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Association of menstrual cycle phase with the core components of empathy

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ABSTRACT

Evidence has accumulated that emotion recognition performance varies with menstrual cycle phase. However, according to some empathy models, facial affect recognition constitutes only one component of empathic behavior, besides emotional perspective taking and affective responsiveness. It remains unclear whether menstrual cycle phase and thus estradiol and progesterone levels are also associated with the two other empathy constructs.

Therefore, we investigated 40 healthy right-handed females, 20 during their follicular phase and 20 during their midluteal phase and compared their performance in three tasks tapping the empathic components as well as self-report data. Salivary hormone levels were obtained and correlated with performance parameters. Subjects were matched for age and education and did not differ in neuropsychological function. Analysis of empathy performance revealed a significant effect of phase in emotion recognition, showing higher accuracy in the follicular group. Regarding affective responsiveness, we observed a significant difference in reaction times, with faster responses for sad and angry stimuli in the midluteal group. No significant group difference emerged for emotional perspective taking. Furthermore, significant correlations between progesterone levels and emotion recognition accuracy and affective responsiveness emerged only in the luteal group. However, groups did not differ in self-reported empathy.

Our results indicate that menstrual cycle phase and thus ovarian hormone concentration are differentially related to empathic behavior, particularly emotion recognition and responsiveness to negative situations, with progesterone covarying with both in the luteal phase.

Introduction

Behavioral evidence documents that sex hormone concentration affects cognition, emotion and nonverbal behavior, thus a broad spectrum of human behavior, across the whole lifespan starting within the first trimester of pregnancy (for reviews see Boulware et al., 2011; Hines, 2010; Vincent and Tracey, 2010). Concerning emotional abilities in females, previous studies mostly focused on the impact of menstrual cycle phase on facial emotion processing: Pearson and Lewis (2005) reported a significant positive association of estrogen levels with fear recognition, with highest accuracy during the preovulatory phase when estrogen levels are high. Conway et al. (2007) demonstrated that progesterone levels in healthy female subjects are related to intensity ratings of disgusted and fearful but not happy faces. Thus, the authors assume that elevated progesterone levels are associated with increased sensitivity to facial cues carrying sources of threat or contagion. Our preceding findings (Derntl et al., 2008a,b) showed a significant difference in emotion recognition performance across the menstrual cycle, with higher accuracy during the follicular phase which was further supported by a significant negative correlation of progesterone levels with recognition accuracy. Notably, analysis of error tendencies strongly corroborated results by Conway et al. (2007) as we observed statistically significant higher recognition errors for anger and disgust during the luteal phase, thus further supporting the assumption that raised progesterone levels bias behavioral tendencies towards threatening stimuli with the possible aim of protection from any source of threat or danger (e.g., illness). Moreover, Guapo et al. (2009) reported a significant difference in the identification of anger and sadness between females at three different stages of the menstrual cycle, again with better performance during the follicular phase. Authors also observed a significantly negative correlation between estrogen levels and recognition performance for angry male faces, while no significant association between progesterone and performance was mentioned. Thus, previous research showed that performance in facial affect recognition is modulated by menstrual cycle phase. However, studies investigating a broader spectrum of emotional abilities such as empathy are missing.

Empathy, the ability to infer and share another's internal emotional states, is a multidimensional phenomenon. Due to the complexity of the construct, empathy has various definitions (e.g., Preston and

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de Waal, 2002; Singer and Lamm, 2009; Walter, 2012), but most models differentiate between cognitive and affective empathy. Cognitive empathy refers to the ability to understand the feelings of others. It is very closely related to theory of mind (ToM), i.e. the ability to represent and understand the mental states of others in general. Mentalizing about affective states of others is also called affective theory of mind—which is more or less synonymous with cognitive empathy. Affective empathy refers to an affective response that is elicited by the perceived, imagined, or inferred affective state of another person, which has also been called affect sharing or affective responsiveness. In their comprehensive model, Decety and Jackson (2004) postulate that at least three core components of empathy can be derived: (1) recognition of emotions in oneself and others via facial expressions, speech or behavior, (2) an affective component. i.e. the ability to experience similar emotions as others while being conscious that this is the simulation of the emotional feeling and it is not one's own emotion (affective responsiveness), and (3) a cognitive component, i.e. to take the perspective of another person, though the distinction between self and other remains intact (emotional perspective taking).

As shown above several studies investigated emotion recognition across the menstrual cycle and observed significant group differences, but no such study exists for emotional perspective taking or affective responsiveness.

Hence, we examined whether menstrual cycle phase and sex hormone levels (estradiol and progesterone) are associated with the three core components of empathy by comparing females during the early follicular phase with females during the midluteal phase of their menstrual cycle. Our aim was to analyze whether menstrual cycle phase is significantly related to empathy performance, thus higher order emotional abilities. According to previous results (Derntl et al., 2008a,b; Guapo et al., 2009; Pearson and Lewis, 2005) we hypothesized that females during their follicular phase show better emotion recognition performance due to a probably higher social sensitivity even in the early follicular phase (Guapo et al., 2009; Macrae et al., 2002). Moreover, we expected a significant menstrual phase group effect on the other two components, again with better performance of females during the follicular phase.

Materials and methods

Sample

Forty right-handed healthy females aged 19–34 years (mean age 25.3 years, SD = 3.4) participated in the study. When contacted, female participants were asked about their menstrual cycle phase and cycle duration and were then assigned a testing date. Only females who reported regular cycle duration (range: 25–35 days, M = 29.0, SD = 1.8) were included. Twenty females were in their early follicular phase (days 2–5 of menstrual cycle; low estradiol and progesterone levels; FO), and the other 20 were in their midluteal phase (days 18–25 of menstrual cycle; high estradiol and progesterone levels, LU).

Participants were recruited by advertisements at the University of Vienna and the Medical University of Vienna, Austria. The female participants were screened for history of any psychiatric or mental disorder by using the German version of the structured interview of DSM IV (SCID; Wittchen et al., 1997). Written informed consent was obtained from all subjects prior to the examination.

Saliva samples

To obtain actual estradiol and progesterone levels saliva samples were collected on the day of testing. Saliva samples have been shown to have great potential for studying ovarian hormone levels as a reliable, feasible and non-invasive method (e.g., Gandara et al., 2007). Due to the circadian secretion pattern of steroid hormones all samples were collected between 10 am and 12 am. Furthermore, to exclude external hormone influences only females without oral contraceptives or any hormone treatment were included. Before we started obtaining saliva samples we asked participants to wash out their mouth with water. In order to obtain more representative measures, we collected saliva samples for each hormone every half hour, thus we collected three samples per hormone in total (multiple sampling). For data analysis, the values were then averaged across the three samples for each participant and these mean values were used for further analyses. Participants were instructed to fill a small plastic vial with at least 1.5 ml saliva (max. 3 ml) using a straw to stimulate saliva flow. Participants' collection vials were sealed after each collection and frozen immediately in accordance with previous research on sample storage (see Gröschl, 2008).

Saliva samples were analyzed by the European Institute for Salivary Analysis (Swiss Health Med, Aying, Germany) using an enzyme-linked immunoassay method from DRG (DRG Marburg, Germany; Salivary Estradiol ELISA SLV-4188 and DRG Salivary Progesterone ELISA SLV-2931). Analytical sensitivities (confidence interval 95%) were 0.4 pg/ml (Estradiol) and 3.9 pg/ml (Progesterone). For estradiol, intra- and interassay coefficients were 3.8% and 2.6% respectively. For Progesterone, intra- and interassay coefficients were 7.7% and 5.3%, respectively.

For details on hormone concentration and sociodemographic data see Table 1.

Material

Emotion recognition

We used the Vienna Emotion Recognition Task—Shortversion (VERT-K) that consisted of 36 facial expressions of five basic emotions (anger, disgust, fear, happiness, and sadness) as well as neutral expressions taken from a validated stimulus set (Gur et al., 2002). The instruction was to recognize the emotion depicted and a forced-choice answering format with all emotions and neutral was listed on the right side of the screen. The stimuli were balanced with respect to gender, age, intensity, valence, and brightness. All actors were Caucasians and appeared only once. Facial expressions were presented maximally for 5 s and manual response triggered the next stimulus. Scores were calculated as the percent of items judged correctly and reaction times were assessed. The emotion recognition task is described in more detail elsewhere (Derntl et al., 2008a) and has been used in several studies of our group (e.g., Derntl et al., 2008a, 2009, 2011; Seidel et al., 2010a,b).

Emotional perspective taking

Participants viewed 60 pictures each presented for 4 s depicting scenes showing two Caucasians involved in social interaction thereby portraying five basic emotions and neutral scenes (10 stimuli per

Table 1
Demographic information showing mean values and standard deviation in parentheses. Groups differed significantly in their progesterone and estradiol levels (p-values in bold) as expected but had similar age and years of education.

	Early follicular n = 20	Midluteal n = 17	p-Value
Age (years)	25.1 (3.3)	26.0 (3.3)	.39
Education (years)	18.3 (2.2)	18.4 (1.7)	.81
Estradiol (pg/ml)	2.6 (1.3)	3.7 (1.2)	**.02**
Progesterone (pg/ml)	61.1 (17.9)	221.5 (109.9)	<**.001**