Psychoneuroendocrinology (2009) **34**, 1087—1094

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journal homepage: www.elsevier.com/locate/psyneuen

Effects of sex hormonal levels and phases of the menstrual cycle in the processing of emotional faces

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Received 17 December 2008; received in revised form 10 February 2009; accepted 13 February 2009

KEYWORDS
Facial emotion recognition;
Menstrual cycle;
Progesterone;
Estrogen;
Testosterone;
Sex differences

Summary Several neuropsychiatry disorders have shown a sexual dimorphism in their incidence, symptom profile and therapeutic response. A better understanding of the impact of sex hormones in emotional processing sexual dimorphism could bring light to this important clinical finding. Some studies have provided evidence of sex differences in the identification of emotional faces, however, results are inconsistent and such inconsistency could be related to the lack of experimental control of the sex hormone status of participants. More recently, a few studies evaluated the modulation of facial emotion recognition by the phase of the menstrual cycle and sex hormones, however, none of them directly compared these results with a group of men. We evaluated the accuracy of facial emotion recognition in 40 healthy volunteers. Eleven women were assigned to early follicular group, nine women to the ovulatory group and 10 women to luteal group, depending on the phase of menstrual cycle, and a group of 10 men were also evaluated. Estrogen, progesterone and testosterone levels were assessed. The performance of the groups in the identification of emotional faces varied depending on the emotion. Early follicular group were more accurate to perceive angry faces than all other groups. Sadness was more accurately recognized by early follicular group than by luteal group and regarding the recognition of fearful faces a trend to a better performance and a significantly higher accuracy was observed, respectively, in the early follicular group and in the ovulatory group, in comparison to men. In women, estrogen negatively correlated to the accuracy in perception of angry male faces. Our results indicate sex hormones to be implicated in a sexual dimorphism in facial emotion recognition, and highlight the importance of estrogen specifically in the recognition of negative emotions such as sadness, anger and fear.

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doi:10.1016/j.psyneuen.2009.02.007

1. Introduction

Despite extensive investigation and increasing interest in sex differences in cognitive abilities and emotional processing, this issue remains unresolved, mainly because of several reported studies with negative results (Sanders et al., 2002) and of misconceptions about the meaning of these differences (Cahill, 2006). A better understanding of sexual dimorphism in cognitive and emotional abilities has clinical implications, since several neuropsychiatry disorders have sexual dimorphism in their incidence (Kessler et al., 1993, 1994, 1995), symptom profile (Rapaport et al., 1995; Hirschfeld and Russell, 1997; Dickerson, 2007), and therapeutic response (Kornstein et al., 2000; Simon et al., 2006).

There is reported evidence on sexual differences in brain structure and function. It has long been known that the average brain volume of women is smaller than that of men (Allen et al., 2003) and a sexual dimorphism has also been shown in regard to the size and function of brain regions implicated in cognitive abilities and emotion processing, such as the hippocampus and the amygdala (Goldstein et al., 2001). Behavioral results have also pointed to differences between men and women in the performance of several neurocognitive tasks. Women seem to perform better in tasks of verbal fluency, episodic memory, perceptual speed and fine motor skills, while men score higher in tasks of visual memory, spatial and mathematical abilities (Halpern and Tan, 2001).

It has been proposed that genes located in the sex chromosomes determine brain sexual dimorphism in two ways: by acting on the gonads to induce differences in levels of hormones that have sex-specific effects on the brain, and by acting in the brain itself to differentiate XX and XY neurons (Arnold, 2004). Regarding the role of sex hormones, it has been suggested that they exert greater influence at two different life stages: the prenatal gonodal hormones affect brain organization during development (Collaer and Hines, 1995) and circulating gonodal steroids modulate brain functioning in adults (Kimura, 2002). Plasma levels of estrogen, progesterone and testosterone are markedly different in men and women, and have been assumed to determine sex differences in brain functioning of human adults (Halpern and Tan, 2001). Moreover, estrogen and progesterone vary in a cyclic fashion in adult women, but not in men, what may also account for differences in brain functioning that vary along the menstrual cycle.

The identification of basic emotions in facial expressions is an important ability for social interaction. Some studies have provided evidence for a sexual dimorphism in the identification of emotional faces, with a trend to a better performance for women, in comparison to men (Ladavas et al., 1980; Kirouac and Dore, 1984; Erwin et al., 1992; Hall et al., 1999; Hall and Matsumoto, 2004), although, negative results have also been reported (Gitter et al., 1972; Braun et al., 1988; Duhaney and McKelvie, 1993; Kesler-West et al., 2001; Oyuela-Vargas and Pardo-Velez, 2003; Hall et al., 2004). A likely possibility is that such inconsistent results are due to the lack of experimental control of the phase of the menstrual cycle of the female participants.

More recently, the influence of the menstrual cycle sex hormones in facial information processing has been investigated, interesting results come from studies of facial preferences (Jones et al., 2008) and working memory for emotional facial expressions (Gasbarri et al., 2008), but very few studies addressing the impact of sex hormones in facial emotion perception has been carried out so far. For instance, it has been shown that women in phases of the menstrual cycle characterized by higher levels of estrogen (periovulatory phase) were significantly more accurate in recognizing fearful faces than women in phases of the menstrual cycle with lower estrogen levels (follicular phase) (Pearson and Lewis, 2005). Also, higher levels of progesterone have been associated to a better accuracy in perceiving fearful and disgusted expressions with averted gaze as more intense than those with direct gaze (Conway et al., 2007). However, conflicting results have also been reported: women in the follicular phase (lower levels of progesterone) were more accurate in recognizing all emotions than women in luteal phase (higher levels of progesterone). The behavioral performance was associated to stronger amygdalar activation to emotional faces, measured through functional magnetic resonance imaging (fMRI), with a negative correlation between plasma level of progesterone and amygdalar response to fearful, sad and neutral faces (Derntl et al., 2008a,b).

The present study further explores the role of sex hormones and phases of the menstrual cycle in sex-mediated differences in emotional processing. For, this, the ability of healthy women in identifying facial expressions of basic emotions at three phases of the menstrual cycle having different hormonal status has been compared. We also included healthy male volunteers in our sample, to verify whether the detection of sex differences depends on the phase of the female menstrual cycle. We have hypothesized that the phases of the menstrual cycle that are characterized by higher levels of estrogen and progesterone would be related to a decrease in the identification of negative emotions.

2. Methods

2.1. Participants

Thirty healthy women aged 18—29 years (mean + S.D. 22.1 + 2.9) and ten healthy men aged 20—34 years (mean + S.D. 22.4 + 4.1) were recruited from college students and hospital staff.

All volunteers were screened using the Portuguese version (Del-Ben et al., 2001) of the Structured Clinical Interview for DSM IV, clinical version (SCID—CV; First et al., 1997) to rule out current axis I psychiatry disorders. Exclusion criteria also comprised any serious general medical condition or the use of psychotropic medication or illicit drug in the last 3 months.

Just women that reported regular menstrual cycle (26—31 days) and no hormonal contraceptive use in the last 3 months were included in the study. After the screening interview, women were asked to call as soon as they started their menstrual period (day 1) and the experimental session was booked in one of three experimental groups: early follicular (days 1—5 of onset of menses), ovulatory (days 12—14 of onset of menses) or luteal (days 21—23 of onset of menses).

The study was approved by the local ethical committee, and informed consent was obtained from all volunteers.