Does Oxytocin increase trust in humans, and if so, when?

A short summary of the preregistered replication study

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What makes us trust another person? More than a decade ago, a seminal paper was published in *Nature* showing that oxytocin, a hormone which is better known for its role in childbirth and breastfeeding, increased men's trusting behavior in an economic game. A surge of behavioral studies on the social functions of oxytocin followed, which may in part also have been inspired by the relative ease with which oxytocin can be intranasally administered to humans. However, together these studies raised more questions than they answered, as findings were eclectic, inconsistent and sometimes conflicting, clouding the oxytocin-trust link with confusion. All too often, follow-up experiments suffered from small sample sizes, or they were not true replications in the sense that the researchers did not use the same methods and procedures as in the original study they set out to repeat. This is very important because small changes in the experimental setting can have a large impact on how oxytocin works and hence on how it will affect behavior. For example, behavioral economic experiments are typically conducted in a completely anonymous setting in order to reduce the possibility that the results would be influenced by incidental likings. But if we want to understand the *social* functions of oxytocin, such anonymity may be problematic.

To resolve these issues, we tested, with a large sample size, if oxytocin increases trust in both an anonymous and a minimal social contact condition. In the former, all participants in the experiment sat in private cubicles and never met, while in the latter, they first met in small groups of eight and were seated at the same table prior to the actual experiment (a condition similar to the original experiment that first reported the relation between trust and oxytocin). When seated at the table they could see each other and could, in principle, also talk to each other. While seated they filled out several questionnaires. Our main hypothesis, which was pre-registered in *Nature Human Behaviour* before conducting the study, was that the increase in trust induced by oxytocin would be higher in the minimal social contact condition.

We collected data on 677 males in Magdeburg, Germany, and Antwerp, Belgium. This sample size exceeds the minimal requirement to be able to observe a statistically significant effect of oxytocin (based on previously reported effect sizes). Because we cannot be sure that oxytocin affects men and women alike, we tested only males. Half of the participants in the study received a nasal spray containing 24 IU of oxytocin, while the other half received an identical spray containing a saline solution (the placebo condition). Trusting behavior was assessed with the well-known trust game – a sequentially played game in which the first-mover can earn substantial amounts by transferring money to another person. But at the same time, they can also lose everything when this person is untrustworthy and does not reciprocate a transfer. Although players never knew the precise identity of their interaction

partners, in the minimal social contact condition, they were told that they were playing the game with one of the other seven people they had just met. We presumed that this prior experience would provide sufficient positive social cues, and that oxytocin would enhance the salience of these cues so that trust would be facilitated.

But in fact, the results did not corroborate the main hypothesis that oxytocin (as opposed to a placebo) increases trusting behaviour in the social contact condition. If anything, the social contact condition may have opposed the hypothesized effect of oxytocin, as questionnaire data collected immediately after the experiment indicated that the prior shared experience may have reduced feelings of connectedness between participants, and hence generated negative social cues rather than the intended positive ones. Connectedness was reported to be greater in the anonymous condition, where oxytocin (relative to placebo) appeared to have increased trusting behaviour, but only for those participants who had low dispositional trust to begin with (i.e., those who scored low on a questionnaire collected two weeks prior to the experiment that assessed the participants' intrinsic disposition to trust).

So, the question – does oxytocin increase trust – does not have a simple answer. What the data in our study first and foremost show is that the answer is "no" if we are forced to generalize across all people in all situations. Our data does suggest that oxytocin may facilitate trust for those men who have a generally low disposition to trust, at least in situations where they do not perceive negative social cues. In retrospect, this may sound like a natural result, but it was not anticipated, and therefore should still be treated with caution.

This study points to yet another conclusion, namely how difficult it is to conduct and interpret behavioural data from hormone-administration experiments. Based on our experience, we can make the following recommendations for future research on the social functions of oxytocin: first, to avoid overinterpreting fortuitous findings, studies should be preregistered with explicitly formulated hypotheses and statistical tests to examine these hypotheses, including an ex-ante power analyses of the sample size. Only then will we also be able to properly assess the meaning and credibility of the results including possible null findings. Second, focusing on relevant individual differences can create high additional value. For example, targeting individuals with low dispositional trust or other social deficits will not only avoid ceiling effects, but potentially uncover promising clinical effects, provided that the hypotheses are pre-registered.

Third, experimenters should be vigilant regarding any contextual cues that either facilitate or hamper approach behaviour, as these cues may inadvertently change the direction of oxytocin's effect. Related to this, there is a growing need to assess how these cues are perceived by different people in order to get a grip on how context, individual differences and oxytocin interact in concert. Fourth, researchers who are interested in conducting oxytocin administration studies should be well-aware of the workload involved in designing a sufficiently large experiment that pays attention to the tedious details regarding context and individual differences. Finally, we do not sufficiently understand how, why and when oxytocin works in order to make accurate predictions. Publications reporting some effect of oxytocin proliferate, but many of them provide only fuzzy reasons as to why. Therefore,

empirically grounded theory development on how oxytocin may affect social behaviour in humans is crucial. This will require interdisciplinary work (in humans and animals alike) that includes, more fine-grained investigations on (for example) how oxytocin-related brain activity is triggered in response to different environmental stimuli and cues. Taken together, we believe that these suggestions may help to improve future research on the effects of oxytocin.

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