Psychoneuroendocrinology (2013) xxx, xxx–xxx

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SHORT COMMUNICATION

Stress-induced negative mood moderates the relation between oxytocin administration and trust: Evidence for the *tend-and-befriend* response to stress?

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Received 20 March 2013; received in revised form 9 May 2013; accepted 14 May 2013

KEYWORDS
Intranasal oxytocin;
Tend-and-befriend;
Social rejection;
Yale Interpersonal Stressor;
Negative mood;
Trust, Self-perception

Summary
Introduction: Recent evidence suggests that oxytocin, a nonapeptide posited to underlie the affiliation-related "tend-and-befriend" behavioral response to stress (Taylor et al., 2000), may improve interpersonal functioning by facilitating the acquisition of social support during times of distress. The assertion, however, has not been explicitly tested in humans. Thus, we examined whether the effect of oxytocin on self-perceived trust is magnified in individuals who experienced higher ratings of negative mood following social rejection.
Method: In a double-blind experiment, 100 students (50♀) were subject to a live social rejection paradigm following random assignment to either a 24 IU intranasal oxytocin or placebo administration. Mood and self-perceived trust were measured following social rejection.
Results: Multiple regression and simple slope analysis revealed that oxytocin administration increased self-perceived trust relative to placebo in participants reporting a negative mood response following social rejection [$b = 4.245$, $t(96) = 3.10$, $p = .003$], but not in those whose mood state was euthymic.
Conclusion: These results demonstrate that oxytocin may promote the acquisition of social support in times of distress by increasing self-perceived trust. The findings provide empirical support that oxytocin promotes an affiliation-related behavioral response to stress, consistent with the tend-and-befriend theory.

Oxytocin is a neuropeptide that is produced in magnocellular neurosecretory cells in the supraoptic and paraventricular nuclei of the hypothalamus. Oxytocin has long been described as a stress hormone, with increased release into the blood in humans and animals through the posterior pituitary gland (Lang et al., 1983) and actions as a neuromodulator in distinct brain regions in response to emotional

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0306-4530/$ – see front matter
http://dx.doi.org/10.1016/j.psyneuen.2013.05.006

Please cite this article in press as: Cardoso, C., et al., Stress-induced negative mood moderates the relation between oxytocin administration and trust: Evidence for the *tend-and-befriend* response to stress?. Psychoneuroendocrinology (2013), http://dx.doi.org/10.1016/j.psyneuen.2013.05.006

and physical challenge (Engelmann et al., 2004; Neumann, 2009; Neumann and Landgraf, 2012). More recently, Taylor et al. (2000) proposed that oxytocin is involved in a female-specific ''tend-and-befriend'' behavioral response to stress. It was proposed that in response to threat, oxytocin motivates women to seek out social support to help respond to challenge and ameliorate the negative impact of stress (Taylor et al., 2000). The proposal was later extended to be relevant for men as well (Geary and Flinn, 2002), being an alternative to the traditional ''fight or flight'' view of the stress response. In animals, experimentally manipulated central oxytocin promotes social approach behaviors following social stress (Lukas et al., 2011), however, evidence for the tend-and-befriend hypothesis has only been examined in humans using correlational analysis. Taylor et al. (2010) found a positive relationship between concurrent measures of relationship distress and high levels of plasma oxytocin in women. In a study of mother-daughter dyads, children evidenced high levels of urinary oxytocin following a laboratory stressor when presented with the opportunity to speak with their mother afterwards (Seltzer et al., 2010). These findings are consistent with the view that high oxytocin levels during stress serve as an impetus to seek out social contact during difficult circumstances. Unfortunately, these correlational findings do not directly assess Taylor et al.'s (2000) hypothesis that oxytocin promotes affiliation during stress. As expected, studies of the effects of intranasal oxytocin on the response to different laboratory challenges reveal a stress-dampening effect of exogenous oxytocin on the hypothalamic-pituitary-adrenal axis and fear circuitry, including studies that have explicitly examined stress in an interpersonal context (Ditzen et al., 2009; Linnen et al., 2012). Similarly, other studies show that the intranasal administration of oxytocin promotes trust across different tasks (Kosfeld et al., 2005; Baumgartner et al., 2008; Cardoso et al., 2012). These findings, *in combination*, are consistent with the view by Taylor et al. (2000) that oxytocin may act to promote the acquisition of social support in times of stress. However, most studies have examined the effect of oxytocin on stress *or* trust separately. Thus, the central hypothesis of Taylor et al. (2000) has not been explicitly tested using an experimental design. To do so, it would be necessary to determine if the effect of intranasal oxytocin on trust is more pronounced during interpersonal difficulties. To the best of our knowledge, this question has never been empirically addressed.

We previously reported that intranasal oxytocin lowers cortisol levels in university students during a laboratory-based social rejection challenge, and that this interpersonal stressor elicits robust negative mood change (Linnen et al., 2012). We also found that students rated themselves as more open to new experiences, more extraverted, and more trusting following intranasal oxytocin administration (Cardoso et al., 2012). We re-analyzed the data from these studies to explicitly address the question of whether oxytocin promotes increased trust following acute interpersonal distress. We predicted that, according to the tend-and-befriend theory, participants who experienced a strong and persistent negative mood response to social rejection would demonstrate the greatest increase in self-perceived trust, relative to those who reported a lesser negative mood response.

1. Method

1.1. Participants

One hundred 18—35 year old students were recruited to participate in this study through advertisements placed in local universities. Exclusion criteria included history of mental/physical illness, lifetime recreational use of illicit drugs, current medication use, current tobacco use, pregnancy, and poor English language fluency. Participants were randomized to receive intranasal oxytocin (n = 48 aged 22.4 $\pm$ 3.47 years, 24 men) or placebo (n = 52 aged 21.7 $\pm$ 3.35 years, 26 men). Data on menstrual phase and oral contraceptive use were collected in women, and these variables have not been shown to moderate effects on oxytocin administration in this data set (Cardoso et al., 2012; Linnen et al., 2012). This project was approved by the Human Research Ethics Committee at Concordia University (Montréal, Canada).

1.2. Profile of mood states: bipolar form (POMS)

This 72-item inventory assesses six subjective mood states: elated—depressed, agreeable—hostile, composed-anxious, sure—unsure, energetic—tired, and clearheaded—confused. The total score (sum of all scales; internal consistency, α = .86) was used in the present study. Lower scores indicate higher negative mood.

1.3. NEO-personality inventory-revised (NEO-PI-R)

This inventory contains 240 items that measure five dimensions of personality. The *trust* facet (subscale; α = .84) of the *agreeableness* scale was used in this study. Higher scores reflect greater trust. Items from this scale include, ''*I think that most of the people I deal with are honest and trustworthy.*''

1.4. Yale Interpersonal Stressor (YIPS)

The YIPS consists of two staged 10-min conversations (Stroud et al., 2000). In each conversation, the participant and two same-sex confederates (who are trained to use a standardized social exclusion protocol) discuss a topic provided by the experimenter. The paradigm is presented to the participant as a tool used to study communication behavior. The confederates gradually exclude the participant from each conversation (Stroud et al., 2000). For example, while the participant is treated cordially in the first 2 min of each conversation, he or she is often disagreed with, interrupted, and ignored in the final 4 min. The YIPS has been shown to be effective in inducing negative mood (Linnen et al., 2012).

1.5. Procedure

On arrival to the laboratory, participants provided written consent, completed the first POMS measure (POMS1), and were then administered 24 IU of oxytocin or a placebo using an intranasal spray — a method that reliably increases central

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