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# Oxytocin promotes attention to social cues regardless of group membership

Michaela Pfundmair *, Clarissa Zwarg, Markus Paulus, Anne Rimpel

LMU Munich, Leopoldstr. 13, 80802 Munich, Germany

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ABSTRACT

The social saliency account proposes that oxytocin (OT) plays a major role in modulating attentional shifts toward social cues at early stages of processing. We investigated how OT promotes early attention toward nonsocial and social stimuli and explored differences between in-group- and out-group-related social cues. After participants intranasally self-administered OT or placebo, they were eye-tracked while observing a nonsocial and social cues that were assigned to the in- or out-group by a minimal group paradigm. Participants under placebo did not differ in their fixation durations between stimuli, whereas participants administered OT increased gaze durations toward social but not nonsocial stimuli. In this early stage of processing, no in-group bias occurred: in-group- and out-group-related social cues were fixated equally long. These findings support that OT works by a simple illumination of social cues that seem to be processed regardless of social identity aspects at early stages of attention.



## 1. Introduction

Oxytocin (OT) is a nonapeptide that showed some promising effects at the time of its discovery. After detecting its influence on maternal behavior of female rats (Pedersen and Prange, 1979), research on human OT and its effect on positive social behaviors began intensely, revealing effects on trust (Kosfeld et al., 2005) and mind-reading (Domes et al., 2007). Both these groundbreaking findings are seen as critical today (Nave et al., 2015; Radke and de Bruijn, 2015). Moreover, formerly known as the "love" hormone, OT regularly reveals unfavorable outcomes (e.g., elevating envy and gloating; Shamay-Tsoory et al., 2009). The uncertainty of predicting OT's effects has risen the fundamental question of how OT works. Researchers have argued that it is unlikely that the hormone modulates complex high-order mental processes but rather works by a more general mechanism (Churchland and Winkielman, 2012). A key candidate for this mechanism is social saliency.

This account proposes that OT plays a major role in modulating attentional shifts toward social cues at early stages of attentional processing (Shamay-Tsoory and Abu-Akel, 2016). Evidence for this account was provided by findings showing that OT increases attentional shifts toward emotional cues (Domes et al., 2013; Tollenaar et al., 2013) and elevates the number of saccades toward the eye region (Gamer et al., 2010; Guastella et al., 2008). The focus on social but not nonsocial cues has been supported by findings showing OT to affect memory (Rimmele et al., 2009) and arousal (Norman et al., 2011) for human but not for nonhuman stimuli, and to lead to stronger brain activities when faced with socially relevant than irrelevant stimuli (Kirsch et al., 2005).

Interestingly, OT also seems to promote a stronger differentiation between in-group and out-group members. It makes people more trusting and cooperative toward their in-group but not their out-group (De Dreu et al., 2010; Ten Velden et al., 2014) and promotes in-group compliance and conformity (Edelson et al., 2015; Stallen et al., 2012). These findings, however, are behavior related. An open question remains whether or not the in-group bias (i.e., the tendency to favor the in-group above the out-group; see Brewer, 1979) under OT already occurs at early stages of processing.

We therefore investigated how OT modulates early attentional shifts toward nonsocial and social stimuli. In an attempt to replicate previous findings, we predicted OT to promote attention to social cues more than to nonsocial cues in early stages of attention. Moreover, we examined whether OT increases attentional shifts more toward in-group than toward out-group cues. By including a measure of social-cognitive understanding, we aimed to examine whether OT indeed only affects more general and early information-processing mechanisms or also higher-order processes.

* Corresponding author at: Department of Psychology, LMU Munich, Leopoldstr. 13, 80802 Munich, Germany.
*E-mail addresses:* michaela.pfundmair@psy.lmu.de (M. Pfundmair), C.Zwarg@campus.lmu.de (C. Zwarg), markus.paulus@psy.lmu.de (M. Paulus), A.Rimpel@campus.lmu.de (A. Rimpel).

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To test these research questions, participants intranasally self-administered OT or placebo and were eye-tracked while observing a nonsocial cue and social cues that were assigned to the in- or out-group by a minimal group paradigm. The eye-tracking task was based on an action anticipation paradigm. Those paradigms have the advantage of measuring both simple perceptions of stimuli in early stages of attention as well as cognitive processing in later stages of visual processing. Early stages of processing were assessed by measuring participants' visual attention on the agents. Social-cognitive understanding was assessed by investigating participants' anticipatory gaze shifts to the respective agent's goal target. Goal prediction has been argued to be a key aspect of social cognition (Eshuis et al., 2009; Flanagan and Johansson, 2003).

## 2. Method

### 2.1. Participants and design

Sixty students (mean age = 22.16 years, $SD$ = 2.94; 30 female, 30 male) from a German university participated in this study. Exclusion criteria were significant medical or psychiatric illness, medication, smoking more than five cigarettes per day, drug or alcohol abuse, allergies, hypersensitivity to preservatives in the OT spray, and (for female participants) pregnancy. One participant who did not comply with the instructions was excluded, resulting in the above sample. Participants were instructed to refrain from smoking or drinking (except for water) for 2 h before arrival. The experiment was approved by the local ethics committee.

The study followed a 2 (substance: OT vs. placebo) between-subjects × 3 (cue: in-group vs. out-group vs. nonsocial) within-subjects design with random and double-blind assignment to conditions.

### 2.2. Procedure and materials

After written informed consent was obtained, participants self-administered either 24 I.U. (three puffs per nostril) of OT (Syntocinon Spray, Defiante; $N$ = 30) or a placebo (sodium chloride solution; $N$ = 30) under experimenter supervision. Participants were uninformed about the content of the spray; they were only told that they would receive a hormone or placebo in low dosage.

After 40 min, they underwent a minimal group paradigm according to Cadinu and Rothbart (1996) for approx. 3 min. Participants were presented with 10 pairs of paintings on a computer display each containing one painting by Heckel and one by Pechstein. For each of these pairs, they were asked to indicate which of the two pictures they preferred. Irrespective of their choices, participants were then informed that they preferred more paintings of the artist Pechstein and were consequently assigned to the Pechstein group. Moreover, they were told that participants who preferred paintings of Heckel were assigned to the second group, the Heckel group.

Following an unrelated task which involved probability assessments of everyday events and took approx. 12 min, participants were presented videos on a computer display showing a human arm assigned to the Pechstein group (in-group cue), another human arm assigned to the Heckel group (out-group cue), and a gripper arm (nonsocial cue) moving to an object while their gaze was tracked.

To check for group differences in mood, participants then completed 10 positive ($\alpha = 0.87$) and 10 negative affect items ($\alpha = 0.82$; Watson et al., 1988) on 1 = *not at all* to 5 = *very much* response scales. Finally, as manipulation checks for the minimal group paradigm, participants completed two empathy scales (Batson et al., 1997) indicating how sympathetic, compassionate, soft-hearted, warm, tender, and moved they felt toward the Pechstein ($\alpha = 0.85$) and the Heckel group ($\alpha = 0.89$) on 1 = *not at all* to 7 = *very much* response scales, and, similarly to the classic minimal group experiment (see Tajfel et al., 1971), decided how much out of hypothetical €40 they would assign to the Pechstein and to the Heckel group in any combination they wished. At the end, female participants were asked about hormonal contraceptive use (20 no contraceptive use, 8 contraceptive use, 2 no specification) and, if no, ovarian cycle stage (mean day of cycle = 10.21, $SD$ = 10.03). Then, all participants were debriefed.

### 2.3. Stimuli

Data were collected by corneal reflection on a Tobii eye tracker, on a remote 23″ monitor with integrated eye-tracking technology and a sampling rate of 300 Hz. The monitor was attached to a movable arm so that the participants' distance was always approximately 65 cm from the screen. Each participant received a five-point calibration. For stimulus presentation, the software Tobii Studio 3.3.1 (Tobii Technology, Sweden) was used.

On the basis of an established paradigm by Cannon and Woodward (2012), participants were shown three videos (resolution: 1920 × 1080; duration: 23 s) containing a ball in one corner and a cube in the opposite corner of the scene targeted by either an arm of the in-group, an arm of the out-group, or a gripper arm that served as social vs. nonsocial stimuli (order randomized between participants) (Fig. 1). Each of the three videos included three familiarization parts in which the respective arm moved across the scene to contact one of the objects (each 3.5 s), a swamp event in which the two objects were shown in reversed positions (3.5 s), and a test probe in which participants viewed the arm moving toward the objects just past midline (2 s) and then pausing in this position (5 s); all sequences were separated by 500 ms of black screen. Note that the swamp event (in this type of paradigms) allows to differentiate whether participants anticipatory gaze shifts in the test trials are indeed directed to the goal object (now at the novel location) or merely to the prior location (Cannon and Woodward, 2012; Paulus, 2011; Woodward, 1998). Before the human arms were presented, participants were instructed in written form that the following hand would either belong to a person of the Pechstein or to a person of the Heckel group. No other instructions were given.

Data on fixation durations were collected as described by Cannon and Woodward (2012): Areas of interest (AOI) were designated such that they covered the area of the respective arm (20.01%) and areas of the two objects (each 13.72%) during the 5-s test probe in which the arm paused in the critical position. The Tobii Standard Fixation Filter was used as a fixation classifier with a velocity threshold of 35 pixels/window and a distance threshold of 35 pixels.

## 3. Results

### 3.1. Manipulation check

Social identity was successfully manipulated by the minimal group paradigm: participants indicated significantly more empathy toward their in-group, the Pechstein group ($M$ = 3.49, $SD$ = 1.01), than toward their out-group, the Heckel group [$M$ = 3.25, $SD$ = 1.08; $t(59) = 2.77$, $p = 0.008$, $d = 0.23$]. Moreover they assigned significantly more money to the Pechstein ($M$ = 20.97, $SD$ = 3.74) than to the Heckel group [$M$ = 19.03, $SD$ = 3.74); $t(59) = 2.00$, $p = 0.050$, $d = 0.52$]. Substance did not affect our manipulation check. 2 (substance: OT vs. placebo) × 2 (group: Pechstein vs. Heckel) ANOVAs on the empathy and money variables neither revealed significant main effects of substance ($p \geq 0.923$ for both) nor significant interactions ($p \geq 0.148$ for both).

### 3.2. Social perception

To investigate the hypothesis that OT increases attentional shifts toward social cues, in particular in-group-related cues, we calculated a 2 (substance: OT vs. placebo) × 3 (cue: in-group vs. out-group vs. nonsocial) ANOVA on fixation durations to the arms. It revealed no main effect of substance [$F(1,58) = 0.26$, $p = 0.612$, $\eta^2_p = 0.004$].