ARCHIVAL REPORT

Intranasal Administration of Oxytocin Increases Envy and Schadenfreude (Gloating)

Simone G. Shamay-Tsoory, Meytal Fischer, Jonathan Dvash, Hagai Harari, Nufar Perach-Bloom, and Yechiel Levkovitz

Background: Humans have a strong social tendency to compare themselves with others. We tend to feel envious when we receive less valuable rewards and may rejoice when our payoffs are more advantageous. Envy and schadenfreude (gloating over the other's misfortune) are social emotions widely agreed to be a symptom of the human social tendency to compare one's payoffs with those of others. Given the important social components of envy and gloating, we speculated that oxytocin may have a modulating effect on the intensity of these emotions.

Methods: Fifty-six participants participated in this double-blind, placebo-controlled, within-subject study. Following the administration of oxytocin or a placebo, participants played a game of chance with another (fake) participant who either won more money (envy manipulation), lost more money (schadenfreude manipulation), or won/lost equal amounts of money.

Results: In comparison with the placebo, oxytocin increased the envy ratings during unequal monetary gain conditions involving relative loss (when the participant gained less money than another player). Oxytocin also increased the ratings of gloating during relative gain conditions (when the participant gained more money than the other player). By contrast, oxytocin had no effect on the emotional ratings following equal monetary gains nor did it affect general mood ratings.

Conclusions: These results suggest that the oxytocinergic system is involved in modulating envy and gloating. Thus, contrary to the prevailing belief that this system is involved solely in positive prosocial behaviors, it probably plays a key role in a wider range of social emotion-related behaviors.

Key Words: Emotions, envy, oxytocin, schadenfreude, social behavior, treatment

It has been repeatedly demonstrated that there is a drive within individuals to look to outside images and compare oneself with the other to evaluate their own opinions, abilities, and material payoffs (1,2). Numerous studies have found, for example, that the effect of relative (to other) income is much larger than the effect of absolute income (3,4). Even Capuchin monkeys have been reported to respond negatively to inequitable treatment in comparison with a group mate (5). Comparison with others may lead to various emotional reactions (6), including envy and gloating (schadenfreude), two related emotions that involve social comparison (7). While envy is defined as a negative emotional reaction in the face of another person's good fortune (8), gloating is the malicious pleasure at the other's misfortune (6). Given the social emotional significance of envy and gloating, it can be reasoned that peptide hormones, such as oxytocin (OXT), which have been implicated in the regulation of mammalian social behavior, would have a modulating effect on the experience of these emotions.

Peripherally, OXT regulates uterine contractions and milk ejection during lactation, while centrally, OXT acts as a neuromodulator. It is synthesized in the parvocellular neurons of the hypothalamus (paraventricular nucleus [PVN]), which project to limbic sites, such as the hippocampus, amygdala, midbrain and hindbrain nuclei, and the nucleus accumbens (9)—all regions that are implicated in social behavior, emotions, and reward.

Recent studies have provided compelling evidence regarding the role of OXT in promoting prosocial behaviors, such as trust (10), sensitivity to eye gaze (11), emotion recognition (12), and altruism (13). The administration of OXT has been found to reduce the endocrinal and psychological responses to social stress (14); to modulate social memory (15); and to improve recognition memory for faces (16). Highlighting the positive effects of OXT on prosocial behavior (17) and anxiety reduction (18) have promoted an abundance of research directed at investigating the potential of using this peptide as a treatment for various psychiatric conditions, such as autism (19) and social phobia (20).

One possible hypothesis emerging from this line of study about the role of OXT in social behavior is that it increases mainly positive social emotions. According to this hypothesis, OXT is involved in overcoming fear of betrayal (21), enhancing prosocial behavior (11), and reinforcing altruism (13). Thus, according to this view, the administration of OXT would be expected to diminish the levels of envy and gloating. However, the well-documented role of OXT in territoriality and aggressive behavior, particularly in maternal aggression (22), is inconsistent with the positive effects of OXT on social behavior. Animal research suggests that OXT treatment increases aggressive behavior in rodents (23). Infusion of OXT into the central amygdala increases maternal aggression (24), while lesions of the PVN decrease it (25). It has been suggested that OXT has a dual effect on parental behavior, inhibiting aggression directed toward the offspring, while simultaneously enhancing aggressive behavior toward intruders (26,27).

In view of the diverse behavioral functions of OXT, other interpretations have suggested that OXT may generally enhance social motivation and affiliative behaviors (e.g., [28]). In a similar vein, it is possible that OXT plays a broader role in modulating

From the Department of Psychology (SGS-T, MF, JD, NP-B), University of Haifa, Haifa; and Shalvata Mental Health Center (HH, YL), Hod HaSharon, Israel.

Authors MF and JD contributed equally to this article.

Address correspondence to Simone G. Shamay-Tsoory, Ph.D., Department of Psychology, University of Haifa, Mount Carmel, Haifa 31905, Israel; E-mail: sshamay@psy.haifa.ac.il.

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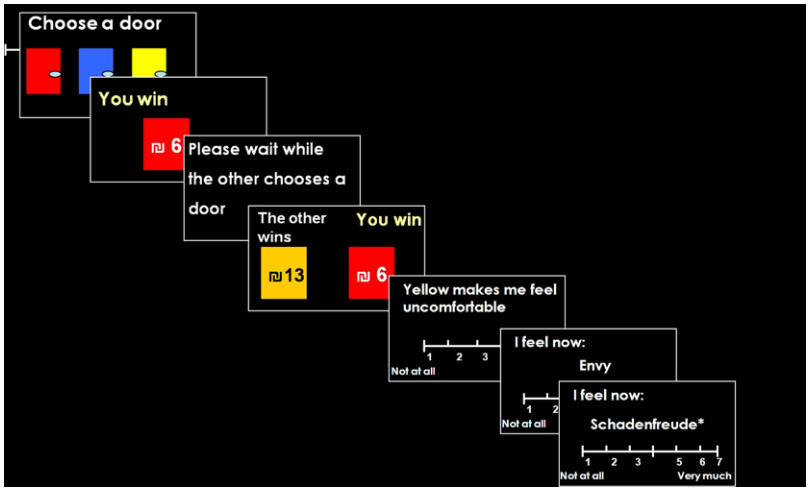

Figure 1. In this example, a relative loss condition is shown. Envy ratings are higher when the other player wins more money than the participant. Following each trial, the participant completed a computerized rating scale (from 1 to 7) that included the envy, gloating (schadenfreude), and colors (4 questions) ratings. *In Hebrew, there is a similar term to schadenfreude ("Simha La-aid"). There is no specific term in English; the closest is gloating or rejoicing in the other's misfortune. ₪ New Israeli Shekels.

social emotions. Therefore, another possible hypothesis is that OXT has a general effect on increasing the salience of social agents, thus provoking a wide range of emotions and behaviors related to social behavior and parenting, such as trusting collaborators, attacking potential intruders, and competing with rivals. With such a general enhancing effect on all social emotions, OXT can be expected to provoke more envy and gloating in competitive situations.

To examine the role of OXT in envy and gloating, we used a paradigm of a game of chance involving monetary gains, which was designed to elicit these emotions in a highly controlled setting. We hypothesized that if the oxytocinergic system is generally involved in modulating social emotions, then the administration of OXT will increase the ratings of envy and gloating following unequal monetary gains.

Methods and Materials

Subjects

A total of 59 subjects (33 female and 26 male subjects) who responded to an advertisement posted at the University of Haifa participated in this double-blind, placebo-controlled, within-subject study. All subjects were Caucasian and fluent in Hebrew. All participants received 100 New Israeli Shekels ($25) for their participation in the experiment (two sessions). The age range of subjects was 20 to 37 years (mean: 26.48, standard deviation: 3.46), and years of education ranged from 12 to 20 (mean: 14.85, standard deviation: 2.42).

Exclusion criteria for participants were assessed using a structured brief interview conducted by a senior psychiatrist (H.H). Exclusion criteria included self-reported history of major depression, bipolar, panic, or psychotic disorders; substance dependence; epilepsy; and traumatic brain injury. Additionally, subjects who reported taking chronic medication other than contraceptive pills were excluded, and females were excluded if they reported being pregnant. The psychiatrist also screened the subjects to ascertain that they had abstained from alcohol and caffeine consumption 2 hours before starting the experiment. Written consent was obtained, and ethical approval was provided by Shalvata Mental Health Center's Ethics Committee.

Task and Stimuli

The paradigm designed uses a simplified behavioral definition of envy and gloating that relates to the disparities between one's own and the other's gain or loss (relative gains and losses). The task was validated in a preliminary study involving 21 different participants and was also validated in the present study (Supplement 1).

The envy condition involved relative losses represented by negative disparity (less than zero) between the participant and the putative player, whereas the gloating condition involved relative gains represented by positive disparity (greater than zero) between the participant and the other player. The equal gain condition served as a control condition (Figure 1).

Participants were presented with three doors of different colors and were told that behind each door was a different amount of money they could win. On each trial of the task, the participants were instructed to choose one of the three doors by clicking the number on the keyboard corresponding to the number on the door. Following each trial, the participants completed a computerized rating scale for items on envy and gloating, as well as six additional emotion items (presented below) and control questions. Each item presented an emotion, and participants were asked to indicate how strongly they were feeling this emotion at that particular moment, rated on a scale from 1 (not at all) to 7 (very much). The control items were statements about the participants' feelings toward different colors (e.g., "Yellow makes me feel uncomfortable"; "Orange symbolizes something positive"). Six additional items adapted from previous studies that examined envy and schadenfreude (29) tapped emotions and attitudes emanating from envy and gloating, with three items each as follows: ("I would like to be in the other person's shoes," "I feel inferior to the other player," and "I feel resentment towards the other player" for envy; and "I feel superior to the other player," "I feel happy," and "It gives me satisfaction to see what happened to the other player" for gloating) (Table 1). All items were presented in a random order after each trial (for detailed description of the task, see Supplement 1).

Procedure

Participants were randomly assigned to two groups: 31 participants received OXT (Novartis, Basel, Switzerland) in the first session of the experiment and a placebo in the second session, while 28 participants received a placebo in the first session and OXT in the second session. Before the beginning of each testing session, the participants were shown into a waiting room in groups of 6 to 8 individuals. To avoid significant interactions between the participants, the investigators did not introduce the participants to each other.

Table 1. Envy and Gloating (as well as Related Emotions) Scores Following Oxytocin and Placebo Administration

	Relative Loss		Relative Gain		Equal Gain	
	OXT	Placebo	OXT	Placebo	OXT	Placebo
Envy-Related Emotions						
Envious	2.00 (1.22)[a]	1.68 (.92)	1.52 (.92)	1.36 (.63)	1.33 (.59)	1.43 (.96)
Would like to be in the other player's shoes	2.61 (1.71)[a]	2.19 (1.25)	1.84 (1.32)	1.59 (.83)	1.77 (1.23)	1.49 (.95)
Inferiority	1.73 (.96)[b]	1.64 (.9)	1.42 (.71)	1.44 (.74)	1.35 (.79)	1.43 (.78)
Resentment	1.73 (1.10)[b]	1.66 (1.08)	1.53 (.93)	1.45 (.74)	1.49 (.906)	1.43 (.75)
Gloating-Related Emotions						
Schadenfreude	1.63 (1.28)	1.45 (1.01)	2.14 (1.43)[a]	1.83 (1.17)	1.64 (1.03)	1.53 (1.02)
Superiority	1.51 (.86)	1.56 (1.5)	1.82 (1.11)[c]	1.78 (1.19)	1.65 (1.20)	1.64 (1.10)
What happened to the other gives me satisfaction	2.24 (1.28)	2.22 (1.16)	2.86 (1.42)[d]	2.68 (1.35)	3.14 (1.46)	3.05 (1.34)
Happiness	3.06 (1.53)	2.95 (1.39)	3.30 (1.48)[d]	3.17 (1.47)	3.49 (1.55)	3.56 (1.51)

Repeated-measures ANOVA indicates a significant difference between conditions in the envy-related emotions: inferiority [$F(5,51) = 5.584$, $p = .0001$]; resentment [$F(5,51) = 3.285$, $p = .012$]; and wanting to be in the other's shoes [$F(5,51) = 11.5847$, $p = .0001$] items. Likewise, significant differences between conditions are evident in the gloating-related items: satisfaction [$F(5,51) = 7.544$, $p = .0001$] and happiness [$F(5,51) = 5.425$, $p = .0001$] items. The superiority questions did not reach significance [$F(5,51) = 2.09$, $p = .08$].

ANOVA, analysis of variance; OXT, oxytocin.

[a]Significantly different from the rest of the emotional ratings in all conditions.

[b]Significantly different from all other ratings in all conditions except for relative loss under placebo.

[c]Significantly different from all other ratings in all conditions except for relative gain under placebo.

[d]Significantly different from the ratings in the relative loss condition.

Each participant was then escorted to another room to receive either 24 international units (IU) of intranasal OXT or the placebo treatment. The OXT was administered using a nasal spray (three puffs in each nostril, 4 IU in each puff). After administration, the subjects were asked to wait 45 minutes to ensure that the OXT levels in the central nervous system had reached a plateau (30).

During this waiting period, participants completed the Dispositional Envy Scale (DES), a reliable and stable measure of individual differences in the tendency to be envious (31). At the end of the 45-minute period, participants completed the Depression Adjective Check List (DACL) (32) to track mood changes following administration of the drug. The DACL is a self-report instrument for the measurement of affect, consisting of an adjective checklist describing mood states. Participants were then told that they would perform a task of chance involving color selection in parallel with one of the other participants from their group. In actuality, all participants played with a putative participant. Based on previous studies (33), the gender of the putative player was matched to that of the participant.

Data Analysis

Ratings of envy, gloating, and related questions were analyzed separately for the relative loss, relative gain, and equal gain conditions. It was expected that similar to other reports in the literature, the direct envy and gloating ratings would be generally rather low (7). Indeed, as observed in Table 1, the means of the envy and gloating ratings ranged between 1.33 and 2.1. To identify potential outliers, all the variables were standardized and three participants who had more than three extreme values (higher than 2.5) were excluded. Therefore, the analyses were conducted on the remaining 56 participants.

Results

The different emotional ratings were analyzed separately as a function of treatment, condition, and order of treatment. First, the direct measures of ratings of envy and gloating were analyzed, followed by the composite measures of envy- and gloating-related emotions, as well as the color ratings.

Envy Ratings

A three-way repeated measures analysis was employed, with treatment (OXT, placebo) and task condition (relative gain, relative loss, and equal gain) as the within-participants factors and treatment order (first OXT, first placebo) as the between-participants factor.

A main effect of treatment [$F(1,54) = 5.168$, $p = .027$] was found, with higher envy ratings under OXT (1.634) than under the placebo (1.489). Follow-up contrasts with Bonferroni corrections indicated that the administration of OXT significantly increased the envy ratings in the relative loss condition [$F(1,54) = 7.869$, $p = .007$] as compared with the placebo, whereas they did not increase in the equal gain condition [$F(1,54) = .697$, $p = .408$] or in the relative gain condition [$F(1,54) = 3.998$, $p = .051$] (Figure 2A).

A main effect of condition [$F(2,54) = 11.537$, $p = .0001$] was found, with higher envy ratings in the relative loss condition (1.841) than in the relative gain condition (1.383) or in the equal gain condition (1.460). Notably, there was a significant interac-

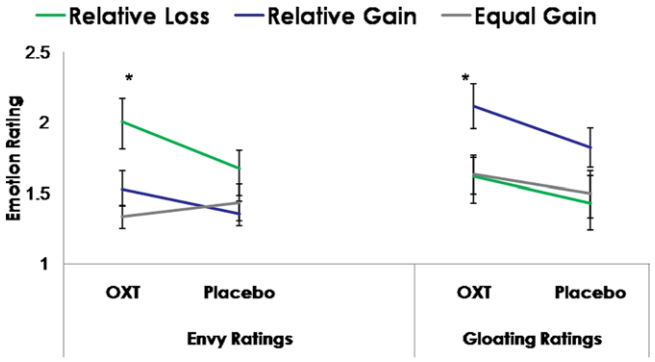

Figure 2. The administration of OXT enhances envy and gloating in the task. A significant treatment effect is evident in the envy ratings and the gloating ratings. As compared with the placebo, OXT significantly increased ratings of envy in the relative loss condition and ratings of gloating in the relative gain condition, but it did not have an effect in the other conditions. *$p < .05$. OXT, oxytocin.

tion between treatment and condition [$F(2,54) = 3.886$, $p = .029$].

No order effect [$F(1,54) = .60$, $p = .807$] was found, meaning that there were no differences in the envy ratings between those participants who received OXT treatment first and those who received the placebo first. There was no significant interaction found between treatment and order [$F(2,54) = .112$, $p = .870$], nor was there a significant three-way interaction found between treatment, condition, and order [$F(2,54) = .382$, $p = .6534$].

To examine gender differences in task performance and treatment, gender was added to the model as the between-subjects factor. The results indicated a main effect of treatment [$F(1,54) = 4.183$, $p = .046$], as well as a main effect of condition [$F(2,54) = 12.147$, $p = .0001$]. There was no gender effect [$F(1,54) = 1.573$, $p = .215$], nor was gender found to interact with treatment [$F(1,57) = .001$, $p = .972$]. The three-way interaction between treatment, condition, and gender was also not found to be significant [$F(2,56) = .948$, $p = .067$].

Gloating Ratings

As in the envy ratings, a three-way repeated measures analysis was employed, with treatment and condition as the within-participants factors and treatment order as the between-participants factor.

A main effect of treatment [$F(1,54) = 5.872$, $p = .019$] was found, with higher ratings of gloating under OXT (2.14) than under the placebo (1.83). Follow-up contrasts indicated that after OXT administration, the gloating ratings significantly increased in the relative gain condition [$F(1,54) = 4.064$, $p = .049$] as compared with the placebo, whereas they did not increase in the conditions of relative loss [$F(1,54) = 3.102$, $p = .084$] or equal gain [$F(1,54) = 1.216$, $p = .275$] (Figure 2B).

A main effect of condition [$F(2,54) = 10.244$, $p = .0001$] was found, with higher gloating ratings in the relative gain condition (1.969) than in the relative loss condition (1.565) or in the equal gain condition (1.525). No order effect [$F(1,54) = 2.079$, $p = .155$] was found between those participants who received OXT treatment first and those who received the placebo first. No significant interactions were found between treatment and condition [$F(2,54) = .488$, $p = .615$] or between treatment and order [$F(1,54) = .013$, $p = .987$], nor was there a significant three-way interaction found between treatment, condition, and order [$F(2,54) = 1.268$, $p = .285$].

To examine gender differences in task performance and treatment, gender was added to the model as the between-subjects factor. The results indicated a main effect of treatment [$F(1,54) = 5.808$, $p = .019$], as well as a main effect of condition [$F(2,54) = 9.968$, $p = .0001$]. There was no gender effect [$F(1,54) = .396$, $p = .532$], nor was gender found to interact with treatment [$F(1,54) = .003$, $p = .956$]. The three-way interaction between treatment, condition, and gender was also not found to be significant [$F(2,54) = 1.330$, $p = .269$].

Envy, Gloating, and Color Indexes

Three composite scores for envy, gloating, and colors were calculated, as described below, to further examine the effect of OXT and experimental manipulation on these different emotions.

Envy Index. The Envy Index was comprised of the mean scores of the questions subserving envy (Table 1). A three-way repeated measures analysis was employed, with treatment (OXT, placebo) and task condition (relative gain, relative loss, and equal gain) as the within-participants factors and treatment order (first OXT, first placebo) as the between-participants factor. The main effect of treatment was found to be significant [$F(1,54) = 4.091$, $p = .048$], as were the main effect of condition [$F(2,54) = 26.253$, $p = .0001$] and the interaction between treatment and condition [$F(2,54) = 4.277$, $p = .043$]. There was no order effect [$F(1,54) = .004$, $p = .947$], nor was order found to interact with treatment [$F(2,54) = .038$, $p = .847$].

Follow-up contrasts indicated that after OXT administration, the envy index significantly increased in the relative loss condition [$F(1,54) = 6.027$, $p = .017$] as compared with the placebo, whereas it did not increase in the conditions of relative gain [$F(1,54) = 2.497$, $p = .120$] or equal gain [$F(1,54) = .321$, $p = .573$] (Figure 3A). The same analysis was conducted with gender as the between-subjects factor, and neither a gender effect [$F(1,54) = .285$, $p = .596$] nor an interaction between gender and treatment [$F(1,54) = .419$, $p = .520$] was found.

Gloating Index. The gloating index was comprised of the mean scores of the questions subserving gloating (Table 1). A three-way repeated measures analysis was employed, with treatment and task condition as the within-participants factors and treatment order as the between-participants factor. The main effect of treatment was not found to be significant [$F(1,54) = 1.536$, $p = .221$]. However, the main effect of condition was found to be significant [$F(2,54) = 17.884$, $p = .0001$], and the interaction between treatment and condition was marginally significant [$F(2,54) = 3.0$, $p = .08$]. There was no order effect [$F(1,54) = .087$, $p = .770$], nor was order found to interact with treatment [$F(2,54) = 2.11$, $p = .152$].

Follow-up contrasts indicated that after OXT administration, the gloating index significantly increased in the relative gain condition [$F(1,54) = 4.509$, $p = .038$] as compared with the placebo, whereas it did not increase in the conditions of relative loss [$F(1,54) = .467$, $p = .497$] or equal gain [$F(1,54) = .120$, $p = .730$] (Figure 3B). The same analysis was conducted with gender as the between-subjects factor, and neither a gender effect [$F(1,54) = .870$, $p = .355$] nor an interaction between gender and treatment [$F(1,54) = .823$, $p = .368$] was found.

Color Index. The color index was comprised of the mean scores of all the color items. A three-way repeated measures analysis was employed, with treatment and task condition as the within-participants factors, treatment order as the between-participants factor, and color index score as the dependent variable. There was no effect of treatment [$F(1,54) = 1.410$, $p = .240$] or condition [$F(2,54) = 1.313$, $p = .278$], nor was there any interaction between

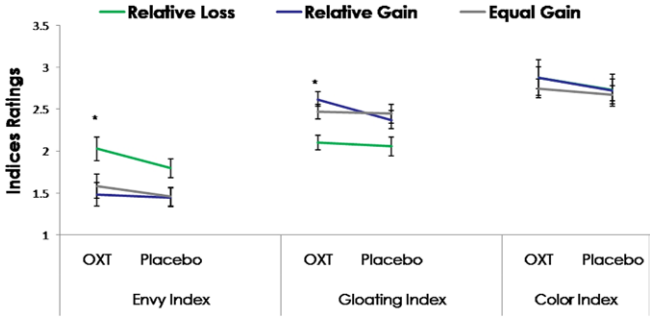

Figure 3. Administration of OXT enhances envy and gloating indexes in the task. A significant interaction effect is evident in the envy index and the gloating index (marginal) but not in the color index. As compared with the placebo, OXT significantly increased ratings of envy indexes in the relative loss condition and ratings of gloating indexes in the relative gain condition, but it did not have an effect in the other conditions. *$p < .05$. OXT, oxytocin.

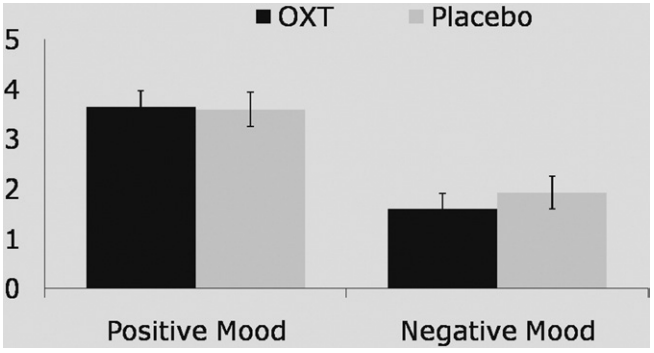

Figure 4. Administration of OXT does not change general mood ratings. Repeated-measures analysis did not reveal any treatment effect on general mood ratings. OXT, oxytocin.

treatment and condition [$F(2,54) = .292$, $p = .747$] (Figure 3C). There was no order effect [$F(1,54) = .811$, $p = .372$], nor was order found to interact with treatment [$F(2,54) = 2.77$, $p = .083$]. Finally, no gender effect was found [$F(1,54) = 2.630$, $p = .111$].

To rule out the possibility that OXT had a general effect on mood, we examined the participants' ratings of the DACL. As shown in Figure 4, in line with previous reports (12), the results indicated no drug effect [$F(1,55) = .754$, $p = .389$] or interaction with valence (positive or negative) [$F(1,58) = .345$, $p = .560$]. There was a general valence effect [$F(1,55) = 13.594$, $p = .001$] demonstrating that participants were generally in a good mood, but their mood was not affected by the administration of OXT.

We also examined the relationship between dispositional envy (DES) and envy ratings. Significant correlations were found between DES and envy ratings in the relative loss condition following OXT treatment ($r = .51$, $p = .0001$), as well as following the placebo ($r = .51$, $p = .0001$).

Discussion

In the present study, we examined the effects of the administration of OXT on envy and gloating. We speculated that if the oxytocinergic system is involved only in prosocial positive emotions, then the administration of OXT would diminish the levels of envy and gloating. By contrast, if OXT is generally involved in modulating social emotions, then the administration of OXT would be expected to increase the ratings of envy and gloating.

Our results support the latter hypothesis by showing that the levels of gloating and envy increased following the administration of OXT. When we examined the envy ratings alone, both a treatment effect and an interaction effect between treatment and condition were evident. A significant interaction effect was also found in the envy index ratings. Furthermore, tests of contrasts indicated that the envy ratings increased only in the relative loss condition. For the gloating index, a treatment effect was also found, but the interaction between treatment and condition was only marginally significant. No effects of gender or treatment order were found for either the envy or the gloating ratings.

The fact that in the gloating ratings and gloating index there was a significant treatment effect found but not a significant interaction with condition may indicate that the administration of OXT had a general subtle effect on increasing feelings of gloating, even in the equal gain and relative loss conditions. Nonetheless, tests of contrasts indicated that the ratings of gloating-related emotions increased significantly only in the relative gain condition. Although it appears that the results are stronger for envy than for gloating, it is clear that the administration of OXT had a consistent effect on both ratings of envy and gloating.

It should be noted that overall, the participants' reports of envy and gloating were mild, which may have obscured the effects of OXT. It has previously been proposed that even strong manipulations of envy and schadenfreude may generate only moderate effects in a laboratory setting (29). Specifically, it has been reported that schadenfreude only rarely reaches a high intensity, even outside the laboratory. Furthermore, most of the time people are reluctant to admit feeling these emotions. Indeed, participants gave somewhat higher ratings of envy- and gloating-related emotions, such as happiness and satisfaction. Additionally, it is possible that larger amounts of money would have increased the incentive of the participants to win money and would have produced larger effects.

Nevertheless, the fact that the administration of OXT did not have a general effect on feelings toward colors or on mood, but did have an effect on envy and gloating ratings, may indicate that OXT specifically increases emotions related to social agents. As envy and gloating are emotions related to negative feelings, such as resentment, the increase in these emotions following OXT administration is largely contradictory to the widely accepted prosocial hypothesis of OXT (13,17). As such, this hypothesis should be re-examined to ascertain the common denominator between the previous reports of prosocial effects of OXT and the present results pointing to involvement of OXT in the modulation of envy and gloating.

Oxytocin supports reproductive functions in virtually all vertebrates and contributes to a wide variety of social behaviors, including social recognition, communication, parental care, territorial aggression, and social bonding. In nonhuman mammals, OXT plays a central role in the ability to form social attachments and affiliations, including parental care, pair bonding, and social memory (34,35).

Although the effects of OXT are species-specific and depend on species-specific receptor distributions in the brain (36), it is possible that it is fundamentally related to increasing the salience of social agents. Oxytocin may increase the individual's attention to social agents, which may result in more trustworthiness and generosity in positive contexts, while leading to more envy and schadenfruede in competitive contexts.

In line with our hypothesis, a recent study involving empathy to the other's pain showed that administration of OXT did not increase levels of empathy (37), suggesting that OXT does not necessarily increase empathic prosocial behavior in all contexts. Rather than increasing only positive prosocial altruistic emotions, it appears that OXT may have a general effect on increasing the salience of social agents and therefore promote social behavior and a wider range of social emotions, such as envy.

Indeed, several animal studies have demonstrated that social emotional stress conditions involving territoriality (induced by exposure to the "social defeat" procedure) activate the septal and hypothalamic oxytocinergic systems in male rats (38,39). This system is also shown to be activated in social attachment in different contexts (40). The social recognition deficits repeatedly seen in male as well as female OXT knockout mice (41) may also imply that in these animals, the salience of social agents is diminished to a point that they fail to learn and remember familiar conspecifics even after repeated social exposures.

Our suggestion regarding the role of OXT in increasing social emotion-related behaviors reconciles the contradictory results

regarding the effects of OXT on prosocial behavior, on the one hand, and aggressive behavior, by contrast. It has been suggested that we envy those who are close to us. Envy and gloating are social emotions elicited in social situations (6) and therefore it is not surprising that OXT may increase the levels of these emotions.

Finally, the well-documented role of OXT in autism spectrum disorders (ASD) (19,42) is also congruent with our social salience hypothesis. It has previously been shown that individuals with ASD demonstrate a lack of attentional modulation, which is particularly evident for social stimuli (43). Accordingly, it has been demonstrated that children with autism reveal a less coherent understanding of jealousy (44), an emotion with characteristics similar to envy that may co-occur in equivalent situations (8). It is thus possible that a dysfunction in the oxytocinergic system may account for the abnormal social behavior evident in ASD.

There are several limitations to the present study that need to be acknowledged and addressed. As mentioned above, the relatively low ratings of envy and gloating may imply that although the manipulation was valid (Supplement 1) it was not strong enough. A related possible shortcoming relates to the use of self-report emotional scales to assess the levels of envy and gloating. Although the majority of studies on envy and schadenfreude to date have used similar scales (29), it is well known that people do not always rate their emotions authentically, particularly when reprehensible items are presented. Nevertheless, despite the nature of the task, the finding that the administration of OXT intensifies the ratings of envy- and gloating-related emotions further places the oxytocinergic system as a core neuropeptide that modulates these emotions.

In sum, our results show that contrary to the widely accepted prosocial hypothesis of OXT, the intranasal administration of OXT increases reported levels of envy and also has a moderate effect on gloating in healthy women and men. We thus propose that the oxytocinergic system is responsible for modulating the salience of social agents in social contexts. As a result, the administration of OXT may provoke a wide range of emotions and behaviors related to social behavior and parenting, such as trusting collaborators, attacking potential intruders, and competing with rivals.

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Supplementary material cited in this article is available online.

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