞ Labor induction
 - ☞ Pro-social Behavior (trust and bonding)
 - ☞ Sexual arousal



Background (cont.)

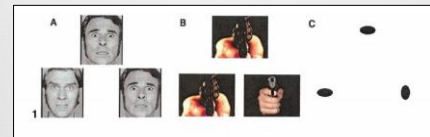
- ☞ Amygdalae
 - ☞ Associated with fear response and anxiety
 - ☞ Fight or flight response
 - ☞ Stimulation release hormones such as
 - ☞ Cortisol, Adrenaline, etc.
 - ☞ Networks with PFC and brain stem regions
 - ☞ Fear learning



Methods (Participants)

- ☞ Participants were healthy, right handed males (age 26.7 ± 3)
- ☞ No history of psychiatric or neurological illness
- ☞ Alcohol and nicotine abstinence 12h prior to studies
- ☞ Self administration of Oxytocin 50min before start of scan
- ☞ Self reported scores for: STAXI, SAM, MDBF as controls

Methods (fMRI)

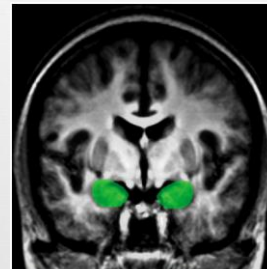


fMRI

- ☞ Measures Blood Oxygen Level – Dependent (BOLD) signal changes in the brain
- ☞ Correlate deoxygenation with brain activity in regions of interest (ROI)

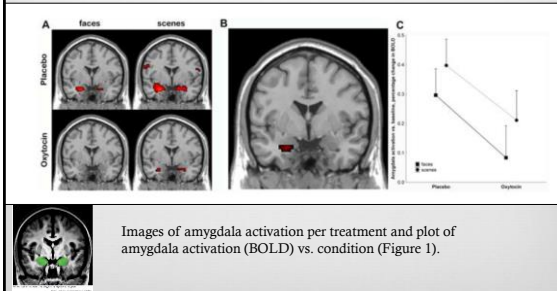


Amygdalae in the fMRI

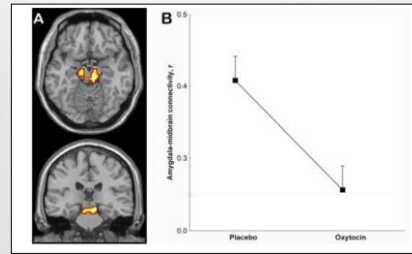


An fMRI scan of the brain. The amygdalae is highlighted in green.
Image courtesy of Professor Paul Whalen, Dartmouth Department of Psychological and Brain Sciences.

Mean amygdala activity is significantly lower under the oxytocin condition



Mean connectivity between the amygdalae and midbrain regions is significantly lower under the oxytocin condition



Activation and connectivity were significantly lower under oxytocin

Table 2. Significant differences in amygdala activation and connectivity

Area	Talairach coordinates	T value
Activation		
Placebo > oxytocin		
Left amygdala (main effect)	-24, 3, -24	2.59
Left amygdala (faces task)	-24, 3, -24	2.12
Left amygdala (scenes task)	-21, 0, -24	1.88*
Connectivity		
Placebo > oxytocin		
Midbrain	9, -27, -15	3.50
Midbrain	-18, -18, -12	2.75

Self-reported behavior was not significantly different

Table 1. Behavioral data

	Placebo before scan	Placebo after/during scan	Oxytocin before scan	Oxytocin after/during scan	t test (after/during scanning)
Faces task					
Accuracy (%)	98.89 (13.3)	99.39 (1.7)	99.39 (1.7)	99.39 (1.7)	p = 0.77
Reaction time (ms)	1094 (202)	1102 (176)	1102 (176)	1102 (176)	p = 0.91
Scenes task					
Accuracy (%)	99.76 (1.8)	100% (0.0)	100% (0.0)	100% (0.0)	p = 1.00
Reaction time (ms)	898 (177)	899 (140)	899 (140)	899 (140)	p = 0.99
STAMP					
State	10.1 (0.4)	10.2 (0.8)	10.6 (1.8)	10.3 (0.8)	p = 0.23
Trait	17.1 (3.8)	17.2 (3.8)	18.3 (3.4)	18.3 (3.4)	p = 0.23
MEQSF					
Attentional	31.3 (6.3)	34.1 (6.8)	33.9 (4.8)	34.1 (6.8)	p = 0.96
Widerfulness	30.1 (9.2)	24.1 (8.9)	32.5 (6.4)	26.2 (7.4)	p = 0.28
Emotional valence*	34.2 (4.8)	35.0 (4.5)	35.5 (1.7)	35.4 (5.4)	p = 0.56
SIAMF					
Attentional	3.7 (0.90)	4.3 (0.70)	3.8 (0.68)	4.1 (0.94)	p = 0.42
Dominance*	3.5 (0.64)	3.6 (0.61)	3.8 (0.54)	3.6 (0.81)	p = 1.00
Emotional valence*	3.9 (0.92)	3.5 (0.68)	3.6 (0.51)	3.7 (0.88)	p = 0.84

Main Findings

- ☞ Results showed reduced amygdalae activity in the presence of oxytocin
- ☞ Reduced connectivity between midbrain and amygdalae

Discussion

“Data fits well with the reported anxiolytic effects of oxytocin”

“Reduction in amygdalae signaling was more significant for socially relevant stimuli... indicating that social and nonsocial fear may depend on dissociable neural systems”

Oxytocin may be an important component to social processes such as fear and prosocial behavior through this mechanism

Other Studies



Decreased amygdala activity linked to hypersociability (Meyer-Lindenberg et al., 2005)

Increased amygdala activation linked to social avoidance and phobia (Stein et al., 2002)

Oxytocin shown to increase aggression toward intruders and inhibited aggression toward young in rats (Bosch et al., 2005)

Oxytocin knock-outs show increased unprovoked aggression and infanticide in rats (Ragnauth et al., 2005)

Questions?

Discussion questions



1. Describe the chemical properties of oxytocin. What other molecules share similar characteristics?
2. What kinds of behaviors do increases/decreases in oxytocin levels produce, based on previous animal studies? How valid is it to assume oxytocin directly causes these behaviors?
3. What concerns do you have about the procedure (subjects, measuring methods, etc...): Is an fMRI a good enough technique for this study? Should women have been used too?
4. Based on this and previous studies mentioned, what role does the amygdala AND oxytocin play in fear and prosocial behavior?
5. What are some implications of the knowledge gained from this study? What sort of future directions could we go?