Supplemental Material

Oxytocin Increases Eye-Gaze towards Novel Social and Non-Social Stimuli.

**Monika Eckstein1\*, Vera Bamert1\*, Shannon Stephens2, Kim Wallen3, Larry J. Young4, Ulrike Ehlert5, and Beate Ditzen1,#**

**Supplemental Methods**

The experiment was created and presented using the software Experiment Center (as part of the package Experiment Suite 360°; SensoMotoric Instruments (SMI), Teltow, Germany). All stimuli were scaled to a 3 to 4 or 4 to 3 (1680 × 1050 px) size and presented on a black frame. Partial data analysis and the definition of Areas of Interest (AOI) were performed employing BeGaze(SMI).

Pupil dilation and fixation patterns were recorded using a Remote Eye Tracking Device (RED; SMI). This contact-free eye tracking system functions as an external device, which records pupillometric data through an integrated infrared sensor at a rate of 60 Hz < 17ms (gaze position accuracy 0.4°; tracking resolution 0.03°). The stimuli were presented on a 22“ computer monitor positioned in 60 cm distance to the participant (Latitude E6520, Dell, Round Rock, Texas). Simple processing of the data was carried out by means of an additional laptop (Lenovo, Morrisvielle, USA) with iVieW X software (SMI).

The photographs with parent-child interactions displayed daily interactions, in which the social actors expressed their affection (e.g. smiling at each other, playing together, caressing, touching each other). Images of the attachment subgroup portrayed signs of affection in human interaction between heterosexual couples (e.g. intense eye contact, touching, kissing). Erotic pictures contained scenes, in which the actors were scantily dressed without visibility of their genitals. In the sexual stimuli category, the couple engaged in explicit sexual acts. The stimulus material partly originated from Rupp and Wallen (2007) and additional photographs available for free online. The experimental trial consisted of 5 blocks, which were always presented in the same order: 1. pre-testing, 2. attachment and parent-child, 3. neutral, 4. erotic and sex, 5. validation (see figure 1b). The order of the images within the blocks was randomized.

Each eye tracking session began with a short instruction and standard routine of calibration. Participants were instructed to avoid head movements during the session. They were asked to focus on the fixation cross and take as much time as they pleased to look at the pictures. Thereafter, prior to each picture the testing block (1 sec) followed with the presentation of a fixation cross in the left upper corner. Before the sexual pictures were displayed, a reminder of the explicit sexual content of the next images appeared. Each picture presentation ended with a participant initiated mouse click, see Rupp and Wallen (2007).

**Supplemental Results**

***Pupil Diameter and Fixation Count***

See Table S1 and S2 on descriptive results of the pupil diameter and fixation count data.

**Table S1.** Pupil Diameter per Stimulus Category and Treatment and Assessment and Effect Sizes

|  |  |  |
| --- | --- | --- |
| **Stimulus Category** | **Oxytocin** | **Placebo** |
|  | ***1st Session******N = 41*** | ***2nd Session******N = 40*** | ***1st Session******N = 41*** | ***2nd Session*** ***N = 39*** |
|  | ***M ± SD*** | ***M ± SD*** | ***M ± SD*** | ***M ± SD*** |
| **Neutral** | 4.51 ± .64 | 3.90 ± .51 | 3.91 ± .50 | 4.10 ± .50 |
| **Attachment** | 4.44 ± .56 | 4.04 ± .50 | 4.21 ± .58 | 4.27 ± .50 |
| **Father-Child** | 4.48 ± .57 | 4.06 ± .50 | 4.19 ± .54 | 4.27 ± .51 |
| **Mother-Child** | 4.63 ± .65 | 4.18 ± .55 | 4.34 ± .60 | 4.41 ± .57 |
| **Erotic** | 4.68 ± .63 | 4.27 ± .55 | 4.41 ± .69 | 4.47 ± .55 |
| **Sex** | 4.80 ± .63 | 4.34 ± .57 | 4.53 ± .60 | 4.57 ± .56  |
|  |  |  |  |  |
| **Effect size** Cohen’s d for repeated measures\* / Cohen’s d  | **Within-subject**1st Session OT, 2nd Session PL | **Within-subject**1st Session PL, 2nd Session OT | **Between-subject** Groups 1st Session | **Between-subject** Groups 2nd Session |
| **Neutral** | 2.56 | 1.07 | 1.05 | .40 |
| **Attachment** | 1.12 | 1.26 | .40 | .46 |
| **Father-Child** | 1.39 | 1.15 | .52 | .42 |
| **Mother-Child** | 1.22 | 1.14 | .47 | .41 |
| **Erotic** | 1.17 | .99 | .41 | .26 |
| **Sex** | 1.17 | 1.08 | .44 | .41 |
|  |  |  |  |  |

*\*According to Morris & DeShon, 2002*

**Table S2.** Fixation Count per AOI, Treatment and Assessment and Effect Sizes

|  |  |  |
| --- | --- | --- |
| **AOI** | **Oxytocin** | **Placebo** |
|  | ***1st Session******N = 41*** | ***2nd Session******N = 40*** | ***1st Session******N = 41*** | ***2nd Session*** ***N = 39*** |
|  | ***M ± SD*** | ***M ± SD*** | ***M ± SD*** | ***M ± SD*** |
| **Adult Eyes** | 1.36 ± 2.12  | .96 ± 1.64 | 1.23 ± 1.95 | 1.03 ± 1.75 |
| **Child’s Eyes** | 2.47 ± 2.90  | 1.81 ± 2.09 | 2.32 ± 2.39 | 1.83 ± 2.04 |
| **Adult’s Face** | 4.05 ± 3.49  | 3.06 ± 2.87 | 3.91 ± 3.21 | 3.41 ± 3.16 |
| **Child’s Face** | 4.78 ± 3.71  | 3.66 ± 3.04 | 4.64 ± 3.24 | 4.27 ± 3.13 |
| **Adult’s Body** | 2.09 ± 3.07  | 1.49 ± 2.47 | 2.01 ± 2.89 | 1.76 ± 2.81 |
| **Child’s Body** | 1.50 ± 2.69  | .85 ± 1.69 | 1.24 ± 2.07 | .99 ± 1.96 |
| **Adult’s Genitals** | 2.27 ± 2.39  | 1.56 ± 1.93 | 2.10 ± 2.26 | 1.91 ± 2.26 |
| **Background** | 2.90 ± 2.91  | 2.05 ± 2.28 | 2.38 ± 2.39 | 2.25 ± 2.44 |
|  |  |  |  |  |
| **Effect size** Cohen’s d / Cohen’s d for repeated measures\* | **Within-subject**1st Session OT, 2nd Session PL | **Within-subject**1st Session PL, 2nd Session OT | **Between-subject** Groups 1st Session | **Between-subject** Groups 2nd Session |
| **Adult Eyes** | .25 | .26 | .06 | .04 |
| **Child’s Eyes** | .35 | .38 | .06 | .00 |
| **Adult’s Face** | .29 | .47 | .04 | .12 |
| **Child’s Face** | .22 | .51 | .04 | .23 |
| **Adult’s Body** | .17 | .33 | .03 | .10 |
| **Child’s Body** | .34 | .36 | .11 | .08 |
| **Adult’s Genitals** | .24 | .44 | .07 | .15 |
| **Background** | .35 | .23 | .19 | .08 |

*\*According to Morris & DeShon, 2002*

***Stimulus Duration***

Descriptive Statistics

Participants watched the pictures as long as they wanted. Mean stimulus duration differed between categories and time of assessment (1st or 2nd session), with longest observation to sexual > bonding > neutral and overall 1st session > 2nd session (see supplementary figure F1).

Statistical Modeling

Parallel to the eye-tracking data, we performed a multilevel model with repeated data entries nested within participants. In the intercept only model, stimulus duration was predicted by subject with an intra-class correlation (ICC) of r = .99.

We then speciﬁed the following conditional model analogous to the eye-tracking data analyses: Stimulus duration was modeled as a function of treatment (OT or PL), time of assessment (session 1 or 2) and category (fixed effects). This model showed high model fit (pseudo R2 = .54) and displayed significant fixed main effects for categories and significant interactions of the categories \* time of assessment, significant interactions for categories \* treatment, and significant 3-way interactions for treatment \* time of assessment \* category bonding (β = -907, p = .00) and for treatment \* time of assessment \* category sexual (β = -1179, p = .00). The significant three-way interactions indicate an increased stimulus observation at the first session under OT for the bonding and sexual pictures, followed by a stronger decline towards the second session. For neutral pictures, no such increase became evident.

**Supplementary Table S3.**  Multilevel Models Predicting Stimulus Duration from Category, Time of Assessment and Treatment

|  |  |  |
| --- | --- | --- |
|  | Coefficients (± SD) |  |
| **Random effects** |  |  |
| Intercept | 2104 |  |
| Assessment | 1645 (.45) |  |
| Treatment | 1055 (.28) |  |
|  | Coefficients (± SEM) | t-value (df) |
| **Fixed effects** |  |  |
| Intercept | 4761 (1294) | 3.68 (15631)\*\* |
| Category Bonding  | 1498 (78) | 19.10 (15631)\*\* |
| Category Sexual | 2443 (77) | 31.56 (15631)\*\* |
| Treatment | 171 (255) | 0.67 (15631) |
| Assessment | -533 (382) | -1.44 (15631) |
| Gender | 1178 (516) | 2.28 (83) |
| Age | -80 (49) | -1.62 (83) |
| Category Bonding \* Assessment | 199 (110) | 1.80 (15631) |
| Category Sexual \* Assessment | 409 (109) | 3.71 (15631)\*\* |
| Category Bonding \* Treatment | 195 (111) | 1.76 (15631) |
| Category Sexual \* Treatment | -259 (109) | -2.36 (15631)\*\* |
| Treatment \* Assessment | -248 (776) | -0.31 (15631) |
| Category Bonding \* Treatment\* Assessment | -907 (157) | -5.77 (15631)\*\* |
| Category Sexual\* Treatment\* Assessment | -1179 (155) | -7.60 (15631)\*\* |
| Model fit AIC | 294798 |  |
| Pseudo R-squared | .543 |  |

*\* p < .05; \*\* p < .01. All estimates calculated with full maximum likelihood. Parameter estimates were calculated with category neutral serving as reference for the other categories; for assessment, 1st session serves as reference; for treatment, placebo serves as reference and for gender, female serves as reference.*

**Supplementary Figure F1**

**Descriptive Values Stimulus Duration**

OT application at the 1st experimental session lead to increased duration of how long participants stayed with each picture (= stimulus duration in milliseconds) in the first session for bonding and sexual stimuli; OT, Oxytocin, PL, Placebo; Error Bars indicate Standard Error of the Mean (SEM).

**Supplementary References**

Morris, S. B., & DeShon, R. P. (2002). Combining effect size estimates in meta-analysis with repeated measures and independent-groups designs. *Psychological methods, 7*(1), 105.

Rupp, H. A., & Wallen, K. (2007). Sex differences in viewing sexual stimuli: An eye-tracking study in men and women. *Hormones and behavior, 51*(4), 524-533.