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A human tendency to anthropomorphize is enhanced by oxytocin

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Abstract
In the course of human evolution, the brain has evolved into a highly sensitive detector of social signals. As a consequence of this socially driven adaptation, humans display a tendency to anthropomorphize, that is they attribute social meaning to non-social agents. The evolutionarily highly conserved hypothalamic peptide oxytocin (OXT) has been identified as a key factor attaching salience to socially relevant cues, but whether it contributes to spontaneous anthropomorphism is still elusive. In the present study involving 60 healthy female participants, we measured salivary OXT concentrations and explored the effect of a single intranasal dose of synthetic OXT (24 IU) or placebo (PLC) on anthropomorphic tendencies during participants' verbal descriptions of short video clips depicting socially and non-socially moving geometric shapes. Our results show that endogenous OXT concentrations at baseline positively correlated with the attribution of animacy to social stimuli. While intranasal OXT had no modulatory effect on arousal ratings and did not make the participants more talkative, the treatment boosted anthropomorphic descriptions specifically for social stimuli. In conclusion, we here provide first evidence indicating that spontaneous anthropomorphism in women is facilitated by oxytocin, thereby enabling a context-specific upregulation of the propensity to anthropomorphize environmental cues.

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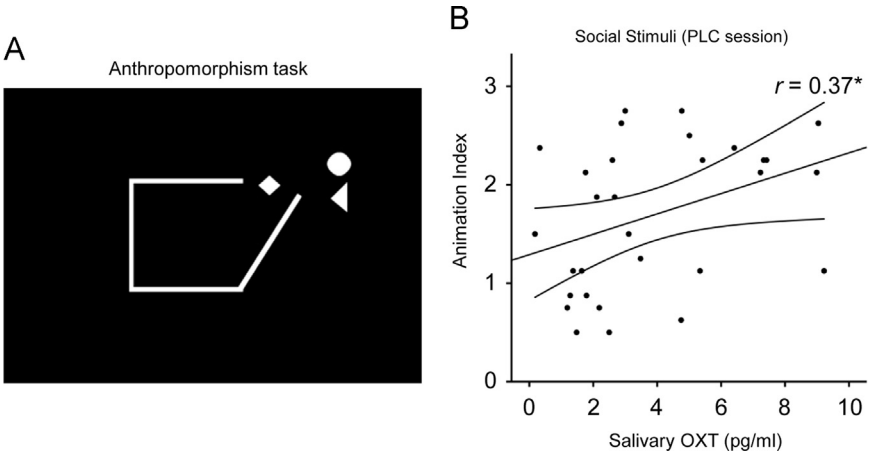

Figure 1 Endogenous oxytocin (OXT) concentrations and anthropomorphism. Anthropomorphism was assessed by asking participants to describe short videos depicting an ensemble of white geometric shapes (a triangle, a diamond, and a circle) moving either socially or non-socially within a static environment. (A) Shown is a still frame from a social stimulus. When the shapes move, they seem to have goals, intentions, and emotions: in short – to have minds (Feldman and Tremoulet, 2008). (B) For social stimuli in the placebo session, higher salivary baseline OXT concentrations were associated with a higher Animation Index measuring the general level of social attribution. Abbreviations: OXT, oxytocin; PLC, placebo; $^{*}P<0.05$.

1. Introduction

Current perspectives on the evolution of the human brain suggest that its extraordinary size and complexity reflect an adaptive response to the immense cognitive demands emerging from social group living and monogamous pair-bonding (Dunbar and Shultz, 2007). A unique consequence of this social adaption may be human consciousness (Graziano and Kastner, 2011), and along with it the inherent propensity to anthropomorphize, that is to imbue animacy and social meaning to various non-social agents (Epley et al., 2007).

Pre-historic art (e.g. the "Löwenmensch" figurine; Conard, 2003) dating back to the upper paleolithic represents the most ancient evidence of anthropomorphism, suggesting that it constitutes a social attribution bias intrinsically tied to the functional architecture of human perceptual machinery. At present, surprisingly little is known about the molecular substrates of anthropomorphism, but one can assume that the underlying biological signals are deeply rooted in pathways intimately linked to human sociality and sexual reproduction.

Since the seminal experiments by Heider and Simmel (1944) in female volunteers, anthropomorphism has been examined in a plethora of neuroimaging and lesion studies, collectively showing that the fusiform face area and amygdala are engaged by the perception of human-like interactions among non-social agents (Heberlein and Adolphs, 2004; Moran et al., 2012; Schultz et al., 2003). Consistent with this neurocircuitry model are recent posits that anthropomorphism has evolved to avoid social exclusion (Epley et al., 2008) as well as findings of impoverished social attributions in populations with amygdala dysfunction, including autism (Klin and Jones, 2006) and schizophrenia (Pedersen et al., 2011).

Central to human sociality and sexual reproduction is the evolutionarily highly conserved hypothalamic peptide oxytocin (OXT), which modulates neural activity in both the fusiform face area (Petrovic et al., 2008) and amygdala (Domes et al., 2010; Eckstein et al., 2014a; Striepens et al., 2012) and is currently being assessed for its potential to ameliorate the social deficits associated with autism (Aoki et al., 2014) and schizophrenia (Feifel et al., 2010). OXT has been implicated in mediating a diverse social behavioral repertoire ranging from basic approach-avoidance tendencies (Scheele et al., 2012) and monogamous pair-bonding (Scheele et al., 2013) to the domains of morality (Scheele et al., 2014b), empathy (Hurlemann et al., 2010), and mentalizing (Domes et al., 2007). Furthermore, OXT promotes social biases including ethnocentric in-group favoritism (De Dreu et al., 2011) and induces human-like interactions with non-living entities in women (Rilling et al., 2014). Given this empirical background, we sought to establish directly whether a propensity to anthropomorphize would be augmented by elevated OXT signaling. Specifically, the rationale was to present brief social and non-social animations based on the classic Heider and Simmel task (Figure 1A) to 60 healthy female subjects administered with either 24 IU of synthetic OXT or placebo (PLC) intranasally. The verbal descriptions of the depicted scenarios served as behavioral index of anthropomorphism and were complemented by salivary measures of OXT concentrations before and after the experiment. We hypothesized that if anthropomorphism is inherent to the perceptual machinery of the social brain, then the attribution of animacy and social meaning should vary as a function of endogenous OXT activity at baseline and be susceptible to its exogenous elevation.

2. Experimental procedures

2.1. Subjects

Sixty healthy, non-smoking adult females (mean age $\pm$S.D.: 23.68 $\pm$ 2.67 years) participated in the present study after giving written, informed consent. Subjects were free of

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