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INCREASES BOTH PAROCHIAL AND
UNIVERSAL ALTRUISM**

By

**SALOMON ISRAEL, ORI WEISEL, RICHARD P.
EBSTEIN and GARY BORNSTEIN**

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**CENTER FOR THE STUDY
OF RATIONALITY**

Feldman Building, Givat-Ram, 91904 Jerusalem, Israel
PHONE: [972]-2-6584135 FAX: [972]-2-6513681

E-MAIL: ratio@math.huji.ac.il

URL: <http://www.ratio.huji.ac.il/>

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Oxytocin, but not Vasopressin, Increases both Parochial and Universal Altruism

Salomon Israel*¹, Ori Weisel^{1,2}, Richard P. Ebstein³, and Gary Bornstein¹

¹Department of Psychology and Center for the Study of Rationality, Hebrew University, Jerusalem, 91501, Israel, ²Max Planck Institute of Economics, Jena, Germany ³Department of Psychology, National University of Singapore, Singapore

*Corresponding Author

Salomon Israel
Department of Psychology
Hebrew University
Jerusalem 91905
ISRAEL
Tel: 972-52-4789754
Fax: 972-2-6516677

salomon.israel@mail.huji.ac.il

Abstract

In today's increasingly interconnected world, deciding with whom and at what level to cooperate becomes a matter of increasing importance as societies become more globalized and large-scale cooperation becomes a viable means of addressing global issues. This tension can play out via competition between local (e.g. within a group) and global (e.g., between groups) interests. Despite research highlighting factors influencing cooperation in such multi-layered situations, their biological basis is not well understood. In a double-blind placebo controlled study, we investigated the influence of intranasally administered oxytocin and arginine vasopressin on cooperative behavior at local and global levels. We find that oxytocin causes an increase in both the willingness to cooperate and the expectation that others will cooperate at both levels. In contrast, participants receiving vasopressin did not differ from those receiving placebo in their cooperative behavior. Our results highlight the selective role of oxytocin in intergroup cooperative behavior.

key words: altruism, oxytocin, vasopressin, intergroup cooperation, nested social dilemma

Introduction

Some collective action problems (Olson 1994), such as global warming and the overuse of natural resources, affect all people and require cooperation at a global scale. Other problems, such as the preservation and maintenance of nature reserves are more local – affecting the members of a specific group and requiring cooperation at the intra-group level. Often global and local problems coexist, compelling individual group members to decide between cooperating with one's own group, cooperating with the larger collective, or not cooperating at all (i.e., acting selfishly). Despite evidence exemplifying mankind's willingness to confront collective action problems at both local and global scales (Dietz, Ostrom et al. 2003), the mechanisms guiding cooperation in such multi-level dilemmas are not well understood. This paper focuses on the role of social hormones in regulating decisions in these complex, yet common, social dilemmas.

Converging lines of evidence have highlighted the neuropeptides oxytocin (OT) and arginine vasopressin (AVP) as modulators of social behavior (Meyer-Lindenberg, Domes et al. 2011). Acting in the brain as neurohormones or neuromodulators, OT and AVP modulate the integration of excitatory information for several elements of the social brain as well as interact with the mesolimbic reward pathway to regulate dopaminergic circuits for reward (Ludwig and Leng 2006). While several experiments have demonstrated that OT increases interpersonal trust and cooperation (Kosfeld, Heinrichs et al. 2005; Baumgartner, Heinrichs et al. 2008; Mikolajczak, Gross et al. 2010), recent studies have suggested that the effects of OT may be limited by group boundaries, stimulating defensive aggression and derogation against outgroups (De Dreu, Greer et al. 2010; De Dreu, Greer et al. 2011). OT may foster parochial altruism – altruistic behavior towards members of one's own group only, or motivate universal altruism – a more generalized increase in interpersonal trust and cooperation extending to all. Similarly, while others have observed that intranasal AVP administration increases reciprocal cooperation (Rilling, DeMarco et al. 2011), its influence in intergroup dilemmas remains an open question.

We investigated the effects of OT and AVP on local and global cooperation by employing a double-blind placebo controlled design where participants first self-administered OT, AVP or placebo and then made costly decisions in the framework of a nested social dilemma (Wit and Kerr 2002; Buchan, Grimalda et al. 2009). In our laboratory setting, as in the reality that it models, one must juggle the tradeoff between personal, local, and global interests. Not contributing best serves the individual interest. Contributing to the local interest provides a smaller return for the individual, but increases the total benefit to the ingroup, and contributing to the global interest provides an even smaller payoff to the self, but produces the highest overall welfare.

Materials and Method

Ninety-six male students (mean age 25.48, SD 2.66) participated in one of 8 experimental sessions. Participants arrived at the laboratory in cohorts of 12 and were randomly assigned to one of four 3-person groups. For the duration of each experimental session, participants were seated at laboratory workstations arranged in a circle with dividers between adjacent workstations and were instructed not to interact with each other. Participants received OT (Syntocinon spray, 24 IU, Novartis), AVP (20 IU, American Regent) or placebo. Drug treatment was randomly determined and administered 40 minutes prior to explanation of the nested social dilemma and decision making.

The study protocol was approved by the Hebrew University ethics committee and the Israel Ministry of Health. All participants signed written consent forms acknowledging their participation. OT, AVP, and placebo were prepared by the Shor-Tabachnik Pharmacy, Tel Aviv, Israel. All three treatments were prepared in identical puffers. Placebo was prepared based on the ingredients of the Syntocinon vehicle, and included di-sodium hydrogen phosphate, citric acid, sodium chloride, glycerin, benzalkonium chloride, and aqua bidest. AVP was prepared by adding benzalkonium chloride (as a preservative) to the AVP 20 IU/ml solution. OT was prepared by diluting 40 IU/ml Syntocinon in the placebo solution to make 24 IU/ml OT. All three solutions had equivalent pH levels. Rather than including two distinct placebo conditions to compare separately to each hormone, we included only one placebo that was based on the OT vehicle and compared it to both, acknowledging that this might call into question the matching of placebo to AVP. Since we cannot rule out this possibility, our results regarding AVP will hold to the extent that the placebo we used would not differ from one based on the AVP vehicle. Participants were asked to guess which substance they received - hormone or placebo, and if they indicated that they received a hormone, to guess which (OT or AVP) – and were unable to differentiate (all p values > 0.8). Selection criteria stipulated that subjects were < 35 years old, had no history of psychiatric or endocrine illness (by self-report), smoked less than 15 cigarettes a day, and were not taking any prescription medications that might interact with OT or AVP. Participants were instructed to refrain from smoking, eating, or drinking (except water) for 2 hours before the experiment.

Before substance administration, participants completed a short visual-analog scale assessing working capacity, tiredness, sadness, anxiety, talking capacity, interpersonal closeness, and concentration. Following substance administration participants were randomly assigned to one of four 3-person groups labeled ‘circles’, ‘squares’, ‘triangles’, or ‘diamonds’, and waited (while reading a magazine) for about 40 minutes, in order for the hormones to exert their full effect (Born, Lange et al. 2002). Participants were only informed about their own group assignment, and therefore were not aware which of their co-participants were fellow group members or members of other groups. Afterwards, instructions for the nested-social-dilemma were read, and, following successful completion of a quiz to test understanding of the game, participants anonymously decided on allocations to the 3 accounts. All parts of the experimental protocol – intranasal administration, group assignment, waiting period, and decision tasks – were performed simultaneously by all 12 participants. The instructions were phrased in neutral language with no reference to cooperation or competition and presented the payoff to each participant as a function of their own decision and the decisions of other participants.

After receiving an initial endowment of 10 tokens, participants allocated resources between individual, local, and global accounts. Each token allocated to the individual account provided the investor with 6 New Israeli Shekels (NIS) and had no effect on other participants; each token allocated to the local account provided each ingroup member (including the investor) with 3 NIS, and had no effect on outgroup members; and each token allocated to the global account provided each of the 12 participants with 1 NIS (See Figure 1). After deciding on their own allocation, but before receiving any feedback, participants estimated the allocations of others (separately for ingroup and outgroup members).

To check for changes in psychological state during the experiment, after making their decisions, participants answered the same visual-analog scale which they completed before hormone

administration. There were no statistical differences in visual analog scale measures between OT, AVP, or placebo conditions (all p values >0.5).

Results

Our data reveal that OT has a considerable influence on contribution levels to both local and global accounts (see Figure 2). On average, participants receiving OT contributed about twice as much, compared to placebo, to both the local (Mann-Whitney U-test; $z=-2.545$, $p=0.011$, two-sided) and global accounts ($z=-2.100$, $p=0.036$, two-sided). Of the 32 participants in the OT condition, only 6 (19%) were completely selfish, keeping all 10 tokens for themselves and 15 (47%) contributed at least half of their tokens (to the local or global accounts). In contrast, in the placebo condition, 16 participants (50%) kept the entire endowment and only 7 (22%) elected to contribute at least half of their endowment. For both accounts, contribution in the AVP condition did not significantly differ from placebo (local $z=-0.589$, $p=0.556$, global $z=-0.462$, $p=0.644$).

The effects of OT extended to estimates of others' behavior as well. As compared to placebo, participants receiving OT estimated others would contribute more to both local (difference is marginally significant; Mann-Whitney U-test, one-sided; $z=-1.399$, $p=0.081$) and global accounts ($z=-2.614$, $p=0.005$).¹ Furthermore, the overall contributions of participants receiving OT were not different than their estimates of others' contributions (Repeated measures [total contribution X ingroup estimate X outgroups estimate] ($F(2,62)$, $p>0.5$ Huynh-Feldt corrected), whereas participants receiving placebo or AVP contributed less than what they estimated others to contribute (placebo: $F(2,62)$ $p=0.027$; AVP: $F(2,62)$, $p=0.019$).

Discussion

A recent meta-analysis investigating the effects of OT on intergroup trust concluded that OT administration enhances ingroup trust but does not decrease outgroup trust (Van IJzendoorn and Bakermans-Kranenburg 2011). The studies reviewed in the meta-analysis, most notably De Dreu et al. (2010), and De Dreu et al., (2011), were set in contexts of intergroup *competition*. While consistent with this finding, our results demonstrate that when set in a context of intergroup *cooperation* OT not only improves contributions to the ingroup, but also increases contribution rates to the collective interest of all groups. These results suggest that group-oriented prosocial effects of OT may be sensitive to contextual cues, which may differ depending on the inherent structure of the social dilemma. Importantly, these prosocial effects do not extend to AVP, suggesting an OT specific neuropeptide influence on cooperative intergroup behavior.

Additionally, within the framework of our nested social dilemma, participants receiving OT were not only more willing to give to others, but they also expected that others would reciprocate their cooperative behavior. This effect is supported by the positive effect of OT on the expectation that

¹ Comparison based on averaged estimates of ingroup and outgroup contributions, which were not statistically different ($p>0.5$).

others would contribute to both local and global interests, and by the closer pairing of expectations to behavior in the OT condition only.

We examined cooperation in a nested social dilemma under the controlled structure of the laboratory environment, using artificial groups. A natural extension would be to examine the effects of OT and AVP on behavior in more realistic intergroup settings. Decisions can have real world consequences (Barraza, McCullough et al. 2011; Van IJzendoorn, Huffmeijer et al. 2011), and participants can belong to meaningful groups, possibly with a history of conflict (Hein, Silani et al. 2010). Additionally, our report focused on the effects of intranasal OT and AVP on males only, to avoid the potential confounds of gender and female hormonal influences. However, several studies on both animals and humans have observed that the effects of oxytocin and vasopressin on social behavior may be sexually dimorphic (Thompson, George et al. 2006; Donaldson and Young 2008; Meyer-Lindenberg, Domes et al. 2011), so it is clearly of considerable interest to examine the effects of intranasal administration of OT and AVP on intergroup cooperation in females as well.

In today's increasingly interconnected world, deciding with whom and at what level to cooperate is a matter of increasing importance as large-scale cooperation often comes at the expense of cooperating at the local level and vice versa (Dietz, Ostrom et al. 2003). The current study helps to delineate the behavioral effects of OT and AVP in these types of social dilemmas, and provides additional evidence for the positive effects of OT in facilitating cooperative behavior, both within and across groups.

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Figures

Figure 1

The nested social dilemma: Each individual (I) is given 10 tokens and allocates them between personal (dotted line), local (dashed line), or global (solid line) accounts. The three numbers in brackets (x,y,z) indicate the per-token-return to the individual making the allocation (x), to each of his group members (y), and to the members of the other groups (z). A token allotted to the personal account yields 6 NIS (New Israeli Shekels) to I and has no effect on anyone else. A token allotted to the local account yields 3 NIS each to members of I's group (including I). A token allotted to the global account yields 1 NIS each to all members of all groups.

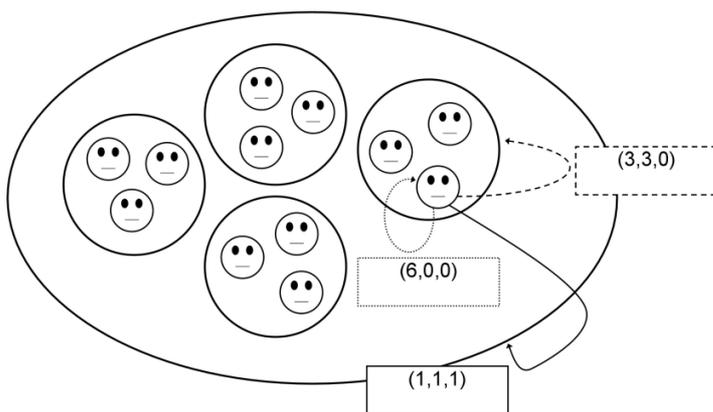


Figure 2

Financial contributions made to local (parochial) and global (universal) accounts in the nested social dilemma. Error bars represent standard error of the mean. Contribution amounts were as follows; Local account: placebo M = 1.15, SD = 1.59 ; oxytocin M = 2.34, SD = 2.13 ; vasopressin M = 1.38, SD = 1.48. Global account: placebo M = 0.97, SD 1.94 ; oxytocin M = 1.78, SD = 2.37, vasopressin M = 1.50, SD = 2.57. ‘*’ denotes significance at the $p < 0.05$ level.

