Oxytocin and social perception: Oxytocin increases perceived facial trustworthiness and attractiveness

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A B S T R A C T

The neuropeptide oxytocin is involved in the development and maintenance of attachment behaviours in humans and other species. Little is known, however, about how it affects judgements of unfamiliar others. In a double-blind placebo-controlled study we investigated the effect of a single intranasal dose of oxytocin on judgements of facial trustworthiness and attractiveness. We found that oxytocin administration increased ratings of trustworthiness and attractiveness of male and female targets in raters of both sexes relative to control ratings, suggesting that higher levels of this neuropeptide may enhance affiliative behaviour towards unfamiliar others. Our results provide evidence in support of a general facilitative role of oxytocin in promoting positive trait judgements.

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Introduction

Research on the neurobiology of attachment behaviour in human and non-human mammals has examined the central role of oxytocin (OT). OT is a small neuropeptide produced in the hypothalamus and released into the bloodstream through the posterior pituitary gland. It acts centrally and peripherally, is produced in males and females but can be higher in females (e.g. in monogamous and polygynous rodents; Kramer et al., 2004). Findings from animal and human studies point unequivocally to the involvement of OT in the development and maintenance of attachment and affiliative behaviours (for reviews please see Lim and Young, 2006; Bartz and Hollander, 2006; Heinrichs and Domes, 2008). For example, in the prairie vole (a monogamous species) exogenously administered OT has been shown to enhance female preferences for a male partner after only a short cohabitation (Williams et al., 1994). In humans, a correlational study has shown that women’s OT levels during pregnancy and the early postpartum period are related to higher levels of maternal behaviours, such as gaze, affectionate touch and repeated checking of the infant (Feldman et al., 2007). Inferences regarding the effects of OT on behaviour cannot, however, be drawn based on correlational data alone. More direct evidence comes from a study by Ditzen et al. (2009) showing that intranasal administration of OT increased the duration of positive behaviour (e.g. eye contact) relative to negative behaviour (e.g. defensiveness) during a couple conflict interaction.

Results of a number of human imaging studies have suggested that OT may promote affiliative behaviour through the dampening of amygdala activity. For example, compared to placebo, OT administration reduced activity in the amygdala during completion of a matching task for which fear-inducing faces were paired with an identical target (Kirsch et al., 2005), but did not affect accuracy or reaction times. Similarly, OT administration lowered activity in the amygdala in response to facial expressions of positive and negative emotion, while it did not affect the ability to identify the gender of faces (Domes et al., 2007a). Domes et al. (2007a) argued that such lowered amygdala activity may be associated with less ambiguity regarding the value of social stimuli, which then leads to the promotion of approach behaviour, thus facilitating affiliation.

To date, few studies have investigated the impact of exogenously administered OT on social perception. A direct investigation of the effect of OT on social judgements was carried out in a recent fMRI study by Petrovic et al. (2008) in males. Participants viewed faces that had direct or indirect gaze, and were either associated with an electric shock or not, and had to rate how sympathetic the faces looked. OT, compared to placebo, attenuated negative ratings for faces paired with fear conditioning and reduced amygdala activation. Furthermore, Thompson et al. (2006) administered exogenously central arginine vasopressin (AVP), a neuropeptide closely related to OT, and showed sex-dimorphic effects of AVP on social perception. Specifically, AVP intranasal administration led males to perceive faces of unfamiliar
males as less friendly, while females perceived unfamiliar females as more friendly compared to placebo.

A study that examined OT influences on social behaviour with regard to trust was conducted by Kosfeld et al. (2005). In this double-blind, placebo-controlled study participants played a ‘trust game’ in which ‘investors’ could transfer money to an anonymous ‘trustee’ and the sum was then tripled. The trustee, then, had the option to either share the earnings with the investor or keep all the money for themselves. Experimentally elevated OT levels were found to increase trust behaviour as reflected by higher amounts of money transferred to the trustees. Investors’ self-reported expectations of trustees’ trustworthiness, however, were not affected by OT. It appears that even though participants were more trusting in others they did not also expect them to be more trustworthy. The authors concluded that elevated OT leads to an enhanced ability to overcome betrayal aversion and, in turn, engage in prosocial behaviour. Interestingly, a further study examining the relationship between peripheral OT and trustworthiness used the ‘trust game’ in two conditions of intentional and unintentional trust and found that higher peripheral OT levels in the trustees were associated with voluntary money transfers from the investors (intentional trust), and higher back transfers of money (trustworthiness) from the trustees (Zak et al., 2005). The latter findings should be interpreted with caution as the data are correlational and plasma OT levels do not reliably relate to behaviour or correspond to levels of the hormone in the central nervous system (Landgraf and Neumann, 2004).

The results of these latter two studies suggest that OT increases trusting behaviour. However, an unanswered question relates to whether OT affects social judgements of others at zero acquaintance; for example when making attributions on the basis of facial appearance. As mentioned above, the amygdala is implicated in critical social judgements which can, in turn, determine whether to approach or avoid another (Adolphs, 2003). Evidence for the role of the amygdala in trustworthiness inferences comes from a study in humans with bilateral amygdala damage who rated unfamiliar faces as more approachable and trustworthy compared to control viewers (Adolphs et al., 1998). Taken together, the above findings suggest that enhancing OT levels is likely to lead to higher ratings of facial trustworthiness, an issue which we examine in the current study.

Although much research on OT has concerned trustworthiness, perception of other social characteristics may also be influenced by the hormone, particularly if social perception of unfamiliar faces takes place in a limited dimensional space (for example, on two dimensions of trustworthiness and dominance, as proposed by Todorov et al., 2008). The second aim of the current study was to investigate this possibility by examining the influence of OT on judgements of facial attractiveness. Although OT has been implicated in the facilitation of approach behaviour and specific attachments, the question still remains whether it would influence judgements of unfamiliar others’ attractiveness. Given that OT enhancement promotes approach behaviour, it follows that it should also lead to finding others more attractive. In other words, it seems plausible that higher levels of OT should enhance perceptions of others’ attractiveness, which then renders social interactions and the formation of attachments more likely.

A third and final aim of the current study was to investigate sex differences in effects of oxytocin on these social judgements. Most human studies that manipulate OT experimentally have tested only one other, very recent, study (by Ditzen et al., 2009) which has recruited both men and women in a sample of a size that is comparable to ours.

Method

Participants

Ninety-six participants (mean age: 21.4 years, age range: 18.3 to 40 years) were recruited mainly from the student population of the University of Bristol, UK. There were 48 females (mean age: 21.4 years, age range: 18.3 to 40 years) and 48 males (mean age: 21.5 years, age range: 18.4 to 30.5 years) in the sample. Forty were romantically attached and 56 single. Posters and emails advertising the study were posted throughout the university and participation was rewarded with either £15 or experimental credit. Selection criteria included not being pregnant, breastfeeding, or on prescribed medication. Baseline questionnaires collected information regarding menstrual cycle phase and contraception use, and confirmed that no participant suffered from severe depression. Trait anxiety was also assessed at baseline by the use of the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983). Approval for the study’s protocol was provided by the University of Bristol Faculty of Science Human Research Ethics Committee.

Design

In this double-blind placebo-controlled study, participants were randomly assigned to either the experimental condition in which they received a single intranasal dose of either 24 IU OT (Syntocinon Spray, Novartis; 3 puffs per nostril, each puff containing 4 IU OT); or the control condition, in which they received a placebo. The placebo sprays contained all the ingredients present in the OT sprays with the exception of OT. We investigated the effect of OT on social perception as reflected by ratings of facial trustworthiness and attractiveness. Sex differences and the effect of OT on mood were also investigated. These measures were taken as part of a larger study in a session lasting approximately 60 min. Participants were required to stay in the laboratory for a total of approximately 2 h to guard for potential side effects of OT.

Stimuli

**Trustworthiness stimuli**

Thirty face stimuli with neutral expression and direct gaze (15 male and 15 female) were taken from the ‘Karolinska Directed Emotional Faces’ set (Lundqvist et al., 1998).

**Attractiveness stimuli**

Forty-eight neutral faces (24 male and 24 female), were obtained from undergraduates at Brunel University (males) and Bristol University (females). Images were taken under controlled conditions with a Canon EOS 300D from a distance of 1.5 mm with a 50 mm focal length and diffuse flash lighting (following guidelines for anthropometric photography detailed in Stephan et al., 2004).

Materials

**Mood: positive affect, wakefulness, and calmness**

The short form of the English version of the Multidimensional Mood State Questionnaire (MDFB; Steyer et al., 1997) was employed to measure levels of positive affect, wakefulness, and calmness at least 40 min following treatment. The MDFB is a 6-point scale consisting of 15 items with answers ranging from ‘definitely not’ to ‘extremely’. Higher scores on this measure’s subscales denote higher levels of positive affect, wakefulness and calmness respectively.
Procedure

Participants were tested individually and were instructed to abstain from alcohol, caffeine and nicotine for 24 h prior to testing and food and drink, except water, for 2 h before testing. At the start of the experimental session, informed consent was obtained and participants self-administered a single intranasal dose of either OT (n = 51, mean age: 21.1 years, age range of 18.3 to 30.5 years, 25 males) or placebo (n = 45, mean age: 21.9 years, age range: 18.5 to 40 years, 23 males). After a waiting period of 25 min, a battery of computer and pen and paper tasks was administered in two blocks in counterbalanced order. Key Block 1 tasks included the electronic rating of faces on facial attractiveness and trustworthiness. Key Block 2 tasks included the electronic rating of mood. Forty seven participants completed Block 1 first (25 min after treatment) and 49 completed Block 1 second (approximately 45 min after treatment). Facial attractiveness was always rated before trustworthiness. For the attractiveness task, stimuli were presented in 2 separate subsets of female and male faces. Order of face subset presentation was counterbalanced (49 participants rated male faces first) and trial order within each face subset randomised. Participants were instructed to respond to the question ‘How attractive is this face (1–7)’ which was presented at the lower part of the target face. Answers ranged from 1 (unattractive) to 7 (attractive). Participants were then instructed to rate face trustworthiness on a 7-point scale, with answers ranging from 1 (very untrustworthy) to 7 (very trustworthy). Trial presentation in this task was also randomised. Ratings on attractiveness and trustworthiness were made using the number keys 1–7 on the upper part of the keyboard. Both tasks were self-paced with the target face displayed until a response was made. Mood was measured either immediately before the trustworthiness and attractiveness tasks or at the end of the experiment (see above). Finally, participants were asked to guess which treatment they had received, in order to assess any effects of expectancies on performance, and were debriefed.

Data analysis

Here, we report statistical findings of the effect of OT and participant sex on ratings of mood, trustworthiness and attractiveness. The effects of task order and treatment expectancies on trait judgements are also examined, as well as the effect of menstrual cycle phase for those females who reported not using contraception1. Repeated measures analyses of variance (ANOVA) tests are conducted on all the aforementioned variables. We also report Pearson correlation analyses on trustworthiness and attractiveness ratings in each drug group, and the results from an independent samples t-test on trait anxiety scores from both drug groups. Finally, we look at the results from a multivariate ANOVA on self-reported mood in each drug group. All statistical tests were conducted by the use of the SPSS 12.0.1 software.

Results

Trustworthiness and attractiveness

Mean attractiveness and trustworthiness ratings in the 2 drug groups are illustrated in Fig. 1. A repeated measures ANOVA with drug (OT, placebo) and sex of participant (male, female) as between-subjects factors, and social judgement (trustworthiness, attractiveness) as a repeated measure was carried out on ratings of facial trustworthiness and attractiveness. A main effect of social judgement was found, F(1, 92) = 6.08, p = .02, showing that faces were rated higher on trustworthiness (M = 3.45, SD = .77) than attractiveness (M = 3.29, SD = .67). Furthermore, there was a main effect of drug, F(1, 92) = 4.23, p = .04, showing that the OT group perceived faces as more attractive and trustworthy compared to placebo. However, results showed no effect of sex of participant, F(1, 92) = 1.56, p = .22, and no significant interactions, [largest F(1, 92) = .82, p = .37]. Moreover, we tested for significant differences between those who completed the task 25 versus 45 min after treatment and found no order effects. Specifically, we ran a repeated measures ANOVA with drug (OT, placebo), task order (face task first, MDFB first) and participant sex (male, female) as between-subjects factors and found no effect of order, F(1, 88) = 1.74, p = .19, or participant sex, F(1, 88) = .18, on trait ratings while the effect of drug remained significant, F(1, 88) = 3.98, p = .049. Furthermore, there were no significant interactions, [largest F(1, 88) = .74, p = .39].

Expectancies

Out of 96 participants only 37 guessed their treatment correctly (placebo group: 25 guessed that they received placebo; OT group: 12 guessed that they received OT). Thirty two participants (33.3% of the total N) thought they had OT and 64 (66.7% of the total N) believed they received placebo. An ANOVA with drug (OT, placebo) and drug expectancy (number of participants that thought they had OT, number of participants that thought they had placebo) as between-subjects factors was carried out on mean trait ratings (trustworthiness, attractiveness). Results showed no effect of drug expectancy, F(1, 92) = .38, p = .54, or interactions involving drug, [largest F(1, 92) = .21, p = .64]. The main effect of drug remained significant, F(1, 92) = 3.97, p = .049. The main effect of social judgement also remained significant, F(1, 92) = 7.21, p = .01.

Correlations

Pearson correlations (2-tailed) were conducted on attractiveness and trustworthiness ratings for the OT and placebo groups and showed a significant positive correlation between these ratings in both groups, OT: r = .61, p < .001; Placebo: r = .58, p < .001.

Trait anxiety

Independent samples t-test showed no difference in mean anxiety scores between drug groups, t(94) = .92, p = .36; OT: M = 40.04, SD = 10.01; Placebo: M = 41.98, SD = 10.56.

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1 As we lacked information about the kind of contraception used we could reliably estimate the estrogen levels for less than 50% of females. A repeated measures ANOVA with menstrual cycle phase (follicular, luteal) and drug (OT, placebo) as between-subjects factors, and judgement (trustworthiness, attractiveness) as a within-subjects factor showed no effect of drug, F(1, 18) = .25, p = .62, and no effect of menstrual cycle phase, F(1, 18) = .03, p = .86 on trait ratings. No interactions were found either, [largest F(1, 18) = 1.22, p = .28].
Table 1

Means and standard deviations (SD) of mood ratings, and the main effect of drug (F and p values).

<table>
<thead>
<tr>
<th>Drug group</th>
<th>M (SD)</th>
<th>F value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive affect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OT</td>
<td>4.25 (.89)</td>
<td>.54</td>
<td>.46</td>
</tr>
<tr>
<td>P</td>
<td>4.11 (.93)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wakefulness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OT</td>
<td>3.41 (.81)</td>
<td>.49</td>
<td>.49</td>
</tr>
<tr>
<td>P</td>
<td>3.29 (.87)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calmness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OT</td>
<td>4.25 (.67)</td>
<td>.41</td>
<td>.52</td>
</tr>
<tr>
<td>P</td>
<td>4.35 (.85)</td>
<td></td>
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</tr>
</tbody>
</table>

df = 92; OT, oxytocin; P, placebo.

Mood: positive affect, wakefulness, and calmness

A multivariate ANOVA with drug (OT, placebo) and sex of participant as between-subjects factors was conducted on subjective mood scores. Results showed no main effect of drug (for full results and means and standard deviations of mood ratings see Table 1). In addition, there was no effect of sex of participant, [largest F(1, 92) = .65, p = .42], and no significant interactions involving drug, [largest F(1, 92) = 1.25, p = .27].

Discussion

The present study investigated the effect of experimentally elevated OT levels on social perception by measuring judgements of facial attractiveness and trustworthiness. This is the first study to examine a) whether OT affects these social judgements, and b) whether OT influences such judgements differentially in men and women. As noted in the introduction, a related study assessed the effects of OT on male participants’ ratings of how sympathetic faces were in a fear conditioning paradigm (Petrovic et al., 2008).

In support of our predictions, results indicate that elevating central OT levels promotes positive social perception, as reflected by higher trustworthiness and attractiveness ratings of unfamiliar faces compared to control. Our prediction regarding trustworthiness judgements was made on the basis of previous research showing that elevating OT levels experimentally dampened amygdala activation (e.g. Kirsch et al., 2005; Domes et al., 2007a) and that patients with amygdala damage (resulting in the dampening of amygdala activation) rated faces as more trustworthy than a control group (Adolphs et al., 1998). That temporary OT elevation leads to higher trustworthiness ratings compared to control does not, however, support Kosfeld et al.’s (2005) observation that while OT treatment (versus placebo control) increases behavioural trust, as evidenced in a trust game, it does not lead to the expectation that others are likely to be trustworthy. It is important to bear in mind, however, that this is a tentative interpretation as Kosfeld et al.’s (2005) study and the present study are not directly comparable.

Our finding that OT also positively influences judgements of facial attractiveness demonstrates that OT does not influence trustworthiness judgements alone. Given the shared variance between ratings of trustworthiness and attractiveness in the social perception literature at large, this is perhaps to be expected (Todorov et al., 2008). This finding supports and extends previous human studies that have examined OT’s effect on prosocial behaviour, and suggest that OT plays a significant role in the promotion of affiliative behaviour (e.g. Kirsch et al., 2005; Domes et al., 2007a). The fact that both men and women in the present study rated both same and opposite-sex faces as more attractive after OT intake leads us to suggest that this neuropeptide may serve to promote affiliative behaviour in general.

Importantly, no differences in mood were found between the two groups as a result of the treatment they received. This is in accordance with findings from previous studies that have exogenously administered OT (e.g. Kosfeld et al., 2005; Domes et al., 2007b; Petrovic et al., 2008). We can, therefore, conclude that the observed effect of OT on judgements of attractiveness and trustworthiness was not caused by mood-enhancing or related psychotropic properties of the hormone. In addition, we found that participants’ guesses regarding the treatment they received had no effect on trait ratings. This finding further supports our conclusion that social perception was indeed influenced by OT rather than by subjective expectations regarding OT’s function.

It should also be noted that a strong positive relationship was observed between ratings of attractiveness and trustworthiness regardless of treatment received. This relationship was only slightly stronger for the OT group, compared to placebo. It appears that the more attractive others were rated, the more trustworthy they were also perceived to be. This is in line with previous findings that trustworthiness judgements correlate highly with judgements of attractiveness (e.g. Oosterhof and Todorov, 2008).

An additional aim of the current research was to examine potential sex differences. The need to examine sex-specific effects of exogenous OT has been stressed by various OT researchers (e.g. Bartz and Hollander, 2006; Heinrichs and Domes, 2008). Most human studies that investigate behavioural effects of experimental OT administration recruit only members of the male population (e.g. Petrovic et al., 2008; Domes et al., 2007a, 2007b; Kirsch et al., 2005; Guastella et al., 2008). Studies that have included both sexes either had fewer females than males (e.g. Guastella et al., 2009) or had equal numbers of males and females but relatively small samples (e.g. Savascan et al., 2008) with the only exception of a very recent study by Ditzen et al. (2009) which used a sample comparable to ours. A useful contribution to the literature of our research is that we recruited equal numbers of males and females and did so using a relatively large sample. Our findings suggest that OT did not have different behavioural effects on males compared to females. This is the first set of reported data on the effects of OT in humans to show that men and women draw similar trait inferences following OT administration. This finding is particularly noteworthy as it indicates that this neuropeptide, thought to have a more significant impact on female than male prosocial behaviour in non-human animals (for review see Cushing and Kramer, 2005), in fact may have the same effect on men and women when it comes to judgements of facial attractiveness and trustworthiness. Although men and women respond in the same way to OT, sex differences in hormone production may nonetheless lead to the sex-specific importance of OT in non-experimental contexts. A caveat of our study, however, is that we did not control for the possible influence of menstrual cycle phase and oral contraception use on the effects of oxytocin and behaviour.

The above finding regarding the absence of sex-specific effects of OT tells a different story to previous research by Thompson et al. (2006) which has shown OT’s sister neuropeptide, vasopressin, to have sex-dimorphic effects on social behaviour. Nevertheless, we need to point out that the latter study and the present study are not directly comparable as a) different neuropeptides were investigated in each, and b) participants viewed and rated only same-sex faces in the study of Thompson et al. (2006), whereas the participants in the present study rated both same- and opposite-sex faces.

In conclusion, our findings indicate that judgements of facial trustworthiness and attractiveness are enhanced by a single dose of intranasal oxytocin in both sexes. Even though it is difficult to draw conclusions about the underlying mechanism by which OT exerts such an impact on social perception, we speculate that it first dampens amygdala activity which leads to the inhibition of defensive behaviour and hence promotes affiliative behaviour. The fact that OT leads people to view others as more attractive and trustworthy suggests that increased levels of this neuropeptide may promote approach behaviour towards unknown others. This effect on approach may be a by-product of OT’s main function (i.e. bond formation with infants and partners). One promising avenue for future research would be to investigate whether OT affects actual approach behaviour towards social (e.g. faces) versus non-social stimuli. Further research should
also consider using functional magnetic resonance imaging (fMRI) to answer the question of whether the amygdala is the underlying brain area involved in the effects of OT on social perception. Furthermore, it is important to continue recruiting both sexes to examine further whether oxytocin exerts sex-dimorphic effects in humans. Future studies that do include females should try to control for the possible influence of menstrual cycle and oral contraception use on the effects of oxytocin and behaviour. Finally, we believe that our findings speak to the involvement of OT in judgements of socially significant traits, and extend our understanding of the neurobiology of human affiliation.

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