



# Oxytocin strengthens the link between provocation and aggression among low anxiety people<sup>☆</sup>

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## ABSTRACT

Oxytocin (OT) not only modulates positive social interactions but also affects negative ones. Several studies have established a link between OT and aggression. However, they also resulted in an inconsistent picture and showed methodological issues. The current studies aimed to address these lacks and test the hypothesis that OT increases provocation-induced aggression in people low in anxiety. Therefore, two studies with 56 males (Study 1) as well as 40 females and 24 males (Study 2) were conducted. After responding to a trait anxiety questionnaire, participants self-administered OT or a placebo. Thereafter, provocation was manipulated by rejecting vs. accepting (Study 1) or insulting vs. accepting (Study 2) the participants by real human counterparts. Aggressive behavior was quantified by measuring how much hot sauce (Study 1) or unpleasant blasts of white noise (Study 2) participants delivered to their opponents, using two classic aggression paradigms. Both studies provided evidence that OT promotes aggression in response to provocation in low anxiety people which was not the case with no provocation or in high anxiety people. These findings confirm the idea that OT can be involved in the creation of aggressive behavior when accounting for situational and dispositional features.

## 1. Introduction

Oxytocin (OT) is both a hormone and a neurotransmitter. It targets a widespread area in the brain, including the amygdala and the hippocampus. Early OT research focused largely on its role in female reproduction. After the discovery of its influence on maternal behavior of female rats (Pedersen and Prange, 1979), researchers examined how OT affects social behavior. It was shown that OT increases social cognition (e.g., gazes to the eye region of human faces; Guastella et al., 2008) and prosocial behaviors (e.g., in-group cooperation; De Dreu et al., 2010). With findings like OT promoting non-cooperation with the out-group (De Dreu et al., 2010), even increasing envy and gloating (Shamay-Tsoory et al., 2009), it became apparent that OT plays a broader role in modulating social behaviors increasing the salience of not only positive but also negative social agents.

Beyond aggression-related effects, research has been conducted on OT and factual aggression, a behavior intended to harm others (Baron and Richardson, 1994). Both endogenous and exogenous OT have been shown to be capable of modulating aggressive behaviors in humans and animals, however, strength and even direction of effects vary (for an

excellent overview, see De Jong and Neumann, 2017). The state of research about the effect of exogenous OT on aggression in healthy individuals appears as follows: In one study, administration of OT promoted inclinations to become violent towards an intimate partner among people high in trait physical aggressiveness (DeWall et al., 2014). In this study, provocation was not manipulated but experienced by all participants in form of negative feedback and physical pain. In another study (Ne'eman et al., 2016), participants conducted a Social Orientation Paradigm which measures real-time aggressive behavior instead of behavioral tendencies by investigating the number of times participants subtract money from a fictitious partner. OT increased the rate of aggressive responses in this study. This effect was independent of provocation, i.e., it was independent of whether own points had been subtracted or not. However, all participants faced a fictitious partner who behaved both provocatively and non-provocatively, which is why the authors assumed that the paradigm was probably not suitable to produce distinct effects. Other work did not find effects of OT on aggressive behavior using a similar Point Subtraction Aggression Paradigm (Alcorn et al., 2015a). In this study, again, provocation was not manipulated but experienced by all participants in form of deducted

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points. As there was a broad range of changes in aggressive responding in this study, the authors suggested that individual differences might play a central role in moderating the effects of OT on aggression.

Indeed, OT's effects critically hinge on dispositional factors (see Bartz et al., 2011). Ne'eman et al. (2016) particularly suggested an interactive effect between anxiety, aggression and OT given the relationship between anxiety and aggression. Low trait anxiety is correlated with high aggression in rats (Veenema et al., 2007) – and OT seems to boost this relationship: In a recent animal study, OT reduced anxious behavior only in rats with low pre-fear baseline startle responses (Ayers et al., 2016). Accordingly, low levels of trait anxiety have increasingly shown to promote effects of OT in humans (Bartz et al., 2010; Pfundmair et al., 2017; Radke et al., 2013), as it has been argued that OT-induced social behaviors might first develop in safe environments (Radke et al., 2013). Individuals with low levels of trait anxiety are less focused on fearing social evaluation (Leary and Kowalski, 1997) and OT might help to increase this low compliance to social standards.

Thus, several processes seem to be in need to activate aggression in response to OT. This is in line with I<sup>3</sup> metatheory of aggression (Finkel, 2014), which argues that the likelihood of aggression (the “perfect storm”) is highest when instigation and impellance are strong and inhibition is weak. Instigation means the exposure to triggers for aggression. This is important since aggression rarely appears out of the blue. It can be triggered by alcohol, media, or even heat. The “most important single cause of human aggression” is interpersonal provocation (Anderson and Bushman, 2002, p. 37). Provocations include insults, physical aggression, but also instances of rejection that lead to hostile aggression (Anderson and Bushman, 2002). Impellance, on the other hand, prepares an individual to experience an urge to aggress; in our case, low anxiety seems to be such. And inhibition is a factor that increases the likelihood that people will override this urge; in conditions of low inhibition, e.g., under OT, aggression is more likely to occur.

Thus, prior work indicates that OT facilitates aggression after provocation in people with low levels of trait anxiety. However, previous research lacked three important points to reliably conclude this: First, the studies did not manipulate provocation. Second, they did not investigate the moderator trait anxiety. Third, they did not examine aggressive behavior embedded in real social interactions, which may cause doubts about its generalizability. The current studies aimed to explicitly address these lacks and test the hypothesis that OT increases aggression in response to provocation in people low in anxiety (not, however, after no provocation or in people high in anxiety) by conducting two experiments. In both experiments, participants first responded to a trait anxiety questionnaire. After administering OT or a placebo, provocation was manipulated by rejecting vs. accepting (Study 1) or insulting vs. accepting (Study 2) the participants by real human counterparts. Then, participants' aggressive behavior was measured by investigating how much hot sauce (Study 1) or unpleasant blasts of white noise (Study 2) they delivered to their counterparts.

## 2. Study 1

Study 1 was a first test to determine OT's influence on aggression. To measure anxiety as a trait, participants were asked to fill out an anxiety questionnaire frequently used in OT research (e.g., Alvares et al., 2012; Pfundmair et al., 2017). As rejection is a reliable source of provocation (Folger and Baron, 1996), we manipulated provocation by the highly effective Get-Acquainted Rejection Paradigm (Twenge et al., 2001). This task is embedded in a real-life social interaction in which participants get to know each other and then receive feedback that the others do or do not want to work with them. Aggression was measured using the Hot Sauce Paradigm (Lieberman et al., 1999) in which participants allocate hot sauce (proxy for aggression) to others. We predicted OT to increase aggression after provocation among people low in

anxiety but not after no provocation or among people high in anxiety. Previous research has shown that OT makes people act more favorably towards the in-group and less toward the out-group (see De Dreu and Kret, 2016). Therefore, we additionally explored if differences in the extent of aggression would occur when faced with in-group vs. out-group members. To investigate this, we added a minimal group paradigm to artificially create in- and out-groups.

### 2.1. Method

#### 2.1.1. Participants and design

Fifty-six healthy males between 18 and 66 years (mean age = 25.79, *SD* = 9.94) from a German university participated in this study that ostensibly investigated the effects of a hormone on taste for art and food. 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 hypersensitivities to preservatives in the OT spray were not allowed to take part. Participants who reported knowing the hot sauce task from previous experiments (*N* = 3) or not having understood for whom they portioned the hot sauce (*N* = 1) were excluded, resulting in the above sample. 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 study followed a 2 (substance: OT vs. placebo) × 2 (provocation: rejection vs. acceptance) between-subjects design with random and double-blind assignment to conditions; anxiety served as continuous moderator variable.

#### 2.1.2. Procedure and materials

Several days before the lab session, participants received a link to an online survey to complete a trait anxiety questionnaire. They responded to the Trait Anxiety Inventory (Laux et al., 1981) which measures a person's general anxiety level independent of context. All 20 items (e.g., “I become nervous and restless when I think of my current issues”) were answered by 1 = *almost never* to 4 = *almost always* response scales ( $\alpha$  = 0.89). Three participants failed to complete this pre-questionnaire.

In each of the following lab sessions, three male participants, one female experimenter and one male or female assistant, who prevented the participants from talking to each other, took part at once; medical attendance was assured. When participants arrived at the lab, written informed consent was obtained. Participants were informed about possible side effects of the spray they would administer, however, remained uninformed about its content; they were only told that they would receive either a hormone or a placebo in low dosage. Following standard procedures (e.g., Ne'eman et al., 2016; Radke et al., 2013), participants intranasally self-administered 24 I.U. (three puffs per nostril) of OT (Syntocinon Spray, Defiante) or a placebo (sodium chloride solution) under experimenter supervision.

Subsequently, they underwent a minimal group paradigm based on procedures by Cadinu and Rothbart (1996), which was framed as an artistic taste task. Participants were presented with 10 pairs of paintings on a computer display. Each pair contained one painting by Heckel and one painting by Pechstein. For each of the 10 pairs, participants were asked to indicate which of the two pictures they preferred. Next, as part of the rejection paradigm (Twenge et al., 2001), participants were individually filmed during a brief interview about their taste, the footage was watched in the group, and participants were asked to write down secretly with whom they would like to work in the following task. By this time, 40 min had passed. Then, the experimenter guided each participant individually into a separate room. There, she explained to the participant that he was assigned to the Pechstein group due to his artistic taste. Participants were then exposed to the provocation manipulation. Participants assigned to the rejection condition were told

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