Psychoneuroendocrinology 78 (2017) 229–232

Contents lists available at ScienceDirect

Psychoneuroendocrinology

journal homepage: www.elsevier.com/locate/psyneuen

Short Communication

A matter of distance—The effect of oxytocin on social discounting is empathy-dependent

Sabrina Strang[a,*], Holger Gerhardt[b], Nina Marsh[d], Sergio Oroz Artigas[a], Yang Hu[b], René Hurlemann[c,d], Soyoung Q. Park[a]

[a] Department of Psychology, University of Lübeck, Germany
[b] Center for Economics and Neuroscience, University of Bonn, Germany
[c] Department of Psychiatry, University Hospital Bonn, Germany
[d] Division of Medical Psychology, University Hospital Bonn, Germany

ARTICLE INFO

Article history:
Received 28 October 2016
Received in revised form 26 January 2017
Accepted 27 January 2017

Keywords:
Oxytocin
Generosity
Empathy
Social distance
Social discounting

ABSTRACT

Generosity is an important behavior enriching human society and can be observed across cultures. However, generosity has been shown to be modulated as a function of social distance, also referred to as social discounting. Oxytocin and empathy are other factors that have been shown to play an important role in generous behavior. However, how exactly oxytocin and empathy impact social discounting is yet unknown. Here, we administered oxytocin or placebo in a double-blind design, and measured social discounting behavior. Additionally, individual differences in empathy were assessed. Our results show that the effect of oxytocin on generous behavior is modulated by trait empathy; only for those subjects who received oxytocin there was a positive correlation between individual trait empathy and their generous behavior towards close others.

1. Introduction

Generous behavior is a universal phenomenon and fundamental cornerstone of all human societies (Strang and Park, 2016). Importantly, people are not equally generous to everyone alike. Generosity declines as a function of social closeness between individuals (Jones and Rachlin, 2006; Strombach et al., 2015), i.e., humans are most generous to close others (e.g., parents or partner), less generous to others in their social environment whom they do not feel that close to (e.g., colleagues), and even less to others they rarely see or have never seen before. In a variety of studies generosity was further found to be modulated by oxytocin (OXT) and empathy (Batson et al., 2015; De Dreu, 2012a). While empathy was shown to have a general positive impact on generous behavior (Batson et al., 2015), OXT has been shown to have differential effects depending on the receiver; it increases generosity towards in-group members and decreases it towards out-group members (De Dreu, 2012a). A recent study suggests that OXT induces a prosocial bias, which is sensitive to contextual framing and social cues (Marsh et al., 2015). Interestingly, OXT and empathy were also shown to interact; individual differences in empathy have been associated with endogenous and exogenous OXT levels (Barraza and Zak, 2009; Bartz et al., 2010), and an OXT receptor gene polymorphism is associated with differences in trait empathy (Rodrigues et al., 2009). Therefore, the question arises how OXT and trait empathy modulate social discounting.

Here, we investigate how OXT compared to placebo (PLC) impacts social discounting and the role of trait empathy. We hypothesize that OXT will increase generous behavior towards close social distances and that this effect will be modulated by trait empathy.

2. Material and methods

2.1. Subjects

We invited 132 healthy male subjects (mean age 24.4 ± 3.2 SD). Subjects were asked to maintain their regular sleep and waking times and to abstain from caffeine and alcohol intake on the day of the test session. Before receiving either OXT or PLC, subjects underwent an initial screening session. The screening entailed the exclusion of current or past physical or psychiatric illness (Appendix A in Supplementary material). All subjects gave writ-

* Corresponding author at: Department of Psychology, University of Lübeck, Ratzeburger Allee 160, 23562 Lübeck, Germany.
E-mail address: sabrina.strang@uni-luebeck.de (S. Strang).

http://dx.doi.org/10.1016/j.psyneuen.2017.01.031
0306-4530/

Fig. 1. Social distance scale. The red icon represents the subject and all other icons his social environment. In this example, social distance 10 is highlighted. Subjects had to indicate representatives for social distance 1, 2, 3, 5, 10, and 20.

ten informed consent after being instructed about the procedure according to the Declaration of Helsinki. The study was approved by the Institutional Review Board of the Faculty of Medicine of the University of Bonn.

2.2. Social environment measurement

Subjects were asked to describe their social environment before receiving instructions for the behavioral task (Strombach et al., 2015). The concept of social distance was explained by presenting a scale consisting of 101 icons (Fig. 1). The leftmost icon represented the subject and the other icons the subject's social environment. Subjects were told that the icon closest to the leftmost icon was labeled as social distance 1 and represented their socially closest person. The rightmost person was labeled as social distance 100 and represented a stranger, while social distance 50 indicated a person they might have seen, but whose name they do not know. After subjects were familiarized with the concept of the social distance scale, they were asked to indicate names of representatives for social distances 1, 2, 3, 5, 10, and 20. Notably, they were instructed to only include persons they have positive feelings about.

2.3. Social discounting task

A dictator game in combination with the social distance scale was used to measure social discounting. In each trial subjects received an endowment and decided how much they want to give to a person at a specific social distance. Three different endowment levels (€13, €15, and €17) and eight social distances (1, 2, 3, 5, 10, 20, 50, and 100) were used. Thus, subjects played in total 24 rounds presented in a randomized order (Appendix B in Supplementary material). Subjects were informed that (1) at the end of the experiment one trial would be randomly selected; (2) they would be paid according to the split of that trial and (3) the receiver for that social distance would receive the actual money they decided to send to (Appendix C in Supplementary material). The dependent variable was the percentage of money shared with each social distance.

2.4. General procedure

During the screening session subjects were asked to fill in the interpersonal reactivity inventory (IRI; Davis, 1983) to measure subjects' trait empathy. In the experimental session subjects were randomly assigned into OXT ($N = 64$) and PLC ($N = 68$) group. We used a double-blind, randomized, parallel-group design, and administered a 24-IU nasal dose of either OXT or PLC (both provided by Novartis, Basel, Switzerland) correspondingly. The PLC solution contained the same ingredients as the OXT solution except for the peptide itself. Each subject was seated alone in a separate cubicle equipped with a PC and closed off with curtains in order to exclude any interaction between subjects. Subsequently, subjects first conducted the social environment measurement. Approximately 45 min after the OXT or PLC application, subjects received a detailed description of the social discounting task and carried it out subsequently.

2.5. Data analysis

To quantify the degree of social discounting, we applied a standard hyperbolic function (Jones and Rachlin, 2006; Strombach et al., 2015, Eq. (1)):

$$v = \frac{V}{(1 + kD)} \quad (1)$$

where v is the discounted value of the reward for the other person (the percentage of money shared), V is the undiscounted value of this reward and can be interpreted as the generosity level at close social distances, D is a measure of the social distance and k is a constant measuring the degree of discounting. Larger values of the latter correspond to a steeper decrease in generosity as social distance increases. In order to estimate the individual social-distance–dependent changes in generosity, this hyperbolic function was fitted to the percentage of money shared at each social distance on an individual level (Appendix D in Supplementary material). The parameter V was used to estimate subjects' generosity levels for close social distances and the parameter k to estimate the decline of generosity across social distances. Mean squared root errors (MSE) were calculated to assess the fit of the estimated data.

Total IRI scores (calculated as the mean of all subscales) were used as an index for trait empathy. In order to test for a general effect of OXT and empathy on generosity, independent of social distance, the area under the curve (AUC) of the shared money of each subject across social distances was compared between the OXT and PLC group (Appendix D in Supplementary material).

The trait empathy-dependent effect of OXT on V was analyzed by using a linear regression model with condition (OXT/PLC; coded as a dummy variable) × trait empathy as regressor. Corresponding post-hoc tests were applied when appropriate. The OXT effect on generosity independent of social distance and empathy was analyzed by using an independent t-test with the AUC values as the dependent measure.

3. Results

We tested whether OXT has differential effects on generous behavior towards close others depending on trait empathy levels. The OXT and PLC groups did not differ in empathy levels ($t(128) = 1.10$, $p = 0.27$, two-sided). Regression results indicate that trait empathy has a positive influence on the V-parameter in the OXT group ($b = 0.0736$, $p = 0.017$). Post-hoc correlation analyses for OXT and PLC group separately show that only in the OXT group empathy correlates with the V-parameter ($r = 0.282$, $p = 0.024$, two-sided) but not in the PLC group ($r = 0.020$, $p = 0.87$, two-sided; see Fig. 2A). Thus, the higher the empathy score of a participant in the OXT group, the greater is his V-parameter (see Fig. 2A, B). This relation is virtually absent and not statistically significant in the PLC group (see Fig. 2A, C; for additional results see Appendix E in Supplementary material).

On the group level the hyperbolic model provided a good fit of the data which did not differ between groups (MSE $M_{TOTAL} = 0.08$, $SE = 0.006$; $M_{OXT} = 0.08$, $SE = 0.01$; $M_{PLC} = 0.23$, $SE = 0.008$; $U = 0.815$, $p = 0.42$). Furthermore, OXT had no general, social-distance–independent effect on generous behavior; the AUC