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Oxytocin amplifies the influence of good intentions on social judgments

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ABSTRACT

Studies have shown that the evolutionarily conserved neuropeptide oxytocin (OT) promotes various prosocial behaviors, yet there are few studies of the effect of OT on social judgments, especially on judgments when the actor's intention and the final outcome are incongruent. In a double-blind, placebo-controlled experiment, participants were asked to play the role of the recipient in a dictator game and to make social judgments about the dictator after intranasal OT administration. To isolate the outcome and the intention of the dictator's allocation, we developed a novel social judgment task in which recipients were told that 50% of the dictators' proposals would be reversed. The results showed that the effect of OT on social judgment was modulated by intention: OT increased goodness ratings only towards dictators with hyperfair intention. Our findings support the affiliative-motivation theory which states that OT enhances the affiliative motivation and recognition of positive-valence social stimuli.

1. Introduction

Accumulating studies have shown the effects of oxytocin (OT) on a wide range of social cognition and behaviors related to morality and prosociality (Declerck et al., 2010; Ebstein et al., 2009; Heinrichs et al., 2009; Israel et al., 2009; Radke and De Bruijn, 2012; Riem et al., 2013; Shalvi and De Dreu, 2014; Sindermann et al., 2018; Zak et al., 2007) (for reviews, see MacDonald and MacDonald, 2010; Striepens et al., 2011). Although the pharmacokinetic characteristics and effectiveness of intranasal OT application in humans remain to be further studied (Leng and Ludwig, 2016), animal studies suggest that intranasal delivery of OT can bypass the blood-brain barrier in rats and macaques, possibly via extracellular pathways in the olfactory epithelium situated in the superior nasal conchae (Chang et al., 2012; Guastella et al., 2013; Modi et al., 2014; Neumann et al., 2013). Recently, there has been an interest in examining the effects of intranasal OT on moral judgment. Intranasal OT has been found to bias behavioral responses towards endorsement of moral dilemmas involving self-benefit in men and decrease behavioral endorsement of self-benefit scenarios in moral dilemmas in women (Scheele et al., 2014), and decrease the neural responses to moral dilemmas (Preckel et al., 2015). Using scenarios describing offenses made mostly with criminal intent, Krueger et al. (2012) found that OT increased men's rating of harm done to victims but did not influence the judgment that the criminal offenders deserved punishment (Krueger et al., 2012). Other researchers found that moral judgments are influenced by genetic variations on oxytocin receptor genes (OXTR) (Bernhard et al., 2016; Walter et al., 2012). Specifically, Bernhard et al. (2016) found that the more copies of the C allele of rs237889, the higher the frequency of utilitarian judgments in moral dilemmas. Walter et al. (2012) found that carriers of at least one C allele (CC and CT genotype carriers) of rs2268498 gene judged accidental harm to be more blameworthy than carriers of the TT genotype, indicating that the former reduces the relative weight placed on intention versus outcome.

Most of the research on moral judgments has focused on situations in which an actor's intention and outcome are congruent (for an exception, see Walter et al., 2012). However, as the aphorism goes, the road to hell can be paved with good intentions. Intention and outcome can be dissociated in many situations. For example, you may want to offer your thirsty friend tea, but accidentally knock over the cup and spill the tea on his suit: the intention is good, but the outcome is bad. Furthermore, previous studies focused mainly on negative-valued behaviors. However, we make social judgments not only about the "bad guys", but also about good people. We also do not often make social judgments on serious moral issues such as killing. Instead, we routinely judge the goodness of ordinary social behaviors. In sum, except a few studies (Gan et al., 2016), no study has examined systematically the roles of intention and outcome when people make judgments about

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relatively positive real-life behaviors.

To test the effects of OT on the roles of intention and outcome in social judgments, we developed a novel dictator game in which a reversal procedure was introduced to disambiguate the intention of the dictator from the outcome of his/her allocation. For example, in the novel task the proposer may propose to give 80% of the total amount to the receiver (good intention); however, due to the reversal procedure, in some trials, the receiver may end up receiving only 20% of the total amount (bad outcome). This reversal procedure is designed to mimic real-life scenarios in which even that good/bad intentions, when acted upon, may have unintended bad/good consequences. For instance, one may give only one lottery ticket to his friend and keep ninety-nine tickets for himself. Ironically, his friend may win a $1 million jackpot with just one ticket and he may end up with nothing. Although morality is complex and multi-faceted, fairness is central to the moral domain (Huebner et al., 2009). Moral emotions like disgust, anger, guilt, might be important causes of strong reciprocity (Gummerum et al., 2010). Behavioral studies also indicate that unfair treatment elicits the same disgust as disease vectors and bad tastes (Chapman et al., 2009). Studies have shown that unfair offers from human partners consistently activated anterior insula (Sanfey et al., 2003), a region often activated by physical sensations of disgusting taste and odor (Calder et al., 2000; Calder et al., 2001), suggesting that moral disgust may contribute to rejecting unfair offers in the ultimatum game. Here, we asked participants to judge the goodness of others' behaviors and examine how perceptions of fair/unfair intentions and outcomes in the dictator game influence their social judgments.

Aforementioned studies related to social judgment, as well as other studies (Alvares et al., 2010; Cardoso et al., 2016) have shown that OT effects on social cognition were modulated by features of contexts and/or individuals (Bartz et al., 2011). For example, included participants in the Cyberball game reported a stronger desire to play again with the same participants after OT administration, while OT had no effects for ostracized participants (Alvares et al., 2010). Apart from this overarching interactionist account, other theories on OT's social effects have been proposed, such as social salience theory, and affiliative-motivation theory (for a review, see Bartz et al., 2011). Another goal of the present study was to test the two theories in social judgment. It is noteworthy that following hypotheses both derived from social salience theory and affiliative-motivation theory are in line with the interactionist account, as both of them predict that OT effects are dependent on contexts (i.e., salience and valence, respectively).

According to social salience theory (Shamaytsoory et al., 2009), OT intensifies the salience of existing social cues regardless of valence. For example, OT enhances cooperation in the presence of social information about the interaction partner but reduces it in the absence of social information about the interaction partner (Declerck et al., 2010). According to social salience theory, we hypothesize that OT should polarize social judgment. That is, OT should enhance goodness judgments of people with good intentions (such as offering the bigger proportion of rewards to others), but decrease goodness judgments of people with unknown (dictators whose proposals are not revealed) or bad intentions (dictators who treat others unfairly).

Consistent with research in animals on OT and attachment bonding (Lim and Young, 2006), the affiliative-motivation theory proposed that OT increases social motivation/affiliative drive (Bartz et al., 2011). It has been found that OT enhances affiliative motivation, such as recognition of positive-valence social stimuli (Bartz, 2016; Guastella et al., 2008). For example, OT enhances trust towards reliable interaction partners, but not towards unreliable ones (Mikolajczak et al., 2010). Based on this theory, it is reasonable to hypothesize that OT may particularly enhance goodness judgments about people with good intentions as they are potential collaborators that individuals want to affiliate with, while leaves judgments of unknown or bad intentions unaffected.

2. Method

2.1. Participants

In a placebo-controlled, double-blind study, 80 college students (63 females; age $M = 19.67$ years, $S.D. = 1.39$) were recruited through flyers on the university campus. Participants were randomly assigned to receive either 24 IU OT (three puffs per nostril, each with 4 IU OT) or placebo (containing all ingredients except for the neuropeptide) intranasally. We utilized a dose of 24 IU because it is the most commonly reported dose in the literature and has been shown to affect social functions and behavior (Huang et al., 2015; Zheng et al., 2016). There were 32 females and 8 males in the OT group, and 31 females and 9 males in the PLC group. Selection criteria included no intake of caffeine, alcohol or nicotine within 2 h before the experiment. Participants reported no history of neurological or psychiatric disorders (including substance abuse and obesity). By self-report, no female participant was pregnant or used hormonal contraception in the last three months.

There was only one session for each participant. At baseline and before drug administration, participants provided demographic information (age and monthly consumption expenditures) and completed a set of questionnaires: Positive and Negative Affect Scale (Watson et al., 1988), Big Five Inventory (John and Srivastava, 1999), State-Trait Anxiety Inventory (Spielberger, 2010), Self-Esteem Scale (Rosenberg, 1965), Rational and Intuitive Decision Styles Scale (Hamilton et al., 2016), Interpersonal Reactivity Index (Davis, 1980). Participants were given RMB 40 for showing up, and then additional earnings were based on their participation in the formal task. After the formal task, participants were asked to guess whether they took OT or a placebo. The number of correct guesses was not significantly different between the OT and PLC groups (Pearson's $\chi^2 = 2.40$, $p = 0.12$). The Institutional Review Board of South China Normal University approved the present study. All participants provided informed consent before the experiment.

2.2. The dictator game social judgment task

We adapted the dictator game, a commonly used method for studying decision-making, for the purposes of the current study. There were two roles in the dictator game, Player A dictator role and Player B receiver role. In the beginning, Player A was endowed with 12 RMB and Player B received no endowment. Player A made a proposal for how to allocate the endowment and Player B could do nothing but accept Player A's allocation. The social judgment task consisted of two consecutive stages. First, there was a dictator role stage. Participants were told to act as Player A for one round and decide how to allocate 12 RMB, with their decisions determining the earnings of both Player A and Player B. Offers could range from 2 to 10 RMB as an integer value. Second, there was a receiver role stage, about which participants had not been told earlier. Participants were told that all proposals made by previous players in the role of Player A would undergo a reversal procedure: 50% of the proposals would be reversed by a computer while the rest would be left intact, and Player A and Player B's final earnings would be calculated after the reversal procedure. In each trial, the final payoffs were presented. Then Player A's initial proposal was revealed or not revealed. Participants were told that a previous anonymous player was randomly chosen from our subject pool in each trial without repetition. In fact, no counterparts existed and the proposals and payoffs were predetermined.

In the dictator role stage, participants were told that they would play an allocation game, paired with a random person who would participate in the experiment later. In the receiver role stage, participants were then asked to act as Player B (receiver role) and make a social judgment about Player A (Fig. 1). A seven-point goodness rating scale, ranging from very bad to very good, was employed to indicate the judgment of Player A's behavior. There were 81 trials (3 intention

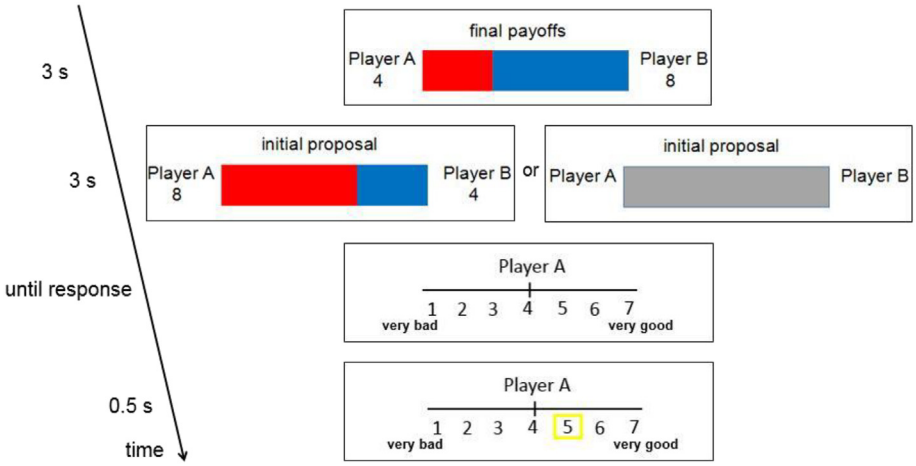

Fig. 1. Example of the social judgment task. First, final payoffs after the reversal procedure were presented, then Player A's initial proposal was revealed or not revealed. Finally, participants were asked to make a social judgment with no time limit. The judgment result was then shown, followed by a 3 s inter-trial interval.

conditions × 9 offer levels × 3 repetitions) in total. There are three intention conditions within-subjects: reversal condition (initial proposals were reversed), nonreversal condition (initial proposals were the same as final payoffs), and unknown condition (initial proposals unknown). Each offer level (from 2 to 10 RMB with an increment of 1 RMB) in each intention condition was presented three times. After the formal task, one pair of final payoffs were randomly selected, and participants were paid accordingly. Each participant's total payoff included the showing-up fee, a random final payoff as Player A and a random final payoff as Player B.

2.3. Procedure

On their arrival, participants were asked to complete a set of questionnaires to collect information about demographics and personality traits, before drug administration. The dictator social judgment task started 45 min after drug administration. Previous studies have shown intranasal OT (or vasopressin, another nonapeptide with similar bioavailability) enhanced OT levels in cerebrospinal fluid (CSF) 45 min after intranasal administration in both humans (Born et al., 2002) and macaques (Chang et al., 2012; Dal Monte et al., 2014). OT-induced changes in resting regional cerebral blood flow (rCBF) peaked between 39 and 51 min after administration, and were sustained over the entire post-administration observation period (25–78 min) (Paloyelis et al., 2016). A host of earlier experiments reporting OT effects (Huang et al., 2015; Krueger et al., 2012; Mikolajczak et al., 2010; Pornpattananangkul et al., 2017; Zheng et al., 2016) have adopted a similar administration-task interval (i.e. 30–50 min).

3. Results

Table 1 shows that there were no significant differences between the OT and PLC groups in terms of demographic information and psychological traits (*ps* > 0.27).

For the dictator role stage, we conducted a one-way ANOVA on dictators' offers with drug (OT, PLC) as a between-subjects factor. The results showed no significant OT effect on generosity, $F(1,78) = 1.24$, $p = 0.27$, $\eta^2 = 0.02$.

For the receiver role stage, the allocation amounts were categorized into three conditions: hyperfair (> 6 RMB), fair (6 RMB) and unfair (< 6 RMB) (see Table 2). It is worth noting that the fair condition has only one value (6 RMB) and its reversal is itself. We did not include this condition into analyses as it is irrelevant to our main research focus. We conducted a repeated-measures ANOVA on social judgment with intention (hyperfair, unknown, unfair) and outcome (hyperfair, unfair) as within-subject factors and drug (OT, PLC) as the between-subjects factor. The results showed a significant main effect of intention ($F(2,156) = 254.12$, $p < 0.001$, $\eta^2 = 0.66$) and outcome ($F(1,78) = 28.44$, $p < 0.001$, $\eta^2 = 0.02$).

Table 1
Ages and traits scores for participants in PLC and OT groups (mean ± SEM).

Measurements	PLC	OT	*t* value	*p*
Age	19.80 ± 0.19	19.55 ± 0.24	0.805	0.423
Monthly consumption expenditures	1300.00 ± 88.07	1187.50 ± 88.07	1.052	0.296
Positive affect	23.68 ± 1.03	23.93 ± 0.84	−0.189	0.851
Negative affect	12.75 ± 0.70	12.95 ± 0.77	−0.192	0.848
NEO-Five Factor Inventory (NEO-FFI)				
Neuroticism	24.60 ± 0.47	24.08 ± 0.50	0.767	0.445
Extraversion	25.48 ± 0.37	26.18 ± 0.51	−1.116	0.268
Openness to experience	27.83 ± 0.59	27.85 ± 0.74	−0.026	0.979
Agreeableness	23.85 ± 0.51	23.90 ± 0.40	−0.077	0.939
Conscientiousness	30.40 ± 0.48	30.40 ± 0.36	0.000	1.000
State-Trait Anxiety Inventory (STAI)-state	43.73 ± 0.65	43.98 ± 0.78	−0.248	0.805
State-Trait Anxiety Inventory (STAI)-trait	39.62 ± 0.83	40.90 ± 0.83	−1.087	0.280
Self-esteem scale	23.13 ± 0.32	23.08 ± 0.31	0.111	0.912
Rational and intuitive decision style scale				
Rational style	19.93 ± 0.35	20.15 ± 0.40	−0.423	0.674
Intuitive style	13.18 ± 0.44	13.88 ± 0.57	−0.968	0.336
Interpersonal reactivity index	40.10 ± 1.30	39.93 ± 1.26	0.097	0.923

The main effects for intention and outcome were subsumed under two interaction effects. First, there was a significant interaction between intention and outcome, $F(2,156) = 9.36$, $p < 0.001$, $\eta^2 = 0.004$. Post hoc analysis using Bonferroni corrections showed that the difference between a hyperfair outcome ($M = 3.00$) and unfair outcome ($M = 2.84$) in the unfair intention condition was smaller than the difference between a hyperfair outcome ($M = 5.45$) and unfair outcome ($M = 5.06$) in the hyperfair intention condition (Cohen's d = 0.40, $p = 0.001$), and was also smaller than the difference between a hyperfair outcome ($M = 4.05$) and unfair outcome ($M = 3.56$) in the unknown intention condition (Cohen's d = 0.45, $p < 0.001$), while the difference between the latter two was not significant (Cohen's d = 0.13, $p = 0.81$). In other words, participants judged hyperfair outcome as better than an unfair outcome, though this difference was attenuated when the intention was unfair.

Table 2
Illustration of the design.

	Condition	Final payoff for play B	Initial offer from play A
Nonreversal	Unfair outcome + unfair intention	2	2
		3	3
		4	4
		5	5
	Fair outcome + fair intention	6	6
	Hyperfair outcome + hyperfair intention	7	7
		8	8
		9	9
		10	10
Reversal	Unfair outcome + hyperfair intention	2	10
		3	9
		4	8
		5	7
	Hyperfair outcome + unfair intention	6	6
	Hyperfair outcome + unfair intention	7	5
		8	4
		9	3
		10	2
Unknown	Unfair outcome + unknown intention	2	Unknown
		3	Unknown
		4	Unknown
		5	Unknown
	Fair outcome + unknown intention	6	Unknown (6)
	Hyperfair outcome + unknown intention	7	Unknown
		8	Unknown
		9	Unknown
		10	Unknown

Note: there are 27 combinations (3 intention conditions × 9 offer levels). Each combination has 3 repetitions which are not shown in the table.

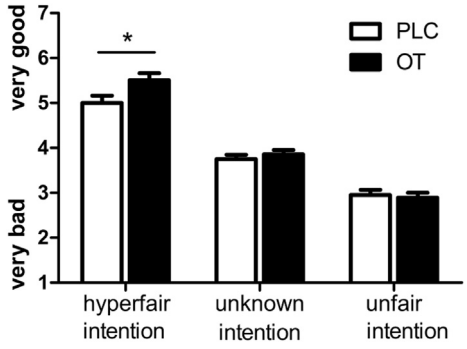

Fig. 2. The interaction between drug and intention. OT selectively augmented the dictator's good (hyperfair) intention across outcomes. Error bars indicate the standard error of the mean. * $p < 0.05$. PLC = Placebo Control, OT = Oxytocin.

The second significant interaction was between drug and intention, $F(2,156) = 3.85$, $p = 0.043$, $\eta^2 = 0.01$. Post-hoc analysis using Bonferroni corrections showed that the OT group judged hyperfair intention as better than the PLC group ($M = 5.51$ vs. $M = 5.00$, Cohen's d = 0.50, $p = 0.03$), while there was no significant group difference in judgment for unknown intention ($M = 3.86$ vs. $M = 3.75$, Cohen's d = 0.19, $p = 0.41$) or unfair intention ($M = 2.89$ vs. $M = 2.95$, Cohen's d = 0.08, $p = 0.70$) (Fig. 2). In other words, OT selectively augmented the dictator's good (hyperfair) intention. An exploratory analysis with Bonferroni corrections showed that the OT group judged hyperfair intention with either a hyperfair or unfair outcome as better than the PLC group (for hyperfair outcome, $M = 5.68$ vs. $M = 5.23$, Cohen's d = 0.45, $p = 0.05$; for unfair outcome, $M = 5.34$ vs. $M = 4.78$, Cohen's d = 0.51, $p = 0.03$). No other significant effects were found, $ps > 0.16$ (Fig. 3). We run a moderation analysis using the PROCESS toolbox (Hayes, 2013), and found that these OT effects on

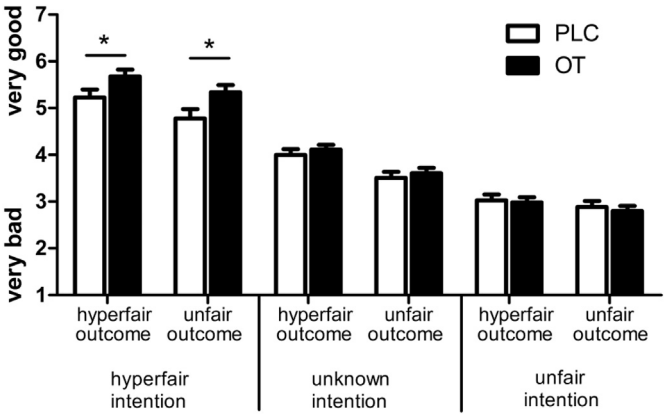

Fig. 3. Results of the social judgment task. Error bars indicate the standard error of the mean. * $p < 0.05$. PLC = placebo control, OT = oxytocin.

social judgments of good intentions were not moderated by generosity in the first stage, $p > 0.25$.

We re-run all analyses for female participants only and found similar results. For the first stage, we conducted a one-way ANOVA on dictators' offers, and found that OT effect was not significant ($F(1,61) = 1.38$, $p = 0.24$). For the second stage, we conducted a repeated measures ANOVA on social judgment, and found significant main effects of intention ($F(2,122) = 222.55$, $p < 0.001$, $\eta^2 = 0.57$), outcome ($F(1,61) = 22.68$, $p < 0.001$, $\eta^2 = 0.02$), as well as a significant interaction between intention and outcome ($F(2,122) = 6.78$, $p = 0.004$, $\eta^2 = 0.002$). The effect between drug and intention decreased to $\eta^2 = 0.006$ ($F(2,122) = 2.42$, $p = 0.12$). No other significant effects were found, $ps > 0.64$.

We added gender as the covariate and re-run analyses and found similar results. For the first stage on dictators' offers, we found that no significant effects ($ps > 0.26$). For the second stage, we found significant main effects of intention ($F(2,154) = 8.03$, $p < 0.001$, $\eta^2 = 0.04$), gender ($F(1,77) = 7.18$, $p = 0.009$, $\eta^2 = 0.03$), as well as significant interactions between intention and outcome ($F(2,154) = 3.89$, $p = 0.03$, $\eta^2 = 0.003$), and between intention and drug ($F(2,154) = 3.75$, $p = 0.04$, $\eta^2 = 0.02$). There was also a marginally significant interaction effect between intention, outcome, and gender ($F(2,154) = 2.54$, $p = 0.09$, $\eta^2 = 0.002$). No other significant effects were found, $ps > 0.17$.

4. Discussion

Consistent with previous studies on moral judgments (Young et al., 2010; Young et al., 2007), we demonstrated that both intention and outcome modulated social judgment. Importantly, the present study demonstrated for the first time that OT influences the role of proposers' intention in judgment. Specifically, we found that OT enhanced goodness judgment of a dictator with hyperfair intention regardless of outcomes, while it did not affect the judgment of a dictator with unknown or unfair intention. Participants who received OT gave higher goodness judgments to good intentions than those in the control condition.

Previous studies on the influence of OT on social judgment only focused on negative-valence behavior, leaving unclear the impact of OT on the judgment of positive social behaviors such as hyperfair offers in a dictator game. Consistent with previous studies, we found that OT did not modulate the judgment of negative intentions. Radke and De Bruijn (2012) found that in a modified ultimatum game, OT did not influence the rejection rate of unfair proposals when there was a fair alternative available. Using scenarios describing offenses with criminal intention, Krueger et al. (2012) also found no OT effect on judgments of the criminals. Taken together, these findings suggest that OT has no significant effect on social judgments of negative intentions.

Importantly, we found that OT specifically impacted the social judgment of positive intention. The interactionist account of OT effects stresses the modulation roles of social contexts and individual differences. Furthermore, the affiliative-motivation theory emphasizes the positive effect of OT on prosocial behavior and social cognition related to positive-valued social stimuli (Bartz et al., 2011). Our intention-dependent effects of OT are consistent with both of the two theories. Our findings are also in line with a host of studies on prosociality (MacDonald and MacDonald, 2010; Striepens et al., 2011), such as social attachment (Carter, 1998), stress-coping related behavior (Taylor et al., 2000; Tops et al., 2013; Uvnäs-Moberg et al., 2015). Other researchers have argued, from an evolutionary perspective, that making positive moral judgments of a certain action can increase the probability of engaging in that action later (Joyce, 2007). The amplified positive judgment of others' good intention may promote individuals' own prosocial behaviors, such as reciprocity. Previous studies showed adults with autism spectrum disorders (ASD) preferred to make utilitarian judgments (Gleichgerrcht et al., 2012; Zalla et al., 2011) and displayed an overreliance on the action's bad outcome (Moran et al., 2011). Our finding that OT enhanced judgments about good intentions (no matter the outcome is good or bad) may have clinical implications on treating clinical disorders such as schizophrenia and autism. OT in the central nervous system (CNS) influences social cognition and behavior, making it a candidate to improving social skills in patients with social deficits, especially on judging social intentions (Yatawara et al., 2016).

Recent studies have shown that carriers of the T vs. C allele of rs237889 in the OXTR tend to show decreased utilitarian moral judgments in moral dilemmas (Bernhard et al., 2016) and that carriers of the T vs. C allele of rs2268498 tend to show lower attributions of blameworthiness for accidental harm (Walter et al., 2012), indicating a decreased influence of outcome on moral judgment. Other research has shown that the TT genotype of rs2268498 was associated with more efficient OT signaling (Montag et al., 2011). These genetic studies seem to suggest that OT decreases reliance on outcome in moral judgment. However, in our study, we did not find that OT had a significant effect on the weight of the outcome dimension in judgment.

We found that when participants played the proposer role in the novel dictator game (DG), OT did not influence generosity in the one-shot DG. Consistent with our finding, Zak et al. (2007) found that OT increased the amount of money transferred to the receiver in the ultimatum game (UG), but did not influence the amount of money transferred in the DG. However, another study showed that OT decreased rejections of unfair offers in UG, and decreased the amount of money transferred to the receiver in the subsequent DG (Radke and De Bruijn, 2012). Methodological differences across studies may explain the inconsistencies. In Radke and De Bruijn's (2012) study, DG was always played after the UG in which participants faced many unfair offers. Therefore the UG may prime participants that their partners on average were not fair. OT may promote this priming effect and make participants less generous in the subsequent DG. In the present study and in Zak et al.'s (2007) study, participants played DG first and had no prior information regarding their partners' reputation. Second, Radke and De Bruijn (2012) started formal tasks approximately 75 min after drug administration, while the present study started the dictator game about 45 min after drug administration (Guastella et al., 2013). OT may influence generosity in a time-dependent fashion. In addition, our null finding on generosity also contrasts with previous studies showing a significant correlation between genetic variations on OXTR and generosity in DG with a sample size of 303 participants (Ebstein et al., 2009; Israel et al., 2009). This discrepancy may be due to the underpowered sample size in the present study for usually small to moderate OT effects (Bartz et al., 2011; Lane et al., 2016), or to genetic modulation of intranasal OT (Sindermann et al., 2018). A pharmaco-genetic approach with a larger sample may help shed light on this issue.

There are several limitations in the current study. First, we did not specify exact criteria participants should use to make social judgments of allocations. Participants were simply asked to judge the social goodness of allocators' behavior. Future studies may explicitly ask participants to make fairness judgment and see whether the patterns can be replicated or not. Second, in our second-person paradigm, we examined social judgments when participants' self-interest was involved. Using the ultimatum game, researchers have extensively studied social judgment and punishment behaviors in both second parties whose economic payoff is directly affected by the norm violation and third parties whose interest is not affected by the norm violation (Buckholtz et al., 2008; Sanfey et al., 2003). It would be interesting to extend our research to the third party condition in which participants are asked to evaluate the blameworthiness/goodness of the resource allocator in a scenario as an “impartial” third party. Third, it is possible that the significant interaction effect between OT and intention may result from interpersonal differences, such as OT receptor gene types. A within-subject design may be adopted for future research to control for inter-individual differences. Fourth, anxiety reduction theory claims that OT has an anxiolytic effect and consequentially promotes prosocial behavior (Bartz et al., 2011). Future studies may measure participants' anxiety both before and after drug administration and study whether and how anxiety may modulate the effects of OT on social judgments. Fifth, we did not have conditions in which participants offer zero or full amount. It would be interesting to see whether OT also modulates responses to these extreme unfair/fair offers. Future studies may also explore whether the sequence of presenting intention and outcome may have an effect. Sixth, we did not collect information to identify the fertile period in the ovarian cycle for female participants. We only collected self-reported data and used a forward counting method to roughly determine the stages of the menstrual cycle. Seventh, previous studies have shown dose-dependent and/or time-dependent social and non-social effects of OT (Cardoso et al., 2013; Paloyelis et al., 2016; Quintana et al., 2017; Spengler et al., 2017). Future research may systematically vary dose–test latencies (e.g., 15–40, 45–70, and 75–100 min) and doses of OT (e.g., 12, 24, 48, and 81 IU) to identify the most robust OT effects on social functions. Finally, we only gained relatively small effects of OT. The OT effects were generally quite small in previous studies (Bartz et al., 2011; Lane et al., 2016). It may be due to the true nature of OT effect, or to false discovery, or to the potential gender modulation of OT effects (Scheele et al., 2014). A direct replication study with a more balanced gender ratio is needed to detect potential gender moderation. Finally, similar to other studies on the effects of OT on social behaviors (Nave et al., 2015), the effect size in the current study is very small. Given several failed replications of OT effects (Lane et al., 2016; Lane et al., 2015), our findings should be interpreted carefully.

5. Conclusions

Using a novel dictator task that disambiguated the effects of the actor's intention and outcomes, we showed that OT specifically enhanced social judgments of good intention, but did not affect judgments of unknown and bad intention. This is the first study to show the prosociality effect of OT in the social judgment domain.

Author contributions

J. Zhang developed the study concept. J. Zhang and C. Zhou performed research. J. Zhang analyzed and interpreted the data under the supervision of R.Yu. J. Zhang wrote the first draft, and R.Yu provided critical revisions. All authors approved the final version of the manuscript for submission.

Declaration of competing interest

The authors declared that they had no conflicts of interest with

respect to their authorship or publication of this article.

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