The Effects of Intranasal Oxytocin on the Neural Circuitry of Social Cognition

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INTRODUCTION

Oxytocin (OT) is a neuropeptide synthesized in the hypothalamus, known for its multiple functions in the human body. OT plays an important part in social bonding and sexual reproduction and, in recent years, emerging evidence suggests that OT modulates neuronal activity in brain regions that play a main role in social cognitive processes. This effect appears to be due to the binding of OT to specific receptors in particular brain regions that have not been fully explored. Advances in human non-invasive neuroimaging techniques have allowed researchers to begin to reveal the neurobiological basis of human social behavior. The identification of the brain regions affected by OT during a social task might begin to shed a light on the neurobiological foundations of its effects in human social cognition and behavior.

OBJECTIVE

The present study aims to assess and summarize the current knowledge on how exogenous OT influences the activity of different brain areas during social cognitive tasks.

METHODS

❖ Search Strategy

We conducted a systematic review assessing placebo-controlled studies that used functional magnetic resonance imaging to investigate the effects of intranasal OT in the brain of healthy subjects. we used a systematic search strategy following the PRISMA guidelines for systematic reviews. we identified nineteen original studies that met our eligibility criteria.

❖ Data Analysis

The selected studies were screened with the purpose of determining OT’s effect on the activity of different brain areas. Collected information: sample size, population features (including mean age, gender and race), study design, dose of OT, time between OXT administration and fMRI scan, total scan duration, description of the social task and the brain areas which responded to the administration of OXT.

❖ Selection criteria

Inclusion criteria: 1) primary research studies using intranasal OT in humans and measuring brain activity with fMRI during social-cognitive tasks based on visual-stimuli; 2) double-blind, placebo-controlled design; 3) studies with healthy participants with no history of neurological, psychiatric or endocrine disease, no intake of medication that could interfere with the experiment and no drug or alcohol abuse.

❖ Assess the risk of bias

To assess the methodological quality of the included studies, the authors determined the risk of bias using the Cochrane Collaboration’s tool. We found the risk of bias was reasonably small for each individual study.

CONCLUSION

RESULTS

The aforementioned results refer to the specific neural effects of exogenous OT compared to placebo. **Table 1** summarizes the main brain areas affected by OT.

PART OF THE BRAIN STUDY	TASK	CONTRAST	EFFECT	
			Left	Right
AMYGDALA				
Domes et al.	Implicit facial emotion processing	All emotions (valenced stimuli)	=	↓
Domes et al.	Explicit facial emotion processing	Fearful>Neutral	↑	=
Kirsch et al.	Implicit facial emotion processing	Fearful>Neutral	↓	=
Petrovic et al.	Aversely conditioned face processing	Direct gaze	=	↓
INSULA				
Domes et al.	Explicit facial emotion processing	Fearful>Neutral Happy>Neutral	↑ ↑	= =
Luo et al.	Implicit facial processing	Females: FN>NN	↑	=
Rilling et al.	Cooperation game/interaction	Reciprocated cooperation	↑	↑
CINGULATE CORTEX				
Bos et al.	Empathy for pain	Pain condition>Control condition	↓	↓
Kanat et al.	Implicit facial processing	Fearful>Happy	↓	=
Rilling et al.	Cooperation game/interaction	HP cooperation>CP cooperation HP defection>CP defection	= ↓	↑ ↓
HIPPOCAMPUS				
Hu et al.	Reinforcement association learning task	Response phase to Social Female	↔	↑
Wittfoth-Schardt et al.	Implicit facial processing	Unfamiliar child>Familiar child	↓	=
CAUDATE NUCLEUS				
Feng et al.	Cooperation game/interaction	Reciprocated cooperation (males>females)	↑	↑
PUTAMEN				
Rilling et al.	Cooperation game/interaction	Reciprocated cooperation	d	↑
Rilling et al.	Cooperation game/interaction	Reciprocated cooperation (males>females)	=	↑
TEMPORAL LOBE				
Groppe et al.	Social incentive delay task	Social reward anticipation	↑	=
Hecht et al.	Animations of moving shapes	Social relationships>Physical relationship	↓	=
Petrovic et al.	Aversely conditioned face processing	Direct gaze	=	↓
FRONTAL LOBE				
Groppe et al.	Social incentive delay task	Social punishment anticipation	↓	↓
Hu et al.	Altruistic interaction	Help>Punish (computer decision) Help>Punish (self-decision)	↑ ↓	= ↓

↓: decreased activity; ↑: increased activity; =: no alterations in the activity.

In recent years, several OT-based fMRI studies have revealed promising findings, allowing a significant advance to our knowledge of the brain regions in which social cognition is modulated by OT. In this review, we found evidence of OT’s effects in social brain areas in every included study. The most frequently identified brain region whose activity was affected by OT was the amygdala, followed by the frontal and temporal lobes. Altogether, our findings allow the development of an approach that could be used to demonstrate differential OT modulation of brain circuitry between psychiatric patients and healthy controls, regarding the identification of treatment targets and OT-based therapies. We rely on future work to consider these factors in order to unify the current findings and to define the modulatory role of OT on the neurobiological basis of human sociality.

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