



The role of oxytocin in terror management processes

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ABSTRACT

Research on terror management theory found evidence for the idea that attachment and interpersonal touch attenuate existential concerns and worldview defense reactions after mortality salience. Oxytocin, on the other hand, is known for stimulating the attachment system. Therefore, we hypothesized that worldview defense reactions after mortality salience would be attenuated under oxytocin. In the present study, participants administered oxytocin or placebo and performed a typical terror management paradigm: After visualizing death or a control topic, worldview defense reactions were assessed by evaluating the authors of a pro- and an anti-German essay. Overall, the results did not provide strong support for the hypothesis. There was no effect of mortality salience on the overall worldview defense measure and, importantly, no moderation by oxytocin. However, with regard to the sympathy dimension, the expected pattern was revealed: The pro- and anti-German authors were evaluated as more balanced under oxytocin after mortality salience, whereas this was not the case under placebo. This was due to more positive evaluations of the anti-German author in the oxytocin group. Although this specific result was not expected a priori, sympathy was the only trait among all worldview defense variables that referred to a social level. Therefore, it seems possible that oxytocin is able to buffer existential concerns, but only if they are socially relevant.

1. Introduction

Humans have an instinctive drive for continued existence. Combined with the awareness of mortality, this drive is suggested to create the potential for paralyzing terror. To cope with this, terror management theory (Rosenblatt et al., 1989) argues that humans turn to the belief that some valued aspect of themselves will continue: either by assuming that one is meeting or exceeding standards and values of one's cultural worldview, or by the belief in the validity of the cultural worldview and its standards and values. Terror management theory accordingly posits that people who are confronted with their mortality (i.e., mortality salience) show increased reactions of worldview defense, thus, react more positively to others who support their worldview and more negatively to those who violate it (e.g., Greenberg et al., 1990; Schmeichel et al., 2009).

Close relationships are able to bolster faith in one's cultural worldview as they provide protection against existential concerns through a basic attachment mechanism (e.g., Bowlby, 1982). Consistently, previous research has shown that recalling attachment and a secure attachment style can reduce worldview defense reactions in

response to mortality salience (e.g., Cox et al., 2008; Mikulincer and Florian, 2000; Mikulincer et al., 2002). Likewise, in several studies, Koole et al. (2014) found evidence for the idea that interpersonal touch attenuates existential concerns and worldview defense reactions after mortality salience. The authors suggested that the comfort of touch is likely to be based on the bodily release of oxytocin (OT).

The hormone and neurotransmitter OT plays an important role in modulating sensing and responding to social stimuli (Young, 2015). In recent years, OT effects were observed across a broad range of social processes, ranging from social cognition issues to social behaviors (for an overview, see Bartz et al., 2011). The assumption that OT could indeed be involved in attenuating the awareness of mortality receives support from studies that show that OT is able to stimulate the attachment system. For example, studies revealed associations between genetic variations in the OT receptor gene and attachment styles, both among genetically related and non-related humans (Chen et al., 2011; Kovács et al., 2018). Providing a more causal link, in another study, intranasal OT enhanced the experience of attachment security in humans (Buchheim et al., 2009).

Thus, being reassured of the social system through an endogenous

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substance like OT could protect against existential concerns and, in consequence, attenuate worldview defense reactions after mortality salience. However, to our knowledge, empirical evidence on this idea is lacking so far. The aim of the present study was to address this gap. We hypothesized that typical worldview defense reactions after mortality salience would be attenuated among people under OT but not under placebo. To test this hypothesis, participants intranasally administered OT or placebo and performed a validated terror management paradigm.

2. Method

2.1. Participants and design

We conducted an a priori power analysis to test the adequacy of our sample size to detect a two-way interaction with numerator degrees of freedom of 1 using G*Power (Faul et al., 2007). We specified an alpha level of .05, a 1- β error probability of .95, and an effect size f of .37 (oriented towards the mean effect size of mortality salience manipulations; Burke et al., 2010). The results of the analysis suggested a total recommended sample size of 97.

One hundred and eight males between 17 and 66 years¹ (mean age = 25.25; SD = 6.96) from a German university participated in this study that ostensibly investigated the effect of a hormone on perception. Due to logistical reasons, only males participated in this study. Those who regarded themselves as having a significant medical or psychiatric illness, taking medication, smoking more than five cigarettes per day, abusing drugs or alcohol, or having allergies or hypersensitivity to preservatives in the OT spray were not allowed to take part. Participants were instructed to abstain from smoking or drinking (except water) for 2 h before arrival. The study was approved by the local ethics committee.

The experiment followed a 2 (substance: OT vs. placebo) \times 2 (mortality salience: death vs. dental pain) between-subjects design with random and double-blind assignment to conditions.

2.2. Procedure and materials

After participants arrived at the lab, written informed consent was obtained. Participants were informed about possible side effects of the spray, however, uninformed about its content; they were only told that they would receive either a hormone or a placebo in low dosage. Following standard procedures, participants self-administered either 24 I.U. (three puffs per nostril) of OT (Syntocinon Spray, Novartis) or a placebo (sodium chloride solution) under experimenter supervision. After a 40-min waiting period, mortality salience was manipulated (based on Routledge et al., 2004).² In the death condition, participants responded to the following instruction: “Please briefly describe the emotions that come up in you when you think of your own death. Jot down, as specifically as you can, what you think will happen to you as you physically die and once you are physically dead.” In the dental pain condition, they answered parallel questions about experiencing dental pain. Research has shown that mortality salience effects only occur when thoughts of death are highly accessible but outside of conscious awareness. Therefore, as a distractor, participants completed a word search puzzle after the manipulation in which they were asked to search and circle 10 given neutral words (e.g., book, table) out of a 10 \times 10 matrix of letters. To check the impact of the manipulation, participants were then asked to respond to measures of death-thought accessibility

¹ As research suggests that terror management processes change during aging (McCoy et al., 2000), we re-analyzed our data dropping participants older than 50 (n = 2). This did not change pattern of results.

² Thirty participants started the study after an unrelated task of approximately 20 min. Including starting time as a covariate did not change the pattern of results.

and affect. After that, they completed a measure of worldview defense. In the end, participants were thanked, debriefed, and compensated.

2.2.1. Death-thought accessibility

Based on previous research (e.g., Greenberg et al., 1994), we used a word stem completion task to measure the accessibility of death-related thoughts. Participants were presented 25 word fragments, seven of which could be completed with either a neutral or death-related word. We counted how many words participants completed death-related and how many they completed in total, calculating its ratio.

2.2.2. Affect

Affect was assessed by the Implicit Positive and Negative Affect Test (Quirin et al., 2009). Participants were instructed to rate how well six artificial words (e.g., VIKES), purportedly from an artificial language, expressed six different affect adjectives on 1 = *does not fit at all* to 5 = *fits very well* response scales. Negative (e.g., “helpless”; α = .77) and positive affect adjectives (e.g., “pleased”; α = .69) were combined.

2.2.3. Worldview defense

Participants were asked to read two brief essays, ostensibly written by foreign students. One essay was pro-German and the other was anti-German (based on Greenberg et al., 1994). After reading, they were asked to evaluate the essays with regard to the following five questions on a 1 = *not at all* to 5 = *very* response scale: “How do you like the author?” (sympathy), “How intelligent do you experience the author?” (intelligence), “How competent do you experience the author?” (competence), “How much do you agree with the author’s opinion about Germany?” (agreement), and “How true do you experience the author’s statements about Germany?” (truth). In accordance to previous research (e.g., Greenberg et al., 1994; Schmeichel et al., 2009), worldview defense was operationalized using the difference score of the corresponding values evaluating the pro- and anti-German essay. We treated all subscales separately but also created an overall score (evaluation of the pro-German author: α = .81; evaluation of the anti-German author: α = .86).

3. Results

Reporting of descriptive statistics can be found in Table 1.

3.1. Death thought accessibility

To test the success of the mortality salience manipulation, we calculated a 2 (substance) \times 2 (mortality salience) ANOVA on the death-thought accessibility ratio score. In line with previous research, the ANOVA revealed a significant main effect of mortality salience, $F(1,104) = 5.44$, $p = .022$, $\eta_p^2 = .05$. Participants in the death condition completed significantly more death-related words ($M = 0.07$, $SD = 0.05$) than participants in the dental pain condition ($M = 0.05$, $SD = 0.04$). No other significant effects emerged, $ps \geq .485$.

3.2. Affect

To test whether the findings were influenced by the participants’ affective state, we calculated two 2 (substance) \times 2 (mortality salience) ANOVAs on affect. No significant effects emerged on negative, $ps \geq .419$, and positive affect, $ps \geq .087$.

3.3. Worldview defense

To investigate the hypothesis that OT attenuates defense reactions after mortality salience, we conducted a 2 (substance) \times 2 (mortality salience) ANOVA on each worldview defense subscale and the worldview defense overall score. On the sympathy subscale, no significant main effects emerged, $ps \geq .195$. However the ANOVA revealed a

Table 1
Means and standard deviations (in parenthesis) of study variables as a function of substance and mortality salience.

	OT		Placebo	
	Death (n = 28)	Dental pain (n = 26)	Death (n = 26)	Dental pain (n = 28)
WVD: sympathy	0.71 (0.85)	1.44 (1.33)	1.42 (1.03)	1.25 (1.14)
WVD: intelligence	0.61 (0.79)	0.77 (1.21)	0.62 (0.98)	0.50 (1.14)
WVD: competence	0.71 (0.76)	1.00 (1.17)	0.69 (1.38)	0.71 (1.30)
WVD: agreement	1.07 (1.51)	1.38 (1.47)	1.58 (1.55)	0.96 (1.40)
WVD: truth	0.82 (1.28)	0.92 (1.55)	1.27 (1.40)	1.07 (1.18)
WVD: overall	0.79 (0.74)	1.08 (1.09)	1.12 (1.06)	0.90 (0.99)
DTA	0.06 (0.06)	0.05 (0.04)	0.07 (0.05)	0.05 (0.04)
Negative affect	2.30 (0.58)	2.18 (0.47)	2.32 (0.58)	2.26 (0.59)
Positive affect	2.71 (0.46)	2.66 (0.49)	2.79 (0.38)	2.91 (0.66)

Note: WVD = worldview defense (difference score), DTA = death-thought accessibility (ratio).

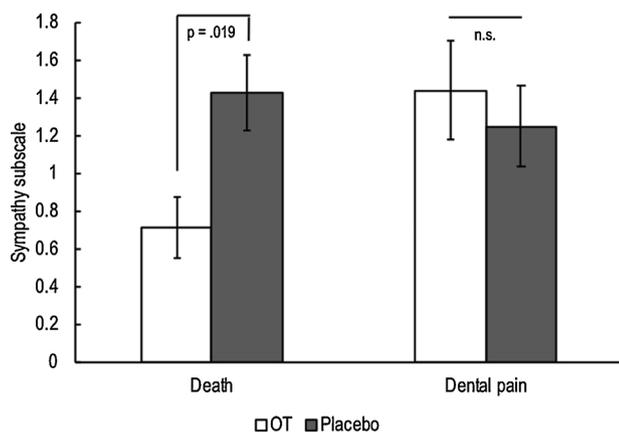


Fig. 1. The effect of substance \times mortality salience on the sympathy subscale; lower values represent a more balanced attitude toward the pro- and anti-German author, higher values a more positive attitude toward the pro- than toward the anti-German author. Error bars represent ± 1 SE.

significant interaction effect, $F(1,103) = 4.50$, $p = .036$, $\eta_p^2 = .04$. Simple main effect analyses showed that, when reminded of their own death, participants under OT had a lower difference score on sympathy ratings than participants under placebo, $F(1,103) = 5.65$, $p = .019$, $\eta_p^2 = .05$. That is, participants in the OT condition experienced rather equal sympathies for the pro- and anti-German author, whereas participants under placebo experienced more sympathy for the pro-German author than for the anti-German author. When reminded of dental pain, participants under OT and placebo did not differ in their sympathy ratings, $F(1,103) = 0.40$, $p = .530$, $\eta_p^2 = .004$, see Fig. 1. The ANOVA revealed no significant effects on the intelligence subscale, $ps \geq .490$, the competence subscale, $ps \geq .497$, the agreement subscale, $ps \geq .109$, the truth subscale, $ps \geq .256$, as well as on the overall score, $ps \geq .179$.

To investigate whether the attenuating effect of OT on worldview defense after morality salience was due to less positive evaluations of the pro-German author or more positive evaluations of the anti-German author, we not only used the classic difference score but treated the evaluations of the pro- and anti-German essay separately. Consequently, we conducted a 2 (substance) \times 2 (mortality salience) \times 2 (essay) ANOVA on each worldview defense subscale and the worldview defense overall score. On the sympathy subscale, the ANOVA revealed a significant main effect of essay, $F(1,103) = 129.69$, $p < .001$, $\eta_p^2 = .56$. In general, participants felt more sympathy towards the author of the pro-German essay ($M = 3.36$, $SD = 0.77$) than towards the author of the anti-German essay ($M = 2.17$, $SD = 0.89$). Moreover, a significant three-way interaction emerged, $F(1,103) = 4.50$, $p = .036$, $\eta_p^2 = .04$. Simple main effect analyses indicated that, when reminded

of their own death, participants under OT expressed more sympathy for the anti-German author ($M = 2.46$, $SD = 0.84$) than participants under placebo ($M = 2.00$, $SD = 0.80$), $F(1,103) = 3.77$, $p = .055$, $\eta_p^2 = .04$. No difference occurred under mortality salience when participants in the OT and placebo conditions evaluated the pro-German author (OT: $M = 3.18$, $SD = 0.67$; placebo: $M = 3.42$, $SD = 0.86$), $F(1,103) = 1.36$, $p = .247$, $\eta_p^2 = .01$. When reminded of dental pain, participants under OT and placebo did not differ in their sympathy ratings, neither with regard to the anti-German author (OT: $M = 2.08$, $SD = 0.86$; placebo: $M = 2.11$, $SD = 0.99$), $F(1,103) = 0.01$, $p = .911$, $\eta_p^2 < .001$, nor with regard to the pro-German author (OT: $M = 3.52$, $SD = 0.96$; placebo: $M = 3.36$, $SD = 0.56$), $F(1,103) = 0.59$, $p = .444$, $\eta_p^2 = .01$. The ANOVA on sympathy revealed no other significant effects, $ps \geq .195$. The remaining subscales and the overall score only showed significant main effects of essay, $ps < .001$, with participants evaluating the author of the pro-German essay as significantly more intelligent, competent, agreeable, and truth-telling than the author of the anti-German essay. No other effects emerged, $ps \geq .109$.

To adjust for multiple comparisons, we also used a Bonferroni correction dividing the desired α level of .05 by the number of tests among the subscales ($.05/5 = .01$). In this case, the effects of OT were no longer significant.

4. Discussion

Inspired by previous findings (cf. Koole et al., 2014), in the present study, we investigated the hypothesis that typical worldview defense reactions after mortality salience are attenuated among people under OT. Overall, the results did not provide strong support for this idea. Although death thought accessibility was increased after mortality salience, there was no effect of mortality salience on the overall worldview defense measure and, importantly, also no moderation by OT. However, with regard to sympathy, the expected pattern was revealed: The pro- and anti-German authors were evaluated as more balanced under OT after mortality salience, whereas this was not the case among participants under placebo. This was due to a more positive attitude towards the anti-German author of participants in the OT (compared to the placebo) group. This specific result was not expected a priori. However, sympathy was the only trait among all worldview defense variables that referred to an empathetic and, thus, social level. Therefore, it seems possible that OT is able to buffer negative mortality salience reactions, but only those that refer to social relationships. This is consistent with research showing OT to only promote socially relevant but not irrelevant issues: For example, OT increased brain activities when faced with socially relevant but not irrelevant cues (Kirsch et al., 2005). Nonetheless, it should be considered that an adjustment for multiple comparisons eliminated this pattern.

If we assume validity of the OT effect, the present findings suggest that OT might help people to deal with existential concerns (at least, on a social level). As activation of attachment can protect against existential concerns (Bowlby, 1982) and reduce worldview defense reactions in response to mortality salience (e.g., Cox et al., 2008; Mikulincer and Florian, 2000; Mikulincer et al., 2002), we suppose that the intake of OT increased feelings of social embeddedness in our participants which attenuated the effect of mortality salience. This is in line with past OT research showing enhanced attachment security under OT (Buchheim et al., 2009). It also fits more general attempts to explain OT's functioning which propose an increased approach motivation, reduced anxiety, and an intensified salience of social cues under OT (see Bartz et al., 2011). It would be a fruitful avenue of future research to investigate the underlying mechanism of this effect empirically. From a terror management perspective, it is an interesting question whether the existential comfort induced by OT is able to provide such a stable anxiety buffer as cultural worldviews do (as assumed by the theory). It may be that an OT-based buffer is fleeting and limited to short-term effects. However, more research is needed to determine the potential of

OT when confronted with death.

In future research, additional aspects could be addressed. It might be worth including critical traits as possible moderators, for example self-esteem or dispositional attachment orientations as the works by Koole et al. (2014) and Bartz et al. (2010) suggest. A modification of the measurements' order might also be reasonable. In the current study, we cannot exclude the possibility that measuring death-thought accessibility before cultural defense could have blurred the mortality salience conditions and led to an overall increased worldview defense response. Although the word stem task did not explicitly present death-related words, it might have stimulated such by the participants' completion efforts (cf. Hayes and Schimel, 2018). Lastly, a larger sample size should be considered. Although our a priori power analysis suggests that the present study is not underpowered, the assumed effect size might be overestimated given the interaction hypothesis.

One common but in several ways problematic strategy is to suppress null findings and to only report significant findings (John et al., 2012). In light of this debate, we believe that the present study substantially contributes to the empirical investigation of the proposed idea. Reporting null findings, especially of extensive and sound studies, is in line with the (new) guidelines of good scientific practice.

Coping with the paralyzing terror of mortality, humans have developed (seemingly) useful strategies. Whereas psychological means had been focal in the past, our findings encourage to take supportive biological factors into account when people are confronted with death.

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