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Oxytocin enhances the experience of attachment security

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Summary

Repeated interactions between infant and caregiver result in either secure or insecure relationship attachment patterns, and insecure attachment may affect individual emotion-regulation and health. Given that oxytocin enhances social approach behavior in animals and humans, we hypothesized that oxytocin might also promote the experience of attachment security in humans. Within a 3-week interval 26 healthy male students classified with an insecure attachment pattern were invited twice to an experimental session. Within each session, a single dose of oxytocin or placebo was administered, using a double-blind, placebo-controlled within-subject design. In both conditions, subjects completed an attachment task based on the Adult Attachment Projective Picture System (AAP). Thirty-two AAP picture system presentations depicted attachment-related events (e.g. illness, solitude, separation, loss), and were each accompanied by four prototypical phrases representing one secure and three insecure attachment categories. In the oxytocin condition, a significant proportion of these insecure subjects ($N = 18$; 69%) changed their rankings of “secure attachment” phrases towards the more appropriate for the AAP picture presentation, and the same subjects decreased in overall rating of the “insecure attachment” phrases. In particular, there was a significant decrease in the number of subjects ranking the pictures with “insecure-preoccupied” phrases from the placebo to the oxytocin condition. We find that a single dose of intranasally administered oxytocin is sufficient to induce a significant increase in the experience of attachment security in adults classified previously as insecure.

Keywords

Human attachment; oxytocin; intranasal; attachment security; attachment insecurity; emotion-regulation

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1. Introduction

The fundamental ability to form attachment is indispensable for human social relationships. During repeated interactions with a supportive and sensitive caregiver, a child develops a stable cognitive schema of the caregiver's availability for reducing stress and providing comfort in potentially threatening situations (Bowlby, 1969). Based on these assumptions, infant and adult attachment is classified either as secure or insecure using standardized measures designed to activate the individual's attachment system (Westen et al., 2006). Notably, attachment insecurity contributes to a wide spectrum of mental disorders (Maunder and Hunter, 2001).

In non-human mammals, receptors for the neuropeptide oxytocin are distributed in various brain regions, including the amygdala, that are associated with the ability to form normal social attachments and affiliation, including parental care, pair bonding, and social memory (Carter, 1998; Uvnas-Moberg, 1998; Young and Wang, 2004). Intranasal oxytocin administration in humans has been found to reduce endocrine and psychological responses to social stress (Heinrichs et al., 2003), to increase trust (Kosfeld et al., 2005), the ability to infer the mental state of another person ('mind-reading') (Domes et al., 2007a), social memory (Heinrichs et al., 2004; Guastella et al., 2008b), and gaze toward the eye region of human faces (Guastella et al., 2008a). Given that oxytocin seems to promote social approach behavior (Heinrichs & Domes, 2008), we hypothesized that oxytocin might also promote the experience of secure attachment in humans. In particular, intranasal oxytocin administration was expected to enhance the subjective perception of attachment security in insecurely attached individuals.

2. Methods and Materials

In the present study, we recruited at the Technical University Munich (March to August, 2006) 26 healthy male students, aged 21 to 33 years, who were classified with an *insecure* attachment pattern using a standardized interview designed and validated to assess attachment patterns in adults by analyzing individual stories to attachment related pictures (Adult Attachment Projective Picture System, AAP) (George and West, 2001). The AAP drawings depict attachment-related events (e.g. illness, solitude, separation, loss, and abuse). The psychometric properties of the AAP were established in an independent validity study with 144 non-patient subjects. The study (George and West, 2001) found strong psychometric validity, including high inter-judge reliability, test-retest reliability (after three, six and twelve months), discriminant validity, and convergent construct validity with the Adult Attachment Interview. In recent neuroimaging studies, the feasibility of the AAP in a neurobiological context has successfully been demonstrated (Buchheim et al., 2006).

To enable statistical comparisons in the experimental procedure (oxytocin vs. placebo) in the present study, we adapted the attachment task in the following way: The eight pictures (drawings) from the AAP were presented four times in the same order. Each of the 32 picture presentations was accompanied by four prototypical phrases representing one of the four established attachment categories: one *secure* and three insecure categories, i. e. *insecure-dismissing*, *insecure-preoccupied*, and *unresolved with respect to loss or trauma*¹. Subjects were presented these 32 pictures in the attachment task in the two experimental conditions. *Secure* individuals demonstrate the ability to draw upon attachment resources (thinking, seeking for help) to remedy distress. *Dismissing* individuals avoid or minimize direct expressions of attachment related distress and often take care of situations on their own. *Preoccupied* individuals are uncertain if an attachment figure might be available to

¹See detailed information about the definition of the AAP categories in Supplemental Material

remedy distress. Individuals, classified as *unresolved with respect to loss or trauma* are not able to integrate attachment related fears related to death, attack, abuse or devastation.

To ensure construct validity of the multiple choice version two independent certified judges of the AAP measure classified the alphabetically sorted 128 phrases into one of the four attachment categories. Agreement was achieved in 123 phrases (97%). The overall inter-rater reliability was $\kappa = .95$. This high agreement was achieved in all four attachment categories, secure: $\kappa = .96$; dismissing: $\kappa = .94$. preoccupied: $\kappa = .96$; unresolved: $\kappa = .94$.

The examined subjects were instructed to rank these phrases from the most to the least appropriate for each presentation (Fig. 1). The phrase chosen as most the appropriate (i.e., their first choice) was scored with a value of 3, the second choice with 2, the third choice with 1, and the last choice with 0. Thus, the summed scores for each attachment scale ("secure", "dismissing", "preoccupied", and "unresolved trauma") ranged from 0 to 96 with a midpoint at 48. Because of the item construction based on the ranking of four statements the sum of these four attachment scales is a 192 (the sum of 0, 1, 2 and 3 = 6 points in each of 32 presentations) constantly by each measurement. The phrases were presented in a randomized balanced sequence in order to minimize simple memory effects across test sessions.

We used a double-blind, placebo-controlled within-subject design (AB-BA design). The participants were recruited on the basis of a pre-test screening of $n=43$ healthy male students with an established attachment measure (George and West, 2001). Eleven subjects with a secure attachment pattern were excluded from the study, because our aim was to examine oxytocin-induced shifts from attachment insecurity towards attachment security. Six subjects refused intranasal application of the substance. The remaining 26 participants were divided into two equally sized, randomly assigned sub-groups to receive the oxytocin or placebo condition first. Only to the collaborating mathematician and the independent administrator masking and blinding the substance were not blind. A single dose of 24 IU oxytocin (Syntocinon spray, Novartis, Basel, Switzerland) or placebo was administered intranasally 50 minutes before the attachment task at both testing sessions (for details of substance administration, see Heinrichs & Domes, 2008). The placebo contained all inactive ingredients except for the neuropeptide. No undesired side-effects of the substances were observed. Subjects underwent both conditions within a minimum of 2 weeks and a maximum of 3 weeks. In order to control for nonspecific effects of arousal, wakefulness, and mood, we assessed these variables at three time points (before applying the drugs, before filling out the questionnaire, and before the attachment task) by means of a suitable 12-item questionnaire (Steyer et al., 1994). Drug and session effects were statistically tested by the sign test, a non-parametric paired test, comparing number of decreases and increases of the dependent variable between two experimental conditions. The same subjects were measured under the placebo and oxytocin conditions, with each person serving as his own control. The sign test was chosen for the following reasons. First, the instrument is based having subjects rank order phrases; this is best captured by non-parametrical methods. Second, most of the attachment scales (as well as differences of scales to be compared) did not achieve the normal distribution as measured by the Shapiro-Wilk test. Finally, in formulating the hypothesis of the present study, we expected small to moderate changes that are nonetheless observed by most subjects. The sign test is sensitive to changes of this kind. The study was approved by the local ethics committee at the Technical University of Munich and conducted according the Declaration of Helsinki. All procedures were carried out with the adequate understanding and written consent of the subjects.

3. Results

Our hypothesis that oxytocin increases the subjective perception of attachment security implies that the subjects in the oxytocin condition will show more selections of those phrases representing *secure attachment* than subjects in the placebo condition, as indicated by increasing the rank of their selection of the “secure” phrases and – consequently – decreasing the rank of “insecure” phrases as their preferred descriptor. The experience of attachment security was operationalized by the scale “*secure*”; the experience of attachment insecurity was formally operationalized by the sum of the three “insecure” scales “*dismissing* + *preoccupied* + *unresolved* – 96”, which is mathematically equivalent to “96 – *secure*”.

Oxytocin increased the rankings of attachment security and decreased the rankings of attachment insecurity (Fig. 2). Under placebo the value of the scale “*secure*” was 49.8 ($s = 15.5$) and under oxytocin mean values increased to 51.5 ($s = 12.7$). This change was observed by the majority of participants: 18 subjects (69%) out of 26 increased in rating “secure attachment”, whereas only 8 subjects (31%) decreased ($p = .038$, one-tailed exact sign test). Consequently, opposite changes were observed by the global *insecurity* scale decreasing from 46.2 to 44.5 points (8 of 18 subjects, $p = .038$, one-tailed exact sign test).

A further analysis of the specific contribution of the three different insecure attachment styles on global insecurity decrease identified the scale “*preoccupied*” as the one which changed most due to oxytocin, whereas no significant changes were observed in the remaining two attachment scales “*dismissing*” and “*unresolved*”. The value of the “*preoccupied*” scale decreased from the mean 53.3 ($s = 9.2$) under the placebo to 50.7 ($s = 8.9$) under the oxytocin condition. A decrease was observed in 18 subjects, an increase by 7 subjects, and one subject did not change. The significance reached by the one-tailed exact binomial test was $p = .022$.

The post-hoc analysis of the concurrent changes in the two significant scales (“*secure*” and “*preoccupied*”) led to the following results. The majority of 14 out of 26 subjects changed to higher security in both scales, 7 subjects improved in only one scale and only 4 subjects worsened in both scales. Finally, we have integrated both scales into one bipolar scale “*secure – preoccupied*” (see Figure 2). Its value increased from the mean 46.2 ($s = 11.4$) under the placebo to 48.4 (10.1) under the oxytocin condition. A significant majority of subjects changed to a higher security score: 20 (77%) out of 26 participants increased on that scale ($p = .005$).

For the sake of statistical discussion of these results we have addressed two questions, first the influence of time (1st vs. 2nd session within the AB-BA design), and second the influence of mood wakefulness and arousal. The comparison of the first and the second session scores for each of the four attachment scales, which were randomly assigned with regard to placebo or oxytocin administration, demonstrated that the effect was not a simple practice effect. The comparison was not significant according to the two-tailed exact sign test for the “*secure* scale” ($p = 1.000$), “*dismissing* scale” ($p = 1.000$), “*preoccupied* scale” ($p = .690$), and “*unresolved* trauma scale” ($p = .307$). There were no significant differences between the oxytocin versus the placebo condition in terms of mood, wakefulness, and arousal throughout the experiment. Dividing the sample into two sub-groups of subjects, no differences between the groups receiving oxytocin or placebo first were observed. For instance, the effect of oxytocin leads by 18 subjects to the increase on the scale “*secure*” and by 8 to the decrease on this scale. In both subgroups (oxytocin or placebo first), this ratio was exactly the same, 9:4. The variance analysis (two repeated measures in ABBA design) –

applied with caution – also excluded the possibility of carry-over effects of oxytocin between the first and second session.

4. Discussion

To our knowledge this is the first study that shows that a single dose of intranasally administered oxytocin is sufficient to enhance the experience of attachment security. Oxytocin seems to induce a *momentary* state of mind change in which as insecure classified subjects shift to experience attachment security as their preference. Attachment security is characterized as the individuals' confidence to rely on attachment figures to achieve care, safety, and protection and, when alone, to have access to internalized attachment relationships. Thus, under the oxytocin condition, the insecure classified individuals experienced phrases as most appropriate associated with attachment related comfort, secure base and feelings of safety. Oxytocin may have provided these individuals with a sense of mental emotional integration with the capacity to connect to others. Investigating a momentary shift of attachment experience we do not conclude that oxytocin has changed the subjects' mental attachment representation.

This result concurs with recent findings from neuroimaging studies in healthy humans, demonstrating that looking at pictures of significant others showed marked overlap with regions that show high densities of oxytocin receptors (e.g., striatum) (Bartels and Zeki, 2004). Interestingly, intranasal oxytocin has recently been shown to attenuate amygdala responses to social stimuli (emotional faces), suggesting a key role of oxytocin in reducing the uncertainty about the predictive value of social stimuli (Domes et al. 2007b). Oxytocin is suggested to release during key pair-bonding events like sexual climax or childbirth. Indeed, oxytocin levels at early pregnancy and the postpartum period are related to a clearly defined set of maternal bonding behaviours (Feldman et al., 2007). In addition, oxytocin levels were also associated with bonding to one's own parents in young adults (Gordon et al., 2008).

The observed differences were significant, although relatively small between the two conditions; we have observed a *small* change by the *majority* of subjects. It should be kept in mind that these systematic differences were caused by a minimal intervention. Thus these initial findings are suggestive rather than conclusive. Investigation of the possible long-term effects of oxytocin administration on attachment is a challenge for future research.

What are possible clinical implications of these results? Psychotherapy researchers emphasize that therapists should take into account that psychotherapy activates attachment (Fonagy and Bateman, 2006). Insecure attachment patterns are predominant in clinical populations (Westen et al., 2006). In psychotherapy the shift from insecure to secure attachment usually requires a year or more in order to work through maladaptive attachment patterns (Fonagy and Bateman, 2006). The present study implies that oxytocin has the potential to change the *momentary* state of mind when the attachment system is activated. In psychotherapy this kind of preparedness might be helpful in perceiving an emotional corrective experience. Hence, future clinical studies might consider whether oxytocin might be a helpful tool integrated as an add-on treatment in the course of the psychotherapeutic process (Heinrichs & Domes, 2008).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Which of the following statements characterize this picture most appropriately for you?

- A. *The girl does not know what to do with her time and stares outside. She wants to play outside or be by herself.*
- B. *A girl did something wrong and her mother punished her with house arrest. She goes into her room and distracts herself reading something.*
- C. *A girl is looking out of the window. She is ill and has to stay inside and thinks about herself. Then her mother comes in and embraces her.*
- D. *This girl seems somewhat desperate, maybe deserted by someone. She just wants to hide and to disappear from the world.*

Please only choose one letter in each line for your answer:

This is the most appropriate statement for me	A	B	C	D
This is the second appropriate statement for me	A	B	C	D
This is the third appropriate statement for me	A	B	C	D
This is the fourth appropriate statement for me	A	B	C	D

Figure 1.

Example of the attachment task (1 of 32 presentations in total).

Note. In the evaluation sentences represent the following attachment categories: A *insecure-preoccupied*; B *insecure-dismissing*; C *secure*; D *unresolved*

Figure 2.
Effect of oxytocin versus placebo on attachment experience. One-tailed exact sign test:
"secure" or "insecure" $p = .038$, "preoccupied" $p = .022$, "secure – preoccupied" $p = .005$