Review

Social effects of oxytocin in humans: context and person matter

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Building on animal research, the past decade has witnessed a surge of interest in the effects of oxytocin on social cognition and prosocial behavior in humans. This work has generated considerable excitement about identifying the neurochemical underpinnings of sociality in humans, and discovering compounds to treat social functioning deficits. Inspection of the literature, however, reveals that the effects of oxytocin in the social domain are often weak and/or inconsistent. We propose that this literature can be informed by an interactionist approach in which the effects of oxytocin are constrained by features of situations and/or individuals. We show how this approach can improve understanding of extant research, suggest novel mechanisms through which oxytocin might operate, and refine predictions about oxytocin pharmacotherapy.

The rise of oxytocin research in humans

The past decade has produced nearly a fourfold increase in published studies on the effects of exogenous oxytocin on social cognition and prosocial behavior in humans [1,2] motivated largely by research showing that oxytocin is involved in regulating such social processes in animals [3]. The excitement about oxytocin has not been confined to the scientific community: dubbed the 'love hormone' (e.g. Alleyne, R., *The Telegraph*, 23 September 2010; http://www.telegraph.co.uk/health/healthnews/8020464/Oxytocin-the-love-hormone-could-cure-shyness.html), oxytocin is a frequent topic in the popular press and among the general public. Indeed, 'Google Insights' reveals that searches for 'oxytocin nasal spray,' 'oxytocin autism' and 'oxytocin social anxiety' have grown by more than 5000% since 2004 (information obtained 14 April 2011).

Although some parallels exist between the social effects of oxytocin across species [4,5], inspection of extant data in humans reveals inconsistencies and small effect sizes that prompt the question: 'what effect, if any, does oxytocin have on human social cognition and prosocial behavior?' This observation echoes the doubts that faced personality psychology in the 1960s due to findings that personality traits rarely predicted behavior in a consistent fashion (Box 1) [6–9]. This impasse was resolved by adopting an interactionist approach in which dispositions were viewed as combining with features of a situation to produce behavior. We argue that a similar interactionist approach can clarify the role of oxytocin in human social cognition and prosocial behavior. Oxytocin is generally thought to exert situation-invariant effects on behavior, being described, for example, as improving social cognition or promoting prosocial behavior. As detailed below, however, empirical support for this view is surprisingly inconsistent, and the effects of oxytocin are often moderated by contextual factors (i.e. features of the situation in which oxytocin is administered) or by stable characteristics of the individuals to whom oxytocin is administered.

This pattern of findings suggests that two key features of an interactionist approach could improve our understanding of the social effects of oxytocin. First, inconsistencies across studies should not be seen as 'noise,' but as clues to the context- and person-dependent nature of the effects of oxytocin. Second, characterizing this context- and person-dependency could enable more refined theorizing on the social effects of oxytocin in humans. Viewing the effects of oxytocin in this way casts new light on extant and emerging empirical data, and can inform a more individualized use of oxytocin as a therapeutic agent.

In this article we review the findings published to date documenting the effects of oxytocin on social cognition and prosociality more broadly to illustrate the context- and person-dependent effects of oxytocin. Studies that do not directly assess social cognitive and/or behavioral outcomes (e.g. functional imaging studies without cognitive and/or behavioral measures, and studies investigating the effects of oxytocin on stress reactivity) will not be focused on in our empirical review, but will be considered in our discussion of potential mechanisms underlying the social effects of oxytocin. Moreover, we focus on studies that experimentally manipulate the availability of oxytocin (e.g. via intranasal administration of synthetic oxytocin) rather than studies investigating the correlates of endogenous oxytocin levels because our primary concern is with understanding the social effects of oxytocin in humans (although we do discuss the literature on endogenous oxytocin towards the end of this review because we suspect that such natural variation could crucially moderate the effects of exogenous oxytocin administration). Finally, we note that this article concerns the social effects of oxytocin in humans rather than animals; thus, we reference the animal literature only where it helps to contextualize the human data (there are several comprehensive reviews on this topic, e.g. [3,10–14], for the interested reader).

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Box 1. Roots of interactionism: the trouble with traits

Interactionism in personality and social psychology was put forward to resolve an uncomfortable paradox. On the one hand, researchers and lay conceptions alike posited that individuals have traits (e.g. introversion and aggression) that should reliably predict their behaviors [79]. On the other hand, a cascade of demonstrations indicated that traits, assessed by individuals themselves or by researchers, produced low or nonexistent correlations with behavior assessed across varying situations (e.g. someone judging themselves as conscientious might study hard for exams but be an irresponsible friend or parent) [8,80]. This failure to validate trait models led to a crisis for personality research [8,81] and eventually to a sea change in the interpretation of individual differences that was spearheaded by Mischel and colleagues [82].

Mischel's reconceptualization of personality made two fundamental points. First, individual differences are best described not as predictors of behavior across all situations but rather as stable predictors of behavior within specific contexts [82]. For example, in several field studies individuals did not differ in their overall display of a given behavior (e.g. verbal aggression) but rather showed stable patterns of individual variability in the situational predictors of the behavior (e.g. one teenager became aggressive when scolded by a teacher but not when teased by a peer, whereas another teenager showed the opposite pattern; see [83,84]). Second, individuals' behavioral profiles across contexts reflect not only the gross features of situations themselves but also the ways individuals interpret those features [82]. Importantly, individuals can differ in the value they assign to certain stimulus types or in the expectancies they have about the meaning of those stimuli, and these 'psychological ingredients' underlie individual differences in behaviors in a given context [82,85]. We argue that both of these points can illuminate our understanding of the effects of oxytocin on human social cognition and behavior.

The effects of oxytocin on social cognition and prosociality in humans

Social cognition

Research shows that oxytocin plays a central role in social recognition in animals (e.g. [15–18]). This research inspired numerous studies examining whether oxytocin has similar effects on social memory in humans [19–21,23], as well as studies examining other aspects of human social cognition such as emotion detection [24–27], emotion recognition or 'theory of mind' [5,28–30], and empathy, including the vicarious sharing of others' internal states [29,31]. Several of these studies report beneficial effects of oxytocin. For example oxytocin has been shown to improve an individual's ability to produce normative ratings of others' emotions based on pictures of the eye region of the face in healthy adults [5], and in individuals with autism spectrum disorders (ASD) [30].

Such findings are clearly grounds for excitement about the therapeutic use of oxytocin to improve social cognitive abilities. However, a closer look at the data reveals that the effects of oxytocin are often nuanced and inconsistent. For example three of the six studies/outcomes evaluating the effects of oxytocin on emotion recognition or affect sharing/empathy report nonsignificant main effects of oxytocin [28,29,31]. Perhaps more importantly, more than two-thirds of studies on oxytocin and social cognition, both those reporting significant and null main effects, demonstrate effects qualified by interactions with task or stimulus variables [5,19–21,23–25,27,28,30] (Table 1). This suggests that the most appropriate question is not 'does oxytocin improve social cognition?' but rather 'under what circumstances does oxytocin improve social cognition?' This question is crucial both to understanding the basic mechanisms through which oxytocin works, and for clarifying the circumstances under which it can be expected to serve as a treatment for psychiatric illnesses involving prominent social deficits such as ASD and schizophrenia.

Although the factors moderating the effects of oxytocin on social cognition are varied, we focus on one to illustrate the point that the relationship between oxytocin and social cognition can be constrained by contextual and/or individual difference factors. Of the four studies investigating the effects of oxytocin on emotion recognition [5,28–30], three have been qualified by factors reflecting task difficulty (the fourth study found no effect of oxytocin on emotion recognition). Namely, one study found that, for typically developing individuals, oxytocin improved performance only on more difficult test items (i.e. pictures generating $< 70\%$ accuracy at baseline [5]). A second study found that for adolescents with ASD, oxytocin improved performance only on easier test items (specifically, adolescents with ASD performed poorly in all conditions except the easy items plus oxytocin condition [30]). Although seemingly contradictory with the first study, this discrepancy can be resolved by considering the possibility that 'easy' items might actually be difficult for individuals with ASD [30]. Finally, one study employing a naturalistic empathic accuracy task to assess emotion recognition [32,33] found that oxytocin had no main effect on the accuracy of interpersonal judgments [28]. Instead, the effect of oxytocin was moderated by individual differences in social proficiency: oxytocin selectively improved empathic accuracy performance for less socially proficient individuals (who performed worse on the task overall and probably found it more challenging) but it had no effect on performance for more socially proficient individuals (who performed equally well whether they were given intranasal oxytocin or placebo) [28]. Taken together, these studies support the view that oxytocin improves emotion recognition only under certain circumstances, such as when a task is demanding for the individual performing it; they also indicate that there is a point beyond which oxytocin cannot improve social cognitive abilities [28,30].

Prosociality

In addition to social cognition, oxytocin has been shown to play a role regulating a suite of behaviors that support the formation and maintenance of attachment bonds in animals (for review see [10]). Building on this research, there are now several published studies investigating the prosocial effects of oxytocin in humans: behaviors that facilitate interpersonal relations, including trusting behavior, generosity and cooperation [4,34–40]; perceiving others in ways that facilitate affiliation/bonding (e.g. perceptions of trustworthiness [34–36,41,42], attractiveness [41], approachability [20], infrahumanization [43], attachment [44,45]), and social-emotional responses such as envy [46] and social aversion [47,48]; as well as various other variables that facilitate interpersonal connection (e.g. ethnocentrism [43], social motivation [49] and social awareness/attentional bias [22,42,50], eye gaze [42,51,52] and communication style [53]). Again, many promising findings