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Effects of menstrual cycle and neuroticism on females' emotion regulation

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ABSTRACT

Fifteen highly neurotic women and 21 women who were low in neuroticism participated in this study. The women were surveyed three times over a single menstrual cycle during the mid-late luteal, menstrual, and late follicular phases. Each time, the participants were asked to use reappraisal to regulate their emotions, which were evoked by a sad film clip, and their subjective emotional experiences and physiological responses were recorded. The results showed that neuroticism had no impact on emotion regulation, and the females experienced fluctuations in their emotion regulation success over their menstrual cycle. During the menstrual phase, women reported significantly higher levels of reappraisal, but subjective sadness did not differ throughout the three phases. Additionally, the regulation effects on galvanic skin response (GSR) were smaller during the menstrual phase than in the mid-late luteal phase. These results suggested that women in the menstrual phase expended more effort but gained less success at regulating their emotions.

1. Introduction

The menstrual cycle is a normal physical process that all women experience and is characterized by tightly orchestrated changes in the levels of ovarian estrogen and progesterone. Researchers have confirmed that diverse body systems (e.g., cardiovascular system, central nervous system, endocrine system, female reproductive system, and immune system) are replete with estrogen receptors and that progesterone also acts on numerous tissues. Therefore, cyclically fluctuating levels of estrogen and progesterone have a significant biological effect on the female body, one with both physical and emotional ramifications (for a review, see Farage et al., 2009). Because of the initiation and mediation roles that these two hormones play in the menstrual cycle, a menstrual cycle can be divided into three phases that are characterized by levels of these hormones. The menstrual phase starts with the onset of menstrual flow, lasts between four and six days, and is characterized by low levels of both progesterone and estrogen. The follicular phase typically begins on day 7 and ends on day 14. Estrogen levels rise rapidly in the late follicular phase (i.e., postmenstrual phase) and reach their peak one day before ovulation. The luteal phase is typically defined as the period between days 15 and 28, during which there is a steady rise in progesterone levels that peak in the mid-luteal phase (i.e., premenstrual phase), in parallel with a second estrogen peak (for a review, see Farage et al., 2008).

Surveys conducted with Chinese women have indicated that approximately 20% to 30% of participants experience physical and/or psychological discomfort during their premenstrual phase (i.e., luteal phase), as well as their menstrual phase, with the most common emotional symptoms being irritability and mood swings (Lee et al., 2009; Yu et al., 1996). According to a review of prospective data studies, a majority of studies (61.7%) have found that mood swings occur during the menstrual cycle (Romans et al., 2012). Researchers suggested that women's emotional responses to negative stimuli appear to be decreased by estrogen but enhanced by progesterone (for a review, see Sakaki and Mather, 2012). Consistent with this, studies that use negative emotional material as stimuli have found that compared to women's responses during the late follicular (high estrogen and low progesterone) phase, women's emotional responses are more intense during the menstrual (low estrogen and low progesterone) phase (Andreano and Cahill, 2010; Goldstein et al., 2005) or the late luteal (low estrogen and high progesterone) phase (Derntl et al., 2008; Gingnell et al., 2012; Ossewaarde et al., 2010).

Some studies have implied that women's emotion regulation may also be influenced by the menstrual cycle. Researchers have studied

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the pattern of change regarding the resting frontal alpha asymmetry across the menstrual cycle and have found that left frontal activity is relatively higher in the menstrual phase than in the late follicular phase (Hwang et al., 2008). In a similar study, researchers used emotional faces as stimuli and found higher left frontal activity during the menstrual phase than in the late follicular phase when participants were presented with fearful faces (Hwang et al., 2009). Using functional magnetic resonance imaging in female subjects, researchers found that orbitofrontal cortex (OFC) activity for negative vs. neutral linguistic stimuli increased in the luteal phase and decreased in the follicular phase (Protopopescu et al., 2005). The regions of the left frontal cortex and OFC have most consistently been implicated in cognitive control processes, including emotion regulation (for a review, see Phillips et al., 2008). Thus, these brain imaging results indicate that the menstrual cycle may influence emotion regulation.

However, the following question arises: Why do women have more intense emotional responses during the menstrual or luteal phases (Andreano and Cahill, 2010; Derntl et al., 2008; Gingnell et al., 2012; Goldstein et al., 2005; Ossewaarde et al., 2010), even though their activation of brain regions related to emotion regulation appear to be higher during these two phases (Hwang et al., 2008; Hwang et al., 2009; Protopopescu et al., 2005)? We believe that one possible explanation is that women do make more efforts to regulate negative emotions during the menstrual or luteal phases, but their efforts may not give them the expected return. To test this possibility, we need to investigate women's efforts and success at regulating their emotions in an emotion regulation paradigm.

It should be noted that previous studies still have several limitations. First, researchers have not investigated women's emotional responding with respect to a task that calls for intentional emotion regulation. Second, previous lab studies compared women's emotional responses and brain activity to emotional stimuli during the menstrual (Andreano and Cahill, 2010; Goldstein et al., 2005; Hwang et al., 2009) or luteal phase to those during the follicular phase (Derntl et al., 2008; Gingnell et al., 2012; Ossewaarde et al., 2010; Protopopescu et al., 2005); however, they failed to find differences between the luteal and menstrual phases in terms of emotional responding. Third, previous studies have not focused on individual differences. Women's unique traits may play a role in determining their emotional responding during a menstrual cycle. For example, researchers have found that subjective experience and physiological responses towards negative emotion during a menstrual cycle are more influential for neurotic women than they are for women who are low in neuroticism (Wu et al., 2014). Furthermore, it has been observed that women who are high in neuroticism report having more premenstrual symptoms than women who are low in neuroticism do (Treloar et al., 2002; Van Den Akker et al., 1995). Generally, researchers consider neuroticism to be an influential factor regarding emotional experience; indeed, people high in neuroticism are particularly susceptible to negative mood inductions (Thake and Zelenski, 2013). However, the relationship between neuroticism and emotion regulation during a menstrual cycle requires further study.

Based on the previous studies, the aim of the current study was to test the effects of the menstrual cycle and neuroticism on females' emotion regulation efforts and success. We investigated the emotional outcomes for highly neurotic women and women low in neuroticism when they were instructed to regulate induced negative emotions. All participants were tested three times, once during their mid-late luteal phase, once during menstrual phase and once during the late follicular phase. The specific emotion regulation strategy that we tested was cognitive reappraisal, which is defined as construing a potentially emotion-eliciting situation in nonemotional terms. Experimental studies have observed reappraisal to be an effective strategy for decreasing negative emotional experience, physiological arousal and behavioral expression (for a review, see Gross, 2002). According to our previous findings, highly neurotic women's physiological responses (i.e., galvanic skin response, heart rate) are more likely to be affected by their menstrual cycle than those of women low in neuroticism when watching sad film clips (Wu et al., 2014). Similarly, we used sad film clips as stimuli, and the mean amplitude of galvanic skin response (GSR) and heart rate (HR) were used as physiological arousal indices in the current study. GSR and HR were sensitive to sadness arousal (Kreibig et al, 2007; Kreibig, 2010; Troy et al., 2010; Wu et al., 2014), and they could be regulated by reappraisal, according to previous studies (Giuliani et al., 2008; Yuan et al., 2011).

Emotion regulation success can be measured by the decrease of negative emotions and physiological arousal after cognitive reappraisal of negative stimuli (McRae et al., 2012; Troy et al., 2010). We adopted a 9-point scale for the assessment of self-reported efforts of cognitive reappraisal (Gruber et al., 2012). Two hypotheses related to emotion regulation across the menstrual cycle were tested: (1) highly neurotic participants reported more efforts of cognitive reappraisal in the menstrual and mid-late luteal phases than in the late follicular phase, while the self-reported efforts of participants low in neuroticism didn't differ across the menstrual cycle; (2) highly neurotic participants' emotion regulation success was smaller in the menstrual and mid-late luteal phases than in the late follicular phase, while success of participants low in neuroticism didn't differ across the menstrual cycle.

2. Method

2.1. Participants

Ninety-six female graduate students completed the Revised Eysenck Personality Questionnaire Short Scale for Chinese (EPQ-RSC; Qian et al., 2000). Ultimately, 36 participants were obtained, based on their responses on the EPQ-RSC. They were divided into two groups based on their neuroticism (N) subscale scores on the EPQ-RSC, and the two groups were matched on their scores for extraversion/introversion (E), psychoticism/socialization (P), and lying (L). The high-neuroticism group (HN group) contained 15 participants whose N scores were higher than the norm, and the low-neuroticism group (LN group) consisted of 21 participants whose N scores were lower than the norm. All of the participants were healthy, right-handed Chinese women with regular menstrual cycles and no diagnosis of PMS, which was screened by use of the Premenstrual Syndrome Questionnaire (PMS, Bancroft, 1993). Exclusion criteria included pregnancy, breastfeeding, use of hormonal contraception, history of substance abuse, treatment of psychotropic drugs, or presence of any ongoing psychiatric disorder. Absence of depression and anxiety symptoms was confirmed by using the Beck Depression Inventory (BDI) and Beck Anxiety Inventory (BAI) for Chinese people (Wang et al., 1999).

Table 1
Demographic data and scale scores of HN group and LN group ($M \pm SD$).

		LN group ($n = 21$)	HN group ($n = 15$)	t
Age, years		25.10 ± 0.89	25.27 ± 1.03	0.53
Menarche age, years		13.33 ± 1.24	13.20 ± 1.21	0.32
Menstrual phase, days		5.19 ± 1.29	5.87 ± 0.99	−1.70
Menstrual cycle, days		28.71 ± 1.49	29.93 ± 2.71	−1.73
BDI		1.48 ± 1.33	2.80 ± 2.48	−2.07*
BAI		22.67 ± 1.62	24.87 ± 3.04	−2.81**
EPQ-RSC	N	37.25 ± 2.93	54.71 ± 2.63	−18.39***
	P	46.79 ± 6.93	47.00 ± 8.78	−0.80
	E	56.62 ± 9.89	51.29 ± 11.27	1.50
	L	52.34 ± 8.88	47.83 ± 8.57	1.53

Note: Menarche age refers to the age when menstruation first occurs in a woman's life. Menstrual phase here refers to the duration of the menstrual phase in a single menstrual cycle. Menstrual cycle here refers to the interval between two consecutive menstrual cycles.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.