Figures and figure supplements

Oxytocin promotes coordinated out-group attack during intergroup conflict in humans

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Data from 480 participants (80 sessions) were included in the formal data analysis.

**Mood measurement**
- Positive and Negative Affect Scale

**Personality traits**
- Empathic capacity
- Cooperative personality
- Social value orientation
- Prosocial personality
- Impulsiveness
- Socio-economic status

**Double-blind, Placebo-controlled between-subjects**

- **24 IU Oxytocin**
  - 40 sessions
  - 240 participants

- **24 IU Placebo**
  - 40 sessions
  - 240 participants

- Rest and read the introduction of the game
- 35 minutes

- 15 rounds of simultaneous protocol
- The order of two protocols was counterbalanced between 80 sessions.

- 15 rounds of sequential protocol

**Mood measurement**
- Positive and Negative Affect Scale

**Manipulation check**

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**Figure 1.** General experimental procedure.
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Figure 2. Illustration of one round of the IADC game in the simultaneous and sequential decision-making blocks, respectively.

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Figure 3. Oxytocin modulates contributions to group fighting. (A) Attackers contribute less than defenders, especially in early rounds (range 0–20). Curves were smoothed with a moving average window of three investment rounds. (B) Giving individuals oxytocin rather than placebo increases the number of non-contributing members in attacker groups especially under simultaneous decision-making (with 0–3 members per round across 15 rounds; range 0–45; displayed M ± 1 SE). Connectors indicate significant difference, with *p<0.05.

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Figure 4. Response time for decisions to (not) contribute. Oxytocin increased the speed with which attackers made their decisions to not contribute. Connectors indicate significant difference, with *p<0.05.

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Figure 5. Oxytocin modulates within-group coordination. (A) Giving individuals oxytocin rather than placebo enables better coordination (lower within-group variance) in attacker groups, especially in early rounds. Curves were smoothed with a moving average window of three investment rounds. (B/C) Giving attackers oxytocin rather than placebo increases their leftovers when not winning the conflict (B) and spoils from winning conflicts (C) (N = 76 because four attacker groups never won). (D) Bootstrapping illustration of the oxytocin shifts on the contribution and payment. Bivariate distributions of 1000 bootstrapped sample means for each condition (Treatment x Procedure) plotted against the contribution and payment. (E) Oxytocin increased non-contributing attackers only in failed attacks but not in successful attacks. Connectors indicate significant difference, with † p < 0.10; *p < 0.05; **p < 0.01.

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Figure 5—figure supplement 1. Oxytocin increases attacker group’s within-group coordination especially in the simultaneous decision-making block. Connectors indicate significant difference, with *p<0.05, ***p<0.001.
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Figure 6. Oxytocin enables a track-and-attack strategy (strength of attack increases when defender groups are vulnerable rather than strong, as indicated by $\alpha \rightarrow -1$). (A) When attacker groups are given oxytocin investments regress negatively on $\alpha$ (the rival’s historical investments to defense). Figure 6 continued on next page.
especially during simultaneous than sequential decision-making. (B) Stronger negative regression of attack on rival’s defense history (α → −1) among attacker groups associates with better coordination (i.e. lower within-group variance). (C) Better coordination (i.e. lower within-group variance) associates with higher spoils when winning the conflict. (D) Oxytocin’s effect on spoils from successful attacks is mediated by treatment effects on tracking α (more strategic when α → −1) and better within-group coordination. † p < 0.10; * p < 0.05; ** p < 0.010).
Figure 6—figure supplement 1. Oxytocin influences payment through its effects on strategic tracking and better within-group coordination. (A) Better coordination (i.e. lower within-group variance) associates with higher spoils and leftovers. (B) Oxytocin’s effect on attacker groups’ spoils from successful attacks and leftovers from attack failure is mediated by treatment effects on tracking and better within-group coordination. Significant pathways were highlighted in bold. (* p < 0.05; ** p < 0.01).
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