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## Master`s thesis

# Oxytocin and parenting: Does oxytocin impact perception of infant characteristics?

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**Abstract**

The neuropeptide oxytocin has been implicated in prosocial behavior and social cognition. However, little is known on the influence of oxytocin on the perception of infant positive and negative characteristics. In a double-blind placebo-controlled study, 40 females ($M_{age}$ = 20.11) were asked to rate characteristics of infants with high, medium and low infantile physical features before and after receiving nasal spray containing either 16 IU of oxytocin or placebo. We found an increase of adults` perception of infant positive characteristics over time. In both conditions females perceived infants with less infantile physical features as displaying significantly more positive characteristics at posttreatment compared to pretreatment. We also found that participants perceived positive characteristics of infants in the high infantile physical features category as even more positive at posttreatment compared to pretreatment, but depending on treatment. Participants who received placebo perceived infants with more infantile physical features as more positive at posttreatment than at pretreatment, but oxytocin prevented increase on positive perception. Females who received oxytocin perceived infants with high infantile physical features almost equally positive both at pretreatment and at posttreatment. We conclude that when young adults are already highly prosocial to infants with infantile physical features, oxytocin may prevent an even more positive perception of infants. Our findings indicate that the effects of oxytocin are nuanced, and its effects contingent on personal and contextual factors.

**Keywords:** oxytocin; perception; characteristics; infantile physical features; parenting

**Introduction**

Infants begin to develop affective bonds with their caregivers from birth and these social bonds continue to regulate social, emotional and cognitive functions throughout the lifespan (Fries, Ziegler, Kurian, Jacoris, & Pollak, 2005; Bartz et al., 2010a). The quality of the bonding may depend on the presence of certain types of interactions ranging from sensitive and responsive infant care to child abuse and neglect (Hoffman, Gandelman, & Schiffman, 1982; Heim et al., 2009; Strathearn, Foangy, Amico, & Montague, 2009). Sensitive parenting is characterized by an ability to accurately perceive infant`s signals from subtle facial or other non-verbal expressions as the first and significant step to respond in an adequate and prompt manner to the infant`s age appropriate needs (Bowlby, 1988; Feldman, Eidelman, & Rotenberg, 2004; Bakermans-Kranenburg & Van IJzendoorn, 2008).

Certain infant cues such as an infant`s smiling and crying facial expressions are motivators of human parental behavior (Casey & Ritter, 1996; Strathearn et al., 2009). For instance, infant crying alerts parents to the needs of the infant and induces parental proximity or can be an aversive stimulus bringing to abusive parenting responses (Barr, Trent, & Cross, 2006; Del Vecchio, Walter, & O`Leary, 2009; Bakermans-Kranenburg, Van IJzendoorn, Riem, Tops, & Alink, 2011; Riem et al., 2011a). For mothers with secure attachment infant cues may act as an important signal of reinforcing and motivating responsive maternal care, whereas mothers with insecure attachment representations more likely demonstrate avoidance or rejection of negative infant cues and difficulties to establish secure relationships with the infant (Fonagy, Steele, & Steele, 1991; Strathearn et al., 2009). Previous studies demonstrate that adult behavior might be also affected by the perceived cuteness of the infant, which is partially impacted by the infant`s facial features (Hildebrandt & Fitzgerald, 1979; Power, Hildebrandt, & Fitzgerald, 1982). To illustrate, infantile physical features such as large head and eyes, small nose and mouth stimulate cuteness perception and motivation for caretaking (Glocker et al., 2009). Thus, infant`s facial appearance not only gives signals to parents, but also influence impressions of one`s psychological qualities and character (Berry & McArthur, 1986; Leinbach & Fagot, 1991; Casey & Ritter, 1996; Haxby, Hoffman, & Gobbini, 2002; Rogers & Ritter, 2002; Adams Jr et al., 2012).

Differences in parental caregiving can be underlied by neurobiological processes. One of the systems facilitating and maintaining parental behavior is the oxytocinergic system (Feldman,

Weller, Zagoory-Sharon, & Levine, 2007; Strathearn et al., 2009; Feldman, Gordon, Schneiderman, Weisman, & Zagoory-Sharon, 2010b; Gordon, Zagoory-Sharon, Leckman, & Feldman, 2010). Oxytocin is a peptide of nine amino acids or nonapeptide. The paraventricular (PVN) and the supraoptic (SON) nucleus are the primary hypothalamic sources of oxytocin in the brain (Carter et al., 2007) (see figure 1).

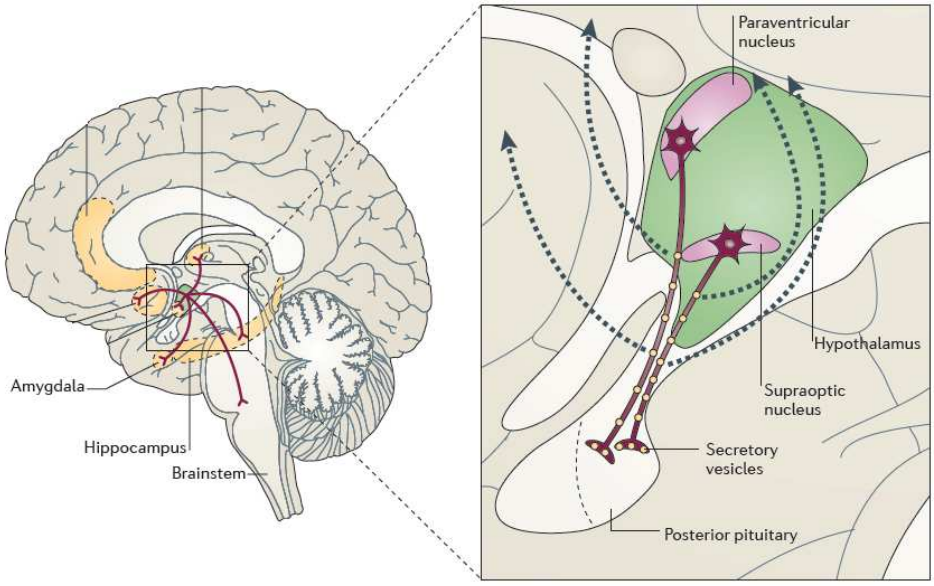



***Figure 1.*** Neurophysiology of oxytocin. Oxytocin from both the paraventricular and the supraoptic nucleus of the hypothalamus is carried to the posterior pituitary where it is stored in secretory vesicles and released into peripheral circulation. Oxytocin also is centrally released into the brain from dendrites of hypothalamic neurons and acts on relatively distant targets (shown by the dotted arrows) including the amygdala, hippocampus, and brainstem. Visual representation of neurophysiology of oxytocin reproduced from Meyer-Lindenberg et al. (2011).

Oxytocin from both PVN and SON of the hypothalamus is carried to the posterior pituitary for peripheral release into the blood stream functioning as a neurohormone (Buijs, De Vries, Van Leeuwen, & Swaab, 1983; Carter et al., 2007; Donaldson & Young, 2008). Oxytocin also is centrally released into the brain from dendrites of hypothalamic neurons functioning as a neuromodulator (Buijs et al., 1983; Ludwig & Leng, 2006; Carter et al., 2007; Donaldson & Young, 2008). As a neurohormone oxytocin is associated with peripheral actions in facilitating uterine contractions during labor and milk ejection during lactation (Feldman et al., 2007;

Strathearn et al., 2009). As a neuromodulator oxytocin influences sexual and social behavior (Donaldson & Young, 2008; Landgraf & Neumann, 2004). For instance, oxytocin has well-described central actions associated with attachment bond formation and onset of maternal behavior (Donaldson & Young, 2008; Strathearn et al., 2009). Animal studies demonstrate that both peripheral and central oxytocin levels are associated with individual variations in affectionate contact between mother and young. To illustrate, recent study with rhesus macaques demonstrated a positive correlation between time spent nursing and grooming and maternal plasma oxytocin levels (Maestripieri, Hoffman, Anderson, Carter, & Higley, 2009). In another study Francis and colleagues (2000) reported that maternal female rats presenting higher levels of licking-and-grooming and arched-back nursing (LG-ABN) showed greater oxytocin receptor densities in brain areas important for the development of parenting such as medial preoptic area, the lateral septum, the PVN of the hypothalamus, and the nucleus accumbens. These animal studies demonstrate that there is a significant association between oxytocin levels and the expression of affiliative social behavior. Building on animal research, in the past decade has rapidly increased the interest in the effects of oxytocin on social behavior in humans.

In humans the neuropeptide oxytocin has been related to social processes such as prosocial behavior, stress reactivity and parenting (Donaldson & Young, 2008; Rodrigues, Saslow, Garcia, John, & Keltner, 2009). The role of oxytocin in prosocial behavior in humans has been assessed both in plasma oxytocin levels and with intranasal administration of neuropeptide. Assessment of plasma oxytocin levels in women revealed a positive relation between feelings of romantic love and trust and oxytocin release (Gonzaga, Turner, Keltner, Campos, & Altemus, 2006). In another study both females and males demonstrated a positive correlation between the degree of empathy experienced and the change in plasma oxytocin levels, especially oxytocin response was stronger for women (Barraza & Zak, 2009). Studies with intranasal administration of oxytocin have implicated oxytocin in general behavioral regulation, particularly in positive social interactions (Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005). Indeed, oxytocin has been shown to alter the perception and processing of social cues (Bartz, Zaki, Bolger, & Ochsner, 2011). Theodoridou and colleagues (2009) reported that adult males and females receiving intranasal oxytocin perceived unfamiliar adult face stimuli as more attractive and trustworthy than did adults who received placebo. In another study intranasal administration of oxytocin in adult males modulated face perception, resulting in an improved

ability to infer the affective mental state of others from social cues of the eye region (Domes, Heinrichs, Michel, Berger, & Herpertz, 2007a). Guastella and colleagues (2008) reported that males after intranasal oxytocin administration gazed longer and fixated more frequently toward eyes of presented human faces than males in the control group did. As crucial information for assessing the degree of interest, threat and emotion of another is taken from the eyes, but lesser from the mouth, eye gaze reinforcement underlie the positive effects of oxytocin on face perception and interpersonal communication (Guastella et al., 2008). The effect of intranasal administration of oxytocin suggests the modulation of the amygdala function, which is the main component of the neurocircuitry of fear and social cognition such as mentalizing (Kirsch et al., 2005; Domes et al., 2007a). Previous studies demonstrated that intranasal administration of oxytocin attenuated activation of the amygdala in male for fearful faces (Kirsch et al., 2005; Domes et al., 2007b; Gamer, Zurowski, & Buchel, 2010). Recent fMRI study revealed that experimentally induced oxytocin levels attenuated activation in the amygdala for women when listening to infant crying (Riem et al., 2011a). Reduced amygdala activity contributes to increased empathy and mentalizing ability by increasing sociability and decreasing social fear perception in humans (Kirsch et al., 2005; Kosfeld et al., 2005; Guastella et al., 2008). These results reveal that increased plasma oxytocin levels and intranasal administration of oxytocin facilitate social approach behavior and positive social perception.

The stress reducing effects of oxytocin have been demonstrated in oxytocin`s interaction with the hypothalamus-pituitary-adrenal axis to attenuate stress response (Neumann, 2002). Uvnas-Moberg (1998) reported that oxytocin is implicated as a core component of the mechanisms mediating antistress effects of positive social interactions, by increasing openness to social relationships. Previous studies demonstrated an anxiolytic effect of experimentally induced oxytocin levels for males by decreasing cortisol levels and increasing calmness during stressful situation (Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003; Meinlschmidt & Heim, 2007). During couple conflict, intranasal administration of oxytocin increased positive communication in relation to negative behavior and reduced salivary cortisol levels after the conflict compared with placebo (Ditzen et al., 2009). Taken together, these studies demonstrate that oxytocin increases the benefits from social interactions by modulating social and emotional behaviors and attenuating the stress response. It also demonstrates an essential role as a biological base of bond formation and affiliation in humans.

Neuropeptide oxytocin is one of the key hormones involved in parent-infant bonding not only in animals, but also in humans (Carter, 1998; Bakermans-Kranenburg & Van IJzendoorn, 2008; Donaldson & Young, 2008; Gordon et al., 2010; Riem et al., 2011a; Riem, Pieper, Out, Bakermans-Kranenburg, & Van IJzendoorn, 2011b). The importance of oxytocin in the facilitation of maternal behavior in animals was the first observed by Pedersen and Prange, Jr, through investigation of rat`s maternal behavior (Pedersen & Prange, 1979). Animal studies demonstrate that oxytocin is transmitted from mother to young through mechanisms of early social experience (Francis, Champagne, & Meaney, 2000; Maestripieri et al., 2009). Recent research showed the cross-generation transmission of oxytocin in humans (Feldman, Gordon, & Zagoory-Sharon, 2010a). To illustrate, higher parental salivary oxytocin was associated with higher infant salivary oxytocin resulting in higher infant social engagement and greater affect synchrony (Feldman et al., 2010a). Research has found increased maternal plasma oxytocin levels in response to stimuli such as infant sucking or somatosensory touch (Matthiesen, Ransjo-Arvidson, Nissen, & Uvnas-Moberg, 2001; Feldman et al., 2007). In addition, higher maternal plasma oxytocin levels during pregnancy predict higher quality of postpartum maternal behavior including gaze, vocalizations, positive affect and affectionate touch (Feldman et al., 2007; Levine, Zagoory-Sharon, Feldman, & Weller, 2007). Recent studies have found that not only maternal plasma oxytocin levels are associated with parenting behavior, but also paternal oxytocin levels (Gordon et al., 2010; Feldman et al., 2010b). Mothers and fathers demonstrated equal levels of plasma oxytocin across the first six months of parenthood, but associations between parental oxytocin and parenting behaviors during interactions with the infant were shown to be gender-specific (Gordon et al., 2010). Mothers who provided high levels of affectionate touch and fathers who provided high levels of stimulatory contact to their infant demonstrated elevated plasma and salivary oxytocin levels after parent-infant interaction, but such increase was not observed among parents who provided low tactile contact (Feldman et al., 2010b). Naber and colleagues (2010) reported that intranasal administration of oxytocin led to more responsive interactions of fathers with their child during play, stimulating the child`s exploration and autonomy. Consequently, changes in oxytocin levels are inducing sensitive parenting and specific parenting behaviors may lead to changes in oxytocin levels (Naber, Van IJzendoorn, Deschamps, Van Engeland, & Bakermans-Kranenburg, 2010). Overall, these studies report a significant association between elevated oxytocin levels and sensitive parenting.

Nevertheless, sensitive interactions with the infant include not only tactile contact, but also correct perception of infant cues. There is some evidence that more physically attractive infants are perceived as more likeable, friendly, and competent than less attractive (Casey & Ritter, 1996; Glocker et al., 2009; Parsons, Young, Kumari, Stein, & Kringelbach, 2011). The role of oxytocin in perception of various infant signals such as positive and negative characteristics is poorly understood. In the current study we examine the effect of oxytocin on perception of infant characteristics.

There is some evidence that oxytocin might have a polarizing effect on human behavior. Oxytocin effects on prosocial behavior and stress reduction are more nuanced than previously thought, and it might not promote positive feelings for all people in all conditions (Bartz et al., 2011). De Dreu and colleagues (2010) suggested that intranasal administration of oxytocin drives a "tend and defend" response promoting in-group trust and cooperation, and enhancing defensive aggression toward competing out-groups. A recent study has shown that males with secure attachment remembered their mother as more caring after oxytocin administration while more anxiously attached individuals reported their mother less caring after oxytocin administration (Bartz et al., 2010a). Bakermans-Kranenburg and colleagues (2011) reported that oxytocin reduced the use of excessive force during listening to infant cry sounds, but only for those females who experienced little harsh discipline in their childhood. Moreover, there is some evidence that mothers with the oxytocin receptor gene GG genotype are more sensitive to their toddler`s cry signals than mothers with oxytocin receptor gene AA or AG genotypes (Riem et al., 2011b). These studies demonstrate differential effects of oxytocin suggesting the perspective of the out-group, the importance of the quality of childhood caregiving experiences and of genetic variations. We hypothesized that after intranasal oxytocin administration females perceive infant`s positive characteristics as more positive. Oxytocin might demonstrate different effect in perception of negative characteristics.

## Methods

### *Participants*

Participants were selected from the study "Role of oxytocin in parenting" investigating the effects of intranasal oxytocin administration on behavioral differences of an individual towards infants who are perceived as happy versus infants perceived as distressed. The original

sample consisted of 102 female students. In the current study were recruited a group of 40 first and second year female students from Leiden University, the Netherlands. The mean age of the participants was 20.11 years (*SD* = 1.59, range 18-27). Females were preferably in luteal phase (the 3rd or the 4th week) of their menstrual cycle, because variation in estrogen levels across the menstrual cycle might influence face perception and the effect of oxytocin administration (Penton-Voak et al., 1999; Bakermans-Kranenburg et al., 2011b). The participants were instructed to abstain from alcohol, caffeine and nicotine and excessive physical activities for 24 h before the beginning of the session. At the day the session took place participants were requested to have a gap of 30-45 minutes between the meal and the saliva collection. Exclusion criteria included having own children, pregnancy, breastfeeding, hearing impairments (because sounds were presented during "The baby social reward task"), neurological and psychiatric disorders. The study was approved by the Medical Ethics Committee of the Leiden University Medical center. All participants signed an informed consent form. Students received 20 euros or 5 course credits for participation in the study.

***Procedure***

Participants were tested individually in a lab session lasting about 2.5 h. Figure 3 depicts a timeline of the lab session.

At the beginning of the experimental session, participants were asked to read an information form about the study and sign an informed consent form. Then participants were asked to fill in the Positive and Negative Affect Schedule (PANAS). A basal saliva sample was collected, and then participants completed the first time measurement of infant perception. This first time the infant perception measurement consisted of a training round and three tasks - "mood", "characteristics" and "wanting". In the training round participants were instructed in the use of the rating keys. Completion of the measurement of infant perception took approximately 20 minutes. Then participants self-administered a nasal spray under the supervision of study personnel. During the waiting period of 40 minutes participants had a short break (5 minutes), to recover from nasal spray. Next, they provided answers for general information questionnaire including questions about used beverages on the experiment day, week of menstrual cycle, short term medication, heavy exercises and used drugs, smoke or alcohol day before the lab session.

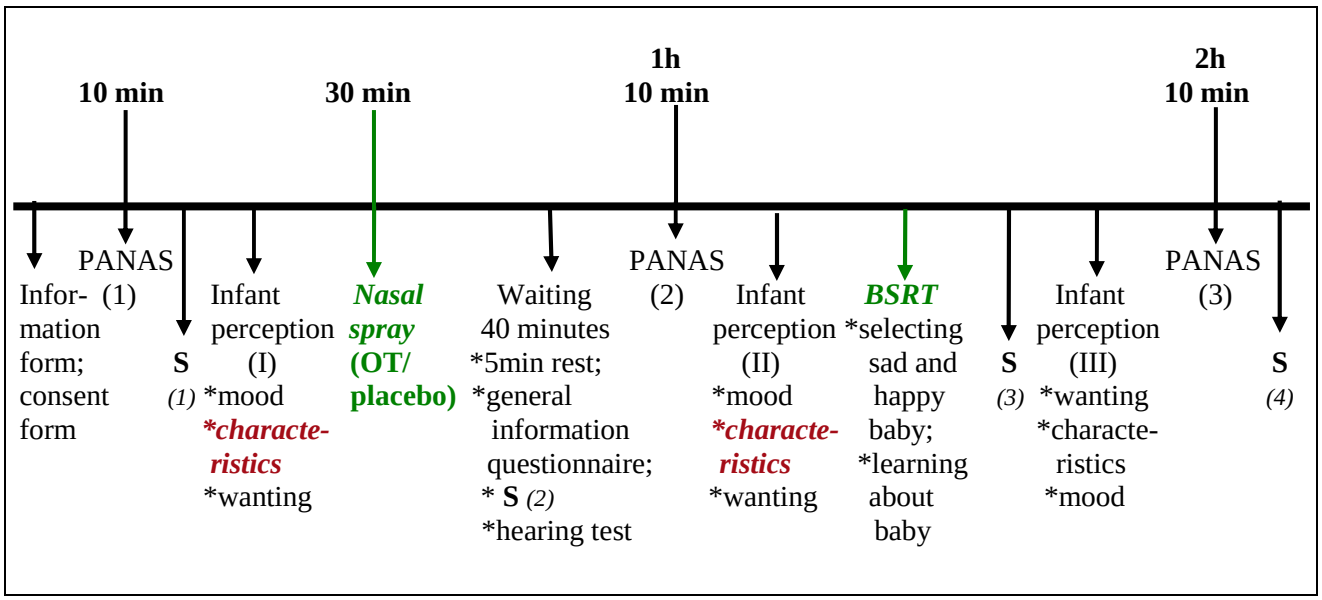



***Figure 3.*** Study timeline. The process of the lab session for each participant. PANAS, the Positive and Negative Affect Schedule; **S**, saliva sample collection; OT, oxytocin; BSRT, The baby social reward task. In the current study is reported the results of participants` perception of infant characteristics (red). Two intervention points are represented - administration of nasal spray and "The baby social reward task" (green).

In a waiting period the second saliva sample was collected for determination of oxytocin receptor gene. A hearing test was completed to adjust the most suitable volume for each individual participant in "The baby social reward task", where cry and laugh sounds were presented. Following a waiting period, participants filled in the PANAS and then completed the second time measurement of infant perception, equal to the first. After the second intervention with "The baby social reward task" where participants identified happy and sad babies, they completed the third time measurement of infant perception which included the same three tasks as in the first and the second time, but in a different order. Firstly, participants chose the time for seeing the infant`s face, then rated how presented characteristics describe the infant, and, finally, rated the mood of each infant. Completion of the second time measurement of infant perception, "The baby social reward task" and the third time measurement of infant perception took approximately 60 minutes. The third and the fourth saliva samples were collected one and two hours after administration of nasal spray, respectively. Finally, participants filled in PANAS for

the third time and were asked whether they felt they had received oxytocin, placebo or they did not have an opinion, in order to assess any effects of expectancies on performance.

### *Measures*

**PANAS.** The Positive and Negative Affect Schedule (PANAS) is a 20-item self-reported measure, which assesses positive and negative affective states. Participants indicate on a 5 point scale the extent to which they have experienced each particular emotion within a specific time period. The scale points are: “very slightly or not at all”, “a little”, “moderately”, “quite a bit”, “very much”. There are two subscales: positive affect and negative affect. Positive affectivity scale includes items: interested, excited, strong, enthusiastic, proud, alert, inspired, determined, attentive, and active. Negative affectivity scale includes items: distressed, upset, guilty, scared, hostile, irritable, ashamed, nervous, jittery, and afraid. The PANAS is a reliable, valid and efficient instrument for measuring two important dimensions of mood (Watson, Clark, & Tellegen, 1988). The PANAS in the current study is used to assess the possible mood - altering effects of oxytocin.

**Infant perception.** Measurement of infant perception assessed participants perception of infant`s mood, characteristics and willingness to view an infant`s face. It was administered on a laptop using Presentation software. There were several tasks and before each task the instructions were presented. Measurement of infant perception included six versions according to which infant faces appeared on the screen. On the computer screen were depicted monochrome infant photographs consisting of male and female infants. All photographs were selected from the set used by Parsons and colleagues (Parsons et al., 2011). Before the creation of measurement of infant perception 40 females rated 13 infant faces, in order to identify gender of infants. As a result more than 75% of females rated two babies as boys and equal percentage of females rated two babies as girls. Two babies were not clearly identified as boys or girls. These six infant faces are depicted in figure 2a. Measurement of infant perception was performed three times: before administration of nasal spray, 40 minutes after receiving nasal spray, and after completing “The baby social reward task”.

*Mood.* In the first task were presented 13 infant faces with a neutral, happy or sad expression. Participants were asked to rate the mood of each infant from positive to negative. Overall, this task consisted of 39 trials.

*Characteristics.* In the second task were presented six neutral infant faces (see figure 2a). Each face appeared nine times, and participants were asked to rate how different characteristics describe the infant. Responses on the scale were measured from +4 (characteristic highly describes the baby) to –4 (characteristic not at all describes the baby) (see figure 2b). Participants made their rating by using the upward and downward keys to adjust the bar. In total there were presented nine characteristics for each infant face: “easy”, “attractive”, “difficult”, “secure”, “cute”, “spoilt”, “irritable”, “smart” and “responsive”. These characteristics were chosen to represent positive characteristics: “attractive”, “cute” and “easy”; negative characteristics: “difficult”, “irritable” and “spoilt”, and neutral characteristics: “smart”, “responsive” and “secure”. Overall, this task consisted of 54 trials.

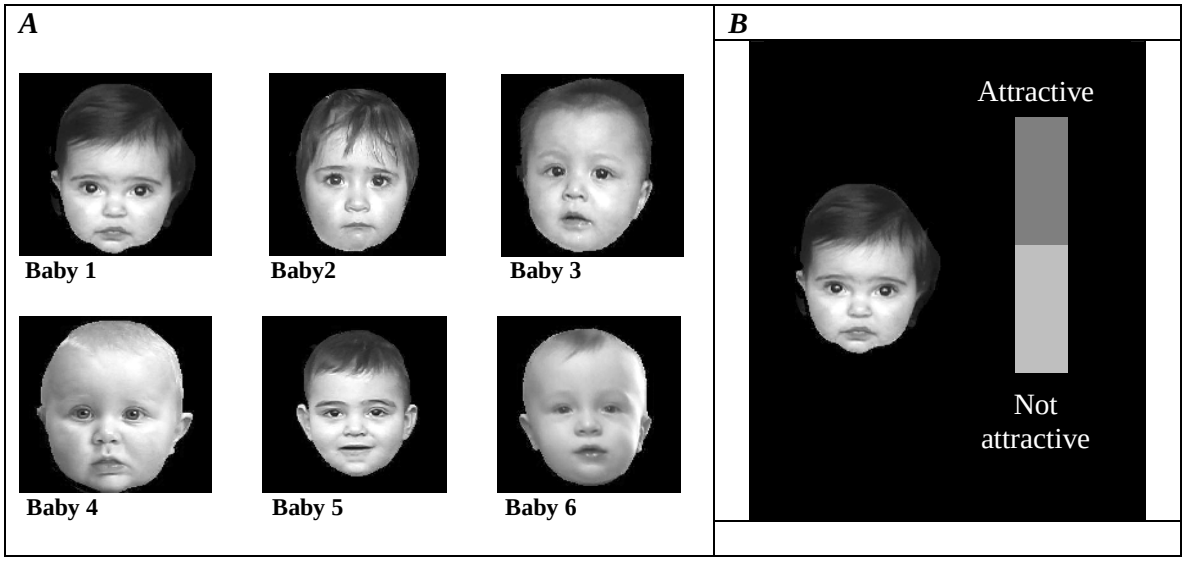



***Figure 2. A,*** Six baby faces presented in measurement of infant perception in the tasks “characteristics” and “wanting”. ***B,*** Screenshot of the characteristics task. Participants were asked to rate how different characteristics describe the infant by moving bar to the upper level, indicating that presented characteristic highly describes the infant or to the bottom level, indicating that presented characteristic less describes the infant.

*Wanting.* In the third task also were presented six infant faces, each face five times. Participants were asked to choose the time to see the infant`s face. They were instructed to use

upward arrow on a keyboard to increase the time for seeing the infant`s face or downward arrow to decrease the time for looking at the infant`s face. Overall, this task consisted of 30 trials.

**The baby social reward task.** This is a computer based task to assess individuals' behavior towards infants perceived as happy and consolable versus distressed and unresponsive. Briefly, a participant will be randomly shown three pairs of infant faces (AB, CD, EF) which are matched in their gender, attractiveness, emotion, size and luminance. The participant, by trial and error, has to identify the happy infant from the crying infant. Feedback will follow to indicate whether the choice is correct: if the participant chooses the happy infant, a chuckle response will follow and if the participant chooses the crying infant, the participant will hear a cry sound. This feedback is probabilistic. In AB trials, choosing infant 'A' leads to positive feedback (chuckle) in 80% of the AB trials, whereas choosing infant 'B' leads to negative feedback (crying) in these trials. For the CD and EF pairs, it is more difficult to identify which of the infants are happy, with infant 'C' correct in 70% of the CD trials and infant 'E' correct for 60% of the EF trials. By this pre-task, we aim to create a perception of a hierarchy of infants, with some perceived as happy and consolable and other perceived as distressed and unresponsive.

**Oxytocin.** In a double-blind, placebo-controlled study design, participants randomly received oxytocin or placebo. The experimental group ($n$ = 20) received a single intranasal dose of 16 IU oxytocin (Syntocinon spray, Novartis, Basal, Switzerland; three puffs per nostril; each with 2.6 IU oxytocin). The control group ($n$ = 20) received saline solution. It was previously demonstrated that intranasally administered neuropeptides cross the blood-brain barrier and therefore allow investigating the effect of oxytocin on brain function (Born et al., 2002). Because central nervous oxytocin levels reach a plateau approximately 40 minutes after substance administration (Gamer et al., 2010), participants waited for 40 minutes before the start of the second part of measurement of infant perception.

**Saliva samples collection.** Salivary oxytocin is considered a reliable, valid and noninvasive source to measure oxytocin levels in humans (Carter et al., 2007). Saliva samples were collected at several time points in order to reveal changes in oxytocin levels and to determine oxytocin receptor gene genotype. During the lab session four saliva samples from each participant were obtained. A sample of the participants provided saliva samples after the 3$^{rd}$, 4$^{th}$, 5$^{th}$, 6$^{th}$ and 7$^{th}$ hour of receiving nasal spray. They received an additional 30 euros.

***Data analysis***

This study utilized repeated measures design. There were two time points of assessment of infant characteristics: before receiving nasal spray (pretreatment) and 40 minutes after receiving nasal spray (posttreatment). Here, we report statistical findings of the effect of oxytocin on the perception of infant characteristics. All data analyses were conducted by the use of the SPSS statistical software package (SPSS V19 Inc). Statistical tests were two-tailed with the level of significance set at $p < 0.05$.

**Descriptive statistics.** Careful data inspection was conducted in order to provide the quality and reliability of the data. The nature of the variables was investigated by frequencies which provide information on characteristics of variables such as mean, median, mode, standard deviation, skewness, kurtosis and minimal and maximal values. Graphical analysis such as histogram with normal curve was employed to investigate the normal distribution of variables. Missing value analysis was used to reveal potential missing data, and box plots were employed to detect outliers. Scatter plots were used to reveal bivariate outliers. Cronbach`s Alpha was conducted to assess the internal consistency of a set of variables.

**Grouping baby faces according to infantile physical features.** In order to investigate the effect of oxytocin on perception of infant characteristics and to increase reliability of results, six infant faces were divided into separate categories based on a set of infantile physical features (Hildebrandt & Fitzgerald, 1979; Glocker et al., 2009; Parsons et al., 2011). A set of infant`s facial features are considered as typical infantile physical features including large head, round face, high forehead, large eyes, small nose and mouth (Hildebrandt & Fitzgerald, 1979; Glocker et al., 2009). Various dimensions of each baby face included in the current study were measured by Parsons et al. (2011), based on the procedure described by Glocker and colleagues (Glocker et al., 2009; Parsons et al., 2011). Facial measurements were obtained by measuring distances between facial landmarks. Figure 4 depicts facial landmarks (red dots) and infant facial features measured (black arrows). The following distances were measured: head length, face width, forehead length, face length, eye width, nose length, nose width and mouth width. Based on these measures were calculated five scores to reveal proportional indices: forehead length compared to face length, eye width compared to face width, nose length compared to head length, nose width compared to face width and mouth width compared to face width.

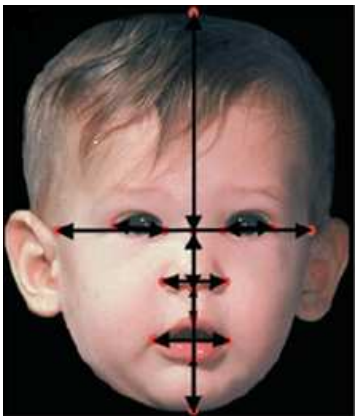


***Figure 4.*** Measures of infantile facial features. Facial landmarks (red dots) and measures (black arrows). Five measurement scores were obtained for each baby face: forehead length compared to face length, eye width compared to face width, nose length compared to head length, nose width compared to face width and mouth width compared to face width. Baby face with facial measures reproduced from Glocker et al. (2009).

Next, to reveal whether these obtained scores are above or below the mean and to quantify the extent of the infantile physical features in each face, z-scores were calculated. To classify the infant`s face as displaying more infantile physical features, facial parameters such as forehead compared to face length and eye width compared to face width should be above the mean, but nose length compared to head length, nose width compared to face width and mouth width compared to face width should be below the mean. After obtaining z-scores, three variables (nose length compared to head length, nose width compared to face width and mouth width compared to face width) were reversed to make those measures comparable to the measures of forehead compared to face length and eye width compared to face width. Three reversed and two not reversed z-scores were used to compute the average amount of infantile physical features for each baby face.

**Factor analysis.** To aggregate nine characteristics into separate groups we conducted principal components factor analysis. A priori, characteristics were chosen on the following criteria: positive: “attractive”, “cute” and “easy”; negative: “difficult”, “irritable” and “spoilt”; neutral: “responsive”, “smart” and “secure”. A factor analysis was performed for each baby face. The characteristics were grouped on the bases of consistent loadings of the same characteristics

under the one factor for each baby face. Factor analyses were conducted on pretreatment perception of infant characteristics.

**Repeated measures analysis of variance (ANOVA).** At first, repeated measures ANOVA was conducted separately for ratings of positive and negative characteristics with time (pretreatment, posttreatment) and infantile features category (high, medium, low) as a within-subjects factors and drug condition (oxytocin, placebo) as a between-subjects factor. Then, a repeated measures ANOVA was performed separately for each infantile physical features category (high, medium, low) and each characteristic (positive, negative) with time (pretreatment, posttreatment) a within-subject factor and drug condition (placebo, oxytocin) a between-subjects factor. It resulted in 6 computed analyses. We performed this data analysis technique because it allows to investigate changes in characteristic ratings at two time points in two drug conditions.

## Results

### *Descriptives*

All variables were normally distributed both at pretreatment and at posttreatment and did not demonstrate serious outliers. There were no missing data for characteristic ratings. Only one female`s date of birth was missing, but since only students were participating in our study this is unlikely to strongly affect the mean age of participants.

### *Grouping baby faces according to infantile physical features*

Six infant faces were divided into three categories, based on the measurements of various dimensions of the infant faces. Table 1 depicts z-scores of the measures used to quantify the amount of the infantile features in each baby face. As a result high infantile physical features depicted the first and the fourth babies; medium infantile physical features depicted the third and the fifth babies, and low infantile physical features depicted the second and the sixth babies.

**Table 1.** *Z-scores of the measures used to quantify the extent of the infantile physical features in each baby face. Mean scores of infantile physical features demonstrate the average amount of infantile features for each baby face.*

| | z-scores | | | | | |
|---|---|---|---|---|---|---|
| | **Forehead length/face length** | **Eye width/ face width** | **Nose length/head length** | **Nose width/face width** | **Mouth width/face width** | **Mean infantile physical features** |
| **Baby 1** | 1.980 | 1.233 | -0.984 | -1.379 | 0.907 | **0.93** |
| **Baby 2** | -0.111 | -1.046 | 1.464 | 0.813 | -0.007 | **-0.69** |
| **Baby 3** | -1.014 | -0.987 | 0.096 | -0.886 | -1.377 | **0.03** |
| **Baby 4** | -0.348 | 0.820 | -0.912 | -0.338 | -0.755 | **0.50** |
| **Baby 5** | 0.127 | 0.777 | -0.696 | 1.361 | 1.468 | **-0.25** |
| **Baby 6** | -0.634 | -0.797 | 1.032 | 0.429 | -0.235 | **-0.53** |

***Positive and negative characteristics***

*Positive characteristics.* The characteristics “attractive” and “cute” loaded consistently under the same factor forming a set of positive characteristics. Cronbach`s alpha revealed high levels of internal consistency between characteristics “attractive” and “cute” for each infant face both at pretreatment ranging from .59 to .76 and even higher relation between items at posttreatment ranging from .72 to .91, justifying grouping of the characteristics.

*Negative characteristics.* “Easy”, “difficult” and “irritable” loaded into the same factor. Although it was not predicted that “easy” would be combined with “difficult” and “irritable”, “easy” reversed loaded under this factor providing a logical justification for this outcome. Consequently the characteristic “easy” was reversed. As a result a set of negative characteristics was formed from “difficult”, “irritable” and “easy” reversed. Also for negative characteristics Cronbach`s alpha revealed high levels of internal consistency both at pretreatment ranging from .55 to .75 and at posttreatment ranging from .59 to .76.

The characteristics “responsive”, “smart”, “secure” and “spoilt” are excluded from the current report because they did not load consistently under a factor across six infant faces.

***Impact of drug condition and time on perception of infant characteristics***

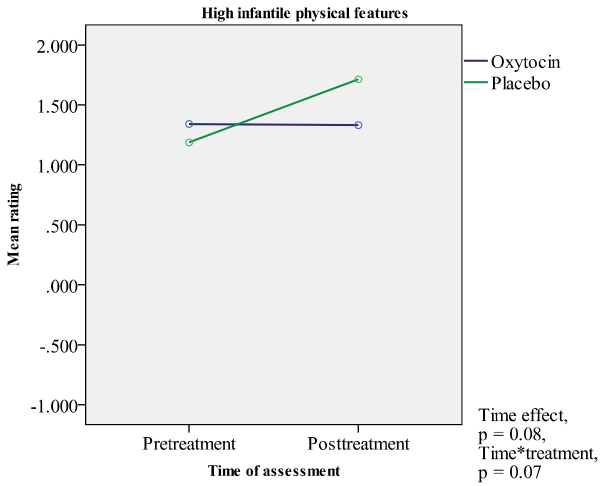
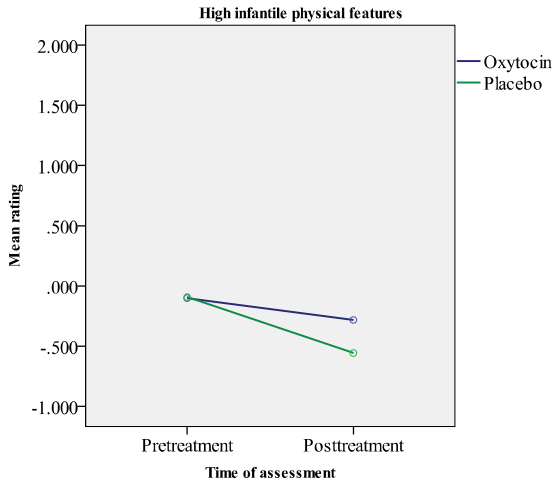
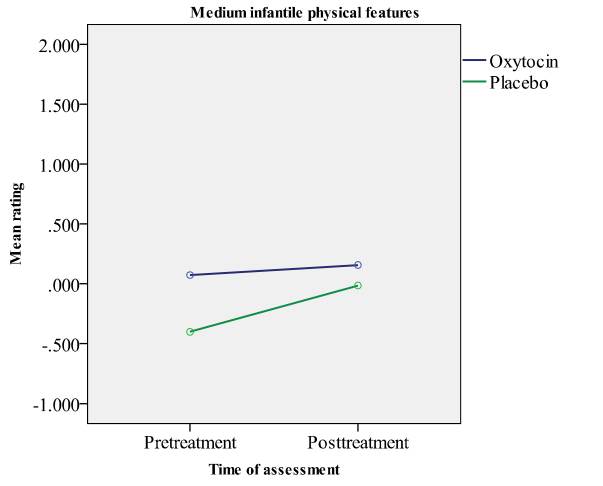
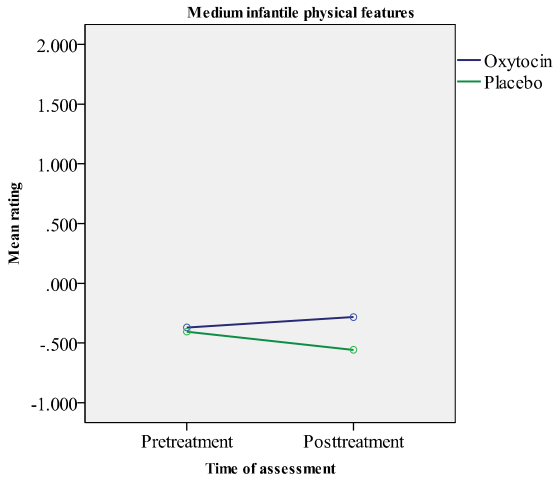
Repeated measures ANOVA was conducted to explore whether drug condition impacts perception of infant characteristics. When performing repeated measures ANOVA with three infantile features categories together, a main effect of infantile features category, $F(2,76) = 31.189$, $p < 0.001$, partial $\eta^2 = 0.451$, was found on perception of positive characteristics. Infants with high and low infantile physical features were perceived as displaying more positive characteristics compared to infants with medium infantile features. Also a main effect of time, F(1,38), 11.067, $p = 0.002$, partial $\eta^2 = 0.226$, was found on perception of positive characteristics. Participants' perceived infants in all categories as more positive at posttreatment compared to pretreatment (see table 2). Thus, females viewing infants repeatedly perceive them as more positive. There was neither significant effect of group nor of time on perception of negative characteristics.

**Table 2.** *Ratings of positive and negative characteristics both at pretreatment and posttreatment of infants in the high, medium and low infantile physical features categories. Data show means and standard deviations.*

| | **Positive characteristics** | | | | **Negative characteristics** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Pretreatment** | | **Posttreatment** | | **Pretreatment** | | **Posttreatment** | |
| | *Oxytocin* | *Placebo* | *Oxytocin* | *Placebo* | *Oxytocin* | *Placebo* | *Oxytocin* | *Placebo* |
| | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| **High infantile features** | 1.340 (1.155) | 1.187 (0.906) | 1.331 (1.162) | 1.714 (0.896) | -0.101 (1.074) | -0.092 (0.831) | 0.044 (1.003) | 0.122 (1.046) |
| **Medium infantile features** | 0.073 (0.867) | -0.401 (1.181) | 0.157 (0.860) | -0.013 (1.477) | -0.369 (0/709) | -0.405 (1.126) | -0.282 (0.856) | -0.557 (0.875) |
| **Low infantile features** | 1.163 (1.046) | 0.937 (0.947) | 1.689 (0.891) | 1.370 (1.015) | -0.148 (0.977) | -0.103 (0.640) | -0.351 (0.811) | -0.329 (0.834) |

To investigate participants` perception of infant characteristics in each infantile features category repeated measures ANOVA was conducted for each category separately. Participants` perception of positive and negative characteristics of infants in the high, medium and low infantile features categories both at pretreatment and at posttreatment is illustrated in figure 5.

In relation to repeated view of infants, a main effect of time was found on perception of positive characteristics of infants in the low infantile physical features category, $F(1,38) = 13.407$, $p < 0.01$, showing that participants perceived those infants` positive characteristics significantly more positive at posttreatment compared to pretreatment. Partial eta squared demonstrated large effect size, $\eta^2 = 0.261$, showing that 26% of variance is explained by performing the measure of infant perception twice.

| Positive characteristics | Negative characteristics |
|---|---|
|  |  |
|  |  |

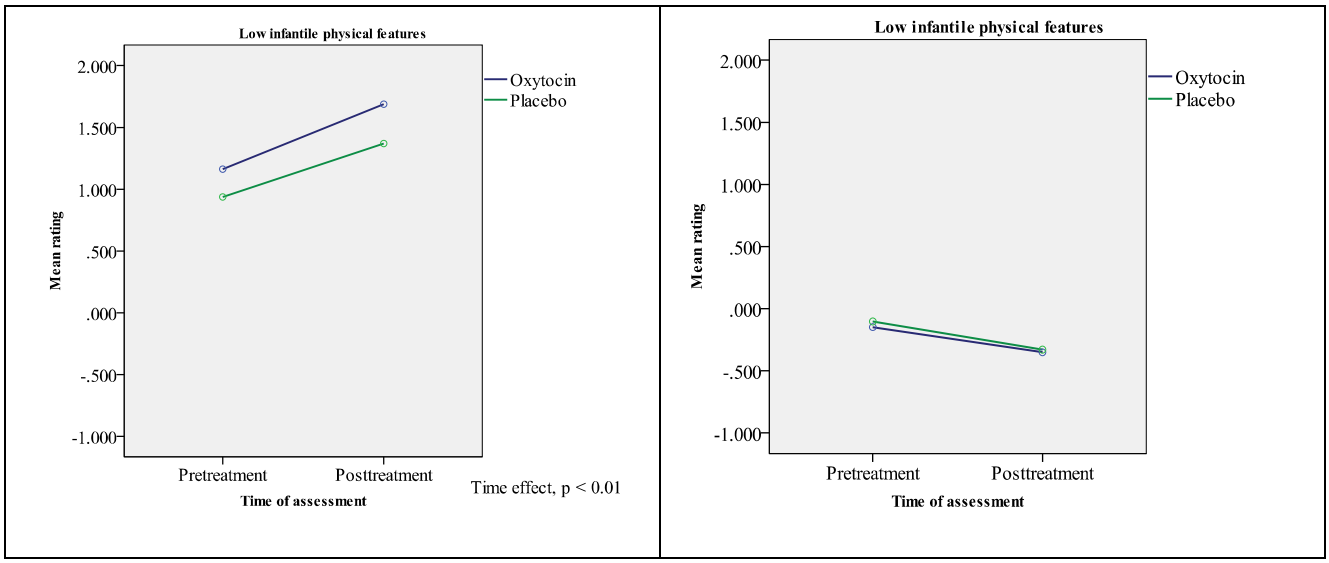



***Figure 5.*** Participants` perception of positive and negative characteristics of infants in the high, medium and low infantile physical features categories both at pretreatment and at posttreatment. At posttreatment positive characteristics of infants in the low infantile physical features category were perceived as significantly more positive compared to pretreatment, $F(1,38) = 13.407$, $p < 0.01$. There was a trend for an interaction between time of assessment and drug condition, $F(1,38) = 3.374$, $p = 0.07$, on perception of positive characteristics of infants with more infantile physical features. Participants who received placebo tended to perceive those infants as more positive at posttreatment than at pretreatment, but oxytocin prevented increase on positive perception.

We also found a trend for participants to perceive positive characteristics of infants in the high infantile physical features category as even more positive at posttreatment compared to pretreatment, but depending on treatment. There is a trend for an interaction between time of assessment and drug condition, (time*treatment, $F(1,38) = 3.374$, $p = 0.07$). Participants who received placebo perceived infants with more infantile physical features as more positive at posttreatment than at pretreatment, but oxytocin prevented increase on positive perception. Females who received oxytocin perceived infants with high infantile physical features almost equally positive both at pretreatment and at posttreatment.

The main effect of time on perception of positive characteristics of infants in the medium infantile physical features category did not reach statistical significance, $F(1,38) = 1.963$, $p$ = ns.

No significant interaction between time and drug condition was found on perception of positive characteristics of infants in the medium and low infantile physical features categories. These findings demonstrate that participants` perception of positive characteristics of infants with low and medium infantile physical features was not impacted by drug condition.

There was neither a statistically significant effect of time or drug nor an interaction between time and drug condition on perception of negative characteristics of infants in the high, medium and low infantile physical features categories. Thus, there were no changes on participants` perception of infant negative characteristics over time for oxytocin and placebo groups.

**Conclusion and discussion**

This is the first study which demonstrates the effect of oxytocin on perception of positive and negative infant characteristics. Participants were asked to rate characteristics of infants with high, medium and low infantile physical features before receiving oxytocin or placebo and forty minutes after the administration by nasal spray. In sum, there were differences on perception of infant characteristics at the two time points. Females perceived infants with less infantile physical features as displaying significantly more positive characteristics at posttreatment compared to pretreatment. Participants who received placebo tended to perceive infants with more infantile physical features also as more positive at posttreatment than at pretreatment, however, oxytocin seemed to prevent increase on positive perception. Females who received oxytocin tended to perceive infants with high infantile physical features almost equally positive both at pretreatment and at posttreatment. There were no differences on females' perception of negative characteristics of infants with high, medium and low infantile physical features over time for oxytocin and placebo groups.

The importance of perception of infant cues and characteristics cannot be overestimated. Adults` perception of infant facial features and expressions influences the nature of caretaker-infant interactions (Leinbach & Fagot, 1991; Rogers & Ritter, 2002). To illustrate, mothers of more attractive infants are more affectionate and playful, and these infants are receiving more adult attention and guidance than less attractive infants (Leinbach & Fagot, 1991; Langlois, Ritter, Casey, & Sawin, 1995; Glocker et al., 2009). Nevertheless, there are also other factors which determine individual differences in social perception and caregiving. Research has

implicated oxytocin in prosocial behavior by enhancing positive social perception (Domes et al., 2007a; Guastella et al., 2008; Theodoridou et al., 2009) and in parental behavior by facilitating sensitive parenting and parent-infant bonding (Feldman et al., 2007; Feldman et al., 2010a; Gordon et al., 2010; Naber et al., 2010; Matthiesen et al., 2011).

We found that females perceived infants positive characteristics as significantly more positive at posttreatment compared to pretreatment. This tendency confirmed our pilot study results, showing that females viewing infants repeatedly perceive them as more positive. When looking separately at perception of positive characteristics of infants in three infantile features categories, we found that despite of received drug condition participants perceived infants with less infantile physical features as displaying more positive characteristics at posttreatment compared to pretreatment. In addition, females who received placebo tended to perceive positive characteristics of infants with more infantile features as more positive when viewing them repeatedly. It seems that infants were perceived as more positive after viewing them the second time, because of the females` familiarity with the infant. Familiarity with the infant may be important for adults` evaluation of the infant as well as for sensitive caregiving (Leinbach & Fagot, 1991; Koyama et al., 2006).

However, oxytocin might prevent this time effect on perception of positive characteristics of infants with high infantile physical features. Females receiving oxytocin perceived infants with more infantile physical features equally positive both at pretreatment and at posttreatment. In our sample we only found a trend for an interaction between time of assessment and drug condition. Parsons et al. (2011) demonstrated that infants with high infantile physical features are rated as the most attractive and both women and men are willing to view them for a longer time period compared to infants in the low and medium infantile features categories. Given these previous results, and the acknowledgment of diverse effects of oxytocin (De Dreu et al., 2010; Bakermans-Kranenburg et al., 2011), it is speculated that oxytocin prevents females from more positive perception of positive characteristics of infants with more infantile physical features, when viewing them once again. Adults are already prosocial to infants with more infantile physical features and therefore oxytocin might prevent from even more positive perception. Past research seems to favor the view that oxytocin enhances positive social perception, but selectively (Domes et al., 2007a; Singer et al., 2008; Bartz et al., 2010b).

Our finding supports and extends previous human studies that oxytocin plays a nuanced role in social cognition and benefits only some people (Alvares, Hickie, & Guastella, 2010; Bartz et al., 2010a; Bartz et al., 2010b; Bartz et al., 2011; Bakermans-Kranenburg, Van IJzendoorn, Riem, Tops, & Alink, 2011). There is some evidence that personal and context factors might moderate the effects of oxytocin. Past research demonstrates that social-cognitive competence moderates the effects of oxytocin. For example, oxytocin improved empathic accuracy only for less socially proficient individuals (Bartz et al., 2010b). The effects of oxytocin might also be moderated by individual attachment representations. Bartz et al. (2010a) reported that less anxiously attached individuals remembered their mother as more caring and close after oxytocin (versus placebo), but those male adults who were more anxiously attached remembered their mother as less caring after oxytocin (versus placebo). Parental love-withdrawal is one of the components of insensitive parenting bringing to insecure attachments (Van IJzendoorn, Huffmeijer, Alink, Bakermans-Kranenburg, & Tops, 2011), and it also might moderate the effects of oxytocin. To illustrate, oxytocin increased willingness to donate money to a charity only for females who experienced low levels of parental love-withdrawal (Van IJzendoorn et al., 2011). Also social context might be crucial in shaping the effects of oxytocin on social cognition. The effects of oxytocin might depend on trustworthiness and familiarity with other individuals (Bartz et al., 2011). Declerck and colleagues (2010) found that oxytocin enhanced cooperation in participants who socially interacted before the cooperation game, but decreased cooperation when social information was lacking. Moreover, intranasal administration of oxytocin increased socially included participants desire to play the ball-tossing game once again, but oxytocin did not impact ostracized participants wish to play the game (Alvares et al., 2010).

Although we did not investigate moderating factors on effects of oxytocin, an overall picture emerges that effects of oxytocin depend on personal and context factors. There is some evidence that almost all infants have some of the facial features considered as babyish (high forehead, large eyes and cheeks, small nose and mouth), which as a result induce at least minimal approach and positive attitude from adults (Hildebrandt & Fitzgerald, 1978; Langlois et al., 1995; Casey & Ritter, 1996; Koyama, Takahashi, & Mori, 2006; Glocker et al., 2009). For instance, when viewing an infant`s picture, an adults` typical response is to smile (Hildebrandt & Fitzgerald, 1978) and both children and adults prefer to view pictures of infants over pictures of adults (Fullard & Reiling, 1976; Hildebrandt & Fitzgerald, 1979). Thus, humans have a natural

attraction to infantile physical features and such an attraction increases motivation to engage in caregiving behavior. Our sample includes student population studying education, which indicates that these participants are already open to infants. This could mean that in a context where females are highly prosocial to infants, oxytocin cannot increase positive perception anymore. This is in line with studies demonstrating that oxytocin selectively improves social cognition, demonstrating only a small effect on socially proficient individuals.

Our findings have implications for general caretaker-infant interactions. Oxytocin prevents normally occurring increase on positive perception of infants with high infantile physical features, when viewing those infants the second time. In caretaker-infant relationships it might prevent from enhanced positive perception because of infant`s physical attractiveness. Our finding that infants with less infantile physical features are perceived as more positive when females are familiar with them might also have implications for bonding formation. Physical attractiveness is not the main determinant of perception of an infant`s positive characteristics, when a female is familiar with an infant.

There are several limitations of the study. We tested a population of non-parents, which do not give a view on parents` perception of familiar and unfamiliar infants` characteristics. However, our study demonstrates general perception of infant characteristics, because parents` perception might be influenced by their individual experience. Secondly, we used a single intranasal dose of 16 IU oxytocin while most of the previous studies have used dosages ranged from 18 to 40 IU (MacDonald et al., 2011). We planned to employ nasal spray containing 24 IU of oxytocin, but by force of circumstances we used nasal spray containing 16 IU oxytocin. Although a lesser dosage of oxytocin might not give an expected effect, it should be noted that in recent research Huffmeijer et al. (2012) found that also nasal spray containing 16 IU of oxytocin is sufficient to demonstrate effects of oxytocin and parental love-withdrawal on donating behavior.

In conclusion, the effects of oxytocin are nuanced, and it does not provide broad positive effects on prosocial behavior in every individual in all circumstances. Our results suggest that oxytocin may even prevent from more positive perception of infants with more infantile physical features, when young adults are already highly prosocial to infants. Context and personal factors might impact the effects of oxytocin. Future research might investigate the role of moderating factors (such as love-withdrawal) on effects of oxytocin on perception of infant characteristics.

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