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Oxytocin increases the likeability of physically formidable men

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Physical size and strength are associated with dominance and threat. The current study tested (i) whether men's evaluations of male strangers would be negatively influenced by cues indicating physical formidability, and (ii) whether these evaluations would be influenced by oxytocin, a neuropeptide that mediates social behavior and reduces social anxiety. In a placebo-controlled double-blind design, we administered either oxytocin (24 I.U.) or placebo intranasally to 100 healthy males and assessed their responses to an image of either a physically formidable (strong) or physically non-formidable (weak) male peer. Whereas participants receiving placebo expressed dislike and avoidance of the strong male relative to the weak male, oxytocin selectively improved social evaluation of the strong male. These results provide first evidence that oxytocin regulates social evaluation of peers based on body features indicating strength and formidability. We discuss the possibility that oxytocin may promote the expansion of social networks by increasing openness toward potentially threatening individuals.

Keywords: social perception; social evaluation; oxytocin; neuropeptides; body morphology

Size and strength have featured as archetypal features of legendary foes across cultures and throughout human history. The role of physical size and strength in social evaluation is also reflected in modern English, with the idea of 'sizing up' other individuals being synonymous with assessing their formidability. Empirical research confirms the importance of physical strength in social information processing. Men's physical size and strength influence ratings of their social dominance (Bryan *et al.*, 2011) and are key dimensions in the cognitive representation of the formidability of potential foes (Fessler *et al.*, 2012). Furthermore, danger and threat are subconsciously associated with large physically strong men (Fessler *et al.*, 2012; Fessler and Holbrook, 2013).

An association of size and strength with danger and threat may be evolutionarily adaptive. For males of species ranging from insects to mammals, size and strength predict aggression, resource control, mating opportunities and ultimately reproductive success (see Blanckenhorn, 2005). In humans, men's height and/or upper body strength predict social status and income (Steckel, 1995), history of fighting behavior and endorsement of using physical force to resolve conflicts (Sell *et al.*, 2009). Men's handgrip strength is correlated with body morphology, aggressiveness and sexual behavior and is theorized to serve as a signal of genetic quality (Gallup *et al.*, 2007). Based on such evidence linking physical strength with threat, aggressiveness and competitiveness, we predicted that men's physical strength would also influence how they are consciously perceived by peers. This study investigated whether physical strength predicts explicit negative social evaluations (e.g. reduced likeability and approachability ratings) of male strangers by male peers.

We also investigated a potential neuroendocrine mechanism regulating men's negative social evaluations of strong peers. Here, our research is guided by evidence that threat and competitive responses to strangers, as well as motivations for affiliation and social contact, are influenced by fluctuations in hormonal states and the functioning of neuroendocrine systems—in particular, the 'social neuropeptides' (Meyer-Lindenberg *et al.*, 2011). Oxytocin, an evolutionarily highly conserved 'social neuropeptide', downregulates the mammalian stress response in social situations while increasing social approach behavior and bonding (Carter, 1998; Insel and Young, 2001; Neumann, 2008; Meyer-Lindenberg *et al.*, 2011; Bosch and Neumann, 2012). In humans, oxytocin increases trusting behavior (Kosfeld *et al.*, 2005) and eye contact (Guastella *et al.*, 2008), increases sensitivity to social support (Heinrichs *et al.*, 2003), facilitates socially reinforced learning and emotional empathy (Hurlemann *et al.*, 2010) and has been theorized to underlie the affiliative 'tend and befriend' response pattern to stress (Taylor *et al.*, 2000). Some studies suggest that oxytocin effects are sensitive to whether the social information at hand is potentially threatening (Kirsch *et al.*, 2005; Domes *et al.*, 2010). Initial evidence suggests that oxytocin administration also enhances perceptions of others' attractiveness and trustworthiness based on facial cues (Theodoridou *et al.*, 2009; Colonnello *et al.*, 2013) and can encourage the selection of allies with more dominant or threatening facial features in intergroup conflict (De Dreu *et al.*, 2012).

Overall, the evidence points to the possibility that oxytocin regulates reflexive social evaluations, specifically when the target represents a potential threat to the perceiver. In this study, we aimed to test this possibility directly. We intranasally administered either oxytocin or placebo to participants and then assessed their responses to a target peer whose physical formidability was manipulated. The intranasal method of administration has been shown to increase central nervous system availability of neuropeptides (Born *et al.*, 2002; Striepens *et al.*, 2013). We first examined whether strong male peers would be rated as less likeable and approachable than weak male peers under placebo. Second, given oxytocin's role in attenuating stress responses and its potential sensitivity to threatening social information, we tested whether oxytocin would improve evaluations of the strong male peer to a greater extent than the weak male peer.

METHODS

Participants

One hundred heterosexual male German university students ($M_{age} = 23.68$, s.d. $= 2.53$) participated in the study. All participants

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were fluent in German, not psychology majors, had a normal body mass index (BMI) ($M = 22.74$, s.d. = 1.87), had not been diagnosed with physical or psychological illnesses and were not taking prescription medication. All participants were right-handed and did not have physical handicaps. Participants gave informed consent and were paid 20 € for participation. The study was approved by the local institutional review board.

Procedure

Baseline measurements and oxytocin administration

Participants completed an online battery of personality scales 1–2 weeks before the session. Validated German versions of the Vocabulary Test (WST; Schmidt and Metzler, 1992), State Trait Anxiety Inventory (Spielberger *et al.*, 1983), Social Interaction Anxiety Scale (Mattick and Clarke, 1998), Interpersonal Reactivity Index (Davis, 1983) and Autism Quotient (Baron-Cohen *et al.*, 2001) were used.

On arrival at the laboratory, participants provided a saliva sample using a commercially available sampling device (Salivette; Sarstedt, Nümbrecht, Germany). This procedure allowed us to control for baseline testosterone levels, which have been linked in previous literature to competition, dominance and status-maintenance motives (see Eisenegger *et al.*, 2011). Saliva samples were frozen at −20°C until analysis.

To assess baseline objective physical strength, handgrip strength (maximum force over two 4 s trials, with a 10 s break between measurements) was measured using a Biopac MP36 dynamometer (Biopac Systems, Inc., Goleta, California). This measure allowed us to control for potential effects of participants' own objective strength on their peer ratings. Participants also completed a baseline mood questionnaire (MDBF; Steyer *et al.*, 1997).

Next, the participants self-administered 24 IU (three puffs per nostril) of either oxytocin (Syntocinon, Novartis, Basel) or placebo (including all ingredients except for the neuropeptide) spray. Participants were assigned to receive either oxytocin or placebo in a double-blind, randomized, placebo-controlled design. After a 45 min waiting period, participants completed a second mood questionnaire (MDBF) and second handgrip assessment.

Experimental manipulation

The computer screen displayed a picture of a target individual: either a formidable male peer (strong condition) or a non-formidable male peer (weak condition), with condition determined via random assignment. Digitally manipulated photo montages were used such that the musculature of the target varied across conditions while his facial features and emotional expression remained constant (Figure 1). Participants were instructed to imagine a social interaction with the target and describe this interaction by typing into a text box.

Dependent measures

Participants assessed their own strength in 12 individual questions. Standardized (z-scored) responses to these questions were averaged to create a strength self-assessment measure (Cronbach's $\alpha = 0.78$). Participants also completed a third handgrip strength assessment, which allowed us to assess whether oxytocin induced changes in participants' objective strength.

Participants then answered seven questions regarding their subjective impressions of the target. First, they estimated the target's strength. Second, they rated how similar the target was to themselves, to a typical student at the university and to a typical friend of theirs. Third, they rated the degree to which they could imagine being friends with the target and how likeable he was. For each of these questions, participants responded using a 9-point Likert scale (ranging from 1 = not at all to 9 = very). Finally, participants estimated the target's age. Responses to the three questions regarding similarity of the target to the participant and his peer group were averaged to create a 'similarity' measure (Cronbach's $\alpha = 0.67$). For the 'likeability' measure, responses were averaged from the two questions regarding how likeable the target was and the degree to which the participant could imagine being friends with him (Cronbach's $\alpha = 0.82$).

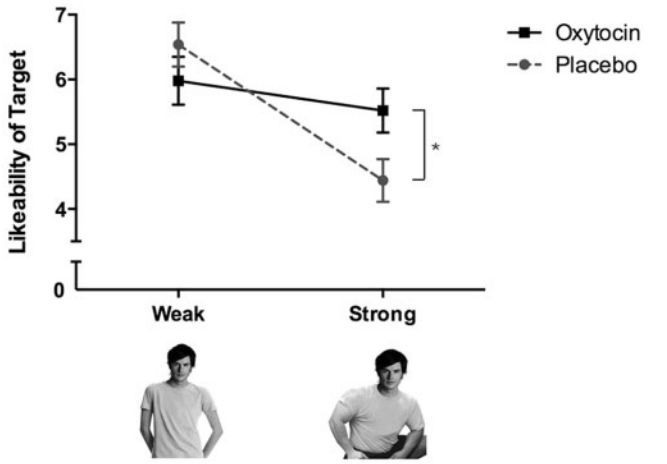

Fig. 1 Effects of oxytocin *vs* placebo on the rated likeability (1 = not at all, 9 = very) of strong and weak peers (pictured). Error bars are SEM.

Finally, a German version of the competitiveness index (Smither and Houston, 1992) was administered to determine whether the experimental manipulations had influenced participants' self-reported competitiveness. Participants were then asked to guess which substance they had received and completed a third and final mood questionnaire (MDBF).

Statistics

One participant was excluded for failing to follow instructions, leaving 99 participants for analyses. Univariate analysis of variance with two between-subject factors [condition (strong or weak target) and substance (oxytocin or placebo)] was used to test the effects of the experimental manipulations on the dependent variables. We determined our sample size a priori and report all manipulations and dependent measures.

Saliva analysis of baseline testosterone levels was performed using CLIA kits (IBL International). The intra- and interassay coefficients of variation were <10 and <12%, respectively. Handgrip strength data were analyzed using Biopac Student Lab Pro 3.7.3 (BIOPAC Systems, Inc., Goleta, California).

RESULTS

Participant characteristics and control variables

Participants' scores did not differ between groups on verbal intelligence, trait anxiety, social anxiety, empathy and autism-spectrum characteristics, nor did participants differ in BMI, baseline mood (positivity, alertness and calmness), handgrip strength or testosterone levels (all $P > 0.05$). Mood, handgrip strength and competitiveness were not differentially affected by substance or condition, nor could participants determine above chance which substance they had received (all $P > 0.05$).

Manipulation check

Participants rated the strong target as significantly stronger than the weak target ($M_{strong} = 8.04$, s.d. = 0.71; $M_{weak} = 3.18$, s.d. = 1.19; $t(97) = 24.66$, $P < 0.001$). Across conditions, participants estimated the target to be in his early to mid-20s ($M = 24.67$, s.d. = 2.34), confirming that he was indeed considered a peer in age.[1]

Social evaluation

The strong target was evaluated as significantly less likeable than the weak target ($M_{strong} = 4.97$, s.d. = 1.72; $M_{weak} = 6.26$, s.d. = 1.79; $F(1, 95) = 13.69$, $P < 0.001$, Figure 1). Furthermore, there was a significant interaction between condition and substance on likeability ratings ($F(1, 95) = 5.63$, $P < 0.05$). *Post hoc* *t*-tests revealed that this interaction was driven by an effect of substance on the strong target. Specifically, oxytocin improved likeability ratings of the strong target ($M_{oxytocin} = 5.52$, s.d. = 1.66; $M_{placebo} = 4.44$, s.d. = 1.63; $t(47) = 2.28$, $P < 0.05$) but did not influence likeability ratings of the weak target ($M_{oxytocin} = 5.98$, s.d. = 1.86; $M_{placebo} = 6.54$, s.d. = 1.72; $t(48) = 1.11$, *ns*).

Across substance groups, the strong target was evaluated as less similar to the participant and his peer group than the weak target ($M_{strong} = 3.00$, s.d. = 1.27; $M_{weak} = 5.09$, s.d. = 1.32; $F(1, 95) = 63.50$, $P < 0.001$). There was no interaction between condition and substance on similarity ratings ($F(1, 95) = 1.13$, *ns*), suggesting that oxytocin improved the strong peer's likeability without making him seem more similar.

To ensure that our results were not influenced by participants' own strength (or perceptions thereof), we reanalyzed the data including participants' height, weight, BMI and subjective ratings of their own strength, as well as maximum handgrip force at baseline, post-spray and post-manipulation, as covariates. The interaction between oxytocin and condition on the target's likeability remained significant ($P < 0.05$) when these covariates were included, and none of these covariates was itself a significant predictor of target's likeability (all $P > 0.05$).

DISCUSSION

Our results provide evidence that oxytocin improves men's ratings of the likeability of physically formidable peers without affecting their evaluations of weaker peers. This effect contrasted with a more general (i.e. under placebo) tendency of men in our study to rate physically formidable peers as less likeable and approachable than weaker peers. Our study therefore reveals a link between men's physical features and their peers' explicit social evaluations of them, and it also elucidates a neurobiological mechanism that attenuates negative social evaluations in this context. These results suggest not only how physical cues can elicit potentially powerful reflexive stereotypes but also one mechanism that regulates them.

To our knowledge, this study provides the first evidence that increased central nervous oxytocin availability affects men's social evaluation of male peers based on physical size and strength cues. This study is also the first to demonstrate that the effects of oxytocin on social cognition are modulated not only by facial features but also by information from the rest of the body. The fact that oxytocin increased liking of a formidable peer but did not affect liking of a weaker peer is consistent with a more general capacity of oxytocin to attenuate responses specifically to threatening social stimuli or situations.

Additional research will be necessary to determine whether and how these effects are influenced by other neuroendocrine systems such as vasopressin, which has previously been shown to increase males' perceptions of threat and unfriendliness in male strangers' faces (Thompson *et al.*, 2006). Follow-up work varying the sex of the evaluators and targets is needed to clarify the generalizability of these effects to women. The effects of oxytocin on women's social judgment may interact with other hormonal systems such as the surge of luteinizing hormone associated with ovulation, which has been found to influence women's perceptions of the formidability of outgroup men and the threat represented by these men (McDonald *et al.*, 2011). As the individuals depicted in our photos varied both in terms of their musculature and their posture (both of which may contribute to the impression of formidability), further research will also be necessary to isolate the role of these specific physical dimensions on social judgments. Furthermore, research combining intranasal oxytocin administration with peripheral measurements of oxytocin (e.g. from saliva, blood or urine) should be a goal for further methodological research in the field. This approach will be necessary to clarify whether baseline levels of circulating oxytocin are correlated with any of the effects discussed here.

Our results suggest that oxytocin may promote the expansion of social networks by increasing openness toward individuals who under other circumstances might be avoided. Such oxytocin-induced effects would be consistent with the positive effects of priming secure attachment on openness to outgroup members (Mikulincer and Shaver, 2001), and the positive effects of self-affirmation on openness to threatening information (Sherman and Cohen, 2002). These effects are also consistent with a growing body of evidence that oxytocin reduces aggression in non-human animals, for example, between resident and intruder rodents (Calcagnoli *et al.*, 2013; de Jong *et al.*, 2014). Alternately, by promoting favorable evaluations of formidable potential allies, oxytocin may play a role in the motivation to strengthen one's in-group (De Dreu *et al.*, 2012). However, explicit in-group defense motivations are unlikely to account for these particular findings, as the oxytocin-induced improvements in social evaluations of the strong peer occurred without increasing the perceptions of the target's similarity to peers and without experimental induction of intergroup conflict. Further research will be necessary to clarify which precise contextual cues (e.g. cooperative situations *vs* competitions over limited resources) elicit different psychological and behavioral effects of oxytocin.

Oxytocin is released endogenously in a range of social contexts, including positive interactions and affectionate physical contact (Carter and Altemus, 1997; Uvnäs-Moberg, 1997). Future research should confirm whether the systematic alterations in men's social evaluations of their peers that we observed in the lab also occur in these natural contexts. Given the complex interactions between environmental and biological factors involved in phenomena such as social affiliation and friendship formation, future advances in our understanding of the regulation of such phenomena will require continued collaborative efforts across the traditional boundaries of social psychology and neurobiology. This line of research has the potential to shed new light on the foundations of core social phenomena that have shaped the course of our species' evolutionary history and the expansion of human social networks.

Conflict of Interest

None declared.

[1] The strong peer was estimated to be slightly but significantly older than the weak peer ($M_{strong} = 25.45$, s.d. = 2.18; $M_{weak} = 23.90$, s.d. = 2.25; $t(97) = 3.48$, $P < 0.01$). Therefore, we also conducted all preliminary analyses including estimated age of target as a covariate. However, as inclusion of this variable does not significantly affect any of the reported findings, and because participants' estimates of both the strong and weak peers' age did not differ between substance groups (oxytocin *vs* placebo), analyses are reported in the text without the inclusion of this covariate.

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