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Oxytocin increases recognition of masked emotional faces

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Summary The neuropeptide oxytocin has been shown to improve many aspects of social cognitive functioning, including facial emotion recognition, and to promote social approach behaviour. In the present study, we investigated the modulatory effects of oxytocin on the recognition of briefly presented facial expressions. In order to diversify the degree of visual awareness for the facial stimuli, presentation duration was systematically varied. Fifty-six participants were administered intranasal oxytocin or a placebo in a double-blind, randomized, between-subjects design. Participants viewed angry and happy target faces or neutral distractors for 18, 35, or 53 ms subsequently masked by neutral faces. Participants had to indicate the presence or absence of the briefly presented target face. Discrimination indices (d') showed that oxytocin generally enhanced detection accuracy of emotional stimuli. This effect was more pronounced for the recognition of happy faces. We provide evidence that a single dose of intranasally administered oxytocin enhances detection of briefly presented emotional stimuli. The possible role of stimulus valence and recognition difficulty is discussed.

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1. Introduction

The neuropeptide oxytocin is essential for bonding and attachment in mammals (Carter et al., 2008; Donaldson and Young, 2008) and has also been associated with human social behaviour (Heinrichs et al., 2009). In recent years, a number of studies focusing on the cognitive and affective effects of oxytocin have shown that intranasally administered oxytocin promotes recognition of emotional states (Domes et al., 2007b; Di Simplicio et al., 2009; Guastella et al., 2010), recollection of social stimuli (e.g., Rimmele et al., 2009) and improves the processing of positive social cues and facial expressions in particular (e.g., Unkelbach et al., 2008; Di Simplicio et al., 2009; Gamer et al., 2010).

Despite these recent advances in characterizing the effects of oxytocin on the processing of socially relevant stimuli such as emotional facial expressions, it is still unclear whether the reported effects of oxytocin are entirely due to modulations in evaluation and appraisal of these stimuli (Guastella et al., 2008) or whether oxytocin also modulates earlier stages of stimulus processing, such as visual attention and awareness (Guastella et al., 2009). Thus, in the present study, we used short presentation times of emotional stimuli in order to assess the effects of oxytocin on recognition of angry and happy facial stimuli under conditions of limited awareness. In order to vary the degree of visual awareness, equidistant increases of presentation durations were used. We expected that intranasally administered oxytocin would improve the recognition of emotional faces, and that the effect would extend even to stimuli presented under conditions of limited awareness.

2. Methods

2.1. Participants

Fifty-six male participants (mean age $\pm$ SD: 24.18 $\pm$ 3.12) were assigned to receive either 24 international units (IU) of oxytocin (N = 28; Syntocinon, Novartis, Basel, Switzerland) or placebo (N = 28) within a double-blind, randomized controlled study design.

All participants had normal or corrected-to-normal visual acuity, were free of medication, and did not report any history of endocrine, neurological or mental disorder. They were instructed to abstain from caffeine and nicotine on the day of the study. Smokers (more than 5 cigarettes a day) were excluded from participation in the study.

We planned to investigate a sample of 50 subjects (25 subjects oxytocin, 25 subjects placebo) to have sufficient power to detect medium-sized differences as determined by G-Power 3. Six additional participants were examined to account for presumed technical difficulties and difficulties in substance application.

The study was approved by the ethics committee of the University of Rostock and was carried out at the Department of Psychiatry, University of Rostock, between November 2009 and January 2010.

2.2. Procedure

After written informed consent was obtained, participants completed questionnaires on depression (Beck Depression Inventory), trait anxiety (State Trait Anxiety Inventory) and were familiarized with the use of the nasal sprays. Participants self-administered 3 puffs of oxytocin (each puff with 4 IU) or placebo per nostril, with the placebo containing all ingredients except for the peptide. Then all participants underwent a training session to ensure appropriate understanding of the experimental task. Forty-five minutes after substance application, participants answered a multidimensional mood questionnaire and started the experiment.

Randomization of substance allocation procedure was generated by the local compounding pharmacist. This sequence was concealed from all persons involved in recruitment and testing of the participants. Unblinding was done after completion of testing.

2.3. Experimental task

The experiment was conducted on a standard computer with a 17″ screen with a resolution of 800 $\times$ 600 and a refresh rate of 170 Hz (confirmed by a photodiode and an oscilloscope). Each trial started with a fixation cross (1000 ms) and a short blank screen (100 ms). Then, an angry, happy, or neutral face was presented for 18, 35, or 53 ms, followed by a ''mask'' showing a neutral face (see Fig. 1). The initial gaze was fixed to the middle of the facial stimulus (between the eyes and the mouth). Participants were explicitly informed that two facial stimuli would always appear in each trial, although they might only perceive one. Facial stimuli (eight male, eight female) were taken from the Karolinska Directed Emotional Faces. They were equivalent with regard to luminance ($F_{2,45}$ = .48, p = .625) and recognizability of the expressed emotions ($F_{2,45}$ = .95, p = .394). Two additional neutral faces (one male, one female) were selected as mask stimuli and presented in a pseudo-randomized order.

The experiment contained 288 trials, divided into eight blocks with 36 trials each. Prior to each block, an instruction was given regarding the target emotion in the following trials. In each block, 12 angry, happy, and neutral facial stimuli were randomly presented with varying durations (18, 35, or 53 ms). Following each target-mask pair, participants had 3 s to indicate whether the target emotion was present or absent (4 blocks angry present/absent and 4 blocks happy present/absent).

2.4. Statistical analysis

Participants' performance was analyzed based on signal detection theory. Conditional probabilities of hits and false alarms were calculated for each condition and participant. Afterwards, individual discrimination indices [$d' = Z_{hits} - Z_{false\ alarms}$] and response biases [$c = -0.5*(Z_{hits} + Z_{false\ alarms})$] were computed and analyzed using separate mixed-design ANOVAs with the within-subject factors of face valence (angry, happy) and presentation time (18, 35, 53 ms) and the group factor of drug condition (oxytocin, placebo). Greenhouse–Geisser corrections were applied if the assumption of sphericity was violated and significant interactions were followed by simple effects analyses. Analyses were performed using SPSS version 17. The significance level for all tests was $p < .05$.