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Oxytocin Selectively Improves Empathic Accuracy

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Oxytocin is known to regulate prosocial behavior and social cognition in animals (Ross & Young, 2009), and recent studies suggest that oxytocin may have similar functions in humans. For example, oxytocin increases trust (Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005) and accuracy in mental-state attribution (Domes, Heinrichs, Michel, Berger, & Herpertz, 2007; Guastella et al., 2009). These findings have generated excitement about oxytocin's potential to ameliorate social deficits in such disorders as social phobia and autism (Bartz & Hollander, 2006; Guastella et al., 2009; Kosfeld et al., 2005). This excitement has not been confined to the scientific community: Dubbed the "hormone of love," oxytocin is a common topic in the popular press.

Is oxytocin truly a universal social panacea? Although some studies have shown that oxytocin improves social cognition and empathy (Domes et al., 2007; Guastella et al., 2009), others have not (Singer et al., 2008). Even studies demonstrating positive effects have ambiguities: Domes et al. (2007) found that oxytocin improved performance for difficult—but not easy—test items. These observations imply that rather than working universally, oxytocin may selectively facilitate social cognition given certain constraints. For example, by altering specific motivational or cognitive states, oxytocin might increase the salience of social cues, which in turn could improve social-cognitive performance for some individuals, but not others. The effects of oxytocin, then, should be most pronounced in individuals who—at baseline—are less socially proficient; this would be consistent with broader interactionist views emphasizing that individual differences in competencies interact with situational variables to determine behavior (Mischel & Shoda, 1995).

To test whether normal variance in social proficiency moderates the effects of oxytocin on social-cognitive performance, we used a randomized, double-blind, placebo-controlled, crossover challenge in which participants received either intranasal oxytocin or a placebo and performed an empathic-accuracy task that naturalistically measures social-cognitive abilities (Zaki, Bolger, & Ochsner, 2008). We measured variance in baseline social competencies with the Autism Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001), a self-report instrument that predicts social-cognitive performance (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). We hypothesized that drug condition and AQ score would interact to predict performance on the empathic-accuracy task, with oxytocin having the most pronounced effects for less socially proficient individuals (i.e., those with higher AQ scores).

Method

Participants and procedure

Twenty-seven healthy men (mean age = 26.8 years, *SD* = 7.0) participated in this experiment in return for $120 in compensation. They completed the AQ at baseline (mean score = 11.6, *SD* = 5.6, range = 2–26) and then self-administered 24 IU of intranasal oxytocin (Syntocinon; Novartis, Basel, Switzerland) or a matching placebo (see Methodological Details in the Supplemental Material available online for inclusion/exclusion criteria and additional information on the AQ). Forty-five minutes later, participants viewed five videos of target individuals discussing emotional events. While watching each video, participants used key presses on a computer keyboard to continuously rate how positive or negative they thought the target felt at each moment during the narrative. Participants used a 9-point Likert scale (1 = *very negative*, 9 = *very positive*) that was displayed at all times on the computer screen (for further details, see the Method section from Zaki, Weber, Bolger, & Ochsner, 2009). Participants returned 3 to 5 weeks later, received the alternate compound, and completed the empathic-accuracy task again, with different stimulus videos.

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Statistical analyses

Empathic accuracy was operationalized as the time-series correlation between a participant's ratings of a target's affect and the target's own ratings of his or her affect. We calculated a separate correlation coefficient reflecting each participant's overall empathic-accuracy score for each video clip (see Zaki et al., 2009, for details). We then modeled empathic accuracy as a function of drug condition (placebo = 0, oxytocin = 1), AQ (z score, continuous), and the Drug Condition × AQ interaction, using a mixed linear model. Because target expressivity is strongly associated with perceiver accuracy (Zaki et al., 2008), we included target expressivity (i.e., targets' scores on the Berkeley Expressivity Questionnaire; see Gross & John, 1997) as a covariate. Mixed-model analyses were performed using PROC MIXED in SAS 9.1 (SAS Institute, 2002), with restricted maximum likelihood to estimate parameters and the Kenward-Roger method to calculate appropriate degrees of freedom (Littell, Milliken, Stroup, Wolfinger, & Schabenberger, 2006).

Results

In the control condition, AQ (in z-score form) had a significant negative effect on empathic accuracy, $b = -0.11$, $t(79) = -2.77$, $p < .01$. However, there was also a significant Drug Condition × AQ interaction, $b = 0.11$, $t(232) = 2.01$, $p < .05$, such that there was no association between AQ and empathic accuracy in the oxytocin condition. Participants with low AQ scores performed well on the empathic-accuracy task in the placebo condition and maintained this performance level in the oxytocin condition, whereas participants with high AQ scores performed poorly in the placebo condition but significantly better in the oxytocin condition; in fact, in the oxytocin condition, performance of participants with high and low AQ scores was indistinguishable (Fig. 1). These findings support the hypothesis that oxytocin selectively improves social-cognitive efficiency for less socially proficient individuals but has little effect on more socially proficient individuals. Additional analyses ruled out the possibility that the pattern of results was due to practice effects, mood, or participants' beliefs about whether they received oxytocin or a placebo (see Additional Analyses in the Supplemental Material available online).

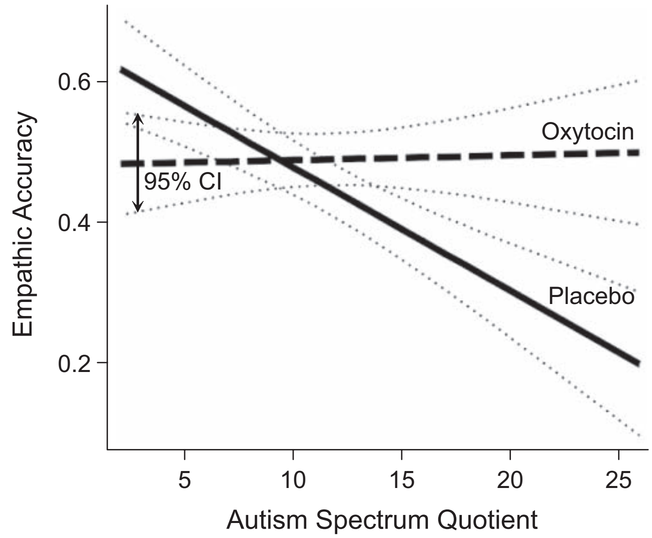

Fig. 1. Results of the regression analysis: predicted empathic accuracy as a function of Autism Spectrum Quotient (AQ) raw score for the oxytocin condition (dashed line) and placebo condition (solid line). The dotted curves indicate 95% confidence intervals (CIs). Lower numbers on the AQ reflect greater social-cognitive proficiency. Higher numbers on the empathic-accuracy index reflect superior performance. Predicted values are shown only for observed levels of the AQ; the predictive equation is as follows: empathic accuracy = 0.44 + 0.048(drug condition) – 0.018(AQ) + 0.018(Drug Condition × AQ).

Discussion

We found that normal variance in baseline social-cognitive competence moderates the effects of oxytocin; specifically, oxytocin improved empathic accuracy only for less socially proficient individuals. These findings constitute evidence against the popular view that oxytocin acts as a universal prosocial enhancer that can render all people social-cognitive experts. Instead, oxytocin appears to play a more nuanced role in social cognition, and helps only some people.

Although these data do not specify one mechanism of action, the fact that oxytocin selectively improved empathic accuracy for people with higher—but not lower—AQ scores may provide clues about underlying mechanisms. For example, these data are consistent with the hypothesis that oxytocin increases the perceived salience of social cues (e.g., Shamay-Tsoory et al., 2009), which suggests that oxytocin should benefit only those individuals who are less attuned to social information and hence fail to make appropriate judgments of social cues at baseline. This would, of course, include those who score high on the AQ. Intriguingly, a recent study reported an association between empathy and a polymorphism (rs53576) of the oxytocin receptor (OXTR) gene, with the A/G or A/A genotypes being associated with lower behavioral and dispositional empathy (Rodrigues, Saslow, Garcia, John, & Keltner, 2009). Increases in the salience of social cues may reflect exogenous oxytocin "correcting" for social-cognitive inefficiencies related to this OXTR gene polymorphism. Future work could explore associations between AQ scores and OXTR gene allelic frequencies.

Whichever mechanisms prove correct, these data suggest a more circumscribed answer to the question of who will benefit from oxytocin, and under what circumstances.

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Declaration of Conflicting Interests

Jennifer A. Bartz is principal investigator on a grant from the National Institutes of Health to investigate the effects of oxytocin on complex social cognition in autism spectrum disorders (NIH 1R21HD065276-01). Eric Hollander has applied for a patent to use oxytocin as a treatment for social deficits and repetitive behaviors in autism. Jamil Zaki, Niall Bolger, Natasha N. Ludwig, Alexander Kolevzon, and Kevin N. Ochsner declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Supplemental Material

Additional supporting information may be found at http://pss.sagepub.com/content/by/supplemental-data

References

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "Reading the Mind in the Eyes" test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry*, *42*, 241–251.

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The Autism-Spectrum Quotient (AQ): Evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders*, *31*, 5–17.

Bartz, J.A., & Hollander, E. (2006). The neuroscience of affiliation: Forging links between basic and clinical research on neuropeptides and social behavior. *Hormones and Behavior*, *50*, 518–528.

Domes, G., Heinrichs, M., Michel, A., Berger, C., & Herpertz, S.C. (2007). Oxytocin improves "mind-reading" in humans. *Biological Psychiatry*, *61*, 731–733.

Gross, J.J., & John, O.P. (1997). Revealing feelings: Facets of emotional expressivity in self-reports, peer ratings, and behavior. *Journal of Personality and Social Psychology*, *72*, 435–448.

Guastella, A.J., Einfeld, S.L., Gray, K.M., Rinehart, N.J., Tonge, B.J., Lambert, T.J., et al. (2009). Intranasal oxytocin improves emotion recognition for youth with autism spectrum disorders. *Biological Psychiatry*, *67*, 692–694.

Kosfeld, M., Heinrichs, M., Zak, P.J., Fischbacher, U., & Fehr, E. (2005). Oxytocin increases trust in humans. *Nature*, *435*, 673–676.

Littell, R.C., Milliken, G.A., Stroup, W.W., Wolfinger, R.D., & Schabenberger, O. (2006). *SAS for mixed models* (2nd ed.). Cary, NC: SAS Institute.

Mischel, W., & Shoda, Y. (1995). A cognitive-affective system theory of personality: Reconceptualizing situations, dispositions, dynamics, and invariance in personality structure. *Psychological Review*, *102*, 246–268.

Rodrigues, S.M., Saslow, L.R., Garcia, N., John, O.P., & Keltner, D. (2009). Oxytocin receptor genetic variation relates to empathy and stress reactivity in humans. *Proceedings of the National Academy of Sciences, USA*, *106*, 21437–21441.

Ross, H.E., & Young, L.J. (2009). Oxytocin and the neural mechanisms regulating social cognition and affiliative behavior. *Frontiers in Neuroendocrinology*, *30*, 534–547.

Shamay-Tsoory, S.G., Fischer, M., Dvash, J., Harari, H., Perach-Bloom, N., & Levkovitz, Y. (2009). Intranasal administration of oxytocin increases envy and schadenfreude (gloating). *Biological Psychiatry*, *66*, 864–870.

Singer, T., Snozzi, R., Bird, G., Petrovic, P., Silani, G., Heinrichs, M., et al. (2008). Effects of oxytocin and prosocial behavior on brain responses to direct and vicariously experienced pain. *Emotion*, *8*, 781–791.

Zaki, J., Bolger, N., & Ochsner, K. (2008). It takes two: The interpersonal nature of empathic accuracy. *Psychological Science*, *19*, 399–404.

Zaki, J., Weber, J., Bolger, N., & Ochsner, K. (2009). The neural bases of empathic accuracy. *Proceedings of the National Academy of Sciences, USA*, *106*, 11382–11387.