

## Supplementary Information

### Effects of intranasal oxytocin administration on empathy and approach motivation in women with borderline personality disorder – a randomized trial

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### Supplemental Methods

#### Sample size estimation

Total sample size was estimated based on previously reported medium effect sizes of oxytocin on socio-affective cognition. Based on a medium effect size of  $f=.30$  (equivalent  $\eta_{\text{part}}^2=.08$ ),  $\alpha=.05$  and a power of  $1-\beta=.80$  a priori sample size calculation with GPower<sup>1</sup> revealed an appropriate size of at least  $N=92$ .

#### Questionnaires

All participants completed the following psychopathological measures: the Borderline Symptom List <sup>2</sup>, the German adaption of the Dissociative Experience Scale <sup>3</sup>, the Brief Symptom Inventory <sup>4</sup>, the

Beck Depression Inventory <sup>5</sup>, the Childhood Trauma Questionnaire <sup>6</sup>, the Social Interaction and Anxiety Scale <sup>7</sup>, the State-Trait Anxiety Inventory <sup>8</sup> and the State-Trait-Anger Expression Inventory <sup>9</sup>.

To control for non-specific drug effects, we collected the following state measures: mood, using the Multimodal Mood Questionnaire <sup>10</sup>, anxiety using the State-Trait-Anxiety-Inventory <sup>8</sup>, anger using the State-Trait-Anger-Inventory <sup>9</sup>

## Supplemental Results

**Table S1.** Descriptive data on cognitive and affective empathy, and approach motivation in patients with Borderline PD and healthy controls treated with oxytocin (OT) or placebo (PLA).

	Healthy controls		Borderline PD	
	PLA	OT	PLA	OT
Cognitive empathy, mean (SD)				
All stimuli	20.62 (3.28)	21.56 (3.07)	19.38 (4.12)	19.56 (3.16)
Positive stimuli	10.23 (1.84)	10.28 (1.59)	9.15 (2.09)	9.24 (1.94)
Negative stimuli	10.38 (2.12)	11.28 (2.17)	10.23 (2.64)	10.32 (1.86)
Affective empathy, mean (SD)				
All stimuli	5.98 (1.19)	6.22 (1.21)	4.43 (1.74)	5.59 (1.67)
Positive stimuli	6.42 (1.42)	6.95 (0.95)	4.11 (1.77)	4.98 (1.74)
Negative stimuli	5.64 (1.51)	5.66 (1.81)	4.67 (2.04)	6.06 (1.56)
Approach motivation, mean (SD)				
All stimuli	5.10 (1.00)	5.27 (1.28)	3.66 (1.62)	5.01 (1.33)
Positive stimuli	6.05 (1.40)	6.63 (1.12)	4.24 (1.88)	5.35 (1.57)
Negative stimuli	4.36 (1.49)	4.25 (1.93)	3.20 (2.07)	4.75 (1.87)

### Non-specific drug effects

To control for non-specific drug effects, we collected the following measures: mood, using the Multimodal Mood Questionnaire (MBDF, Steyer, Schwenkmezger, Notz, & Eid, 1997), anxiety using the State-Trait-Anxiety-Inventory (STAI; Laux, Glanzmann, Schaffner, & Spielberger, 1981), anger using the State-Trait-Anger-Inventory (STAXI; Schwenkmezger, Hodapp, & Spielberger, 1992) and distress with a visual analog scale (VAS) at three times during the time-course of the experiment: before drug application ( $t_1$ ), shortly before the experiment ( $t_2$ ) and directly after the experiment ( $t_3$ ). Descriptive statistics can be found in table S2.

**Table S2.** Scores for mood, anxiety, anger and distress (MDBF and VAS scores) in patients with borderline personality disorder (BPD) and healthy controls (HC) treated with oxytocin (OT) or placebo (PLA).

	HC		BPD	
	PLA (n=)	OT	PLA	OT
Pre-application ( $t_1$ ) mean (SD)				
Mood (MDBF 5-20)	15.42 (1.65)	15.60 (2.02)	8.96 (3.49)	9.72 (3.70)
Anxiety (STAI-State 20-80)	28.69 (11.12)	34.28 (7.28)	54.69 (14.12)	52.12 (14.91)
Anger (STAXI-State 4-40)	9.50 (2.69)	10.24 (0.66)	14.35 (5.50)	14.40 (6.39)
Distress (VAS 0-500)	59.77 (54.04)	51.04 (34.55)	210.54 (125.57)	213.28 (143.13)
Post-application ( $t_2$ ), mean (SD)				
Mood (MDBF 5-20)	15.12 (2.01)	15.40 (2.25)	10.15 (3.70)	9.80 (3.61)
Anxiety (STAI-State 20-80)	32.38 (6.39)	30.08 (5.56)	48.15 (11.08)	48.84 (11.00)
Anger (STAXI-State 4-40)	10.38 (0.98)	10.16 (0.55)	13.00 (4.64)	12.36 (4.37)
Distress (VAS 0-500)	52.92 (73.92)	27.80 (29.28)	150.23 (105.12)	174.00 (138.40)
Post-experiment ( $t_3$ ), mean (SD)				
Mood (MDBF 5-20)	15.96 (1.43)	16.48 (1.58)	11.15 (4.16)	11.24 (2.89)
Anxiety (STAI-State 20-80)	30.88 (4.57)	28.72 (5.10)	47.50 (11.27)	46.72 (8.95)
Anger (STAXI-State 4-40)	10.08 (0.39)	10.12 (0.33)	12.58 (4.55)	11.92 (4.31)
Distress (VAS 0-500)	42.85 (53.10)	24.28 (32.03)	161.15 (118.25)	169.12 (136.81)

We first conducted a two-way ANOVA to control for differences at baseline level. The factor group showed a significant main effect for all variables: mood ( $F_{(1, 98)} = 118.9, p < .001, \eta^2 = .548$ ), anxiety ( $F_{(1, 99)} = 81.8, p < .001, \eta^2 = .455$ ), anger ( $F_{(1, 99)} = 26.3, p < .001, \eta^2 = .212$ ) and distress ( $F_{(1, 99)} = 61.8, p < .001, \eta^2 = .387$ ). BPD patients revealed significantly lower values for mood and significantly higher values for anxiety, anger, and distress.

To further analyze changes in these measures along the time-course, we conducted a three-way ANOVA with repeated measures (time). We identified significant main effects of time on the variables mood ( $F_{(2, 196)} = 16.4, p < .001, \eta^2 = .143$ ), anxiety ( $F_{(1.4, 141.5)} = 6.65, p = .005, \eta^2 = .064$ ), and distress ( $F_{(1.6, 161.1)} = 7.42, p = .001, \eta^2 = .070$ ). The time effect for anger was not significant ( $F_{(1.2, 119.7)} = 3.48, p = .056, \eta^2 = .034$ ). Values for mood increased over time, whereas anxiety and stress decreased over time.

We observed no main effect of drug and no interaction of drug with either group or time. Thus, OT exerted no nonspecific effects on the measures, and the changes over the time course did not significantly differ between the BPD and HC group or between the OT and placebo condition.

### Supplemental References

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