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Short communication

Generous to whom? The influence of oxytocin on social discounting

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ABSTRACT

Oxytocin is thought to play an essential role in pro-social behaviors, such as generosity and altruism, in humans. Yet, most research in humans that demonstrated the pro-social effect of oxytocin had participants interact with partners who were total strangers to them. In real life, however, people often interact with others varying in social relatedness with them (a concept known as social distance), ranging from their parents to total strangers. Here we employed the social-discounting framework to investigate whether the effect of oxytocin on prosociality depends on the social distance between the participants and their interaction partners. In a double-blind, placebo-controlled experiment (n = 172 participants), we measured the amount of money participants were willing to forgo to another person as a function of social distance. We found that oxytocin administration selectively enhanced amount of money forgone toward total strangers, as opposed to someone closer to participants, suggesting that social distance constrained the pro-social effect of oxytocin.

1. Introduction

Given its role in stimulating maternal care and forming social bonds in non-human mammals (Lim and Young, 2006; Wacker and Ludwig, 2012), the hormone oxytocin has been proposed to be involved in prosociality in humans (Bartz et al., 2011). Several studies in humans have confirmed this link by showing the association between oxytocin and generosity as measured in monetary terms. For instance, people receiving intranasal oxytocin gave higher offers in an ultimatum game (Zak et al., 2007), donated more to charities (Barraza et al., 2011) and contributed more money to both in-groups and out-groups (Israel et al., 2012). So far, however, most studies in humans have investigated the effect of oxytocin on generosity toward total strangers. It is unknown whether and how this influence of oxytocin on generosity would differ depending on social distance.

According to the interactionist account (Bartz et al., 2011; Declerck et al., 2014), the effect of intranasal oxytocin on humans' prosociality in-and-of itself is usually weak because its effect interacts with, or is constrained by, social contexts. We aim to examine whether social distance provides such a constraint. Specifically, it is possible that intranasal oxytocin in humans may particularly enhance generosity as measured in monetary terms toward people with closer social-distance, such as family members and close friends, considering its functions in maternal care in animals (e.g., licking/grooming pubs) (Lim and Young, 2006). Alternatively, based on the affiliative-motivation account (Bartz et al., 2011), oxytocin motivates organisms to be affiliative and to approach strangers (Lim and Young, 2006). For example, oxytocin administration in rats enhanced non-sexual physical contact and investigative behavior to new conspecifics (Witt et al., 1992). In humans, intranasal oxytocin enhanced social-conformity to both in-groups and out-groups (Huang et al., 2015). Thus, according to the affiliative-motivation account (Bartz et al., 2011), intranasal oxytocin may instead selectively enhance monetary generosity toward strangers.

To formally test the modulating role of social-distance on generosity-inducing effect of oxytocin, we employed the social-discounting task. Specifically, we tested participants' willingness to forego resources to another person as a function of the social distance between them. Stronger willingness to forego resources to someone further away in social distance (e.g., strangers) in this task is associated with generosity, such as contributing more in a public-good game (Jones and Rachlin, 2009) and stopping smoking

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during pregnancy for the sake of the child (Bradstreet et al., 2012). Based on the interactionist account (Bartz et al., 2011), we predicted that there would be an interaction between social-distance and oxytocin treatment.

2. Methods

Participants were 172 Chinese undergraduates (75 females; age $M = 20.52$ years, $SD = 1.98$). This sample size was determined based on the effect sizes (Cohen's d $M = 0.5992$, $SD = 0.1631$) from previous studies examining the influence of intranasal oxytocin on generosity (Barraza et al., 2011; Israel et al., 2012; Zak et al., 2007). Using G*Power 3.1 (Faul et al., 2007), we set the value α at 0.05 and 1-β at 0.95. This resulted in the sample size necessary to achieve a given level of power (0.95) at 74 people for each group. Note that 1-β of 0.95 (as opposed to a more commonly used value of 0.8) is used to tackle the potential file drawer problem in human oxytocin research (Lane et al., 2016).

In a double-blind study, we randomly assigned half of 172 participants (38 female) to the oxytocin-administered condition, and the other half (37 females) to the placebo-administered condition. Participants had no history of neurological or psychiatric disorders (including substance abuse/use and obesity) and had normal or corrected to normal vision. Some of traits and demographic variables were collected as baseline variables before administering oxytocin: the Autism Spectrum Quotient (AQ) (Baron-Cohen et al., 2001), Social Values Orientation (SVO) (Van Lange et al., 1997), Behavioral Inhibition/Activation Scale (BIS/BAS) (Carver and White, 1994), State-Trait Anxiety Inventory (STAI) (Spielberger, 2010) and monthly consumption expenditure. None of these baseline measures significantly differed between the oxytocin-administered and placebo-administered groups (p's > 0.05). Thus, it is unlikely that our random assignment failed. Participants provided informed consent prior to the experiment and were given RMB 40 for showing up. South China Normal University institutional review board approved the present study.

We strictly followed the standard guideline for oxytocin nasal-spray administration (Guastella et al., 2013). Specifically, participants administrated an intranasal dose of 24 IU (three puffs of four IU per nostril, with 30 s interval) of either oxytocin (Oxytocin-Nasal Spray, Sichuan Meike Pharmacy Co. Ltd., China) or placebo by themselves under experimenters' supervision. Our placebo contained all the same ingredients (sodium chloride and glycerine) except for the neuropeptide and was packaged in the same manufactured bottle.

Fourty-five minutes after nasal administration, we started the social-discounting task, following an established paradigm recently used and validated among Chinese-undergraduate participants (Ma et al., 2015). First, to familiarize participants with the concept of social distance, we asked them to rate how close they were (1 = closest; 100 = most distant) to people in their social environment (e.g., mother = ~1, total stranger = ~100). Then, we asked them to think of people whose social distance was equal to 1, 2, 3, 5, 10, 20, 50, 100, and wrote down these people's names (except for people at social-distance 50 and 100 as these two were strangers). In each trial of the formal task (see Fig. 1, left), participants chose between (a) the selfish option – taking a specific amount of money (nine possibilities, varied from RMB 130–290 in increments of 20) for themselves – or (b) the generous option – equally splitting RMB 260 with a partner at one of the eight social-distance levels whom they thought of earlier. We randomized the order of the 72 unique trials (9 monetary-amount possibilities for the selfish option × 8 social-distance levels). After the task, one trial was randomly picked, and 5% of the money based on the chosen choice in this trial was paid immediately to participants and paid via smartphone applications (Alipay, WeChat) to their partner (if the generous option was chosen). If their partner was at social-distance 50 or 100, then a random person on campus would receive the money.

3. Data analyses and results

Conforming to previous research (Ma et al., 2015), we first employed logistic regression separately at each social-distance level to determine indifference points of all levels where statistical probabilities of choosing each option were at 50%. Each indifference point indicates the amount of money in which one is willing to forgo to a person at a particular social-distance level (Jones and Rachlin, 2006). When the selfish or generous option was selected throughout a particular social-distance level, the amount forgone would be set at half of an increment below and above the range of selfish options at RMB 120 and 300, respectively. We selected these values based on the procedure used in other social-discounting studies (Jones and Rachlin, 2006; Ma et al., 2015; Strombach et al., 2014). We then subtracted 130 (the amount participants would have earned if they chose generously) from the calculated amount, resulting in the amount forgone as the real cost of choosing generously. Next, based on an established algorithm used for identify non-systematic data in the delay-discounting literature (Johnson and Bickel, 2008), we excluded the data that has at least twice increases (as opposed to decreases) of more than 20% of the largest amount forgone (i.e., 20% of 290 minus 130 = 160, or 32 RMB) in the amount forgone between any subsequent social-distance levels. After this exclusion, both groups had 75 participants left.

Two analytic strategies (Ma et al., 2015; Strombach et al., 2014) were employed. First, we did not impose any model onto the relationship between the amount forgone and social distance, thereby making no assumptions about the shape of the discounting curve. Specifically, we ran a 2 between-subject (oxytocin-administered vs. placebo-administered) × 8 within-subject (social-distance levels) mixed-design ANOVA on the amount forgone (see Fig. 1, right). While a main effect of oxytocin was not significant ($F(1, 148) = 0.07$, $p = 0.79$, $\eta_p^2 < 0.001$), there was a main effect of social distance ($F(3.51, 519.12) = 186.07$, $p < 0.0001$, $\eta_p^2 = 0.56$, Greenhouse-Geisser corrected) and an interaction ($F(3.51, 519.12) = 2.59$, $p = 0.043$, $\eta_p^2 = 0.017$, Greenhouse-Geisser corrected).

To follow up on this interaction, we performed simple-effect analyses to test the oxytocin effect at each social distance using a bootstrap with 10,000 samples. The bootstrap was used as a robust statistical method to avoid the assumptions of parametric statistics, such as normality of the data (Efron and Tibshirani, 1993; Wright et al., 2011). Moreover, it is argued that the confidence intervals computed via bootstrapping may be closer to the population than the confidence intervals computed via traditional methods (Wright et al., 2011). For the bootstrap to work appropriately, researchers should have a large enough sample (Chernick, 2008). The rule of thumb put forth by Chernick (2008, p. 174) is to have a sample size of at least 50. Our sample size is clearly larger than that recommended. We found that oxytocin-administered participants (M = RMB 32.04, SD = 56.96) had higher amount forgone than placebo-administered participants (M = RMB 13.75, SD = 37.12) at social distance 100 ($p = 0.024$, $CI_{95\%}$ [3.34, 34.14]), but not at any other social distance (p's > 0.05; $CI_{95\%}$ [>−30.17, <24.03]). Please see Supplementary Document for additional information regarding exclusion criteria, pattern of the social-discounting choices and multiple-comparison corrections for ANOVA.

Note that to test whether gender modulates the effect of oxytocin on the amount forgone, we added gender as another factor and ran a 2 (oxytocin) × 8 (social-distance levels) × 2 (gender) mixed-design ANOVA on the amount forgone. Both the three-way

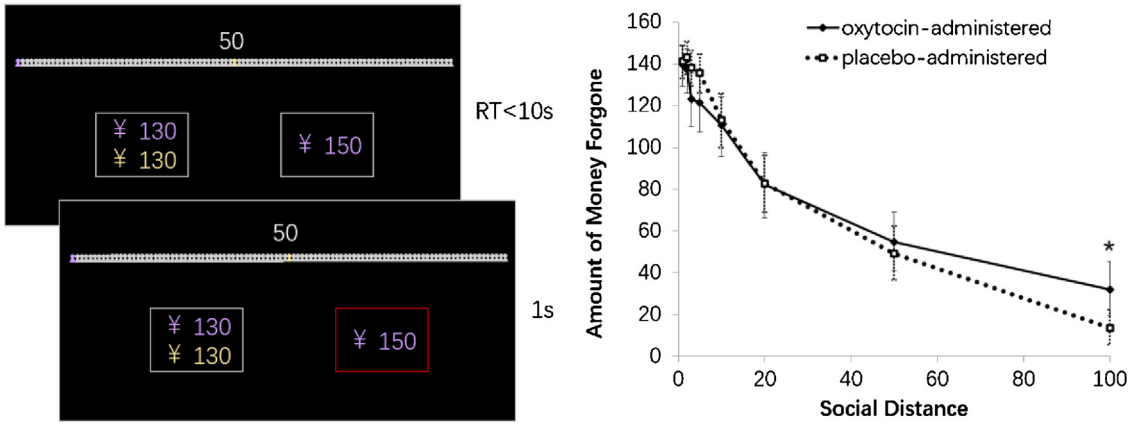

Fig. 1. Social discounting task and behavioral results. Left panel: In each trial, we showed participants social-distance information on the top of the screen using both number and icons. Specifically, number (including 1, 2, 3, 5, 10, 20, 50, 100) indicated the social-distance level of the interacting partners (50 here). There were 101 icons in total. The leftmost icon, shown in purple, represented the participant him/herself. One of the icons on the right, as shown in yellow, represented his/her interaction partner. Thus, the distance between the purple and yellow icons indicated the social-distance between the participant and his/her interaction partner. The participant was asked to choose between the selfish option (here taking RMB 150 for him/herself) and the generous option (here equally splitting RMB 260 with his/her interaction partner, so that each received RMB 130). The participant had 10 s to choose. A feedback screen was presented for one second confirming his/her decision, which was followed by a 4 s inter-trial intervala. Right panel: Men amount of money forgone for another person as a function of social distance. Error bars represent bootstrapped $CI_{95\%}$ $^*p < 0.05$. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

interaction (oxytocin x social-distance levels x gender) and the two-way interaction between oxytocin and gender were not significant (p's > 0.05). Given that gender did not significantly modulate the effect of oxytocin, it is appropriate to collapse across male and female participants in the main analyses. Similarly, to test the moderating roles of our baseline variables [including the AQ (Baron-Cohen et al., 2001), SVO (Van Lange et al., 1997), BIS/BAS (Carver and White, 1994), STAI (Spielberger, 2010) and monthly consumption expenditure], we examined the interaction between our baseline variables and oxytocin on the amount of money forgone at the social distance 100 using a moderation model (Baron and Kenny, 1986). Nonetheless, running the moderation model using the PROCESS toolbox (Hayes, 2013), we found that none of our baseline variables significantly moderated the effect of oxytocin on amount of money forgone at the social distance 100 (p's > 0.05).

Second, we fitted the amount forgone at each social distance to the standard hyperbolic model, $v = \frac{V}{(1+kD)}$, (Jones and Rachlin, 2006) where v is the amount forgone at each social distance, D is the social-distance level, and V and k are free parameters representing the intercept (undiscounted amount given to self at $D = 0$) and slope of the function (steepness of the discounting function), respectively. R-squared, as a model-fit index, was on average 0.73 (SD = 0.19). Using a bootstrap with 10,000 samples, we did not find significant differences in V ($p = 0.97$, $CI_{95\%}$ [−16.25, 17.05]) and k ($p = 0.16$, $CI_{95\%}$ [−0.018, 0.139]) between oxytocin-administered ($V_M = 168.50$, SD = 6.24; $k_M = 0.16$, SD = 0.30) and placebo-administered ($V_M = 168.13$, SD = 5.74; $k_M = 0.11$, SD = 0.17) participants.

4. Discussion

Consistent with the interactionist account (Bartz et al., 2011), oxytocin administration did not have an across-the-board influence on generosity toward everybody. Instead, the effect of oxytocin administration was modulated by social-distance, such that oxytocin administration selectively enhanced generosity toward total strangers. Our results extend previous oxytocin-administration research showing enhanced generosity toward strangers in economic games (e.g., Israel et al., 2012; Zak et al., 2007) by demonstrating the nuances of the relationship between oxytocin and generosity and further pinpointing social-distance as a social-context constraining the influence of oxytocin (Bartz et al., 2011). Moreover, the selective enhancement in generosity toward total strangers (as opposed to close others) is consistent with the affiliative-motivation account (Bartz et al., 2011). Hence, perhaps being more generous/altruistic toward strangers after oxytocin administration in our study is due to an increase in cooperative tendencies toward unknown others. Future research is needed to test this possible mechanism more fully.

Nonetheless, the selective generosity toward total stranger in our study may appear contradictory to one line of research by De Dreu and colleagues (De Dreu et al., 2010; De Dreu and Kret, 2016; Ten Velden et al., 2016) showing the effect of oxytocin on promoting in-group trust and cooperation, but not out-group affiliation. It should be noted, however, that some research also shows findings that contradict De Dreu and colleagues' research. For instance, after oxytocin administration, Israeli Jewish participants increased empathy toward Palestinian Arabs (potential outgroup members) but not to Israeli Jewish (potential ingroup members) (Shamay-Tsoory et al., 2013). More importantly, it is difficult to reconcile De Dreu and colleagues' findings and ours because (1) in the context of social discounting, total strangers are not necessarily out-groups or in-groups (2) De Dreu and colleagues used prisoner dilemma in their study, which may not exactly reflect generosity. When facing a decision whether to trust in-groups or out-groups in prisoner dilemma, other processes rather than the motivation to be affiliate with others (such as social saliency (Insel, 1992)) may also play a role. We need future studies to reconcile this. Perhaps the first step is to see whether the results change if the strangers in our social-discounting task are framed as out-groups or in-groups. Please also note that when the motivation to be affiliated is the main process in a given context, oxytocin may also influence the interaction with out-groups. In fact, in our previous studies, we found that intranasal oxytocin enhanced social-conformity to both in-groups and out-groups (Huang et al., 2015).

It is important to note that, while oxytocin administration significantly enhanced amount forgone at the highest social-distance level, oxytocin administration did not significantly alter the slope or intercept of the social-discounting hyperbolic model. Similar patterns have been shown in previous social-discounting research. Strombach et al. (2014), for instance, found higher amount forgone at the high social-distance levels among Chinese (relative to Ger-

man) participants, but failed to show the differences in the slope or intercept between the two groups. Such patterns may suggest that free parameters in the hyperbolic model are not sensitive enough to the oxytocin effect at the highest social-distance level.

In light of the recent criticisms on intranasal oxytocin and human behaviors raised by Nave and colleagues (Lane et al., 2016; Nave et al., 2015), it is important that we address them. First, Nave et al. (2015) paper targets the inconsistences of the intranasal oxytocin effect on trust (e.g., as measured by decisions in the trust game). However, trust may confound generosity with the salience of social cues (Insel, 1992). That is, in the trust game, when investors decide to trust trustees after oxytocin administration, it may be because (1) the investors are more motivated to be affiliative with the trustees as would be predicted by the affiliative-motivation framework (Bartz et al., 2011; Kemp and Guastella, 2011; Lim and Young, 2006), or because (2) the investors are not fearful of their investment not being returned by the trustees, as would be predicted by the social-cue saliency framework (Insel, 1992). 'Purer' generosity tasks (such as donating to charities, distributing money to others in economics games and social discounting) should be less influenced by the salience of social cue, but more by an affiliative motivation. Because, in all previous generosity research (Barraza et al., 2011; Israel et al., 2012; Zak et al., 2007), participants interacted with total strangers, the situations in these studies would be most similar to the decisions our participants made to people with high social distance. The effect sizes of these generosity studies are much larger than the studies using the trust game (Nave et al., 2015). Altogether, the criticisms raised in Nave et al. (2015) paper do not appropriately apply to our social-discounting task.

In a more-recent paper (Lane et al., 2016), Nave and colleagues also raised a criticism regarding the file drawer problem in intranasal oxytocin studies in humans. Their argument is that very few small-effect and null-effect studies on human intranasal oxytocin get published, and this results in an inflation of the effect size of intranasal oxytocin on human's social-cognitive behaviors. When examining unpublished (or rather unpublishable based on rejections by journals) data from their lab, Nave and colleagues found that most of their studies did not produce a significant effect of intranasal oxytocin on a wide range of social-cognitive behaviors. We agree with their observation and adhere to their recommendations to solve this file drawer issue. First, we used a large sample size based on previous studies (Barraza et al., 2011; Israel et al., 2012; Zak et al., 2007). In fact, to account for the publication bias based on the file drawer problem, we used a power level of 1-β at 0.95 (as opposed to a more commonly used value of 0.8) to calculate a sample size. Many of Nave and colleagues's studies that produced null effects were, in fact, underpowered (e.g., those that used n = 30 people per cell). This made it difficult to publish these null-results to begin with. Should these studies be well powered, the effects may be statistically significant, albeit small in terms of their effect sizes. Given that we have a reasonable level of power, and found a small-size effect of intranasal oxytocin, our study is in line with their framework. Additionally, Nave and colleagues (Lane et al., 2016) also pointed out that many intranasal oxytocin studies used a single-blind design, which may create an experimental bias. Our study addressed this issue by using a double-blind, placebo-controlled paradigm. Additionally, most of several behavioral tasks listed in their paper (Lane et al., 2016) are not decision-making tasks. The only decision-making task listed there is the trust game. However, as mentioned above, the nature of the trust game is very different from our social-discounting task in terms of assessing generosity. Altogether, our approach to study the influence on oxytocin on human's social behaviors is in line with (rather than contradicts) Nave and colleages' recommendations.

Being the first to investigate the influence of oxytocin on social-discounting, our study opens several questions for future research. First and foremost, future work needs to examine how robust our effect is, and to what extent it can be generalized. In addition to replications, identifying the modulators and mediators of the effect would better our understanding of the relationship between oxytocin and generosity. For instance, given that our participants are Chinese, examining the effect in the West may reveal culture as a possible moderator. In fact, our oxytocin effect on social-discounting is similar to the cultural effects on social-discounting shown previously (Strombach et al., 2014). Thus, one may speculate that oxytocin administration leads to a cultural-congruent pattern of social-discounting. As for mediators, future research may also measure other variables after administrating oxytocin in addition to social-discounting. This would allow researchers to test, for instance, if the changes in the level of variables, such as empathy or theory-of-mind, following oxytocin administration account for the changes in social-discounting. Similarly, future research may incorporate non-monetary measures of generosity into the task so as to better approximate animal-model studies. Future studies conducted in these directions would unify evidence for the effects of oxytocin administration across domains of prosociality. Next, we have demonstrated that inducing oxytocin led to a change in social-discounting, but it is unclear if individual differences in the level of oxytocin is related to social-discounting. Thus, to understand the role of oxytocin on social discounting more fully, future studies should replicate our effect not only using intranasal oxytocin, but also using baseline peripheral, endogenous oxytocin and genotyping oxytocin receptor genes (e.g., OXTR). Finally, while we demonstrated the causal relationship that oxytocin changed social-discounting, it is still unclear if the reversed relationship can also occur. That is, after being generous to strangers, the oxytocin level may also be enhanced. Such study would fit with a recent framework encouraging researchers to measure the influence of social interaction on the endogenous oxytocin level (Crockford et al., 2014).

Our study is, however, not without limitations. First, we did not control for smoking, alcohol and caffeine intake. Also while we excluded people with obesity, we did not measure any cardiovascular parameters and exact body mass index. Given that we employed a random assignment with a relatively large sample, it is unlikely that our effect is solely due to these factors. It is also important to note that it is relatively uncommon for Chinese undergraduates to engage in smoking (Luo et al., 2016). Second, when the same option was selected throughout each social-distance level, we used a half of the increment away from the range of selfish choice as participants' amount forgone for that social-distance level, following previous research (Jones and Rachlin, 2006; Ma et al., 2015; Strombach et al., 2014). Thus, this means that participants' amount forgone was restricted to the range used in our study. To be mosre accurate at measuring amount forgone, future studies with a wider ranger is needed.

5. Conclusions

To conclude, we sought to extend our understanding of the role of oxytocin on generosity by employing the social-discounting framework. The effect of oxytocin was especially enhanced toward total strangers, as opposed to someone closer to participants. Our results support an affiliative-motivation mechanism of oxytocin that may constrain the oxytocin effect on generosity.

Contributors

RY developed the study concept. JC and QC collected the data. NP analyzed and wrote a first draft. RY and BK revised. All authors approved the final version of the manuscript for submission.

Declaration of interest

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Appendix A. Supplementary data

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References

Baron, R.M., Kenny, D.A., 1986. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J. Pers. Soc. Psychol. 51 (6), 1173–1182, http://dx.doi.org/10.1037/0022-3514.51.6.1173.

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., Clubley, E., 2001. The autism-spectrum quotient (AQ): evidence from asperger syndrome/high-functioning autism, malesand females, scientists and mathematicians. J. Autism Dev. Disord. 31 (1), 5–17, http://dx.doi.org/10.1023/a:1005653411471.

Barraza, J.A., McCullough, M.E., Ahmadi, S., Zak, P.J., 2011. Oxytocin infusion increases charitable donations regardless of monetary resources. Horm. Behav. 60 (2), http://dx.doi.org/10.1016/j.yhbeh.2011.04.008.

Bartz, J.A., Zaki, J., Bolger, N., Ochsner, K.N., 2011. Social effects of oxytocin in humans: context and person matter. Trends Cogn. Sci. 15 (7).

Bradstreet, M.P., Higgins, S.T., Heil, S.H., Badger, G.J., Skelly, J.M., Lynch, M.E., Trayah, M.C., 2012. Social discounting and cigarette smoking during pregnancy. J. Behav. Decis. Making 25 (5), http://dx.doi.org/10.1002/bdm.750.

Carver, C.S., White, T.L., 1994. Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: the BIS/BAS scales. J. Pers. Soc. Psychol. 67 (2), 319–333, http://dx.doi.org/10.1037/0022-3514.67.2.319.

Chernick, M.R., 2008. Bootstrap Methods: A Guide for Practitioners and Researchers, 2nd ed. Wiley-Interscience, Hoboken, N.J.

Crockford, C., Deschner, T., Ziegler, T., Wittig, R., 2014. Endogenous peripheral oxytocin measures can give insight into the dynamics of social relationships: a review. Front. Behav. Neurosci. 8 (68), http://dx.doi.org/10.3389/fnbeh.2014.00068.

De Dreu, C.K.W., Kret, M.E., 2016. Oxytocin conditions intergroup relations through upregulated in-group empathy, cooperation, conformity, and defense. Biol. Psychiatry 79 (3), 165–173, http://dx.doi.org/10.1016/j.biopsych.2015.03.020.

De Dreu, C.K.W., Greer, L.L., Handgraaf, M.J.J., Shalvi, S., Van Kleef, G.A., Baas, M., Feith, S.W.W., 2010. The neuropeptide oxytocin regulates parochial altruism in intergroup conflict among humans. Science 328 (5984), 1408–1411, http://dx.doi.org/10.1126/science.1189047.

Declerck, C.H., Boone, C., Kiyonari, T., 2014. The effect of oxytocin on cooperation in a prisoner's dilemma depends on the social context and a person's social value orientation. Soc. Cogn. Affect. Neurosci. 9 (6), 802–809, http://dx.doi.org/10.1093/scan/nst040.

Efron, B., Tibshirani, R., 1993. An Introduction to the Bootstrap. Chapman & Hall, New York.

Faul, F., Erdfelder, E., Lang, A.-G., Buchner, A., 2007. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav. Res. Methods 39 (2), 175–191, http://dx.doi.org/10.3758/bf03193146.

Guastella, A.J., Hickie, I.B., McGuinness, M.M., Otis, M., Woods, E.A., Disinger, H.M., Banati, R.B., 2013. Recommendations for the standardisation of oxytocin nasal administration and guidelines for its reporting in human research. Psychoneuroendocrinology 38 (5), 612–625, http://dx.doi.org/10.1016/j.psyneuen.2012.11.019.

Hayes, A.F., 2013. Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach. The Guilford Press, New York.

Huang, Y., Kendrick, K.M., Zheng, H., Yu, R., 2015. Oxytocin enhances implicit social conformity to both in-group and out-group opinions. Psychoneuroendocrinology 60, http://dx.doi.org/10.1016/j.psyneuen.2015.06.003.

Insel, T.R., 1992. Oxytocin—a neuropeptide for affiliation: evidence from behavioral, receptor autoradiographic, and comparative studies. Psychoneuroendocrinology 17 (1), 3–35, http://dx.doi.org/10.1016/0306-4530(92)90073-G.

Israel, S., Weisel, O., Ebstein, R.P., Bornstein, G., 2012. Oxytocin, but not vasopressin, increases both parochial and universal altruism. Psychoneuroendocrinology 37 (8), http://dx.doi.org/10.1016/j.psyneuen.2012.02.001.

Johnson, M.W., Bickel, W.K., 2008. An algorithm for identifying nonsystematic delay-discounting data. Exp. Clin. Psychopharmacol. 16 (3), http://dx.doi.org/10.1037/1064-1297.16.3.264.

Jones, B.A., Rachlin, H., 2006. Social discounting. Psychol. Sci. 17 (4), http://dx.doi.org/10.1111/j.1467-9280.2006.01699.x.

Jones, B.A., Rachlin, H., 2009. Delay, probability, and social discounting in a public goods game. J. Exp. Anal. Behav. 91 (1), http://dx.doi.org/10.1901/jeab.2009.91-61.

Kemp, A.H., Guastella, A.J., 2011. The role of oxytocin in human affect: a novel hypothesis. Curr. Dir. Psychol. Sci. 20 (4), 222–231, http://dx.doi.org/10.1177/0963721411417547.

Lane, A., Luminet, O., Nave, G., Mikolajczak, M., 2016. Is there a publication bias in behavioural intranasal oxytocin research on humans? Opening the file drawer of one laboratory. J. Neuroendocrinol. 28 (4), http://dx.doi.org/10.1111/jne.12384.

Lim, M.M., Young, L.J., 2006. Neuropeptidergic regulation of affiliative behavior and social bonding in animals. Horm. Behav. 50 (4), http://dx.doi.org/10.1016/j.yhbeh.2006.06.028.

Luo, X., Han, L., Zhou, Y., Liu, X., Chen, Q., 2016. Current status of smoking and its influencing factors among students in a comprehensive university in Guangzhou. Pract. Prev. Med. 23 (9).

Ma, Q., Pei, G., Jin, J., 2015. What makes you generous? The influence of rural and urban rearing on social discounting in China. PLoS One 10 (7), e0133078, http://dx.doi.org/10.1371/journal.pone.0133078.

Nave, G., Camerer, C., McCullough, M., 2015. Does oxytocin increase trust in humans? A critical review of research. Perspect. Psychol. Sci. 10 (6), http://dx.doi.org/10.1177/1745691615600138.

Shamay-Tsoory, S.G., Abu-Akel, A., Palgi, S., Sulieman, R., Fischer-Shofty, M., Levkovitz, Y., Decety, J., 2013. Giving peace a chance: oxytocin increases empathy to pain in the context of the Israeli-Palestinian conflict. Psychoneuroendocrinology 38 (12), 3139–3144, http://dx.doi.org/10.1016/j.psyneuen.2013.09.015.

Spielberger, C.D., 2010. State-trait anxiety inventory. In: The Corsini Encyclopedia of Psychology. John Wiley & Sons, Inc.

Strombach, T., Jin, J., Weber, B., Kenning, P., Shen, Q., Ma, Q., Kalenscher, T., 2014. Charity begins at home: cultural differences in social discounting and generosity. J. Behav. Decis. Making 27 (3), http://dx.doi.org/10.1002/bdm.1802.

Ten Velden, F.S., Daughters, K., De Dreu, C.K., 2016. Oxytocin promotes intuitive rather than deliberated cooperation with the in-group. Horm. Behav., http://dx.doi.org/10.1016/j.yhbeh.2016.06.005.

Van Lange, P.A.M., De Bruin, E.M.N., Otten, W., Joireman, J.A., 1997. Development of prosocial, individualistic, and competitive orientations: theory and preliminary evidence. J. Pers. Soc. Psychol. 73 (4), 733–746, http://dx.doi.org/10.1037/0022-3514.73.4.733.

Wacker, D.W., Ludwig, M., 2012. Vasopressin, oxytocin, and social odor recognition. Horm. Behav. 61 (3), 259–265, http://dx.doi.org/10.1016/j.yhbeh.2011.08.014.

Witt, D.M., Winslow, J.T., Insel, T.R., 1992. Enhanced social interactions in rats following chronic, centrally infused oxytocin. Pharmacol. Biochem. Behav. 43 (3), http://dx.doi.org/10.1016/0091-3057(92)90418-f.

Wright, D., London, K., Field, A., 2011. Using bootstrap estimation and the plug-in principle for clinical psychology data. J. Exp. Psychopathol. 2 (2), 252–270, http://dx.doi.org/10.5127/jep.013611.

Zak, P.J., Stanton, A.A., Ahmadi, S., 2007. Oxytocin increases generosity in humans. PLoS One 2 (11), e1128, http://dx.doi.org/10.1371/journal.pone.0001128.