



Vasopressin, but not oxytocin, increases empathic concern among individuals who received higher levels of paternal warmth: A randomized controlled trial

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Summary

Background: Empathy improves our ability to communicate in social interactions and motivates prosocial behavior. The neuropeptides arginine vasopressin and oxytocin play key roles in socioemotional processes such as pair bonding and parental care, which suggests that they may be involved in empathic processing.

Methods: We investigated how vasopressin and oxytocin affect empathic responding in a randomized, double-blind, placebo controlled, between-subjects study design. We also examined the moderating role of parental warmth, as reported in the early family environment, on empathic responding following vasopressin, oxytocin, or placebo administration.

Results: Among participants who reported higher levels of paternal warmth (but not maternal warmth), vasopressin (vs. placebo and oxytocin) increased ratings of empathic concern after viewing distressing and uplifting videos. No main or interaction effects were found for individuals who received oxytocin.

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Conclusions: Vasopressin has a role in enhancing empathy among individuals who received higher levels of paternal warmth.

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Empathy improves our ability to communicate in social interactions and motivates prosocial behavior (Batson et al., 1987, 1988). While a great deal of psychological research has shown the social importance of empathy, far less is known about the neurobiological processes that influence empathy. Recent research has examined the role of the neuropeptide oxytocin (OT) in empathy due to its involvement in many socioemotional processes (Bartz et al., 2011). Studies investigating the effects of OT on empathy in healthy individuals have produced mixed results. Initial evidence suggested no effect (Singer et al., 2008), but more recent work has shown that empathy does increase following OT administration (Abu-Akel et al., 2014; Shamay-Tsoory et al., 2013). Other studies suggest that OT may influence specific components of empathy (Hurlemann et al., 2010; Theodoridou et al., 2013) and that the effect of OT on empathy may be moderated by individual differences (Bartz et al., 2010a,b).

Less work has explored the role of the neuropeptide arginine vasopressin (AVP; which is structurally similar to OT and diverges by two amino acids; Gimpl and Fahrenholz, 2001) in empathy. In addition to AVP's function in vasoconstriction and water retention, AVP plays a key role in pair bond formation, parental care, and social approach in a variety of species (Goodson, 2013; Lim and Young, 2006) and thus may influence empathic responses. In a recent study of the social monogamous coppery titti monkey, AVP V1a receptor binding was wide-spread throughout the brain, including the cingulate and insular cortices (Freeman et al., 2014a,b), which are implicated in emotional empathy (Shamay-Tsoory, 2011). Additionally, in monogamous male prairie voles, an AVP V1a receptor antagonist reduced affiliative and attachment behavior (Winslow et al., 1993). In humans, variation in the AVP V1a receptor gene has been associated with prosociality (Avinun et al., 2011; Knafo et al., 2008), including partner bonding in married couples (Walum et al., 2008). Variation in AVP V1a receptors has also been associated with autism spectrum disorders, a neurodevelopmental disorder characterized by social impairments including deficits in empathy (Kim et al., 2002; Wassink et al., 2004; Yirmiya et al., 2006). In addition, studies of heterosexual couples have found positive associations between plasma AVP and indices of positive relationship functioning as well as decreased negative communication behaviors (Gouin et al., 2010, 2012, but see Taylor et al., 2010).

Although AVP is hypothesized to contribute to the neurobiological mechanisms underlying empathy, little experimental research in humans has examined the effect of AVP on empathic responding. Empathy is typically decomposed into two components: (1) cognitive empathy, which refers to the ability to understand others' thoughts and to take their perspective and (2) emotional or affective empathy, which consists of empathic concern, or feelings of concern and warmth toward others, along with personal distress that involves experiencing stress and anxiety as a

result of another's suffering (Batson et al., 1987; Shamay-Tsoory, 2011). Although research has shown that AVP does not seem to improve cognitive empathy (Kenyon et al., 2013; Uzefovsky et al., 2012), less work has examined affective empathy. Given that empathic concern, one component of affective empathy, is the primary motivator of prosocial behavior (Batson et al., 1988, 1987) and that multiple studies have shown that AVP increases human prosocial behavior (Rilling et al., 2012, 2014), AVP may have specific effects on empathic concern.

Another factor that may be important to consider in understanding the effect of AVP and OT on empathic concern is the role of the early environment. For example, research on OT has shown that its effects on human prosociality are sensitive to early environmental factors. Recent studies have demonstrated that the early family environment, and specifically a positive family environment, appears to make people more susceptible to OT's effects on prosocial behavior often motivated by empathy (Riem et al., 2013; Van IJzendoorn et al., 2011). For example, in an all female sample, Van IJzendoorn et al. (2011) found that OT increased charitable giving, but only among those who reported having more supportive parents.

Given the role of AVP and OT in socioemotional processing, and recent findings demonstrating that positive early family environments may increase susceptibility to the effects of OT on prosociality (e.g., Riem et al., 2013; Van IJzendoorn et al., 2011), we investigated the interaction between drug condition (AVP, OT, and placebo) and an aspect of the family environment that has been shown to affect empathy development: reported experiences of parental warmth (Zhou et al., 2002). In addition, based on previous studies demonstrating sexually dimorphic effects of AVP and OT (Rilling et al., 2012, 2014; Thompson et al., 2006), we included a sample of women and men. We hypothesized that AVP and OT would increase empathic concern compared to placebo, but only among individuals who received higher levels of parental warmth.

1. Materials and methods

1.1. Participants

Participants were 125 undergraduate students from the University of California, Los Angeles (90 female, age range = 18–31 years, Mean age = 20.88, $SD = 2.71$). They were randomly assigned to receive intranasal AVP ($n = 42$; 30 female, 12 male), OT ($n = 42$; 30 female, 12 male) or placebo ($n = 41$; 30 female, 11 male). Exclusion criteria included current allergies or cold symptoms as well as present or history of heart disease, hypertension, myocardial infarction, cardiac arrhythmia, kidney or liver disease, vascular disease, epilepsy, migraine, asthma, nephritis, diabetes or another

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