Anxiety Symptoms and Precautionary Behaviour across the Menstrual Cycle: The Role of Hormones

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Abstract

The present study examined the influence of hormones on obsessive-compulsive disorder (OCD) symptoms and related phenomena across the menstrual cycle. After exclusions, 223 participants (51 free-cycling women, 100 hormonal contraceptive users, and 72 men), completed questionnaires on disgust sensitivity, OCD symptoms, responsibility beliefs, risk-taking, and anxiety two weeks apart using a within-subjects design (follicular and luteal phases for free-cycling women). Laboratory participants (n = 178) also completed an emotion discrimination task, had 2D:4D measured, and a subset of women provided saliva samples (n = 56). Contrary to the compensatory prophylaxis hypothesis, subclinical OCD contamination symptoms, disgust sensitivity, and related phenomena did not increase with progesterone levels. However, changes in salivary progesterone levels across the cycle were positively correlated with changes in anxiety and negatively correlated with risk-taking. Sexual activity and level of contamination fears were significant moderators of behavior change across the cycle. Non-sexually active (versus sexually active) women and women with high (versus low) contamination fears showed an increase in OCD symptoms from the follicular to the luteal phases. Women with PMS (versus those without) showed increased OCD symptoms, disgust-sensitivity and responsibility beliefs at both phases of the menstrual cycle. Finally, women were more sensitive to detecting facial expressions of disgust than men. Greater disgust sensitivity detection was also associated with higher 2D:4D, and use of oral contraceptives with either high progesterone dosage or low androgenicity. The current findings suggest that perhaps not all women experience an increase in precautionary behaviour across the menstrual cycle, but that there may be subgroups of women who are more susceptible to behavioural changes as a result of fluctuating hormone levels.

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Table of Contents

List of Tables

List of Figures

Anxiety Symptoms and Precautionary Behaviour across the Menstrual Cycle: The Role of Hormones

There are particular "windows of vulnerability" across a woman's lifetime where the risk of mood disturbance increases, such as puberty, the premenstrual phase, pregnancy, the postpartum period, and menopause (Soares, 2010b). Reproductive events such as the premenstrual phase, pregnancy, and the postpartum period have also been shown to affect obsessive compulsive symptoms in women (Labad et al., 2005). These major reproductive events correspond to periods of fluctuating reproductive hormone levels in women (e.g., estrogen and progesterone). Emerging research suggests that the hormone progesterone may affect obsessive-compulsive symptoms related to fears of contamination. Examining the association between hormones and sub-clinical obsessive compulsive symptoms (and related phenomena) may help to explain sex differences in anxiety symptoms.

Mood across reproductive events

Rates of depression are equivalent between boys and girls in childhood but radically shift as women experience menarche, or the commencement of menstruation. Following puberty women are two times more likely to develop depression compared to men, a difference that persists throughout the reproductive years and declines again following menopause (Steiner, 2009). These marked sex differences in mood have implicated gonadal steroid hormones (e.g., estrogen, progesterone) in the development of depression. Women experience a series of reproductive events across the lifespan that are accompanied by specific hormonal changes. These include menarche, across different menstrual cycle phases, pregnancy, the postpartum period, and menopause.

Menarche. Puberty refers to a series of changes that take place in adolescence to develop the capacity for reproduction. Pubertal changes include the development of primary and secondary sexual characteristics (e.g., development of the sex organs and pubic hair growth), physical maturation (e.g., growth spurt), and the occurrence of specific events such as menarche (first menstruation) for women and oigarche (first ejaculation) for men (Reardon, Leen-Feldner, & Hayward, 2009). Although puberty occurs on average between the ages of 12 and 13, pubertal changes can span over the course of up to four years (Reardon et al., 2009). Compared to other aged-matched peers, onset of puberty can be early, on-time, or late (Reardon et al., 2009). In a longitudinal study of over 2,000 girls, Joinson, Heron, Lewis, Croudace, and Araya (2011) found earlier age at menarche was associated with higher levels of depressive symptoms compared to girls with a normal and later age at menarche.

The menstrual cycle. In order for women to be able to reproduce, a complex process is maintained on a monthly basis by the secretion of hormones from several endocrine glands. The hypothalamus secretes gonadotropin-releasing hormone (GnRH) through the hypophyseal portal system to the anterior pituitary (Hawkins & Matzuk, 2008). Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) are then secreted from the anterior pituitary and travel through the bloodstream to reach the ovaries (Becker, Breedlove, Crews, & McCarthy, 2001). Follicle-stimulating hormone, as the name suggests, stimulates the growth of follicles in the ovary. Each follicle contains an egg, or an oocyte (Greenberg, Bruess, & Conklin, 2011).

The menstrual cycle can be divided into three general phases: the follicular phase (days 1-13), ovulation (days 13-14), and the luteal phase (days 15-28; Sigmon & Schartel, 2008). Although the average cycle length is 28 days, there is significant variation in cycle length with anywhere from 24 to 35 days considered normal (Sigmon & Schartel, 2008). The menstrual

cycle also has a number of sub-phases within the overarching phases. Although there are subtle differences across definitions, days 1-5 generally correspond to the early follicular or menstrual phase, days 6-10 to the mid-follicular or postmenstrual phase, days 11-14 to the late follicular or periovulatory phase, days 15-18 to the early luteal phase, days 19- 23 to the mid-luteal phase, and days 24-28 to the late luteal phase (Bäckström, Boyle, & Baird, 1981; Sanders, Warner, Bäckström, & Bancroft, 1983).

During the follicular phase the ovaries secrete estrogen, which causes the endometrium (lining of the uterus) to proliferate (Hawkins & Matzuk, 2008; Luria, Friedman, & Rose, 1987). As estrogen levels increase throughout the late follicular phase, a negative feedback signal is sent back to the anterior pituitary causing a surge in LH that triggers ovulation (Hawkins & Matzuk, 2008). The release of an egg leaves a ruptured follicle that becomes the corpus luteum. During the luteal phase the corpus luteum secretes progesterone and estrogen and the endometrium thickens in order for a fertilized embryo to attach (Greenberg et al., 2011; Hawkins & Matzuk, 2008; Luria et al., 1987). High levels of estrogen and progesterone cause negative feedback which keeps FSH and LH levels low. If the egg is not fertilized and fails to attach, the corpus luteum degenerates and progesterone and estrogen levels consequently drop (Luria et al., 1987). Decreased levels of estrogen and progesterone signal the endometrium to shed, or menstruation to begin. During the menstrual or early follicular phase FSH levels start to rise and the cycle starts anew.

Both estrogen and progesterone levels fluctuate across the menstrual cycle, but show considerably different patterns. Progesterone levels remain low throughout the early and mid-follicular phases, and start to rise during the late follicular phase just prior to ovulation. Progesterone levels continue to rise during the early luteal phase, peak during the mid-luteal

phase, and then begin to fall during the late luteal phase (Sanders et al., 1983). In contrast, estrogen levels are initially low during the early follicular phase, rise in the mid-follicular phase, and peak in the late follicular phase just prior to the LH peak. Estrogen levels fall after the late follicular phase peak, then begin to rise again during the early luteal phase, peak during the mid-luteal phase, and then fall during the late luteal phase (Sanders et al., 1983).

For many women natural changes in estrogen and progesterone levels across the menstrual cycle have noticeable effects on mood. Premenstrual syndrome (PMS) is likely the most well-known mood disturbance related to the menstrual cycle. Premenstrual symptoms can include sadness, tension/anxiety, mood lability, irritability or anger, lack of interest in normal activities, fatigue, appetite changes, insomnia, feeling overwhelmed, and physical symptoms such as headaches, muscle pain, bloating, or breast tenderness (American Psychiatric Association, 2000). A recent large-scale study of nearly 4,000 women (Tschudin, Bertea, & Zemp, 2010) found that 91% of women sampled experienced at least one PMS symptom, but only 10.3% met criteria for PMS according to the Premenstrual Symptoms Screening Tool (PSST; Steiner, Macdougall, & Brown, 2003). To meet criteria for PMS according to the PSST women must experience at least five symptoms that occur exclusively in the pre-menstrual period, which moderately to severely interfere with at least one of five psychosocial domains of functioning (Steiner et al., 2003). There appears to be a genetic component to PMS, as concordance rates for identical twins are 90% compared to 44% for fraternal twins (Clayton, 2008). Furthermore, PMS is more likely in women whose mothers have a history of PMS, although this could also be due to environmental causes such as attitudes and expectancies surrounding menstruation (Clayton, 2008).

Premenstrual Dysphoric Disorder (PMDD) is a more severe form of premenstrual mood disturbance that significantly interferes with work, school, or social functioning, or causes significant distress. It is far less common than PMS, occurring in only 3 to 8% of women (Steiner, Dunn, & Born, 2003). Although PMDD was previously listed under "Criteria Sets and Axes Provided for Further Study" (i.e., Appendix B) of the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR*; American Psychiatric Association, 2000, p. 759), it has been added to the *DSM-5* as a new depressive disorder (American Psychiatric Association, 2013). In order to meet criteria for PMDD, five of the following nine symptoms must be present: marked affective lability, marked irritability, marked depressed mood, marked anxiety, decreased interest in usual activities, difficulty concentrating, lack of energy/fatigue, hypersomnia/insomnia, feeling out of control/overwhelmed, and physical symptoms such as breast tenderness and bloating. Out of the four core affective symptoms (i.e., depressed mood, anxiety, irritability/anger, and affective lability), at least one must be present (Sigmon & Schartel, 2008). Most importantly, these symptoms must be present during the week before menstruation, improve shortly after the onset of menses, and be minimal or absent in the week after menses (American Psychiatric Association, 2013; Tschudin et al., 2010).

Given the lack of reliability with retrospective self-reports, prospective daily measures are needed across two cycles in order to more accurately diagnose PMDD (American Psychiatric Association, 2011; Sigmon & Schartel, 2008). However, this gold-standard approach is not always feasible in research or in practice. It is also expected that to receive the diagnosis, symptoms must be present in the majority of menstrual cycles in the past year. A diagnosis of PMDD should not be given if there is premenstrual exacerbation of another disorder (e.g., major depression, panic disorder; American Psychiatric Association, 2011). However, distinguishing

between PMDD and premenstrual exacerbation of anxiety or mood disorders can be extremely challenging. There is significant comorbidity between diagnoses of PMDD and major depression, as 30 to 70% of women with PMDD have a history of a depressive episode (Burt & Stein, 2002). Furthermore, selective serotonin reuptake inhibitors (SSRIs) have been found to be effective for treating both depression and PMDD (Braverman, 2007; Soares & Zitek, 2008). Although this suggests a common cause, SSRI treatment for PMDD improves symptoms immediately (1-2 days) rather than requiring 4 to 6 weeks, and is only needed during the luteal phase of the menstrual cycle rather than continuously (Braverman, 2007).

Hormonal contraceptives. Contraceptive use is very common in women of childbearing age, with one national study finding that 62% of women aged 15-44 in the United States were using some form of contraception between 2006 and 2010 (Jones, Mosher, & Daniels, 2012). There are a number of different methods of contraception, including pills or oral contraceptives (OCs), contraceptive patch (e.g., Ortho-Evra), injectable birth control (e.g., Depo-Provera), vaginal rings (e.g., NuvaRing), implant (e.g., Implanon), intrauterine device (IUD), and barrier methods (e.g., diaphragm, cervical cap; Jones et al., 2012). Whereas the methods listed above are reversible, there are also permanent methods of birth control such as female sterilization. Of all the types of contraception, the pill was found to be the most common contraceptive method for younger women and female sterilization was the most common method for older women (Jones et al., 2012).

Oral contraceptive pills come in many different formulations with different types of synthetic hormones. Ethinyl estradiol (EE) is the form of estrogen typically used in OCs whereas several different types of progestins are used across different brands of OCs (e.g., norgestimate, desogestrel; Kiley & Hammond, 2007). OCs can be described as monophasic or triphasic

according to their specific formulations. Monophasic OCs supply consistent amounts of estrogen and progesterone across the first three weeks of the cycle whereas triphasic OCs provide increasing amounts of progesterone each week (Kiley & Hammond, 2007). The final week is either a pill-free interval or consists of placebo pills, which are hormonally equivalent (Kiley & Hammond, 2007). Triphasic pills were created with the aim of more naturally mimicking the menstrual cycle as well as decreasing side effects (Van Vliet, Grimes, Lopez, Schulz, & Helmerhorst, 2006). In a meta-analysis of 21 trials, Van Vliet and colleagues (2006) found that mono and triphasic formulations were equally effective for contraception and there were no differences in the rates of discontinuation. Extended use OCs are also available (e.g., Seasonale), where a woman can reduce the number of menstrual periods down to four a year by taking 84 straight days of active pills (Kiley & Hammond, 2007). Thus, Seasonale contains the same formulation of hormones as other monophasic OCs, but removes the monthly seven day pill-free interval. Extended use OCs have demonstrated long-term safety (Anderson, Gibbons, & Portman, 2006) and are similar to standard 28-day cycle OCs in terms of contraceptive efficacy, compliance, and satisfaction rates (Edelman, Micks, Gallo, Jensen, & Grimes, 2014). There is also evidence suggesting that extended use OCs may reduce premenstrual symptoms (Coffee, Kuehl, Willis, & Sulak, 2006; Edelman et al., 2014), although more research is needed in this area.

Oral contraceptives contain a combination of estrogen and progesterone that inhibit LH, FSH, and GnRH levels and thereby typically prevent ovulation from occurring (Rapkin, Biggio, & Concas, 2006). Women taking OCs do not experience the characteristic rise of estrogen and progesterone across the cycle and therefore they act as a naturally occurring control group for menstrual cycle research (Fleischman, Navarrete, & Fessler, 2010). Thus, women taking OCs

show clear hormonal differences compared to naturally cycling women, including lower serum levels of estradiol and progesterone (Fleischman et al., 2010; Kjeld, Puah, & Joplin, 1976), and more recently evidence has emerged suggesting lower androgen levels. A recent meta-analysis of over 40 studies concluded that OC use significantly decreased circulating levels of total and free testosterone (Zimmerman, Eijkemans, Coelingh Bennink, Blankenstein, & Fauser, 2014).

Oral contraceptives differ in their level of androgenicity or androgen receptor binding, which may have an effect on mood symptoms. Some formulations of OCs contain progestins with high levels of androgenic activity (e.g., norgestrel, levonorgestrel), while other formulations contain progestins with anti-androgenic properties (e.g., drospirenone, norgestimate; Chiang, 2005; Dickey, 2010). Research suggests that low androgenicity OCs may have a more favourable effect on mood compared to high androgenicity OCs (Poromaa & Segebladh, 2012).

Research suggests that hormonal contraceptives may have a protective effect on mood. In a review of the effects of OCs on mood, Oinonen and Mazmanian (2002) found that generally speaking, OC users experience less variability in affect across the menstrual cycle and less negative affect during menstruation compared to non-users. Monophasic OCs were found to provide more mood stability compared to triphasic OCs (Oinonen & Mazmanian, 2002). Furthermore, a recent study of a large sample of sexually active women in the United States found that current hormonal contraceptive users (aged 25-34) had lower levels of depressive symptoms compared to women using non-hormonal contraception or no form of contraception, even when controlling for past depressive symptoms (Keyes et al., 2013). Oral contraceptives can be helpful for women with severe premenstrual symptoms, as they have been shown to improve negative mood symptoms (e.g., Nyberg, 2013).

Despite the seemingly protective effect of OCs on mood, there is a subset of women who experience adverse mood and somatic symptoms when taking OCs (Oinonen & Mazmanian, 2002). Prospective studies suggest that between 4 and 10% of women experience deterioration in mood or emotional well-being as a result of OC use, with these symptoms being most pronounced during the pill-free interval of the cycle (Poromaa & Segebladh, 2012). A prior history of depression or premenstrual mood symptoms, pregnancy-related mood symptoms, family history of OC-related mood symptoms, and being in the postpartum period were several factors that Oinonen and Mazmanian (2002) identified as increasing the risk for women experiencing negative mood symptoms as a result of OC use. Use of OCs can also affect symptom severity for existing psychological conditions. For instance, in a small retrospective study of 16 patients diagnosed with OCD, Labad and colleagues (2006) found that 19% of patients reported that OC use was associated with a change in OCD symptoms. Two patients reported an improvement in symptoms and one patient reported a worsening of symptoms. Therefore, OC use may represent an additional period of vulnerability to fluctuating hormone levels in some women.

The postpartum period. Although depressive symptoms can occur during pregnancy, the postpartum period is still recognized as a time of particular vulnerability for a range of mood disturbances. There appears to be something unique about the postpartum period which triggers index episodes of depression (Stowe & Nemeroff, 1995). Depressive symptoms can range considerably in severity from the “baby blues” to postpartum depression.

The “blues” is the most common postpartum mood disturbance, occurring in 39 to 85% of mothers (Spinelli, 1998). Symptoms include tearfulness, fatigue, dysphoria, mood lability, irritability, insomnia, and fatigue (Heron, Craddock, & Jones, 2005; Steiner et al., 2003).

Symptoms typically emerge in the first week postpartum, peaking around day 5, and subside by the second week postpartum (Steiner et al., 2003). Due to the common occurrence of the blues and the fact that symptoms typically resolve themselves, treatment is not generally sought for this condition (Heron et al., 2005). However, women who experience the blues are thought to be at a greater risk of developing postpartum depression (Spinelli, 1998; Steiner et al., 2003). Therefore, in some cases the blues can endure and lead to more serious depressive symptoms.

Postpartum depression is a more severe form of the blues and occurs in between 10 to 15% of women following delivery (Steiner et al., 2003). For 50% of women who experience postpartum depression, it is their first mood episode (Stowe & Nemeroff, 1995). Although the diagnostic criteria for postpartum depression is the same as depression at any other stage of life, the *DSM-IV-TR* includes additional symptoms which may be more specific to the postpartum period such as mood lability, anxiety, preoccupation with the well-being of the infant, over-intrusiveness, and disinterest or fear of being alone with the infant (American Psychiatric Association, 2000). Similarly, Sharma (2005) refers to additional symptoms which may occur in the postpartum including features of anxiety such as obsessionality, feeling inadequate as a mother, and having a fear of harming the baby.

Menopause. By the age of 51, most women experience menopause, or the absence of menstruation for 12 consecutive months (Burt & Stein, 2002). Perimenopause marks the 5 to 15 year period of gradual estrogen depletion until the cessation of menstruation, or amenorrhea (Burt & Stein, 2002; Deecher, Andree, Sloan, & Schechter, 2008; Rapkin, Mikacich, Moatakef-Imani, & Rasgon, 2002). Perimenopause is a time of particular variability in estrogen levels as menstrual cycles become more irregular closer to menopause (Douma, Husband, O'Donnell, Barwin, & Woodend, 2005; Rapkin et al., 2002). The perimenopausal period has been found to

be a time of heightened risk for developing depression. Women with a history of depression during other reproductive events are especially at risk for relapse during perimenopause (Parry, 2008). A perimenopausal period of longer duration has also been found to increase the risk of depression (Rapkin et al., 2002).

In terms of new onset of depression, Cohen, Soares, Vitonis, Otto, and Harlow (2006) examined 460 pre-menopausal women between the ages of 36 and 45 with no prior history of major depression. After controlling for age upon entering the study and negative life events, women entering perimenopause were twice as likely to develop symptoms of depression compared to women who did not begin the transition to menopause. A similar study of 231 pre-menopausal women without a history of depression was conducted by Freeman, Sammel, Lin, and Nelson (2006). After an eight year follow-up period, 43% of participants had begun transitioning to menopause. Women who had begun the menopause transition were four times more likely to have high depression scores compared to premenopausal women. Interestingly, variability in mean estradiol levels was associated with high depressive scores, highlighting the possible role of fluctuating estrogen levels in the development of depression.

Hormones and mood

The mood-altering effects of estrogen have been well documented. Estrogen receptors have been found throughout the brain in areas such as the amygdala, the hippocampus, and the hypothalamus, to name a few (Soares & Zitek, 2008; Wise, Felker, & Stahl, 2008). Estrogen has been found to modulate a number of neurotransmitters such as serotonin, dopamine, norepinephrine, glutamate, and GABA (Douma et al., 2005; Wise et al., 2008). Estrogen has been found to act in accordance with the first class of antidepressants, the monoamine-oxidase inhibitors (MAO-Is). The MAO-Is work by inhibiting the enzyme MAO, which is responsible

for metabolizing monoamine neurotransmitters (e.g., norepinephrine, dopamine, serotonin) lingering in the pre-synaptic terminal, thus increasing their availability (Meyer & Quenzer, 2005). Estrogen also breaks down MAO, thus causing antidepressant-like effects (Studd & Panay, 2009). In addition, estrogen exerts influence on the expression of the serotonin reuptake transporter (SERT) and activates other enzymes involved in increasing the availability of serotonin (e.g., tryptophan hydroxylase; Deecher et al., 2008).

The importance of estrogen in the development of depression is also evidenced by the effectiveness of estrogen therapy for treating depression across numerous reproductive events, such as the postpartum (Ahokas, Kaukoranta, Wahlbeck, & Aito, 2001) and perimenopausal period (de Novaes Soares, Almeida, Joffe, & Cohen, 2001; Gordon & Girdler, 2014). Cohen and colleagues (2006) found that hormonal therapy acted as a preventive measure, as severe depressive symptoms were less common among women who initiated hormonal therapy to regulate their cycles or to manage perimenopausal symptoms. Hormone therapy has been particularly publicized for use surrounding menopause due to its effects not just on mood, but also on cognitive and vasomotor symptoms (Parry, 2010; Soares, 2010a). For women who have experienced depression across several reproductive events, hormonal therapy may be a more effective choice than antidepressants (Studd & Panay, 2009). Future studies should include head to head trials of antidepressants and hormone therapy in women with depression, with and without a history of depression across several reproductive events.

Hormonal theories of reproductive mood change. There is a strong link between mood and reproductive events. Earlier age at menarche, irregular menstrual cycles, PMS, and PMDD are all associated with an increased risk for developing depression (Bloch, Rotenberg, Koren, & Klein, 2005; Harlow, Cohen, Otto, Spiegelman, & Cramer, 2004; Steiner et al., 2003). Previous

research was heavily focused on examining differences in absolute levels of various hormones such as estrogen and progesterone to explain the occurrence of depression across reproductive events. However, differences have generally not been found between absolute hormone levels and depressive symptoms across reproductive events. For instance, Klier et al. (2007) did not find a relationship between total levels of estrogen and progesterone or the magnitude of change in these hormones and depressive symptoms in the early postpartum period. In addition, PMS is not thought to be related to abnormal levels of estrogen or progesterone, but occurs in women who may be sensitive to normal hormonal fluctuations (Braverman, 2007; Studd & Panay, 2009). Thus, examining the magnitude of hormonal changes may be an overly simplistic approach, as hormonal profiles differ considerably across reproductive events. Progesterone levels increase from late adolescence into the mid-twenties, but become more variable after age 35 and begin to decrease as ovarian function gradually starts to decline (Ellison, 1993). During pregnancy, progesterone and estrogen rise 10-and 50-fold over maximum menstrual cycle levels in the third trimester and then drop dramatically within the first week following delivery (Bloch, Daly, & Rubinow, 2003). In contrast to sudden hormone withdrawal, fluctuating estrogen levels are associated with puberty, PMS, and the perimenopausal period (Douma et al., 2005).

The theory of hormonal sensitivity posits that mood disturbance across major reproductive events can be caused by vulnerability to fluctuating hormone levels. According to this model, reproductive events such as menarche, the premenstrual period, postpartum, and perimenopause are seen as “windows of vulnerability” for mood disorders (Soares, 2010b). A subgroup of women is thought to show a heightened sensitivity to intense hormonal fluctuations across major reproductive events (Deecher et al., 2008; Soares, 2010b; Soares & Zitek, 2008). This affective vulnerability in response to hormonal changes across reproductive events has been

proposed as a reproductive subtype of depression (Payne, Palmer, & Joffe, 2009). More specifically, this vulnerability to depression is thought to be biological, possibly resulting from the interaction between estrogen and specific brain areas or neurotransmitter systems (e.g., serotonin; Payne et al., 2009).

The hormonal sensitivity theory has been likened to the kindling hypothesis (Post, 1992), as women who experience depression at one reproductive event are thought to have an increased risk for developing depression across additional reproductive events (Soares & Zitek, 2008). For instance, a history of postpartum blues and severe PMS have both been found to be predictors of depressed mood during the menopausal transition (Freeman et al., 2004; Woods et al., 2008). Gregory, Masand, and Yohai (2000) examined mood across four major reproductive events (i.e., premenstrual phase, while taking hormonal contraceptives, postpartum period, and perimenopausal period) in 72 women with a major depressive episode. The authors found moderate correlations between premenstrual and perimenopausal mood ratings as well as postpartum and perimenopausal mood ratings. Furthermore, severe depression across at least two reproductive events was associated with earlier age at first treatment, bipolar disorder diagnosis, and family psychiatric history. These results support the hypothesis that certain women may be susceptible to mood difficulties across major reproductive events.

Hormonal sensitivity was examined in a rare double-blind experimental study by Bloch and colleagues (2000), who mimicked the hormonal milieu of the postpartum period with hormonal injections. Sixteen women participated, eight with a history of postpartum depression and eight without such a history. After a baseline period, high levels of estradiol and progesterone were administered to simulate pregnancy. The high levels of hormones were then withdrawn and hypogonadal levels were maintained for four weeks followed by an eight week

follow-up without medication. The results of this study found that 62.5% of women with a history of postpartum depression developed significant mood symptoms compared to 0% of women without such a history. Since hormone levels were kept the same across conditions, these findings clearly show that women with a history of postpartum depression are sensitive to changes in gonadal hormones. Although the hormonal sensitivity hypothesis has received empirical support, it is important to remember that there are also additional factors already known to contribute to the development of depression, such as genetics and vulnerability to stress (Steiner, 2009). These factors may be independent of, or interact with, hormonal sensitivity.

Anxiety across reproductive events

Given the significant degree of comorbidity between depression and anxiety, it is not surprising to find that women also experience exacerbation in anxiety symptoms across reproductive events. Comorbidity rates for anxiety and depression, when considering lifetime diagnoses, are as high as 76% (Moses & Barlow, 2006). Depression and anxiety are thought to share a common diathesis and are both subsumed under the higher order factor of negative affectivity (Moses & Barlow, 2006).

Menarche. Consistent with research examining age at menarche and depression, studies have shown that earlier age at menarche is also associated with increased risk of developing symptoms of anxiety (Leen-Feldner, Reardon, Hayward, & Smith, 2008). After reviewing more than 45 articles and controlling for age, Reardon and colleagues (2009) concluded that early pubertal timing was consistently related to an increased risk of developing an anxiety disorder.

Premenstrual exacerbation. Individuals suffering from anxiety disorders commonly experience a worsening of symptoms during the premenstrual or late luteal phase of the

menstrual cycle. For instance, in a study by Hsiao, Hsiao, and Liu (2004), 52% of individuals with pre-existing generalized anxiety disorder (GAD) and 36% of individuals with panic disorder experienced a premenstrual exacerbation of their symptoms. Premenstrual exacerbation of symptoms extends not only to mood and anxiety disorders but also to psychotic disorders (Kornstein & Sloan, 2006). In a recent article examining sex differences and the *DSM-5*, Kornstein (2010) recommends that "with premenstrual exacerbation" be added as a new specifier akin to "with postpartum onset".

Pregnancy and the postpartum. The term postpartum depression is frequently used as an overarching term to describe any type of emotional distress following childbirth (Abramowitz et al., 2010; Miller, Pallan, & Negri, 2006). However, the exclusive focus on postpartum depression may be misleading, as there is a high prevalence of anxiety in pregnancy and the postpartum period that can be overlooked and not properly treated. Recent research suggests that anxiety may be even more prevalent than depression during pregnancy and the postpartum (Wenzel, Haugen, Jackson, & Brendle, 2005). For instance, Lee and colleagues (2007) found that anxiety was more prevalent than depression in antenatal assessments (54% versus 37% respectively). Using *DSM-IV* criteria, Reck et al. (2008) examined over 1,000 postpartum women across a three-month period and found that anxiety disorders were more common than depressive disorders (11.1% versus 6.1%, respectively). It is also important to recognize that depressive symptoms do not often occur in isolation. For example, Heron, O'Connor, Evans, Golding, and Glover (2004) found that 43.7% of women experiencing postpartum depression also had significant symptoms of anxiety at some point during pregnancy (i.e., early, middle, or late). Similarly, Ross, Gilbert Evans, Sellers, and Romach (2003) found that up to 50% of women with postpartum depression had comorbid anxiety.

Although maternal anxiety is very common, it can cause significant impairment in functioning across multiple domains and therefore warrants attention. Many women do not meet criteria for GAD because their worries are specific to maternal concerns and not focused on a range of topics, thereby excluding the diagnosis. Currently, these women tend to be classified with either sub-threshold symptoms of GAD or with an anxiety disorder not otherwise specified (ADNOS). For instance, Wenzel, Haugen, Jackson, and Robinson (2003) found that 4.4% of women met criteria for GAD and 27.9% of women had sub-threshold generalized anxiety. Wenzel et al. (2005) also found high rates of sub-syndromal GAD (19.7%). More recently, Phillips, Sharpe, Matthey, and Charles (2009) found that 10.8% of women in the postpartum period met criteria for GAD, with an additional 10.8% meeting criteria for ADNOS.

The high prevalence of anxiety and worry during pregnancy the postpartum period is perhaps not very surprising, especially for first-time parents, given the heightened sense of responsibility that occurs with having a highly dependent and vulnerable child and the impetus to protect the child from harm (Fairbrother & Abramowitz, 2007). From an evolutionary perspective there is a clear adaptive value to increased anxiety during pregnancy and the postpartum period, as increased vigilance and attention to possible threats toward the infant could directly impact the child's chances of survival (Eşel, 2010; Ross & McLean, 2006). Therefore, it is important for clinicians to distinguish between "normal" anxiety and maternal anxiety that is significantly interfering with a woman's functioning and requires treatment.

Menopause. Li, Yu, Ma, Sun, and Yang (2008) reported a prevalence of 10.2% for anxiety symptoms during perimenopause. Consistent with the hormonal sensitivity hypothesis, having a history of PMDD was found to be a risk factor for experiencing anxiety symptoms during the perimenopausal period. However, other authors have noted that based on

methodological limitations of research examining anxiety during menopause, conclusions cannot be made at this time. The few studies that have been done to date rely on retrospective reports or cross-sectional designs and have used non-validated anxiety measures (Bryant, Judd, & Hickey, 2012). Furthermore, there is significant overlap between anxiety symptoms and the vasomotor symptoms of menopause (e.g., hot flashes) that have not been adequately disentangled (Hickey, Bryant, & Judd, 2012). Therefore, longitudinal research in this area with validated measures and proper controls is needed before any strong conclusions can be drawn.

Obsessive-compulsive disorder and reproductive events

Obsessive-compulsive disorder (OCD) is defined by the presence of obsessions and compulsions that are excessive or unreasonable, time consuming, and cause marked impairment in daily functioning (American Psychiatric Association, 2000). Obsessions are defined as intrusive thoughts, images, or impulses which occur and are experienced as distressing (American Psychiatric Association, 2000). In order to decrease the anxiety associated with obsessional thoughts or to try and suppress them, an individual feels driven to perform repetitive behaviours or mental acts (i.e., compulsions).

Individuals suffering from OCD are often classified according to the following symptom domains: harm obsessions and checking rituals, obsessions without overt compulsions, contamination and washing/cleaning, and hoarding (Sookman, Abramowitz, Calamari, Wilhelm, & McKay, 2005). Checking behaviour commonly occurs when there is excessive doubt over actions (e.g., “Did I turn the stove off?”) or fear of harm to self or others (e.g., excessive reassurance-seeking that a relative is safe; Sookman et al., 2005). Obsessions without behavioural or overt compulsions can be more elusive compared to other OCD subtypes, but do occur in at least one quarter of all cases of OCD (Sookman et al., 2005). An individual may feel

compelled to repeat a specific word in their head for a predetermined number of times in order to prevent something catastrophic from happening (e.g., a car accident). An individual with contamination obsessions may fear contracting an illness when using a public washroom. This fear may cause the individual to engage in compulsive cleaning behaviour after using a public bathroom, avoidance of public bathrooms altogether, or use of precautionary strategies such as using their elbow to open the bathroom door (Rachman, 2004). Finally, hoarding involves excessive acquisition and accumulation of items which the individual feels emotionally connected to and has difficulty discarding. Although hoarding was long conceptualized as a subtype of OCD, the *DSM-5* now considers hoarding to be its own disorder (American Psychiatric Association, 2013).

Sex differences exist in both the prevalence and presentation of OCD symptoms. Among children, OCD is up to three times more common in boys compared to girls, a difference that disappears once puberty hits (McLean & Anderson, 2009). In one study of over 200 outpatients with OCD, age of onset was significantly younger in men ($M = 22$) compared to women ($M = 26$), and women were more likely to be married and have children compared to men (Castle, Deale, & Marks, 1995). Furthermore, women are twice as likely to have contamination obsessions and cleaning compulsions compared to men (Labad et al., 2010), and men are more likely to have sexual and religious obsessions and symmetry and exactness compulsions (Altemus, Sarvaiya, & Epperson, 2014).

Several lines of evidence point to the influence of hormones and reproductive events on OCD symptoms. The timing of OCD onset has been found to cluster around major reproductive events such menarche, pregnancy, and the postpartum. Furthermore, as noted below, in cases of pre-existing OCD, symptoms tend to worsen across pregnancy, the postpartum period, and

during menopause. However, it should be noted that many of the studies described below (e.g., Labad et al., 2005, 2010; Vulink, Denys, Bus, & Westenberg, 2006; Williams & Koran, 1997) involve retrospective reporting of the onset or exacerbation of OCD symptoms across major reproductive events as opposed to the use of prospective daily measures, and thus should be interpreted cautiously.

Menarche. Labad and colleagues (2005, 2010) found that the onset of OCD occurred at the time of menarche for 22% of outpatients surveyed. Compared to other symptom dimensions of OCD, hoarding was four times more likely to occur in the year surrounding menarche (Labad et al., 2010).

The menstrual cycle. The menstrual cycle itself has been found to impact OCD symptom severity. Premenstrual worsening of OCD symptoms has been frequently observed and ranges from 20% (Labad et al., 2005) to 49% of women sampled (Vulink et al., 2006).

Hormonal sensitivity in individuals with OCD is also evidenced by the high rates of PMS and PMDD. For instance, Williams and Koran (1997) found that 21% of outpatients with OCD who were sampled experienced dysphoric symptoms pre-menstrually. Kim and colleagues (2004) found a rate of 11% for OCD in women who presented for treatment at a PMS clinic. In a sample of 101 women with OCD (Vulink et al., 2006), 11% experienced comorbid PMDD, and a striking 82% of these women experienced premenstrual exacerbation of OCD symptoms.

Pregnancy and the postpartum. A recent meta-analysis found that pregnant and postpartum women were approximately 1.5 to 2 times more likely to experience OCD compared to women in the general population (Russell, Fawcett, & Mazmanian, 2013). Research suggests that the postpartum period may be a time of particular vulnerability for obsessive-compulsive disorder. Prevalence rates for OCD have been found to be higher in the postnatal period

compared to pregnancy (Misri & Kendrick, 2007; Ross & McLean, 2006), with estimates ranging from 7 to as high as 47% (Labad et al., 2005; Leight, Fitelson, Weston, & Wisner, 2010; Miguel et al., 2005). Maina, Albert, Bogetto, Vaschetto, and Ravizza, (1999) found that in eight cases of OCD surrounding childbirth, onset occurred in the postpartum as opposed to pregnancy in all women examined, although premorbid symptoms had been present before pregnancy.

In the postpartum period obsessional thoughts revolve primarily around accidental harm to the baby, fear of being separated from the infant, fear of contamination related to the infant, and fear of criticism of one's competency as a mother (Misri & Kendrick, 2007). However, many women have thoughts or images of deliberately harming their child that are clearly extremely distressing (McGuinness, Blissett, & Jones, 2011). Common compulsions include excessive checking and cleaning behaviours (Misri & Kendrick, 2007).

The postpartum period has also been found to exacerbate pre-existing OCD to a greater extent than pregnancy. For instance, Labad et al. (2005) reported symptom exacerbation in 8% of women with OCD during pregnancy compared to 50% during the postpartum period. In a study by Vulink and colleagues (2006), OCD symptoms were more likely to worsen during the postpartum period (48%) compared to pregnancy (33%) in women diagnosed with OCD.

Given the heightened level of stress associated with having a baby, it is not surprising to find that men also experience the onset of OCD symptoms at this time. However, prevalence rates for men linger around 5%, which is considerably lower than the rates observed for their female counterparts and suggests that hormones may be influential for women (Labad et al., 2005).

Women with OCD appear to be at a greater risk for developing postpartum depression (Misri & Kendrick, 2007). For instance, Williams and Koran (1997) found that 37% of their

sample of 24 outpatients diagnosed with OCD who gave birth experienced postpartum depression, nearly double the expected rate. A literature review by Vulink and colleagues (2006) estimated 37 to 60% comorbidity between OCD and depression in the postpartum. In a study by Abramowitz and colleagues (2010), women who were classified as depressed according to the Edinburgh Postnatal Depression Scale (EPDS) had significantly higher compulsion scores on the Yale-Brown Obsessive Compulsive Scale (Y-BOCS). Obsessive thoughts are more likely to accompany depressive episodes with postpartum onset as opposed to onset outside this window (57% vs. 36%; Wisner, Peindl, Gigliotti, & Hanusa, 1999).

Similar risk factors have been observed for postpartum depression and OCD. Maina and colleagues (1999) found that postpartum OCD was significantly associated with obstetric complications such as ceasarean section, which has also been found to be a risk factor for postpartum depression (Josefsson et al., 2002). Labad et al. (2005) examined outpatients diagnosed with OCD and found that the greater the number of PMS symptoms women experienced, the more likely they were to experience the onset or worsening of OCD during the postpartum period. The fact that the premenstrual and postpartum period are both associated with fluctuating hormone levels and that both OCD and PMS symptoms respond to treatment with selective serotonin reuptake inhibitors (SSRIs) is consistent with the hormonal sensitivity hypothesis (Labad et al., 2005).

Subclinical OCD symptoms during pregnancy and the postpartum. Maternal preoccupations have been found to resemble obsessive-compulsive symptoms (Leckman et al., 1999). Sub-clinical obsessive and compulsive behaviour, among women without a history or diagnosis of OCD, appears to be extremely common in the postpartum period (Misri & Kendrick, 2007). For instance, Abramowitz and colleagues (2010) found that 87% of postpartum

women endorsed having at least one intrusive thought, with the two most common intrusive thoughts involving the infant dying of sudden infant death syndrome (SIDS; 57%) and thoughts of the infant suffocating (52%). Women reporting intrusive thoughts also used neutralizing or ritualistic strategies in response to these thoughts, with the most common being reassurance that everything is okay (72%) and checking on the baby more frequently (68%). Thirty-eight percent of women had clinically significant obsessive compulsive symptoms according to the Y-BOCS, whereas the majority of women experienced only mild obsessive-compulsive symptoms.

The focus of maternal preoccupations was further explored by Brockington, Macdonald, and Wainscott (2006) in the course of interviewing 129 mothers. In the prepartum, the most frequent fear expressed was of foetal abnormality (43%), followed by fear of foetal death (40%), inadequacy as a mother (32%), and fear of inadequate support (21%). Despite these high rates of reported fears, they were only clinically significant in 2-9% of women. Fear of foetal death was more likely to be reported by women who experienced the death of an infant in utero, multiple miscarriages, stillbirths, and infertility problems. Where losing a child increased maternal preoccupations in subsequent pregnancies, in general the unfamiliarity with pregnancy in primiparous (or first-time) mothers leads to significantly higher anxiety and greater preoccupation with their baby compared to multiparous mothers (Eberhard-Gran, Tambs, Opjordsmoen, Skrondal, & Eskild, 2003; Leckman et al., 1999; Maina et al., 1999). Maternal preoccupations in the postpartum period were parallel to those in pregnancy, with morbid anxiety about the infant's health and safety the most common (32%), followed by pathological fear of crib death (29%). These fears were associated with sleep deprivation and frequent checking of the infant throughout the night to ensure the child was still breathing. Additional fears included

fear of criticism or removal of child (19%) and fear of lack of support (16%). Although frequently endorsed, these fears caused significant impairment in only 5 to 12% of women.

Leckman and colleagues (1999) also found a high rate of maternal worry with over 80% of mothers worried that something bad would happen to their baby. With over 90% of women reporting checking on their babies (Leckman et al., 1999), this behaviour is clearly adaptive. Whereas most women reported checking on their babies in response to some type of signal from the infant, 75% of parents admitted to checking behaviour even when they subjectively knew that everything was okay. Thus, excessive anxiety and checking could possibly represent the over-activation of an adaptive behaviour meant to increase parental responsiveness and bonding. Given that the majority of women do experience some degree of obsessive-compulsive symptoms during pregnancy or the postpartum, maternal preoccupations should be viewed on a continuum or dimensionally rather than categorically. It remains unclear whether or not we are over-pathologizing the occurrence of anxiety at a time where it is advantageous.

Menopause. Although research in this area is currently limited, menopause does appear to be associated with an exacerbation of OCD symptoms. For instance, Labad et al. (2005) reported worsening of OCD symptoms in 8% of women during menopause. In addition, Vulink et al. (2006) found that 47% of women with OCD going through menopause experienced symptom exacerbation. Clearly further research is needed to clarify the course of symptoms at this time.

Evolutionary models of OCD

The evolutionary value of increased anxiety and preoccupation with a newborn infant is clear, as increased vigilance increases the chance of infant survival (Eşel, 2010; Ross & McLean, 2006). Human infants, unlike most other species, are born into the world completely dependent

on their mother for survival. Women are highly invested in their offspring given the fact that a woman has a limited number of potential opportunities to reproduce across her lifetime (Hahn-Holbrook, Holbrook, & Haselton, 2011). Furthermore, only recently have infant mortality rates fallen due to increased quality of living and advanced medical care (Leckman et al., 1999). Not only would losing a child be devastating for a mother, but it would also dramatically reduce her reproductive success (Hahn-Holbrook et al., 2011). Therefore, obsessive thinking and ritualistic behaviour that led to harm avoidance would be adaptive in the sense that it increased infant survival and successful reproduction, thereby increasing the likelihood of natural selection of these traits (Eilam, Izhar, & Mort, 2011).

This line of reasoning has led to evolutionary accounts of OCD, which suggest that individuals with OCD have an exaggerated or pathological form of an adaptive mechanism that helps to protect offspring from real or potential threats (Eilam et al., 2011; Hahn-Holbrook et al., 2011; Woody & Szechtman, 2011). This potential mechanism has been described as a motivational system and has received several labels, including the "hazard-precaution system" and the "security motivation system" (Woody & Szechtman, 2011).

When individuals are highly sensitive to potential threats their security motivation system becomes hyperactive, which initiates behaviour aimed at reducing the subjective feeling of danger or that things are "not right." However, individuals with OCD do not stop after completing a ritualistic behaviour because they do not receive a proper stop-signal (Eilam et al., 2011). Researchers have described this stop signal as a "sense of knowing", or yedasentience (Szechtman & Woody, 2004). Often times there is no clear stop-signal from the environment and it must be generated within the individual (Woody & Boyer, 2011). For instance, the smell of rotting food motivates us to throw it out, but an individual with OCD may be unsure whether to

throw out the food beside it as it may also be contaminated. In other words, an internal stop signal is not generated to conclude that the correct precautions have been made and it is now safe to stop. Therefore, excessive activation of the security motivation system and improper inhibition of the system is thought to be the underlying mechanism of OCD.

The security motivation system differs from that of a fear based, flight-or-fight response to an easily identifiable threat or danger (e.g., encountering a bear in the woods). In contrast, it is more focused on anticipated or hidden threats (e.g., potential contamination) that are more difficult to predict and have a high cost (Woody & Szechtman, 2011). Whereas fear commonly encourages avoidance behaviour, the security motivation system is geared more towards the engagement of preventative behaviour (e.g., washing; Woody & Szechtman, 2011). Brain areas activated upon imagination of future scenarios are the same regions implicated in OCD (Brune, 2006). This suggests that individuals with OCD are cognizant of future events and tend to engage in behaviour that would prevent anticipated danger (Brune, 2006). Therefore, it has been hypothesized that individuals with OCD should be less likely to engage in risky behaviour.

Cognitive theory of OCD

According to the cognitive model of OCD, it is not the intrusive thoughts alone that cause distress but the significance and meaning attributed to these thoughts (Salkovskis, 1999). The majority of individuals experience intrusive thoughts but individuals with OCD attribute greater meaning and significance to these thoughts. For instance, a new mother may have an intrusive thought of harming her infant and believe that this thought speaks to her “true” feelings about the infant or she may become afraid that she will harm the infant (Abramowitz, Schwartz, Moore, & Luenzmann, 2003). Due to the significance attributed to intrusive thoughts, individuals with

OCD increase their efforts to control their thoughts using thought suppression or they engage in rituals to "neutralize" the negative thoughts (e.g., by repeating positive thoughts).

The belief that having a thought increases the likelihood of it occurring is referred to as thought-action fusion (Smári & Hólmsteinsson, 2001). There are two components to thought action fusion: a negative thought increases the likelihood of a negative event happening to the self or others, and that having a thought is the moral equivalent of committing the act in question (e.g., thinking about smothering your child is the equivalent of actually smothering your child; Smári & Hólmsteinsson, 2001). Thought-action fusion has been found to be significantly more likely in individuals with obsessional thinking compared to non-obsessionals or "normal" control groups (Shafran, Thordarson, & Rachman, 1996). Additional beliefs surrounding the uncontrollability and danger of thoughts have also been found to predict obsessive-compulsive symptoms (Myers & Wells, 2005).

Inflated responsibility, or the belief that an individual has the power to cause an event or prevent an event from happening, is another important cognitive component of OCD (Myers & Wells, 2005). For instance, believing you caused a fellow student to suffer an anaphylactic shock in the library because you did not clean up your peanut butter cookie crumbs earlier that day (Purdon & Clark, 2005). Similarly, if an individual with OCD has an intrusive thought about a loved one being involved in a car accident and the loved one is involved in an accident several days later, the individual is likely to believe that their thought caused the accident (Shafran et al., 1996). Clearly these beliefs would cause significant distress for the individual. Responsibility beliefs were found to mediate the relationship between intrusive thoughts and obsessive-compulsive symptoms (Smári & Hólmsteinsson, 2001). An inflated sense of responsibility can also occur due to major situational changes, such as the birth of a child (Salkovskis, Shafran,

Rachman, & Freeston, 1999). Infants are born totally dependent on their parents for care and safety, which can cause a heightened sense of responsibility and lead to maternal preoccupations and frequent checking to ensure the infant is not in harm's way (Leckman et al., 2004).

Many constructs that are important for the development and maintenance of OCD (e.g., inflated responsibility beliefs) as well as symptoms of OCD (e.g., excessive washing) can be conceptualized as strategies for reducing harm (Brune, 2006). Alonso and colleagues (2008) found that outpatients diagnosed with OCD had significantly higher harm avoidance scores and lower novelty-seeking scores (according to the Temperament and Character Inventory) compared to matched controls. Similarly, Ettelt and colleagues (2008) found that individuals diagnosed with OCD had higher harm avoidance scores (assessed using Cloninger's Tridimensional Personality Questionnaire) compared to age and sex-matched controls. Furthermore, the first degree relatives of individuals diagnosed with OCD had higher levels of harm avoidance compared to first degree relatives of control subjects. Anxiety in general is associated with risk-avoidance as decision-making is associated with the overestimation of the probability and severity of negative outcomes (Maner, 2009).

Disgust also plays a role in harm avoidance. Sensation seeking was found to negatively correlate with scores on the Disgust Scale (Rozin, Haidt, McCauley, Dunlop, & Ashmore, 1999). In a study by Fessler, Pillsworth, and Flamson (2004), a mood induction procedure was used to examine the influence of different emotions on risk-taking behaviour. Men in the anger condition displayed significantly more risk-taking behaviour in a gambling task than men in the control condition. In contrast, women were found to be less likely to engage in risk-taking behaviour following a disgust induction compared to women in the control condition.

Cross-cultural differences in personality have been found according to the prevalence of infectious disease. Consistent with their hypothesis, Schaller and Murray (2008) found that disease prevalence significantly negatively correlated with sociosexuality, extraversion, and openness to experience. In essence, the risk of disease transmission increases when people expose themselves to unfamiliar people and practices (Schaller & Murray, 2008). Therefore, people living in areas with increased disease prevalence tended to exhibit a more cautious disposition. Similarly, individuals who are prone to contamination fears should be less likely to engage in risky behaviour (e.g., unprotected sex).

There also appear to be consistent sex differences in risk-taking. In a meta-analysis of 150 studies, Byrnes, Miller, and Schafer (1999) concluded that men engage in greater risk-taking compared to women. The effect size was small but meaningful ($d = 0.13$), indicating an approximate 6% difference in the likelihood of engaging in risky behaviour (e.g., unsafe driving) between men and women. However, the authors warn that there is variability in estimates depending upon age and specific contexts. In other words, men are more likely overall to engage in risky behaviour compared to women, but there are specific situations where these sex differences disappear (e.g., smoking). These findings support examining both overall risk-taking as well as risk-taking within specific domains.

Disgust sensitivity

Disgust is one of six basic human emotions that are easily recognizable across cultures, along with happiness, sadness, fear, anger, and surprise (Brune, 2006). The characteristic expression of disgust consists of a wrinkled brow-line and raised upper lip (Jhung et al., 2010; Rozin, Haidt, & McCauley, 1999). Gaping of the mouth is also common in relation to food and can be seen even among rats (Curtis, de Barra, & Aunger, 2011). Physiologically, disgust is

associated with a feeling of nausea and can cause a gagging reflex or vomiting (Rachman, 2004). Brain structures such as the insula and putamen are critical for recognizing and expressing disgust. For instance, a patient (N.K.) with damage to the insula and putamen was significantly less able to recognize facial and vocal expressions of disgust compared to controls, although no differences were observed across the other primary emotions (Calder, Keane, Mane, Antoun, & Young, 2000). In addition, when the insula was electrically stimulated by the famous neurosurgeon Wilder Penfield, patients experienced unpleasant tastes and feelings of nausea (Calder, Lawrence, & Young, 2001). The basal ganglia are also activated when viewing or smelling disgust-provoking stimuli or recalling autobiographical memories of disgust (Curtis et al., 2011). Brain regions found to be involved with processing disgusting stimuli in an fMRI study included the insula, ventrolateral prefrontal cortex, temporal pole, putamen–globus pallidus, dorsal anterior cingulate gyrus, and the visual cortex (Mataix-Cols et al., 2008).

Disgust was initially defined narrowly as a reaction that facilitated the rejection of food (Haidt, McCauley, & Rozin, 1994), but is now viewed more broadly as being potentially induced across a variety of stimuli. Haidt and colleagues (1994) were the first to create a measure of disgust that captured individual differences in disgust sensitivity and identified the different domains of disgust. Following a rational-empirical approach to test construction, a list of disgusting objects and actions was created and continually refined based on item-analysis across four samples of respondents. The final Disgust Scale consisted of eight domains: food (e.g., spoiled milk), body products (e.g., vomit, mucous), animal (e.g., cockroach, maggot), sex (e.g., incest), personal hygiene (e.g., not letting your body touch a public toilet), envelope violations (e.g., seeing someone's intestines exposed), death (e.g., touching a dead body), and magical thinking (e.g., chocolate shaped like dog poop; Haidt et al., 1994). According to a two-stage

theory of disgust, the first three domains pertain to core disgust whereas the next four pertain to animal-reminder disgust. The last domain, magical thinking, is thought to occur across many disgust situations and therefore is not considered its own distinct disgust elicitor. Whereas core disgust is viewed as an oral defense (or a first line defense against contaminated foods), animal-reminder disgust corresponds to stimuli that remind us of our own mortality, or animal nature.

Disgust has also been conceptualized more broadly to include sexual and moral disgust. Tybur, Lieberman, and Griskevicius (2009) propose a multidimensional model of disgust based on factor analysis that consists of pathogen, sexual, and moral disgust. Pathogen disgust aids in the avoidance of potential contaminants and is elicited by exposure to stimuli such as dead bodies or feces. In contrast, sexual disgust motivates avoidance of sexual behaviour such as inbreeding that result in decreased reproductive success. Finally, moral disgust motivates avoidance of individuals who engage in antisocial activities such as stealing that from an evolutionary perspective would have a high cost on one's social group. This model is reflected in the Three Domain Disgust Scale created by the authors, with research showing discriminant validity across the three domains of disgust.

Baumeister, Vohs, and Funder (2007) point out the possible discrepancy between self-reports and actual behaviour. Therefore, it is important to consider the predictive validity of questionnaires. Studies have shown that questionnaire measures of disgust do indeed predict actual behaviour. In an fMRI study Mataix-Cols et al. (2008) found that high trait disgust sensitivity predicted greater brain activation in response to viewing disgusting pictures from the International Affective Picture System. In a series of experiments examining the predictive validity of the 32-item Disgust Scale, Rozin, Haidt, McCauley, Dunlop, et al. (1999) found that willingness to engage in disgust-provoking tasks (e.g., touching or picking up a mealworm) was

significantly correlated with Disgust Scale total scores from two months earlier (r = -.41) and at the time of testing (r = -.51). In addition, the authors found that questionnaire scores were not associated with factors such as embarrassment (e.g., touching an unused tampon or condom) and compliance (i.e., general willingness to engage in unpleasant tasks), that added variance to the prediction of behavioural tasks. Deacon and Olatunji (2007) found that Disgust Scale scores predicted increased anxiety and avoidance of behavioural tasks involving exposure to a used comb, a cookie on the floor, and a bedpan filled with toilet water. Finally, scores on the core, animal-reminder, and contamination subscales of the Disgust Scale-Revised were found to predict specific behavioural patterns. Core disgust, animal-reminder disgust, and contamination disgust uniquely predicted visual avoidance of a video depicting the consumption of coagulated cow blood, surgery, and potential contaminants, respectively (Olatunji, Haidt, McKay, & David, 2008).

The role of disgust in OCD symptomatology. Fear has been characterized as the prominent emotion associated with anxiety disorders, with little focus on disgust (Rachman, 2004). Nevertheless, researchers are now increasingly becoming aware of the role of disgust in the development of anxiety disorders such as OCD. Disgust has been strongly linked to disease avoidance. For instance, Stevenson, Case, and Oaten (2009) found evidence for disgust sensitivity as an adaptive mechanism for preventing illness. In a sample of over 600 university students, higher disgust sensitivity and contamination scores (as measured by the Padua Inventory) significantly predicted fewer recent infections. Disgust may be particularly important in the development of contamination fears. Individuals with OCD often report feelings of disgust rather than fear in the presence of contaminated objects, which leads to excessive washing to reduce these feelings (Tolin, Woods, & Abramowitz, 2006). McKay (2006) reported that

individuals suffering from the contamination subtype of OCD were slower to habituate to disgust-provoking stimuli across exposure sessions compared to individuals with non-contamination OCD symptoms. Furthermore, functional magnetic resonance imaging (fMRI) experiments have shown that metabolic activity in the insula correlates with Y-BOCS scores and Padua Inventory–Revised (PI-R) scores, particularly washing symptoms (Calder et al., 2001; Mataix-Cols et al., 2004).

Over the course of history, humans have developed a physiological immune system that is quick to respond to pathogens and foreign material after it has invaded the body. However, it is also possible that humans have developed a "behavioural immune system" to avoid infection altogether (Neuberg, Kenrick, & Schaller, 2011; Van Vugt & Park, 2009). Disgust can help species avoid potential contaminants and infectious disease by either recognizing cues of potential contamination before direct exposure, or ridding the body of contaminants after exposure (e.g., vomiting; Lienard, 2011; Rozin, Haidt, & McCauley, 1999). For instance, the appearance of rotting food elicits a feeling of disgust that enables us to avoid eating a contaminated substance that could cause infection. On the other hand, experiencing disgust upon eating an unknown but dangerous food source may cause vomiting, ridding of the body of a potential toxin.

Just as the physiological immune system can overreact to normal tissues in the body (as in the case of an autoimmune disease), so too can the behavioural immune system perceive potential threats of contamination or disease that are actually harmless (Neuberg et al., 2011). Sympathetic magic works according to this principle, as a secondary object can acquire the properties of a contaminated object through physical contact. For example, Olatunji, Lohr, Sawchuk, and Tolin (2007) asked participants to pick up a pencil that had been dropped in the

toilet and then sanitized. Participants in the high OCD symptom group were significantly more likely to refuse to comply with the task than participants in the low OCD symptom group. Through the endorsement of a number of irrational beliefs individuals can come to believe that an object is contaminated even when there is no objective threat (Olatunji, Lohr, et al., 2007). For instance, people are reluctant to drink from a water fountain on top of a toilet despite no objective threat of contamination.

Sympathetic magic dates back to writings from the early 1900's that attempted to explain the universal principles underlying magic (Nemeroff & Rozin, 1994). In the disgust literature sympathetic magic refers to the beliefs about the transmission of contagion (Olatunji et al., 2007). Researchers have identified two primary laws of sympathetic magic: the law of contagion and the law of similarity (Rozin, Millman, & Nemeroff, 1986). The "chain of contagion" procedure by Tolin, Worhunsky, and Maltby (2004) clearly demonstrates the law of contagion, or "once in contact, always in contact" (Oaten, Stevenson, & Case, 2009, p. 312). The chain of contagion procedure involved a pencil being touched to a contaminated object, and then a second pencil was touched to the first, and so on until 12 pencils had been used. Anxious and non-anxious control participants reported that the threat of contamination quickly decreased with the addition of pencils and by the end of 12 pencils reported a 100% drop in contamination ratings. In contrast, individuals diagnosed with OCD only reported a 40% drop in contamination ratings following the last pencil. Despite 12 degrees of removal from the original source of contamination, participants with OCD still endorsed a high contamination rating. Thus, an essence of the original contaminant still existed and could not be eliminated. No differences were reported across groups when a non-threatening object was used (i.e., a piece of candy).

The law of similarity refers to the belief that objects that are similar share the "same essence" (Oaten et al., 2009). For example, in a study by Rozin and colleagues (1986), participants were given two pieces of the same chocolate fudge, one in the shape of a disc and another in the shape of dog feces, and were asked to rate their desire for each piece of fudge. The fudge in the shape of dog feces was given significantly lower ratings compared to the fudge in the shape of a disc. Although these beliefs are irrational, they are clearly adaptive as it is safer to avoid an object that has come into contact with a contaminant at some point in time or resembles a known pathogen (Oaten et al., 2009).

Disgust has also been associated with OCD symptoms in non-clinical samples. In a study by Olatunji, Lohr, and colleagues (2007) introductory psychology students were separated into a high and low OCD symptom group based on contamination scores on the Padua Inventory. The high OCD symptom group was less likely to engage in a series of behavioural avoidance tasks (e.g., picking up a pair of stained underwear) and found them more disgust-provoking than the low OCD symptom group. Several other researchers have also found that disgust sensitivity predicted obsessive-compulsive symptoms in a non-clinical sample (Mancini, Gragnani, & D'Olimpio, 2001; Murisa et al., 2000; Tolin et al., 2006). Disgust sensitivity has been found to most strongly predict cleaning and washing symptoms (Mancini et al., 2001; Murisa et al., 2000; Tolin et al., 2006). Whereas disgust is most associated with cleaning and washing subscales, anxiety and depression were found to be better predictors of the impulses and rumination subscales of the Padua Inventory-Revised (Mancini et al., 2001). Furthermore, the relationship between disgust sensitivity and OCD contamination symptoms has been found to be independent of trait anxiety across several studies (Mancini et al., 2001; Moretz & McKay, 2008; Olatunji,

Cisler, McKay, & Phillips, 2010; Olatunji, Sawchuk, Arrindell, & Lohr, 2005; Tolin et al., 2006).

Sex differences in disgust: The potential role of progesterone. Research has shown that women have greater disgust sensitivity compared to men (Druschel & Sherman, 1999; Murisa et al., 2000). For instance, Haidt et al. (1994) found that women scored a full standard deviation higher on the Disgust Scale than men. In a study by Rohrmann, Hopp, and Quirin (2008) women and men were shown pictures and film clips to elicit disgust (e.g., viewing an amputation). Across both pictures and films, women consistently showed greater disgust responses compared to men. In addition to self-reports women showed greater skin conductance to disgust-eliciting stimuli than men. Tybur and colleagues (2009) also found that women scored consistently higher than men in terms of disgust sensitivity, with a large effect size for the sexual domain and small effect sizes for the moral and pathogen domains. In a large sample of undergraduate students, Olatunji and colleagues (2005) found that disgust sensitivity predicted contamination fears, with a greater effect for women than men. The authors also found support for disgust sensitivity mediating the relationship between sex and contamination fears. A consensus regarding the cause of observed sex differences in disgust sensitivity is yet to be established.

It has been argued that greater disgust sensitivity in women is a function of women scoring higher than men in neuroticism. Neuroticism, as generally assessed by the NEO Personality Inventory-Revised, measures the six personality facets of anxiety, depression, angry hostility, self-consciousness, impulsiveness, and vulnerability (Costa & McCrae, 1992). Women are 2 to 3 times more likely to experience depression in comparison to men (Curtis et al., 2011). Disgust sensitivity has been found to be positively related to neuroticism and negatively related

to openness to experience (Druschel & Sherman, 1999; Olatunji et al., 2008). Thus, individuals who are high on neuroticism are more likely to experience negative affect, including disgust (Druschel & Sherman, 1999). However, studies also suggest that disgust sensitivity is distinct from anxiety and depression. For instance, Olatunjia, Lohr, et al. (2007) found that participants in the high OCD symptom group experienced greater disgust sensitivity even when negative affect scores were controlled. Similarly, Tolin and colleagues (2004) found that anxious and non-anxious control participants performed similarly in their chain of contagion procedure and did not show the same degree of sympathetic magic beliefs as the OCD group.

It is also possible that there is a hormonal mechanism underlying the sex differences in disgust sensitivity. Not only are women more likely than men to have obsessions and compulsions concerning contamination, but the onset and exacerbation of OCD symptoms is closely tied to reproductive events such as menarche and pregnancy (Lienard, 2011). These reproductive times correspond to times of increased progesterone levels. Progesterone levels rise after ovulation and are highest in the mid-luteal phase of the menstrual cycle. If conception does not occur progesterone levels decrease. If conception does occur, progesterone levels rise across pregnancy (Fessler, 2002). Whereas estrogen has a stimulating response on the immune system, progesterone suppresses the immune system (Druckmann, 2001). The suppression of the immune system by progesterone ensures that conception can in fact occur without the embryo being rejected (Lienard, 2011). In short, high progesterone levels stimulate the production of progesterone-induced blocking factor (PIBF), which stimulates T Helper cells and thereby decreases Natural Killer cells (Fessler, 2002). Therefore, foreign paternal material is less likely to be attacked by the body, but as a consequence women become more susceptible to infection (Fessler, 2002; Fleischman & Fessler, 2011).

Given the fact that the immune system is reduced when progesterone levels are increased, it would be adaptive to develop behavioural strategies to ensure avoidance of potential contaminants at these times. The idea that disgust sensitivity increases to compensate for greater vulnerability to infection during times of immunosuppression has been termed the compensatory prophylaxis hypothesis (Fessler, Eng, & Navarrete, 2005). In other words, changes in the physiological immune system spark commensurate changes in the behavioural immune system to help avoid exposure to infectious agents (Curtis et al., 2011). Consistent with this hypothesis, healthy faces have been found to be more strongly preferred during times of immunosuppression (or high progesterone). Jones, Perrett, and colleagues (2005) found that women preferred the faces of men that were pre-rated as healthy compared to unhealthy more when they were in the luteal phase of the menstrual cycle versus the follicular phase (in the context of a short-term relationship). Similarly, pregnant women had a stronger preference for healthy faces compared to non-pregnant women (Jones, Perrett, et al., 2005). Furthermore, women who perceive themselves as more vulnerable to disease also show stronger preferences for healthy faces, which would potentially decrease the likelihood of interacting with individuals who could transmit disease (Welling, Conway, Debruine, & Jones, 2007). Conway and colleagues (2007) found that women were more sensitive to cues of nearby threat and contagion when their progesterone levels were higher. More specifically, when progesterone levels were high participants rated disgusted and fearful facial expressions as more intense when the gaze was averted versus direct. However, there was no difference in intensity of happy facial expressions with direct versus averted gaze. The authors state that averted gaze signals the presence of a nearby physical threat or source of contagion. Thus, women with higher progesterone levels were more sensitive to

recognizing facial cues signaling threat or contagion. This heightened sensitivity to potential threats with increased progesterone is thought to be adaptive for protecting the fetus from harm.

Several researchers have conceptualized food aversions and morning sickness during pregnancy as adaptive mechanisms for reducing the risk of infection at times that are critical for reproductive success. Food aversions are closely linked with disgust sensitivity. Lesions to the insula (a region of the brain critical for experiencing disgust) in rats results in difficulty acquiring taste aversions (Calder et al., 2001). After reviewing 41 studies, Flaxman and Sherman (2000) reported that as many as 65% of pregnant women experienced food aversions. Food aversions were significantly more likely to occur in the first trimester of pregnancy than in the second or third trimester. The most common food aversions were to animal products (i.e., meat, fish, poultry, and eggs), with a rate twice as high as non-pregnant controls. In contrast, pregnancy cravings tended to be highest for foods that had the lowest likelihood of being reported as food aversions, such as fruit, grains and starches, dairy and ice cream, and sweets. Avoiding meat during the first trimester of pregnancy may be an important precautionary measure for avoiding food-borne illness. This mechanism would have been particularly important in early human history given the lack of refrigeration and sanitary conditions, as meat that is raw or left for long periods at room temperature is likely to develop bacteria or spoil (Flaxman & Sherman, 2000; Hahn-Holbrook et al., 2011).

Morning sickness during the first trimester of pregnancy has been viewed as a mechanism for voiding the body of potential toxins at a time when the risk of fetal deformation is highest. The first trimester of pregnancy is a critical time for the development of the fetus, as the neural tube is developing and any exposure to viruses or toxins can result in serious deformation (Lienard, 2011). In fact, Flaxman and Sherman (2000) found that increased nausea

and vomiting during pregnancy resulted in a decreased risk of miscarriage across nine studies examined. In addition, societies where morning sickness is less common are significantly less likely to consider meat a staple food.

Disgust sensitivity has also been found to increase during the first trimester of pregnancy along with morning sickness and food aversions. In a study by Fessler and colleagues (2005), 496 pregnant women answered an online survey assessing their disgust sensitivity using the Disgust Scale and their current level of nausea. Consistent with their hypothesis, disgust sensitivity was greatest during the first trimester of pregnancy. Although women in the first trimester of pregnancy experienced greater levels of nausea compared to women in the second and third trimester of pregnancy, even after controlling for nausea there was still a significant elevation in disgust in the first trimester of pregnancy in the food domain. The results of this study suggest that women develop increased sensitivity to disgust in the first semester of pregnancy- a time when the immune system is the most compromised and food-borne illness would incur the greatest risk to the fetus.

Disgust sensitivity has also been examined across the menstrual cycle. Using an internet-based questionnaire, Fessler and Navarrete (2003) examined the effect of conception risk and immunosuppression on disgust sensitivity across the menstrual cycle in free-cycling women. Based on the number of days since the onset of menstruation, the authors calculated the conception risk and presumed level of immunosuppression (according to daily reference values for progesterone) for 307 women. The authors found that sexual disgust was related to conception risk as hypothesized, but presumed conception risk did not predict global disgust scores or any of the individual disgust subscales. However, the subscales of the original Disgust Scale (Haidt et al., 1994) have poor psychometric properties (Olatunji et al., 2008).

Sub-clinical OCD symptoms have recently been found to be associated with progesterone levels in normally cycling female undergraduates (Gonda et al., 2008). Using a prospective design, the well-being of 63 free-cycling undergraduate women was examined across three phases the menstrual cycle (early follicular, late follicular, and late luteal). Obsessive-compulsive symptoms as measured by the Symptom Distress Checklist (SCL-51) were found to increase from the late follicular to the late luteal phase, in addition to increases in anxiety, depression, and somatization (Gonda et al., 2008).

Avgoustinaki and colleagues (2012) examined the association between sex steroids and Minnesota Multiphasic Personality Inventory (MMPI) subscales in a sample of young health professionals (n = 59). All women were free-cycling (non-hormonal contraceptive users) with normal menstrual cycles and were tested on the 21st day of their menstrual cycle (i.e., mid-luteal phase). The authors found a significant correlation between progesterone levels and scale 7 (Psychasthenia/Obsessive compulsive behaviour). However, within a regression model progesterone only explained 7% of the variance in scale 7, which was not significant.

In a recent study by Fleischman and Fessler (2011), undergraduate participants provided a saliva sample for measurement of hormone levels, rated their level of disgust in response to disgust-eliciting photographs, completed the Revised Padua Obsessive-Compulsive Inventory, and completed a self-report questionnaire concerning behaviour in public bathrooms. Public bathrooms display clear clues of potential contamination and can lead to ritualistic behaviour in individuals with and without OCD (e.g., covering the toilet seat, excessive hand-washing). The authors found a significant positive correlation between progesterone levels and OCD symptoms of contamination, but a non-significant trend for non-contamination OCD symptoms (e.g.,

ordering). Furthermore, disgust sensitivity and bathroom behaviour related to disease avoidance were also significantly correlated with progesterone levels.

Upon examining the influence of progesterone levels across the menstrual cycle in relation to OCD symptoms, research to date has a number of methodological limitations. Only one study used a prospective, within-subjects design (Gonda et al., 2008), and none of the studies employed both a prospective, repeated-measures design combined with measuring salivary hormone levels. A within-subjects design would allow for the examination of individual variability in the magnitude of change across the menstrual cycle in OCD symptoms and provide stronger conclusions. Furthermore, women using hormonal contraceptives were excluded in previous studies. Thus, what is needed is a within-subjects design following women across the menstrual cycle where progesterone levels are measured and hormonal contraceptive users are included as a comparison group.

The role of hormones in facial preference and emotion recognition

Hormones have been shown to influence women's facial preferences. Women's preference for masculinized male faces has been shown to vary across the menstrual cycle, with a strong preference for masculine male faces during the menstrual phase compared to the luteal phase of the cycle (Penton-Voak & Perrett, 2000). Penton-Voak and colleagues (1999) found that women preferred less feminine male faces during periods of high versus low conception-risk in the context of short-term relationships. In a study by Macrae, Alnwick, Milne, and Schloerscheidt (2002), female participants were shown 100 faces and asked to categorize them as male or female. During the high conception risk phase of the menstrual cycle (i.e., ovulation) women were faster at categorizing male faces, but no differences were found in the categorization of female faces. Similarly, Johnston, Hagel, Franklin, Fink, and Grammer (2001)

showed that women were significantly more likely to choose a more masculinized face as conception risk increased before ovulation compared to after ovulation. Furthermore, a preference for masculinity in male faces is not shown in pre-pubescent and post-menopausal women, only in women of reproductively active ages, thus strengthening the hormonal account (Little et al., 2010).

Masculinized and symmetrical male faces are thought to be indicators of higher levels of testosterone and disease-resistance (DeBruine, Jones, Tybur, Lieberman, & Griskevicius, 2010; Fink, Neave, Manning, & Grammer, 2006; Penton-Voak et al., 1999; Penton-Voak & Chen, 2004). When women were given a forced-choice task they rated pictures of men who had higher salivary testosterone levels as more masculine than men with lower salivary testosterone levels (Penton-Voak & Chen, 2004). Symmetrical faces are rated as more attractive and healthier compared to faces low in symmetry (Fink et al., 2006). More masculinized faces have been classified as more healthy (Johnston et al., 2001), and facial masculinity has in fact been found to negatively correlate with frequency and duration of disease (Thornhill & Gangestad, 2006). High facial symmetry has been related to measures of increased fertility in men, thus acting as a gauge of greater genetic quality (Oinonen & Mazmanian, 2007). Oinonen and Mazmanian (2007) found that in general women prefer more symmetrical male faces, with greater symmetry detection performance during menses compared to the luteal phase. The fact that Penton-Voak et al. (1999) did not find differences in facial preferences across the cycle in women using hormonal contraceptives, suggests that these differences are influenced by hormones. These findings show a differential pattern of preferences for male faces depending on menstrual cycle phase or conception risk, suggesting that these differences reflect adaptive strategies for acquiring more desirable genes at a time crucial for reproduction (Welling et al., 2007).

High masculinity and related high testosterone is associated with low paternal investment, as research suggests that men with high-testosterone levels are more likely to have short-term relationships, less likely to get married, and are less responsive to infants (DeBruine et al., 2010). Therefore, researchers hypothesize that, for women, a trade-off occurs between the benefits and costs of increased masculinity in a partner (e.g., healthy offspring versus low paternal investment; DeBruine et al., 2010; Penton-Voak & Perrett, 2000). Jones, Little, and colleagues (2005) found that women were most attracted to masculinity during the late follicular phase when progesterone levels are low and most attracted to apparent health during the mid-luteal phase when progesterone levels are highest. High progesterone levels were also associated with a preference for more feminine male faces. Women were also found to report greater commitment to their partner when progesterone levels were highest (Jones, Little, et al., 2005). These findings make sense from an evolutionary perspective, as periods of high progesterone mimic pregnancy and it would be advantageous for pregnant women to seek out high paternal investment within a stable relationship.

Women's preferences for masculinized faces also vary as a function of pathogen disgust. Pathogen disgust scores have been found to be positively correlated with a preference for masculinity in male faces (DeBruine et al., 2010). In addition, women preferred more masculine and symmetric male faces after viewing slides depicting images of high pathogen cues compared to images of low pathogen cues (Little, DeBruine, & Jones, 2011). In a study examining nearly 5,000 women from 30 different countries, preference for masculinized male faces increased as an index of national health decreased (based on World Health Organization statistics such as impact of communicable diseases; DeBruine et al., 2010). These findings are consistent with the findings of Jones, Perrett, and colleagues (2005), who found that high progesterone levels were

associated with increased attraction to apparent health in faces. Therefore, increased pathogen exposure or exposure to pathogen cues may prime the preference for masculinity in male partners in order to reduce the risk of infection during pregnancy (Jones, Little, et al., 2005).

Emotional recognition has also been found to vary across the menstrual cycle. Compared to other facial expressions, disgust, fear, and anger may be the most crucial from an evolutionary perspective as they signal a threat (Collignon et al., 2010). In ancient history, displaying expressions of fear or disgust provided cues to another person to signal potential threats (e.g., a predator or a source of contamination). In many instances, we take cues from other people in terms of what we approach or avoid, which could have a direct impact on our survival (Martin et al., 2006). Using a cross-sectional design, Pearson and Lewis (2005) found that fear recognition was significantly higher in the pre-ovulatory stage when estrogen levels are highest and lowest during menses when estrogen levels are lowest. Although hormone levels were not directly measured in this study, the findings suggest that higher estrogen levels facilitate more accurate recognition of fear. In an fMRI study conducted by Derntl, Windischberger, and colleagues (2008), amygdala activation was significantly stronger in women in the follicular phase compared to women in the luteal phase, corresponding to greater emotion recognition in the follicular phase than in the luteal phase. Derntl, Kryspin-Exner, Fernbach, Moser, and Habel (2008) also found higher emotion recognition accuracy in the late follicular phase. In addition, emotion recognition accuracy was negatively correlated with progesterone levels. However, females were more likely to misperceive other negative emotions (e.g., sadness, fear) as angry or disgusted in the luteal phase compared to the follicular phase.

Women have been found to be more accurate at identifying and portraying expressions of disgust compared to men. In a study conducted by Collignon et al. (2010), male and female

participants were shown emotional stimuli (visual, auditory, and bimodal) representing fear or disgust and then given a forced-choice discrimination test. Women were found to outperform men across all three modalities. Male and female participants were more accurate when the actor portraying the emotion was female. Guapo and colleagues (2009) also found that for every emotion except fear, female faces were identified more accurately than male faces. This female advantage may be a function of differences in caretaking between the sexes, as the importance of conveying and perceiving an emotion quickly is essential (Collignon et al., 2010).

In contrast to previous findings (e.g., Derntl, Kryspin-Exner, et al., 2008), women might be expected to show enhanced recognition of disgust during times of immunosuppression or increased progesterone (i.e., the luteal phase) according to the compensatory prophylaxis hypothesis. As already discussed, women display enhanced preferences for healthy faces (Jones, Perrett, et al., 2005) and enhanced perceptions of intensity of disgusted faces with averted eyes (Conway et al., 2007) during the luteal phase of the menstrual cycle. If considering only immunosuppression, opiate users have a suppressed immune system and were found to be 47% more accurate in recognizing facial expressions of disgust compared to former users, and 31% more accurate than control participants (Martin et al., 2006). Given the increased levels of progesterone during pregnancy, enhanced recognition of disgust would be expected. In a prospective study by Pearson, Lightman, and Evans (2009), facial recognition accuracy was examined in 101 pregnant women at 11 weeks and again at 37 weeks of pregnancy. Participants were shown 60 faces displaying six basic human emotions (i.e., happiness, sadness, fear, anger, disgust, and surprise) and had to choose which of the six emotions was being displayed. The results revealed that women were more accurate at identifying emotions that signal a threat (i.e., fear, anger, and disgust) as well as sadness in late pregnancy compared to early pregnancy.

The fact that women in the later stages of pregnancy were more vigilant towards threats makes sense from an evolutionary perspective as there is clear adaptive value for being able to identify threats in the environment, whether they signal potential danger or contamination. Oxytocin has been found to increase from the first to third trimester of pregnancy (Prevost et al., 2014), and affect emotion recognition (Van IJzendoorn & Bakermans-Kranenburg, 2012). The hormone oxytocin serves several important functions in women including stimulation of uterine contractions, lactation, and promotion of maternal bonding behaviour (Weller, Zagoory-Sharon, & Levine, 2007). Oxytocin levels in pregnancy and the postpartum have been linked to enhanced maternal bonding behaviours (Feldman, Weller, Zagoory-Sharon, & Levine, 2007) and lower oxytocin scores in mid-pregnancy have been linked to higher postnatal depression scores in the early postpartum period (Skrundz, Bolten, Nast, Hellhammer, & Meinlschmidt, 2011). In a recent meta-analysis, Van IJzendoorn and Bakermans-Kranenburg (2012) showed that intranasal administration of oxytocin significantly enhanced facial emotion recognition ($d = 0.21$). Oxytocin administration also improves emotion recognition in individuals with schizophrenia (e.g., Averbeck, Bobin, Evans, & Shergill, 2012). Oxytocin has also been shown to improve accuracy of inferring the emotional states of others based only on viewing pictures of their eyes (Domes, Heinrichs, Michel, Berger, & Herpertz, 2007). However, there is conflicting evidence for the effect of oxytocin administration on amygdala response to fearful stimuli as measured by fMRI, as intranasal oxytocin has been found to reduce amygdala activation in some studies (e.g., Domes, Heinrichs, Glascher, et al., 2007; Kirsch et al., 2005) and increase amygdala activation in others compared to placebo (Domes et al., 2010). Thus, it is not clear whether oxytocin increases or decreases vigilance to threat, but future studies should differentiate women based on cycle phase.

Not all studies examining emotion recognition across the menstrual cycle have shown enhanced recognition of disgust during periods of increased progesterone (i.e., the luteal phase). For instance, Guapo et al. (2009) examined the effect of sex hormones on the recognition of facial expressions. Women were booked to participate in the study during either the early follicular phase (n = 11), ovulatory phase (n = 9), or luteal phase (n = 10) of their menstrual cycle and compared to a sample of men (n = 10). All six basic emotions were presented across different intensity levels (e.g., 10%-100%) and identification accuracy scores were created for each emotion. When examining menstrual cycle phases, women in the early follicular phase more accurately perceived angry faces compared to women in the luteal phase and men. During the ovulatory phase women were more accurate at identifying expressions of fear compared to men, and women were more accurate at recognizing sadness in the early follicular phase compared to the luteal phase. However, women did not differ in their recognition accuracy of disgust across the menstrual cycle. Lastly, the only notable finding pertaining to hormone levels was a negative correlation between estrogen levels and identification of anger. One of the limitations of this study, however, was the small number of women per menstrual cycle phase.

In the real world facial expressions are often perceived at a distance and in a wide variety of contexts, which differs greatly from the standardized presentations used in the laboratory. Thus, instead of using clearly identifiable facial expressions, ambiguous facial expressions and incorrect classifications have been used as measures of perceptual bias. For instance, individuals with PMDD have been shown to display a negative bias similar to that of individuals with depression during the luteal phase of the menstrual cycle, with neutral faces being misjudged as sad (Rubinow, Smith, Schenkel, Schmidt, & Dancer, 2007). These differences were not observed in an asymptomatic control group. Upon examining error patterns in emotion recognition

accuracy, Derntl, Kryspin-Exner, and colleagues (2008) found that women in the luteal phase were biased toward classifying negative emotions as disgusted or angry. Individuals with OCD also show perceptual biases in emotion detection. Jhung et al. (2010) found that individuals with OCD were more likely to perceive disgust and less likely to perceive anger in ambiguous facial expressions compared to control participants, although no differences were observed in non-ambiguous facial expressions. As individuals with OCD have increased disgust sensitivity, they may be primed to perceive facial expressions of disgust in others. Furthermore, increased cleaning symptoms and contamination-based disgust scores increased the likelihood of perceiving disgust in ambiguous facial expressions. These findings suggest state dependent changes in emotional processing and highlight the role of schema-consistent processing or filtering of information.

Moderators of behaviour change across the menstrual cycle

Recent menstrual cycle research suggests that not all women show the same cyclical changes across the menstrual cycle and that different groups of women may experience different patterns across the cycle. For instance, one variable that has been found to moderate behavioral changes across the cycle is sociosexuality. Individuals with lower or more restricted sociosexuality tend to have fewer sexual partners, require commitment and closeness before having sex, and are unlikely to have casual sex, whereas individuals with higher or more unrestricted sociosexuality are more comfortable engaging in uncommitted sexual behavior and tend to have a greater number of sexual partners (Simpson & Gangestad, 1991).

Oinonen, Klemencic, and Mazmanian (2008) found that women with high and low sociosexuality showed opposite shifts in mating strategies across the menstrual cycle, which they termed the Periovulatory Sociosexuality Tactic Shift (PSTS). Whereas restricted women showed an increase in their one-night stand interest during the periovulatory or high conception risk

phase (i.e., became more promiscuous), unrestricted women showed a decrease in their one-night stand interest during the periovulatory phase (i.e., became less promiscuous).

Sociosexuality was also found to moderate the relationship between testosterone levels and relationship status (Edelstein, Chopik, & Kean, 2011). Partnered men with low sociosexual desire (i.e., more restricted) showed significantly lower testosterone levels compared to single men. However, partnered men with a higher sociosexual desire who reported a greater desire for uncommitted sexual activity showed testosterone levels that were comparable to single men. Furthermore, similar results were found for women. Partnered women with more restricted sociosexual behavior had lower levels of testosterone compared to single women, whereas women who reported more frequent uncommitted sexual behavior had testosterone levels comparable to single women (Edelstein et al., 2011).

Digit ratio has also been found to moderate changes in facial preferences across the cycle (Scarbrough & Johnston, 2005). The ratio of the length of the second digit to the fourth digit (2D:4D) is thought to be a proxy measure of prenatal androgen and estradiol exposure (Manning, Scutt, Wilson, & Lewis-Jones, 1998; Manning, Bundred, Newton, & Flanagan, 2003). Whereas women tend to show equal digit lengths or a ratio of approximately 1, men tend to have a longer fourth digit making the ratio below one (Manning et al., 1998). Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, and Manning (2004) found that high levels of fetal testosterone as measured through amniocentesis were significantly related to low 2D:4D ratios measured at two years of age. Experimental studies with mice have shown that sex differences in 2D:4D emerge at a specific time in embryonic development and correspond to differential patterns of androgen and estrogen receptor activity in men and women (Zheng & Cohn, 2011). Furthermore, these

differences persisted throughout the lifespan, providing evidence that 2D:4D is a stable and reliable indicator of prenatal hormone exposure (but see Hampson & Sankar, 2012).

Digit ratio is also related to sociosexuality, as lower (or more masculinized) 2D:4D is associated with unrestricted sociosexuality (Clark, 2004). Scarbrough and Johnston (2005) found that when women had to select the most attractive male face at two points across the menstrual cycle, women with low 2D:4D shifted towards a more masculine face during the high conception probability phase, whereas women with high 2D:4D shifted toward a less masculinized face in the high conception probability phase.

These findings suggests that not all women show the same pattern of behavioral change across the menstrual cycle and it may be important to examine potential moderators of change across the cycle. For instance, sexual activity may be a potential proxy measure of sociosexuality, and research suggests that hormone profiles may differ according to relationship status.

The present study

Evolutionary psychologists posit that precautionary behaviours are evident in childbearing women because they represent adaptive strategies for protecting their offspring from threat. These threats have been present in ancient times and remain important to this day. Hahn-Holbrook et al. (2011) categorize these potential risks to offspring according to the threat of disease, attack, and accidents. In this conceptualization, disgust proneness, contamination fears, and heightened risk aversion have direct benefits such as reducing pathogen exposure that could cause birth defects or by preventing accidental harm to the infant (e.g., falling). In other words, precautionary behaviours provide important functions that increase the likelihood of infant survival. If this mechanism is indeed ingrained, it may also become activated during times

of equal reproductive importance. For instance, in free-cycling women, every menstrual cycle represents the possibility of conception and includes periods of low and high progesterone levels. There is evidence suggesting that disgust sensitivity and contamination-related OCD symptoms increase during times of increased progesterone, although the findings are not consistent. Reproductive hormones may provide important insights into the sex differences in disgust sensitivity and contamination-related OCD symptoms. Furthermore, constructs closely associated with OCD symptoms including harm avoidance and responsibility beliefs have yet to be examined in this context. In the present study harm avoidance will be characterized by lower risk-taking scores.

The purpose of the present study was to examine differences between free-cycling women and women taking hormonal contraceptives in terms of: disgust sensitivity, OCD contamination symptoms, responsibility beliefs, risk-taking across the cycle, and to compare emotion discrimination between men and women over the cycle or corresponding length of time for men. The present study overcame several limitations of past research in this area, while also attempting to find novel associations. Prior studies in many of the areas discussed previously have included the use of hormonal contraceptives as exclusionary criteria in their designs. The menstrual cycle research previously discussed consists of largely cross-sectional designs with low sample sizes per menstrual cycle phase and without the direct measurement of hormone levels. Thus, the present study was designed to address these limitations and make stronger conclusions regarding within-subject differences in precautionary behaviour across the menstrual cycle and the role of hormones in these differences.

Primary Hypotheses

1. Free-cycling women will show an increase in contamination-based OCD symptoms, disgust sensitivity, and responsibility beliefs and a decrease in risk-taking during the luteal phase of the menstrual cycle compared to the follicular phase, whereas women taking hormonal contraceptives will show significantly attenuated effects compared to free-cycling women in terms of these dependent variables.

Potential moderating variables will also be explored to see if subgroups of women display different patterns of behavior change cross the cycle.

2. Increasing salivary progesterone levels across the menstrual cycle will be associated with increased OCD symptomatology, disgust sensitivity, responsibility beliefs, and decreased risk-taking across the cycle.

Since the luteal phase of the menstrual cycle is characterized by high levels of progesterone (which suppress the immune system), the compensatory prophylaxis hypothesis (Fessler et al., 2005) predicts that obsessive compulsive behaviour and disgust sensitivity will increase to compensate for greater vulnerability to infection. Harm avoidance and responsibility beliefs are also hypothesized to increase at this time as they are closely related to OCD (Salkovskis et al., 2000), and changes in behaviour and cognition generally do not occur independently.

Women taking hormonal contraceptives generally have decreased endogenous progesterone levels compared to free-cycling women (Fleischman et al., 2010). Therefore if progesterone is driving changes in precautionary behaviour across the cycle there should be differences between these two groups.

Previous research suggests that not all women show the same pattern of behavior change across the cycle (e.g., Edelstein et al., 2011; Oinonen et al., 2008; Scarbrough & Johnston, 2005). Thus, there may be variables that moderate the pattern of change in the main dependent variables across the cycle. By exploring potential moderating variables it may be possible to identify different subgroups of women who show different patterns of behavior change across the menstrual cycle.

3. a) Women will show increased sensitivity for identifying facial expressions of disgust compared to men.

Women are hypothesized to show greater sensitivity in identifying facial expressions of disgust due to findings of increased disgust sensitivity in women and more accurate identification and portrayal of expressions of disgust compared to men (e.g., Collignon et al., 2010).

b) Free-cycling women with a more liberal bias in terms of perceiving facial expressions of disgust will have increased levels of progesterone and pathogen disgust compared to women with a more conservative bias.

It is predicted, based on the compensatory prophylaxis hypothesis, that during times of immunosuppression (or increased progesterone) it would be beneficial to have a more liberal bias in terms of recognizing potential signals of contamination or threat. Furthermore, individuals with OCD have been found to be biased toward perceiving disgust in ambiguous facial expressions, with high contamination-based disgust scores increasing this effect. Therefore, heightened contamination disgust and increased progesterone may prime individuals to be biased toward perceiving facial expressions of disgust.

Supplementary Hypotheses

1. Sex differences will be found in disgust sensitivity and risk-taking with women scoring higher than men in disgust sensitivity and lower in risk-taking.

This hypothesis is in line with past research showing that women have greater disgust sensitivity than men (e.g., Druschel & Sherman, 1999; Murisa et al., 2000; Rohrmann et al., 2008; Tybur et al., 2009) and a meta-analysis showing that women engage in less risk-taking behaviour than men (Byrnes et al., 1999).

2. Women who are more hormonally sensitive (i.e., meet criteria for PMS) will report greater average OCD symptoms across the menstrual cycle.

This prediction is based on findings showing a high degree of comorbidity between OCD and PMS/PMDD (Vulink et al., 2006; Williams and Koran, 1997). Furthermore, women meeting criteria for PMS or PMDD appear to be more likely to have comorbid psychopathology. For instance, psychiatric symptoms such as depression, anxiety, aggression, and interpersonal sensitivity were found to be significantly higher in a group of women with PMS compared to a "healthy" group of women (Firoozi, Kafi, Salehi, & Shirmohammadi, 2012).

Exploratory Hypothesis

To further study the impact of hormones on precautionary behaviour, the following research question will also be investigated: Is there a relationship between 2D:4D and symptoms of obsessive-compulsive disorder?

High testosterone levels have been linked to obsessive-compulsive disorder, after case studies were published showing that anti-androgen treatment led to symptom improvement (e.g., Eriksson, 2000). More recently, Eriksson (2007) conducted a 48-week open-label trial of

triptorelin in patients diagnosed with OCD who had not shown a response to SSRI treatment. Triptorelin is a gonadotropin-releasing hormone agonist that reduces LH and testosterone levels. Five out of six patients experienced significant reductions in OCD symptoms. In addition, men are more likely to have aggressive and sexual obsessions and compulsions than women (Lochner et al., 2004; Saad, 2006). Although these studies suggest that high levels of testosterone may play a role in the development of obsessive-compulsive disorder, other studies suggest the opposite pattern. For instance, men with more feminized 2D:4D ratios have been found to have greater anxiety symptoms (Evardone & Alexander, 2009). In addition, harm avoidance has been linked to OCD and a recent study found that risk-taking was negatively correlated with 2D:4D ratios in men (Stenstrom, Saad, Nepomuceno, & Mendenhall, 2011). These findings suggest that obsessive-compulsive symptoms may be associated with a more feminized 2D:4D pattern.

Method

Participants

A total of 509 people completed the online screening questionnaire for the study. Participants were recruited locally from Introductory Psychology classes, higher level psychology courses, and the general university community as well as online through social networking websites. Participants were primarily female (77.4%), and were between 17 and 59 years of age (M = 22.00, SD = 6.52).

Of the overall sample of 509 participants, 332 went on to complete the phase questionnaires. Those who only completed the screening questionnaire were slightly younger (M = 21.25, SD = 5.87, n = 177) compared to those who went on to complete the full study (M = 22.39, SD = 6.81, n = 332), although this difference was only a trend, $t(504) = -1.86$, $p = .06$. Women were significantly more likely to complete only the screening questionnaire than men, χ^2

(1) = 7.12, p = .008; phi = - 0.12, although this was a small effect size. No differences were found between people who completed only the screening questionnaire and those who went on to complete the study in terms of ethnicity, marital status, education, religion, or sexual orientation.

Of the 332 people who completed the current study, 261 (78.6%) completed the study in the laboratory whereas 71 (21.4%) completed the fully online version of the study (see Table 1 for demographic characteristics of the total sample). Participants who completed the fully online version of the study were significantly older (M = 26.34, SD = 8.40, n = 71) than participants who completed the laboratory version of the study (M = 21.41, SD = 6.10, n = 261), t(91.25) = - 5.54, p < .001. Men were significantly more likely to participate in the laboratory version of the study compared to women, χ^2 (1) = 5.36, p = .02; phi = 0.13. Participants who completed the study in the laboratory were less likely to be married or common-law and more likely to be single, χ^2 (3) = 15.69, p = .001; phi = 0.22. Participants who completed the fully online version of the study had significantly more years of education (M = 15.77, SD = 2.15, n = 71) compared to participants who completed the study in the laboratory (M = 13.61, SD = 2.58, n = 261), t(330) = - 6.48, p < .001. Participants who completed the study in the laboratory were more likely to be Introductory Psychology students whereas participants completing the fully online version of the study were likely to be students in upper year psychology classes.

Of those who completed the laboratory version of the study, the majority received bonus points (82.8% for session 1, 86.3% for session 2) rather than Tim Horton gift certificates (17.2% for session 1, 13.7% for session 2). Of those who completed the fully online version of the study, the majority received bonus points (78.9% for session 1, 78.8% for session 2), and the rest were entered into a prize draw (21.1% at session 1, 21.2% at session 2).

Exclusions. Of the 332 participants who went on to complete the main part of the study,

Table 1

Demographic Characteristics of the Overall Sample (N = 332)

Variable		Total Sample *n (%)*	Men (*n* = 87) *n (%)*	Women (*n* = 245) *n (%)*
Age (*M* (*SD*))		22.46 (6.94)	22.94 (7.24)	22.29 (6.84)
Years of Education (*M* (*SD*))		14.07 (2.65)	14.48 (2.51)	13.93 (2.69)
Marital status	Married/common law	28 (8.9%)	4 (4.8%)	24 (10.5%)
	Single	276 (88.2%)	77 (91.7%)	199 (86.9%)
	Divorced/separated	7 (2.2%)	3 (3.6%)	4 (1.7%)
	Widowed	2 (0.6%)	0 (0%)	2 (0.9%)
Dating/Relationship	Yes	119 (45.9%)	25 (32.5%)	101 (53.4%)
	No	140 (54.1%)	52 (67.5)	88 (46.6%)
Ethnicity	European Descent	285 (86.1%)	74 (85.1%)	211 (86.5%)
	African Canadian/Black	5 (1.5%)	3 (3.4%)	2 (0.8%)
	Middle Eastern	2 (0.6%)	0 (0%)	2 (0.8%)
	Native-Canadian/Aboriginal	15 (4.5%)	2 (2.3%)	13 (5.3%)
	East Indian	3 (0.9%)	2 (2.3%)	1 (0.4%)
	Asian	11 (3.3%)	2 (2.3%)	9 (3.7%)
	Other	10 (3%)	4 (4.6%)	6 (2.5%)
Religion	Christian	185 (56.6%)	42 (48.8%)	143 (59.3%)
	Agnostic	26 (8.0%)	11 (12.8%)	15 (6.2%)
	Buddhist	6 (1.8%)	1 (1.2%)	5 (2.1%)
	Muslim	4 (1.2%)	1 (1.2%)	3 (1.2%)
	Atheist	60 (18.3%)	20 (23.3%)	40 (16.6%)
	Other	46 (14.1%)	11 (12.8%)	35 (14.5%)
Sexual Orientation	Asexual	2 (0.6%)	1 (1.1%)	1 (0.4%)
	Exclusively heterosexual	266 (80.9%)	65 (74.7%)	201 (83.1%)
	Predominantly heterosexual	38 (11.5%)	10 (11.5%)	28 (11.6%)
	Equally hetero/homosexual	10 (3%)	1 (1.1%)	9 (3.7%)
	Predominantly homosexual	6 (1.8%)	4 (4.5%)	2 (0.8%)
	Exclusively homosexual	7 (2.1%)	6 (6.9%)	1 (0.4%)
Education	High school diploma	88 (26.7%)	20 (23.0%)	68 (28%)
	Some college	3 (0.9%)	1 (1.1%)	2 (0.8%)
	College diploma	25 (7.6%)	6 (6.9%)	19 (7.8%)
	Some university	169 (51.2%)	45 (51.7%)	124 (51%)
	Undergraduate degree	36 (10.9%)	13 (14.9%)	23 (9.5%)
	Master's degree	9 (2.7%)	2 (2.3%)	7 (2.9%)

80 participants were excluded based upon a-priori exclusion criteria including participants who were over the age of 40 *(n* = 14), pregnant or breastfeeding (*n* = 5), had irregular menstrual cycles (under 25 days or over 35 days; *n* = 14), had one or both ovaries removed (*n* = 1), endorsed four or more infrequency scale items (*n* = 1), hormonal contraceptive users who were not currently experiencing menstrual periods and therefore could not be assigned a cycle phase (e.g., extended hormonal contraceptive users; *n* = 10), people who have current or chronic medical conditions that could affect hormone levels (e.g., depression, thyroid disorders, diabetes), or are currently using medication that may affect hormone levels (e.g., steroids, antidepressant medication; *n* = 32), and free-cycling women who used OCs within the past six months (*n* = 3). All participants scored within the normal limit (below 70*T*) for the social desirability scale, and therefore nobody was excluded on that basis.

Of the 252 participants remaining, there were 75 men, 110 hormonal contraceptive (HC) users, and 67 free-cyclers (FCs). The majority of the women who completed the study (64.4%) were in the correct phases during participation in the two parts of the study (i.e., Follicular = days 3 to 10; Luteal = days -3 to -9); whereas 11.9% were outside the target testing days by 1 day, 9.0% by two days, 6.2% by three days, 6.2% were four or more days off, and 2.3% only completed one phase of the study. Participants more than three days outside of the target testing days or those who did not complete both phases of the study were excluded from subsequent analyses (*n* = 15). Of the 237 participants remaining, participants with an anxiety disorder were also excluded (*n* = 6; 3 men and 3 HC users), as we intended to examine sub-clinical symptoms. A further eight participants were excluded based on having progesterone levels inconsistent with their reported cycle phases. Thus, the final sample size was 223 participants, including 72 men, 100 HC users, and 51 FCs (see Figure 1 for the flow of participants through the study). The mean

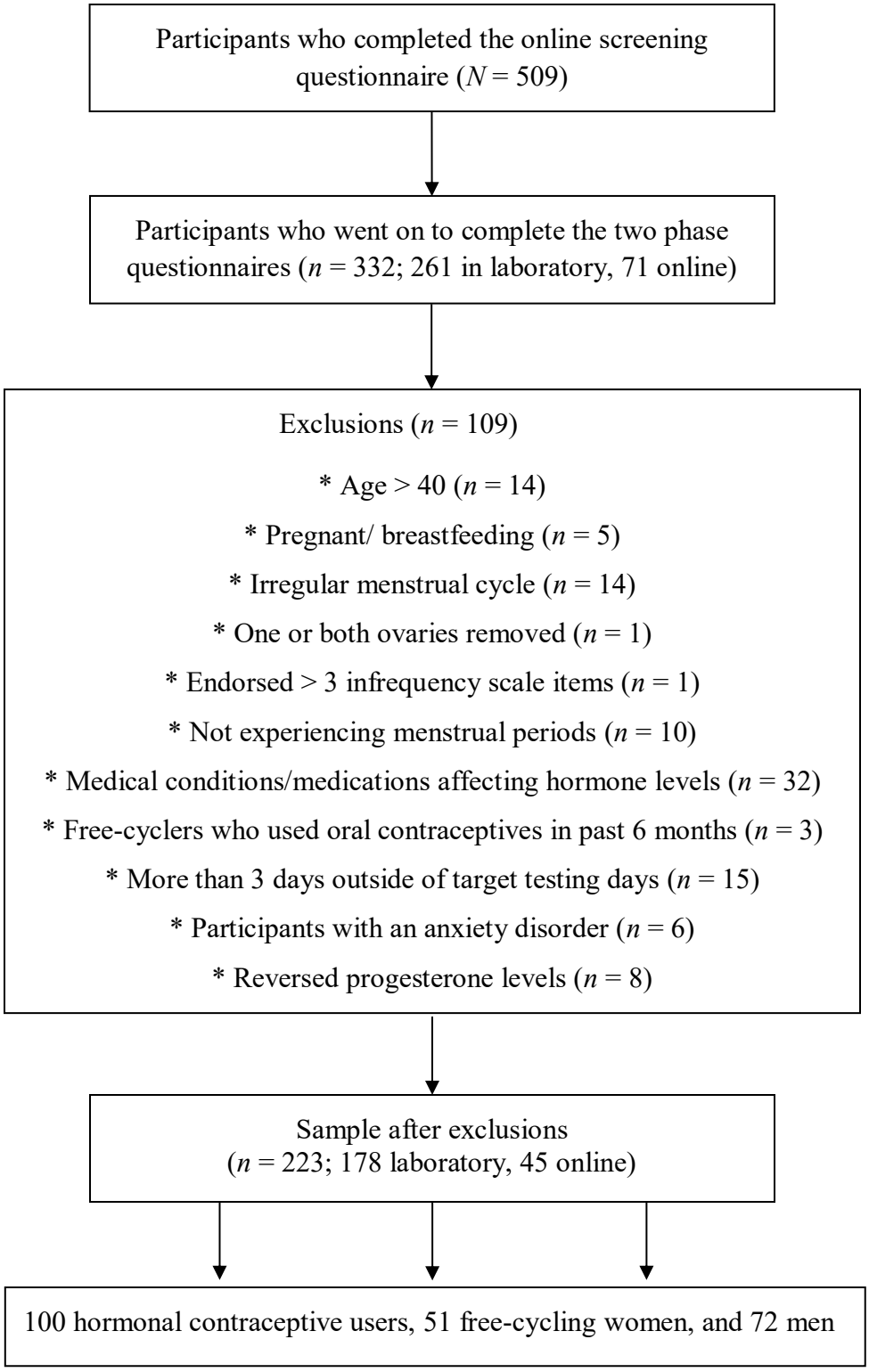

Figure 1. Flowchart of study participants.

age of participants was 20.83 (*SD* = 3.68), with the majority being of European descent (79.4%), single (92.8%), Christian (56.2%), exclusively heterosexual (82.4%), and having some university education (50.4%; see Table 2 and 3 for full demographic characteristics).

Group equivalency between the three groups was examined using chi-squared tests and one-way ANOVAs, depending on whether the variable was dichotomous or continuous. There were no significant differences between the three groups in terms of ethnicity, religion, sexual orientation, or education (see Table 3). However, the groups did differ on age and marital/ relationship status. A one-way ANOVA revealed a significant difference between the groups in terms of age, $F(2, 220) = 7.59$, $p = .001$. A Tukey post-hoc test revealed that age was significantly younger in HC users ($M = 19.79$, $SD = 2.37$, $n = 100$) compared to men ($M = 21.63$, $SD = 4.07$, $p = .003$, $n = 72$) or FCs ($M = 21.73$, $SD = 4.66$, $p = .005$, $n = 51$). There was also a significant difference between groups in terms of marital and relationship status. Free-cycling women and women using hormonal contraceptives did not differ according to relationship status, χ^2 (1) = 71.75, $p = .19$; phi = - 0.11, but men were significantly more likely to be single and less likely to be in a relationship compared to women, χ^2 (1) = 10.20, $p = .001$; phi = .22.

Based on the PSST, twenty-two percent of the sample met criteria for PMS, while 4.7% reported symptoms consistent with PMDD (see Table 4 for more detailed reproductive history). The majority of women taking hormonal contraceptives were taking OCs (88%; see Table 5). The most commonly used OCs were Alesse and Tri-Cyclen Lo (see Table 6). Oral contraceptives were also categorized according to their phasicity (e.g., monophasic, triphasic), progesterone dosage (low versus high), and level of androgenicity for later analyses (Black, Francoeur, & Rowe, 2004; Dickey, 2010; Ninger, 2000; see Table 6). Across all women, the mean testing day for the follicular phase was day 8 ($M = 7.85$, $SD = 2.47$, range: day 2-13, $n = 151$) and for the

Table 2

Demographic Characteristics of the Final Sample after Exclusions (N = 223)

Variable		*M* (*SD*)
Age		20.83 (3.68)
Years of Education		13.96 (2.48)
		n (%)
Marital status	Married/common law	12 (5.4%)
	Single	194 (87.0%)
	Divorced/separated	3 (1.3%)
Dating/Relationship	Yes	125 (56.1%)
	No/Single	89 (39.9%)
Ethnicity	European Descent	195 (87.5%)
	African Canadian/Black	5 (2.2%)
	Middle Eastern	2 (0.9%)
	Native-Canadian/Aboriginal	8 (3.6%)
	East Indian	2 (0.9%)
	Asian	5 (2.2%)
	Other	6 (2.7%)
Religion	Christian	123 (56.2%)
	Agnostic	21 (9.6%)
	Buddhist	3 (1.4%)
	Muslim	2 (0.9%)
	Atheist	45 (20.5%)
	Other	25 (11.4%)
Sexual Orientation	Asexual	0 (0%)
	Exclusively heterosexual	183 (82.4%)
	Predominantly heterosexual	25 (11.3%)
	Equally hetero/homosexual	4 (1.8%)
	Predominantly homosexual	5 (2.3%)
	Exclusively homosexual	5 (2.3%)
Education	High school diploma	64 (28.8%)
	Some college	0 (0%)
	College diploma	13 (5.9%)
	Some university	112 (50.4%)
	Undergraduate degree	27 (12.2%)
	Master's degree	6 (2.7%)

Note. This table includes missing data due to unanswered items.

Table 3

Demographic Characteristics of the Final Sample after Exclusions (N = 223), Separated by Group

Variable	Men (n = 72)	HC users (n = 100)	FCs (n = 51)	p-value
		M (*SD*)		
Age[a]	21.63 (4.07)	19.79 (2.37)	21.73 (4.66)	.001
Years of Education	14.36 (2.47)	13.82 (1.74)	13.68 (3.51)	.25
		n (%)		
Marital status[b]				.04
Married/common law	3 (4.2%)	3 (3.0%)	6 (11.8%)	
Single	65 (90.3%)	90 (90.0%)	39 (76.5%)	
Divorced/separated	1 (1.4%)	0 (0%)	2 (3.9%)	
Dating/Long-term Relationship				.003
Yes	29 (40.3%)	68 (68%)	28 (54.9%)	
No/Single	39 (54.2%)	30 (33%)	20 (39.2%)	
Ethnicity				.16
European Descent	61 (84.7%)	93 (93%)	41 (80.3%)	
African Canadian/Black	3 (4.2%)	0 (0%)	2 (3.9%)	
Middle Eastern	0 (0%)	1 (1%)	1 (2.0%)	
Native-Canadian/Aboriginal	2 (2.8%)	2 (2%)	4 (7.8%)	
East Indian	2 (2.8%)	0 (0%)	0 (0%)	
Asian	2 (2.8%)	1 (1%)	2 (3.9%)	
Other	2 (2.8%)	3 (3%)	1 (2.0%)	
Religion				.46
Christian	34 (47.2%)	55 (56.7)	34 (68.0%)	
Agnostic	10 (13.9%)	9 (9.3%)	2 (4.0%)	
Buddhist	1 (1.4%)	1 (1%)	1 (2.0%)	
Muslim	1 (1.4%)	0 (0%)	1 (2.0%)	
Atheist	18 (25%)	21 (21.6%)	6 (12.0%)	
Other	8 (11.1%)	11 (11.3%)	6 (12.0%)	
Sexual Orientation				.10
Asexual	0 (0%)	0 (0%)	0 (0%)	
Exclusively heterosexual	54 (75%)	86 (86.9%)	43 (84.3%)	
Predominantly heterosexual	8 (11.1%)	11 (11.1%)	6 (11.8%)	
Equally hetero/homosexual	1 (1.4%)	2 (2%)	1 (2.0%)	
Predominantly homosexual	4 (5.6%)	0 (0%)	1 (2.0%)	
Exclusively homosexual	5 (6.9%)	0 (0%)	0 (0%)	

Table 3 - continued

Variable	Men (n = 72)	HC users (n = 100)	FCs (n = 51)	p-value
		M (*SD*)		
Education				.30
High school diploma	18 (25%)	32 (32%)	14 (28.0%)	
Some college	0 (0%)	0 (0%)	0 (0%)	
College diploma	5 (6.9%)	3 (3%)	5 (10.0%)	
Some university	36 (50%)	53 (53%)	23 (46.0%)	
Undergraduate degree	12 (16.7%)	10 (10%)	5 (10.0%)	
Master's degree	1 (1.4%)	2 (2%)	3 (6.0%)	

Note. This table includes missing data due to unanswered items. HC = hormonal contraceptive; FCs = free-cyclers. [a] Hormonal contraceptive users were significantly younger than men or free-cycling women. [b] Men were significantly more likely to be single compared to women.

Table 4

Women's Reproductive History (n = 151)

Variable		*n*	*%*	*M*	*SD*
Age at first menstruation		148		12.75	1.77
Length of menstrual cycle (days)		147		28.14	6.99
Length of period (days)		150		5.02	1.23
Regularity of cycle	Some months I get my period and some months I don't.	3	2.0%		
	I usually get my period every month, but it is irregular.	13	8.8%		
	I usually get my period within 2 to 3 days of when I expect it.	88	59.5%		
	My period is like clockwork.	44	29.7%		
Current HC user	Yes	100	66.2%		
	No	51	33.8%		
Length of HC use (years)		95		3.80	2.80
Former HC user	Yes	22	44.9%		
	No	27	55.1%		
PMS diagnosis	Yes	33	22.0%		
	No	117	78.0%		
PMDD diagnosis	Yes	7	4.7%		
	No	143	95.3%		
Times pregnant	0	136	91.9%		
	1	7	4.7%		
	2	3	2.0%		
	3	2	1.4%		
Number of children	1	3	37.5%		
	2	4	50.0%		
	3	1	12.5%		

Note. Counts may not sum to 151 as a result of unanswered items. HC = hormonal contraceptive; PMS = premenstrual syndrome; PMDD = premenstrual dysphoric disorder.

Table 5

Types of Hormonal Contraceptives used in Current Hormonal Contraceptive Users (n = 100)

Hormonal Contraceptive Type	*n (%)*
Oral Contraceptives	88 (88)
Injection	1 (1)
Contraceptive Patch	3 (3)
Implant	0 (0)
Vaginal Ring	5 (5)
Barrier	0 (0)
Didn’t Specify	3 (3)

Table 6

Oral Contraceptive Brands along with their Phasicity, Progestin Dose, and Androgenic Activity in current Oral Contraceptive Users (n = 88)

Brand	*n (%)*	*Phasicity*	*Progestin Dose*	*Androgenic Act.*
Alesse	18 (20.5)	Monophasic	Low	Intermediate
Alysena	3 (3.4)	Monophasic	Low	Intermediate
Apri	3 (3.4)	Monophasic	Low	Low
Aviane	10 (11.4)	Monophasic	Low	Intermediate
Cyclessa	1 (1.1)	Monophasic	High	Low
Cyclen	1 (1.1)	Triphasic	Low	Low
Demulen 30	2 (2.3)	Monophasic	High	Intermediate
Diane 35	3 (3.4)	Monophasic	High	Low
Linessa	3 (3.4)	Triphasic	High	Low
Loestrin	1 (1.1)	Monophasic	High	High
Marvelon	5 (5.7)	Monophasic	Low	Low
Min-Ovral	4 (4.5)	Monophasic	Low	Intermediate
MinEstrin 1/20	1 (1.1)	Monophasic	High	Intermediate
Portia	1 (1.1)	Monophasic	Low	Intermediate
Seasonale	1 (1.1)	Monophasic	Low	Intermediate
Tri-Cyclen	4 (4.5)	Triphasic	Low	Low
Tri-Cyclen Lo	13 (14.8)	Triphasic	Low	Low
Yasmin	6 (6.8)	Monophasic	High	None
Yaz	8 (9.1)	Monophasic	High	None

Note. Androgenic Act. = androgenic activity.

luteal phase was 6 days prior to menstruation (M = -6.26, SD = 2.67, range: -12- 1, n = 151). Approximately 75% of women were tested first in the follicular phase and second in the luteal phase, while the remaining women were tested first in the luteal phase and second in the follicular phase. In addition, 67% of free-cycling women who completed the study in the laboratory provided confirmation of the start of their next period in order to verify their testing days.

Materials

Online Screening Questionnaire

The screening questionnaire was presented online through SurveyMonkey and included background and reproductive history. The screening questionnaire was used to collect menstrual cycle information so women could be scheduled to complete the additional questionnaires during specific phases of their cycle, as well as screening for later exclusion criteria (e.g., age, irregular menstrual cycles, medical conditions, etc.).

The Background Information Questionnaire consisted of questions pertaining to basic demographic information (e.g., age, sex, education), reproductive history (e.g., age at puberty, use of hormonal contraceptives), and psychological and medical history (e.g., current medication use, psychiatric or medical diagnoses). This questionnaire has been widely used in the Health, Hormones, and Behaviour Laboratory and was included in several published studies (e.g., Oinonen & Mazmanian, 2007). Women also completed the Premenstrual Symptoms Screening Tool (PSST; Steiner et al., 2003). The PSST was designed as a screening tool for both PMS and PMDD and is based on *DSM-IV* criteria for PMDD. A screening tool is ideal in research or in practice when daily prospective measures across two cycles are not practical or possible. Each symptom is rated according to perceived severity (e.g., not at all, mild, moderate, or severe). In a

sample of 508 women who completed the PSST, including hormonal contraceptive users and non-users (Steiner et al., 2003), rates of PMDD and moderate to severe PMS were very similar across hormonal contraceptive users (i.e., 5.9% and 26%, respectively) and non-users (i.e., 4.8% and 25.6%, respectively).

Although published research has used the PSST (e.g., Steiner et al., 2011), the authors of the scale have yet to report the full psychometric properties of the instrument. However, two recent studies that translated the PSST into Korean and Persian found high internal consistency reliability (αs $\geq$ .90; Choi et al., 2011; Siahbazi, Hariri, Montazeri, Banaem, & Hajizadeh, 2011).

Phase Questionnaires

The Padua Inventory-Washington State University Revision (PI-WSUR; Burns, Keortge, Formea, & Sternberger, 1996)

The PI-WSUR consists of 39 items, broken down into subscales that measure five different content dimensions relevant to OCD: contamination obsessions and washing compulsions (e.g., "I find it difficult to touch garbage or dirty things"), dressing/grooming compulsions (e.g., "I feel obliged to follow a particular order in dressing, undressing, and washing myself"), checking compulsions (e.g., "When I handle money, I count and recount it several times"), obsessional thoughts about harm to self/others (e.g., "When I hear about a disaster, I think it is somehow my fault"), and obsessional impulses to harm self/others (e.g., "I sometimes have an impulse to steal other people's belongings, even if they are of no use to me"). Items are rated according to a 5-point Likert-type scale from 0 (*not at all*) to 4 (*very much*).

Burns and colleagues (1996) found the scale had high internal consistency reliability (α = .92). Internal consistency reliability statistics for the 5 subscales were: .85 for contamination obsessions and washing compulsions, .78 for dressing/grooming compulsions, .88 for checking

compulsions, .77 for obsessional thoughts about harming self/others, and .82 for obsessional impulses to harm self/others. The revised version reduced the amount of shared variance with worry, thus making the measure a more distinct measure of obsessionality. Based on the normative data for non-clinical and clinical samples reported by Burns and colleagues (1996), cut-off scores below 6 and above 14 have been used to identify individuals who are low and high in contamination fears (e.g., Deacon & Olatunji, 2007).

Grabill and colleagues (2008) reviewed 16 measures of OCD and reported that the PI-WSUR had good psychometric properties. Test-retest reliability over a 6-month period was adequate (r = .76; Grabill et al., 2008). In terms of convergent and discriminant validity, scores on the PI-WSUR correlated with the Maudsley Obsessive Compulsive Inventory (MOCI; r = .61) significantly more than the Penn State Worry Questionnaire (PSWQ; r = .37) in a large student sample (Jonsdottir & Smari, 2000). Consistent with previous findings, women scored significantly higher on the contamination obsessions and washing compulsions subscale, whereas men scored higher on the obsessional impulses to harm self/others subscale (Jonsdottir & Smari, 2000).

Disgust Scale -Revised (DIS-R; Haidt et al., 1994, modified by Olatunji, Williams, et al., 2007)

The original Disgust Scale consisted of 32 items that measured the following eight domains of disgust: food, body products, animal, sex, personal hygiene, envelope violations, death, and magical thinking. The internal consistency reliability for the entire scale was .84, but the authors cautioned that the internal consistency for the subscales was too low for the scales to be individually interpreted (αs < .63; Olatunji et al., 2008).

Olatunji, Williams, and colleagues (2007) later revised the Disgust Scale after examining its factor structure and psychometric properties across five independent samples. Several items

were removed due to unacceptable item-total correlations and the number of subscales was reduced from 8 to 3 based on factor analysis. The three subscales included core disgust (e.g., "Seeing a cockroach in someone else's house doesn't bother me"), animal reminder disgust (e.g., "It would bother me to be in a science class, and to see a human hand preserved in a jar"), and contamination-based disgust (e.g., "I never let any part of my body touch the toilet seat in public restrooms"). Although the internal consistency reliability increased for the core and animal reminder disgust subscales (.74 and .78, respectively), it remained low for contamination (.61). A recent study by van Overveld, de Jong, Peters, and Schouten (2011) supported the three-factor solution over a two-factor solution, suggesting that although the internal consistency for the contamination scale is lower than the other two scales, it still provides incremental validity. The response format of the scale was also revised from a dichotomous response (i.e., true/false) to a continuous Likert-type scale (i.e., 0 to 4 or *strongly disagree* to *strongly agree*). Finally, the scale includes two questions that act as infrequency items to identify individuals who are not paying attention to the task (e.g., "I would rather eat a piece of fruit than a piece of paper").

Three Domain Disgust Scale (TDDS; Tybur et al., 2009)

This scale represents a multidimensional model of disgust consisting of pathogen (e.g., "Sitting next to someone who has red sores on their arm"), sexual (e.g., "Finding out that someone you don't like has sexual fantasies about you"), and moral disgust (e.g., "Forging someone's signature on a legal document"). The authors demonstrated discriminant validity across the three domains of disgust. For instance, primary psychopathy was negatively correlated with moral disgust and sexual disgust but unrelated to pathogen disgust. Perceived vulnerability to disease was related to pathogen and sexual disgust but not moral disgust. Different disgust domains also had distinct correlations with the Big Five personality traits. For instance,

sensitivity to pathogen disgust positively correlated with neuroticism, sexual disgust sensitivity positively correlated with conscientiousness, and moral disgust positively correlated with extraversion (Tybur et al., 2009).

These three subscales have considerably higher internal consistency reliabilities compared to the Disgust Scale-Revised at .87, .84, and .87 for pathogen, sexual, and moral disgust, respectively. Due to the high internal consistency of the pathogen scale it was preferred in the current study over the contamination-based disgust subscale of the Disgust Scale-Revised when looking only at contamination-based disgust as opposed to general disgust sensitivity. Sexual and moral disgust are not a key focus of the present study and therefore were not included. The pathogen subscale includes 7 items that are rated on a 6-point Likert-type scale from 0 (*not at all disgusting*) to 6 (*extremely disgusting*).

Responsibility Attitude Scale (RAS; Salkovskis et al., 2000)

The RAS consists of 26 items that measure beliefs about responsibility, a key component in the cognitive model of OCD. Sample items include, "I often take responsibility for things which other people don't think are my fault" and "Even if harm is a very unlikely possibility, I should always try to prevent it at any cost." Items are rated using a 7-point Likert-type scale from 1 (*totally agree*) to 7 (*totally disagree*). The total score for the RAS is the mean of all 26 items. For ease of comprehension, scores were reversed (*totally agree* = 7, *totally disagree* = 1) so that higher scores represent higher responsibility beliefs.

Individuals with OCD have been found to score significantly higher on the RAS (M = 4.69, SD = 1.01) compared to individuals with a *DSM-IV* anxiety disorder (M = 4.00, SD = 0.92), and control participants (M = 3.48, SD = 1.01; Salkovskis et al., 2000). The two week test-retest reliability is high (r = .94). Salkovskis et al. (2000) report an internal consistency reliability of

.92, whereas it was slightly lower in a study by Smári and Hólmsteinsson (2001; α = .87). Concurrent validity was demonstrated by showing associations with additional measures of obsessive compulsive symptoms such as the Maudsley Obsessive Compulsive Inventory (MOCI; r = .57) and the Obsessive Compulsive Inventory (OCI; r = .54).

Domain-Specific Risk-Taking scale (DOSPERT; Blais & Weber, 2006)

The original DOSPERT scale (Weber, Blais, & Betz, 2002) contains 50 items assessing risk-taking across five domains: ethical, financial, health/safety, recreational, and social. All five domains of risk-taking were associated with concurrent ratings of sensation seeking. Women were found to be more risk aversive than men, with significant differences in every subscale except for social risk-taking. The scale was refined to 40 items to enhance the psychometric properties and then a shortened version (30-items) was created, which was used in the present study (Blais & Weber, 2006).

The shortened DOSPERT scale measures risk-taking by asking participants to rate the likelihood that they would engage in risky activities if in a given situation. The scale measures risk-taking across five domains: social (e.g., "Admitting that your tastes are different from those of a friend"), recreational (e.g., "Taking a skydiving class") financial (e.g., "Betting a day's income at a high-stake poker game"), health/safety (e.g., "Driving a car without wearing a seat belt"), and ethical (e.g., "Passing off somebody else's work as your own"). Items are rated on a 7-point Likert-type scale from 1 (*extremely unlikely*) to 7 (*extremely likely*). The response scale was increased from a 5-point Likert-type scale to a 7-point Likert-type scale in the most recent version to increase the sensitivity of the measure. Higher scores represent greater risk-taking within domains. Internal consistency ranged from .71 to .86 across the five subscales (Blais & Weber, 2006).

The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983)

The HADS is a widely used screening measure for anxiety (e.g., "I feel tense or wound up") and depression (e.g., "I feel as if I am slowed down"). The scale contains a 7-item subscale measuring anxiety and a 7-item subscale measuring depression. Each item is scored on a 4-point Likert-type scale from 0 to 3, resulting in a maximum score of 21 per subscale. Subscale scores of 7 or under are considered in the normal range, scores between 8 and 10 are considered at risk of a mood disorder, and scores 11 and higher indicate a probable "case" of a mood disorder (Snaith, 2003; Zigmond & Snaith, 1983). However, Bjelland, Dahl, Haug, and Neckelmann (2002) found that a cut-off score of 8 to define a "case" was met with the best balance between specificity and sensitivity.

Bjelland and colleagues (2002) examined the psychometric properties of the HADS across 747 studies. The authors found support for a two factor solution corresponding to the anxiety and depression subscales. The subscales were moderately correlated (mean r = .56). The mean internal consistency reliability for the anxiety and depression subscales were .83 and .82, respectively. Concurrent validity was established by showing medium to strong correlations with established questionnaires measuring anxiety and depression such as the Beck Depression Inventory (r = .62-.73 for HADS-D) and the State-Trait Anxiety Inventory (r = .64 -.81 for HADS-A). Furthermore, sensitivity and specificity were nearly identical between the HADS and the General Health Questionnaire. In a large sample of nearly 52,000 individuals, Mykletun, Stordal, and Dahl (2001) also supported the two-factor solution of the HADS and found appropriate internal consistency reliability and shared variance between the subscales.

Personality Research Form (PRF) Infrequency and Social Desirability Scales (Jackson, 1984)

Two validity scales were used from the PRF: the Infrequency and Social Desirability

scales, both containing 16 items each. The Infrequency Scale assesses careless or non-purposeful responding, confusion, language difficulties, or lying. These items were used in the current questionnaire as a validity check to insure that participants were attending appropriately to item content. Items are coded as true or false, for instance "I have never talked to anyone by telephone." Answering true to this question would indicate an infrequent response. Infrequent responses are coded as "1", while frequent responses are coded as "0". Although one infrequent response alone may not be concerning, endorsing four or more items likely indicates non-purposeful responding (Jackson, 1984). Therefore, participants who endorsed four or more items on the Infrequency Scale were excluded from data analysis.

Social Desirability assesses the extent to which participants are responding to the actual content of the items or if they are consistently answering questions in a socially desirable way. Impression management could be present if an individual attempts to portray themselves in an overly favorable light or free from shortcomings. For instance, answering false to the question, "I would be willing to do something a little unfair to get something that was important to me" would be a socially desirable response.

The Karolinska Directed Emotional Faces (KDEF; Lundqvist, Flykt, & Öhman, 1998)

The KDEF is a set of human facial expressions depicting the six basic human emotions (i.e., fear, anger, disgust, happiness, sadness, surprise) in addition to a neutral expression. These stimuli were created in the Department of Clinical Neuroscience at the Karolinska Institutet in Sweden for use in psychological research and can be obtained free of charge. The stimuli set contains 35 women and 35 men (mean age = 25 years), each displaying all seven expressions from five different angles (straight on, half left profile, half right profile, full left profile, and full right profile). The size of each photo is 562 × 762 pixels.

A validation study was recently undertaken to evaluate the hit rate, intensity, and arousal ratings for 490 stimuli from the KDEF (straight on profiles of the seven expressions; Goeleven, De Raedt, Leyman, & Verschuere, 2008). Close to 300 university students took part in the validation study. The average hit rate was 72%, with fear having the lowest hit rate (43%) and happiness being the most easily identifiable emotion (92%). As expected, neutral expressions were given lower arousal and intensity ratings compared to the six basic emotions. Disgust had the highest intensity rating, although happy and surprised were not significantly lower. Test-retest reliability over the course of a week was very high (88% similarity in ratings), and intensity and arousal ratings were highly correlated across the two times (r = .75; r = .78, respectively). The authors conclude that the KDEF facial database is valid and is comparable to other databases. Goeleven et al. (2008) provide tables with the best 20 pictures per emotion and unbiased hit rate accuracy scores for each emotion. One noted drawback when using this database is that the stimuli are limited to faces of European descent.

Emotion Discrimination Task

In the emotion discrimination task participants were asked to discriminate between disgust, fear, and neutral expressions. One-hundred and eighty colored photographs of facial expressions from the KDEF were used including 60 expressions of disgust, 60 expressions of fear, and 60 neutral expressions. Of the 70 total photographs for each emotion provided in the stimuli set, 10 were removed from each of the three types of expressions used (i.e., disgust, fear, and neutral). These photos were removed based upon reviewing the unbiased hit rate accuracy scores provided by Goeleven et al. (2008). Unbiased hit rate accuracy scores were listed as a decimal number between 0 (never correctly identified) and 1 (always correctly identified). The 10 photos with the lowest unbiased hit rate accuracy scores were removed for each of the three

emotions. Of the 180 photographs chosen, there were an equal number of women (n = 90) and men (n = 90).

Stimuli were presented using a customized script developed with Python programming language (van Rossum & Drake, 2011). The script was loaded onto an Acer Aspire laptop with a 17 inch/43.2 cm screen, with all participants seated an equal distance from the computer screen. A small cross was presented in the centre of the screen for 1000 ms for fixation, followed by a 60 ms mask, and then a 100 ms or 60 ms presentation of facial expressions depending on condition. Facial expressions were presented in a randomized order, one at a time, followed by a forced choice discrimination response between two possible options. Three different forced-choice discriminations were made: fear versus disgust, fear versus neutral, and disgust versus neutral. During the fear versus disgust discriminations emotions were presented for 100ms, whereas neutral discriminations were presented for 60 ms to increase difficulty. Responses were made by pressing one of two keys indicated on the keyboard using the index fingers (e.g., f and j; counterbalanced across participants). Photographs were presented against a black background and instructions were presented in size 18 Gentium Basic Bold font. A text file was generated including participants' responses and reaction times.

Hand Measurements

Hands were scanned and saved onto a desktop computer in the Health, Hormones, and Behaviour Laboratory in order to examine 2D:4D. All jewelry was removed to ensure accurate measurement. Second and fourth digit length was measured from the tip of the finger down to the basal crease connecting to the palm of the hand using Photoshop. For each hand, the length of the second and fourth digits was each measured twice in Photoshop using the ruler tool. The mean second digit length was divided by the mean fourth digit length for each hand to create a

right hand 2D:4D and left hand 2D:4D score. Hand measurements were only taken for participants who completed the study in the laboratory, not for participants who completed the study online.

Salivary Progesterone Collection

Free-cycling women were asked not to eat, drink, smoke, or brush their teeth one hour before coming into the laboratory (as this can negatively affect hormone analysis, Moffat & Hampson, 1996). Saliva samples were collected in the laboratory using the passive drool collection method recommended by Salimetrics. Participants allowed saliva to pool in their mouth and then passively drooled down a straw into a 2mL polypropylene cryovial. Cryovials were tightly sealed, labelled, and stored in a freezer in the Health, Hormones, and Behaviour Laboratory at -20°C, and later shipped to Salimetrics for analysis. Biosafety clearance was obtained through Human Resources at Lakehead University prior to data collection to ensure appropriate safety procedures were employed.

Procedure

Potential participants were recruited through posters across the Lakehead University campus and emails and presentations to students in Introductory Psychology and upper year psychology courses who were eligible for bonus points. Potential participants were told that the purpose of this study was to examine the effects of hormones on emotion and mood. Interested students were asked to email the researcher and were subsequently provided with a secure website link to SurveyMonkey to complete the Online Screening Questionnaire. Participants read the covering letter A (see Appendix A) and filled out consent form A (see Appendix B). The online questionnaire took approximately 5 minutes for men to complete and 10 minutes for women to complete (see Appendix C), as men automatically skipped over the questions related

to OC use and the menstrual cycle. Participants were thanked and given debriefing form A (see Appendix D). Separate consent and debriefing forms were used for the screening and experimental questionnaires due to differences in task completion.

Using the contact information obtained in the online questionnaire, participants were contacted by phone or email within the week and an appointment was scheduled for the first of two laboratory sessions at the Health, Hormones, and Behaviour Laboratory at Lakehead University. Email addresses and phone numbers were stored separately, and used only to schedule appointments. All participants (i.e., free-cycling women, women taking hormonal contraceptives, and men) were scheduled for two sessions approximately 14 days apart. For women, testing appointments were scheduled according to their menstrual cycle phase (i.e., during either the luteal phase or follicular phase of the menstrual cycle). Testing order was assigned in a pseudo-random fashion. Preference was given to random assignment to follicular or luteal phase for the first testing session in order to ensure attrition rates were equal across menstrual cycle phases. However, due to the notable difficulty in menstrual cycle research of ensuring that women were in the correct phase of the cycle, women who were almost in a phase of interest were scheduled for that phase immediately.

Menstrual cycle phase was determined through the help of answers to the online screening questions (e.g., by listing the first day of their last menstrual period and expected start of the next menstrual period). Participants who were scheduled to participate in the follicular phase first were tested on days 3-10 using the forward counting method (i.e., 3 to 10 days after the start of menstruation) and then again 14 days later. In contrast, participants scheduled to participate first in the luteal phase were tested on days -3 to -9 using the backwards counting method (i.e., 3 to 9 days before the start of their next menstrual period), and again 14 days later.

To ensure all participants were treated equally, men were also tested 14 days apart. Free-cycling women were asked to email the experimenter when their next period began for confirmation to ensure proper cycle days. Although ideally all participants would have been tested during the same time each day (e.g., 9:00am-12:00pm) to reduce the variability in hormone levels throughout the day, this would significantly prolong data collection. Therefore, each participant was scheduled at the same time (or as close as possible) for their second session (e.g., 3:00pm for session one and 3:00pm for session two). Time of day was recorded and had no effect on progesterone levels (analyses presented below).

Upon arrival to the laboratory for the first experimental session participants were given covering letter B (see Appendix E) and consent form B to read and sign (see Appendix F). Participants were informed that they would be completing an emotion discrimination task, followed by completion of several questionnaires (see Appendix G), having their hands scanned, and finish by providing a saliva sample for hormonal analysis (only free-cycling women or non-OC users). The emotion discrimination task was presented first to ensure that the disgust questionnaire did not prime participants to perform better on the facial recognition task or influence their perception of the task. The completion time for the laboratory session ranged from 30 to 60 minutes.

An identical procedure as listed above was used for the second experimental session. The phase two questionnaire was identical to the phase one questionnaire found in Appendix G. At the end of the second session, participants were debriefed (see Appendix H) and given details on how they could be provided with a summary of the results of the study if so desired.

This study also included a fully online version for potential participants across Canada in order to increase the sample size. The online screening questionnaire was identical, and

information from this questionnaire was used to schedule women during the two menstrual cycle phases as described above (with men being tested 14 days apart, as before). The only difference between the two versions of the study was that participants in the online version were not able to complete the emotion discrimination task, provide hand scans, or give saliva samples. The fully online version contained different consent and debriefing forms due to the differences in task completion.

Planned Data Analyses

Primary Hypotheses.

1. Free-cycling women will show an increase in contamination-based OCD symptoms, disgust sensitivity, and responsibility beliefs and a decrease in risk-taking during the luteal phase of the menstrual cycle compared to the follicular phase, whereas women taking hormonal contraceptives will show significantly attenuated effects compared to free-cycling women in terms of these dependent variables.

Potential moderating variables will also be explored to see if subgroups of women display different patterns of behavior change cross the cycle.

A 2 × 2 (Group [Free-cyclers, hormonal contraceptive users] × Phase [follicular, luteal]) repeated measures multivariate analysis of covariance (MANCOVA) was conducted with age as a covariate to examine group differences across time on the four dependent variables: OCD symptoms (PI-WSUR scores), disgust sensitivity (DS-R scores), risk-taking (DOSPERT scores), and responsibility beliefs (RAS scores). A group × phase interaction was expected, with free-cycling women scoring significantly higher than women taking hormonal contraceptives on the combined dependent variables during the luteal phase.

A MANOVA is superior to performing multiple ANOVAs because it protects against inflated Type I errors (Tabachnick & Fidell, 2007). Wilks' lambda is the recommended statistic to test the significance of main effects and interactions with MANOVA.

Potential moderators of behavior change across the menstrual cycle were entered as between-subjects factors into a repeated measures MANOVA and the interaction with phase was examined across the four main dependent variables. Univariate follow up tests were conducted if the interaction term was significant.

2. Increasing salivary progesterone levels across the menstrual cycle will be associated with increased OCD symptomatology, disgust sensitivity, responsibility beliefs, and decreased risk-taking across the cycle.

This hypothesis was examined using Pearson product-moment correlations between square root transformed progesterone change scores and change scores (Luteal-Follicular) for the four main dependent variables.

3. a) Women will show increased sensitivity for identifying facial expressions of disgust compared to men.

A 2 × 2 (Testing time [time1/follicular, time2/luteal] × Sex [male, female]) repeated-measures ANOVA was conducted, looking for a main effect of sex.

3. b) Free-cycling women with a more liberal bias in terms of perceiving facial expressions of disgust will have increased levels of progesterone and pathogen disgust compared to women with a more conservative bias.

Independent samples *t*-tests were conducted using average bias scores across the two sessions as the grouping variable and average levels of progesterone and pathogen disgust across the cycle as test variables. Bias scores were divided using a cut-off score of 0, with scores below

0 representing a liberal bias and scores above 0 representing a conservative bias when detecting facial expressions of disgust.

Supplementary Hypotheses

1. Sex differences will be found in disgust sensitivity and risk-taking, with women scoring higher than men in disgust sensitivity and lower in risk-taking.

Sex differences in disgust sensitivity and risk-taking were examined using two *t*-tests with sex as the grouping variable and average disgust sensitivity (DS-R) and risk-taking (DOSPERT) scores across the two testing times as the outcome variables.

2. Women who are more hormonally sensitive (i.e., meet criteria for PMS) will report greater average OCD symptoms across the menstrual cycle.

A *t*-test was conducted to compare women who met criteria for PMS according to the PSST and women who did not meet PMS criteria on average square-root transformed OCD symptoms (PI-WSUR Scores).

Exploratory Hypothesis

Is there a relationship between 2D:4D and symptoms of obsessive-compulsive disorder?

A Pearson product-moment correlation was used to examine the relationship between mean obsessive-compulsive symptoms (PI-WSUR scores) and 2D:4D (ratio of the second to fourth digit).

Signal detection analysis

Signal detection analysis was used to analyze the emotion discrimination data. Signal detection is typically used to determine the threshold where an individual can detect the signal amidst noise (e.g., in the context of a hearing test). The standard format is a “yes” or “no” response. In this case, signal detection would examine the difference between responses (yes/no)

and the stimulus (present/signal, absent/noise). If a participant responded yes and the stimulus was present, that would be classified as a hit (H). If the participant responded no when the stimulus was present, that would be classified as a miss (M). If the participant responded yes when the stimulus was not present, it would be classified as a false alarm (FA). Finally, if the stimulus was not present and the participant responded no, that would be a correct rejection (CR). In the present study the signal detection analysis was used with a forced-choice response format. For instance, when discriminating between disgust and fear, a hit would constitute correctly recognizing the emotion as disgust when it was disgust. A miss would consist of failing to recognize the correct emotion or saying fear when the emotion was disgust. A false alarm would consist of saying the emotion is disgust when it is not and a correct rejection would be classifying the emotion as fear when it is fear.

Accuracy was examined using *d'* (sensitivity index) and *c* (bias index). Sensitivity is a discrimination index that provides an estimate of high or low ability to discriminate (Macmillan, 2002). Perfect sensitivity was present if a participant showed a 100% hit rate and a 0% false alarm rate, whereas poor sensitivity was present if a participant could not distinguish between stimuli and had similar hit and false alarm rates (Macmillan & Creelman, 2005). Theoretically, sensitivity is conceptualized as the difference between the means of the signal and noise distributions. Sensitivity will be estimated using the following equation: $d' = z(H) - z(FA)$, where a score of zero represents performance levels at chance. Furthermore, positive scores show a greater ability to discriminate between stimuli and negative scores show a reduced ability to discriminate between stimuli. Sensitivity scores were calculated for each individual subject across the three discriminations (i.e., fear versus disgust, fear versus neutral, and neutral versus disgust).

Response bias (c) refers to the amount of signal needed in order to say "yes" or "no". For instance, some participants may be more liberal and make more yes judgments, while other participants may be more conservative and make more no judgments (Macmillan & Creelman, 2005). Similarly, in the present study, some participants will require more "signal" to classify a facial expression as disgust while others require less "signal." Response bias was calculated using the following equation: $c = -\frac{1}{2}[z(H) + z(FA)]$. Scores of 0 represent performance free from bias, whereas scores below 0 represent a liberal bias and scores above 0 represent a conservative bias.

Results

Data Screening

All variables were screened prior to analysis in order to check for missing data, errors in data coding, and extreme cases or outliers. For participants who were missing data on the main dependent measures (e.g., PI-WSUR, DS-R, DOSPERT, RAS, and HADS), if less than 20% of the data from a given scale were missing, the missing items were replaced with the participant's averaged item score from the remaining items that were completed from the total scale or subscale (if relevant). None of the participants were missing more than 20% of items on any given scale. Imputing mean scores for missing items can help increase statistical power and provides a good estimate of reliability for the measure (Bono, Ried, Kimberlin, & Vogel, 2007).

Univariate outliers were identified as z-scores greater than $\pm$ 3.29 (e.g., skewness value/ standard error for skewness = skewness z-score; Tabachnick & Fidell, 2007). According to these criteria, one participant (ID: 198) had a score on the time 2/Luteal DOSPERT scale that was identified as an outlier. The raw score appeared to be part of the distribution but was the largest score, resulting in a positive skew. This largest score was changed to one unit larger than the

next most extreme value (Tabachnick & Fidell, 2007, p. 77), restoring normality, Shapiro-Wilk's (277) = .99, p = .26.

Three univariate outliers (z-scores greater than 3.29) were found for fear versus disgust sensitivity (d') time 1/follicular scores and for fear versus disgust sensitivity (d') time 2/luteal scores. These six scores represented sensitivity scores between -1 and -2 and were removed. As mentioned above, scores of zero represent chance levels of discrimination and these scores would represent a very poor ability to discriminate between facial expressions.

Multivariate outliers were examined using Mahalanobis distance ($p < .001$; Tabachnick & Fidell, 2007). When examining the main four dependent variables across both time points for multivariate outliers using Mahalanobis distance (chi-squared critical value = 26.12), four outliers were identified (2 men, 1 hormonal contraceptive user, 1 free-cycler). These participants were therefore excluded from the hypotheses involving OCD symptoms, disgust sensitivity, risk-taking, and responsibility beliefs.

Kurtosis and skewness were examined in order to check for normality in the data. Mean progesterone levels at both the follicular and luteal phase were found to be significantly positively skewed. A square-root transformation was applied to both mean follicular and mean luteal progesterone levels, restoring normality, Shapiro-Wilk's (43) = .98, $p > .05$.

Screening Survey

Five-hundred and nine participants completed the initial screening questionnaire (394 women, 115 men). In terms of family psychiatric history, the majority of participants (67%) responded that their parents or siblings had never been diagnosed or treated for a mental illness, compared to 24% who responded yes, and 9% of participants who were unsure. Only 3% of participants in the entire sample had parents or siblings diagnosed or treated for OCD.

Participants with a positive family psychiatric history of a mood or anxiety disorder had significantly higher than expected rates of PMS according to the PSST, χ^2 (1, N = 338) = 13.54, p < .001; phi = 0.2 (see Figure 2). Furthermore, participants with a positive family psychiatric history of a mood or anxiety disorder were more likely to report moderate to severe symptoms of anxiety pre-menstrually compared to women without such a family history, χ^2 (1, N = 336) = 24.25, p < .001; phi = 0.27.

Progesterone Analysis

Of the free-cycling women who participated in the lab-based version of the study, saliva samples from 56 women were sent to Salimetrics for progesterone analysis. Of the 56 samples (112 samples across both time points), each sample was tested in duplicate, with a correlation of .99 between Result 1 and Result 2 (p < .001). The mean concentration of the two progesterone samples from each session were used in all subsequent data analyses. Measurement reliability, or precision, was assessed using the coefficient of variation (CV). Intra-assay CV is the degree to which the two duplicate measurements of the sample differ (i.e., the standard deviation of the two duplicate results divided by the duplicate mean, multiplied by 100). The average % CV for this sample was 4.9, with less than 10% being considered good (Salimetrics, 2010; Schultheiss & Stanton, 2009).

Salivary analyses from 44 participants remained after the exclusion criteria were applied, as reported above. Eight of these participants were found to have reversed progesterone levels, with significantly higher progesterone levels in the follicular phase (M = 83.13 pg/mL, SD = 43.57, n = 8) compared to the luteal phase (M = 53.84 pg/mL, SD = 34.20, n = 8), t(7) = 4.84, p = .002, and were therefore excluded from subsequent analyses. For these eight participants, they were tested on day five on average in the follicular phase (M = 5.13, SD = 1.96) and nine days

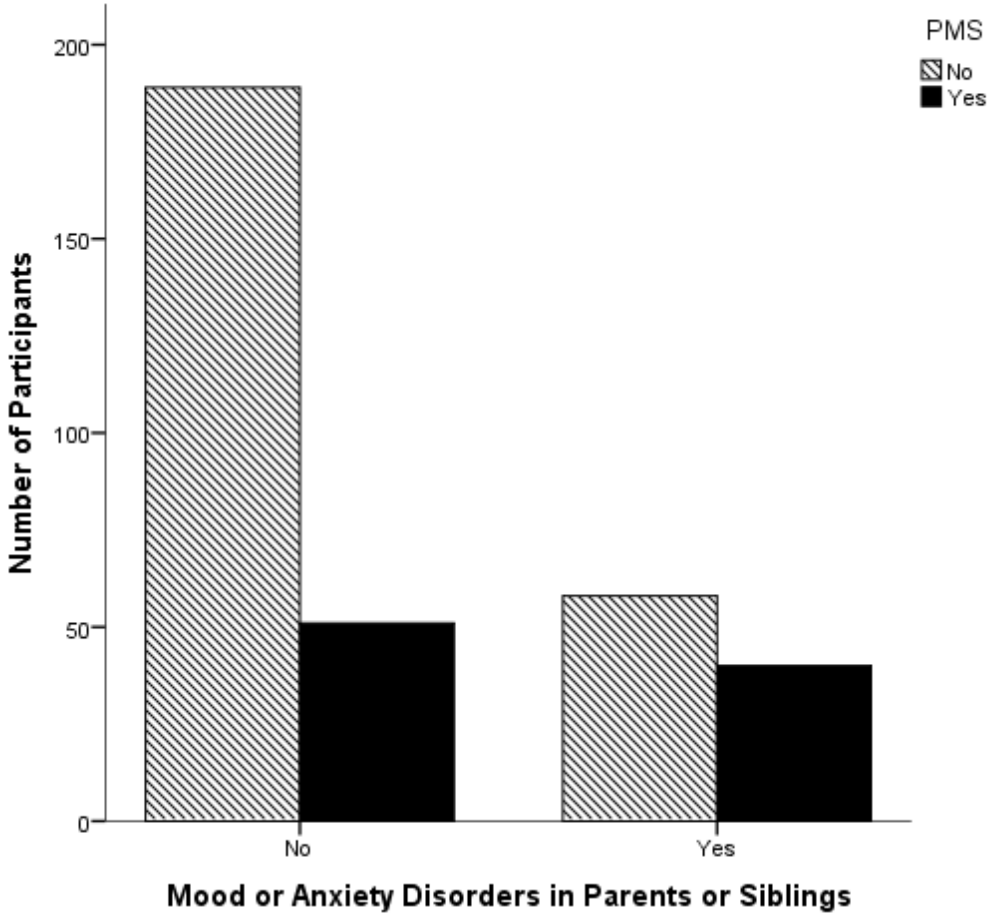

Figure 2. The relationship between family psychiatric history and PMS diagnosis. Women with a positive family psychiatric history of a mood or anxiety disorder had significantly higher than expected rates of PMS ($p < .001$).

before menstruation in the luteal phase (M = -9.0, SD = 3.34). However, only 5 of these 8 women were tested during the intended period in the luteal phase (i.e., days -3 to -9). Five women were tested in the luteal phase 10-12 days prior to menstruation, likely before the peak rise in progesterone that occurs in the luteal phase, which may help to explain the uncharacteristic progesterone levels. Consistent with this idea, difference scores in progesterone levels across the two phases were relatively small in these women (M = -29.29, SD = 18.50, n = 8) compared to the majority of free-cycling women (M = 122.29, SD = 85.78, n = 36).

For the remaining participants with usable salivary progesterone samples, day eight was the average testing day for the follicular phase (M = 8.06, SD = 2.21, range: 3-12, n = 36) and six days prior to menstruation was the average testing day for the luteal phase (M = -6.14, SD = 2.93, range: -12- 1, n = 36). As expected, progesterone levels were significantly higher in the luteal phase (M = 192.88 pg/mL, SD = 99.94, n = 36) compared to the follicular phase (M = 70.60 pg/mL; SD = 39.09, n = 36), $t(35) = -8.55$, $p < .001$. In a review of the measurement of salivary progesterone, Ellison (1993) reports average follicular progesterone levels of below 30 pg/mL and average luteal progesterone levels of 100-200 pg/mL. Thus, the luteal phase progesterone levels in the current study were well within normal limits, but follicular levels were somewhat higher than normal by this estimation. However, Immuno-Biological Laboratories report normal values for progesterone in the follicular phase as 28-82 pg/mL and 127-446 pg/mL in the luteal phase (IBL Hamburg, 2006), which are consistent with levels found in the current study.

Engaging in more than three hours of vigorous exercise a week and having gained or lost five pounds in the past month have both been linked to lower progesterone levels in the literature (e.g., Ellison, 1993). Thus, these variables were explored to see if they affected progesterone

levels in the current sample. Although a change in weight in the past month did not affect follicular , $t(34) = .04$, $p = .97$, or luteal progesterone levels, $t(34) = .99$, $p = .33$, women who exercised vigorously for more than three hours a week did have significantly lower luteal progesterone levels ($M = 123.69$ pg/mL, $SD = 35.53$, $n = 10$) compared to women who exercised less than three hours a week ($M = 219.50$ pg/mL, $SD = 104.30$, $n = 26$), $t(33.81) = 4.10$, $p < .001$. Therefore, exercise was included as a covariate for further progesterone analyses.

Data were collected between 11:00 am and 7:00 pm, with a median time of 3:00 pm. Time of day had no effect on progesterone levels, with no difference between mean follicular progesterone levels before 3:00 pm ($M = 62.20$ pg/mL, $SD = 30.52$, $n = 16$) and after 3:00 pm ($M = 77.31$ pg/mL, $SD = 44.42$, $n = 20$), $t(34) = 1.16$, $p = .26$, or between mean luteal progesterone levels before 3:00 pm ($M = 183.88$ pg/mL, $SD = 80.83$, $n = 16$) and after 3:00 pm ($M = 200.08$ pg/mL, $SD = 114.54$, $n = 20$), $t(34) = 0.48$, $p = .64$.

Details of Study Measures

The scale means, standard deviations, and internal consistencies for the final sample are shown in Table 7, separated by time 1 and time 2. The data were recoded for all subsequent analyses, so that time 1 always refers to the follicular phase and time 2 always refers to the luteal phase for women.

Women who met criteria for PMS had significantly higher HADS anxiety scores averaged across both sessions ($M = 11.44$, $SD = 3.86$, $n = 33$) compared to women without PMS ($M = 7.95$, $SD = 3.29$, $n = 116$), $t(147) = -5.17$, $p < .001$. Average HADS depression scores were also significantly higher in women with PMS ($M = 5.82$, $SD = 2.87$, $n = 33$) compared to women without PMS ($M = 3.20$, $SD = 2.19$, $n = 116$), $t(147) = -5.64$, $p < .001$. Finally, although average HADS depression scores were similar between men ($M = 3.68$, $SD = 2.26$, $n = 68$) and women

Table 7

Scale Means, Standard Deviations, and Internal Consistencies for the Final Sample (N = 223)

	Time 1			Time 2		
Scale	*N*	*M* (*SD*)	Internal Consistency	*N*	*M* (*SD*)	Internal Consistency
PI-WSUR						
Total	223	23.73 (16.26)	.91	219	21.92 (15.60)	.92
Contamination Obsessions And Washing Compulsions Subscale	223	8.72 (6.58)	.86	219	8.48 (6.65)	.88
Disgust Scale-Revised						
Total	223	46.31 (16.33)	.87	218	50.12 (16.59)	.88
Contamination-Based Disgust Subscale	223	5.55 (11.91)	.51	218	5.43 (3.28)	.50
Three Domain Disgust Scale						
Pathogen Disgust Subscale	222	21.16 (78.88)	.84	218	21.92 (9.49)	.88
DOSPERT						
Total	223	92.61 (23.50)	.86	218	92.17 (24.79)	.88
RAS						
Total	223	3.89 (.89)	.92	218	3.62 (1.05)	.94
Social Desirability Scale	221	11.62 (2.76)	.07	215	11.59 (2.84)	.11
HADS						
Anxiety	223	8.41 (3.92)	.83	218	8.11 (3.76)	.80
Depression	223	3.67 (2.60)	.65	218	3.77 (2.76)	.72
Infrequency						
Total	222	.19 (.45)	.09	211	.24 (.53)	.20

Note. PI-WSUR = Padua Inventory-Washington State University Revision; DOSPERT = Domain-Specific Risk-Taking Scale; RAS = Responsibility Attitude Scale; HADS = Hospital Anxiety and Depression Scale.

(M = 3.76, SD = 2.58, n = 150), t(216) = -0.22, p = .83, average HADS anxiety scores were significantly higher in women (M = 8.72, SD = 3.69, n = 150) compared to men (M = 7.39, SD = 3.24, n = 68), t(216) = -2.56, p = .01.

The intercorrelations between the four main dependent variables are presented in Table 8. As expected, disgust sensitivity was positively correlated with OCD contamination symptoms and responsibility beliefs, OCD contamination symptoms were positively correlated with responsibility beliefs, and disgust sensitivity was negatively correlated with risk-taking. OCD contamination symptoms were not correlated with risk-taking, although this might have been expected.

There were no significant differences in baseline scores between free-cycling women and women using hormonal contraceptives in terms of the main dependent variables: contamination OCD symptoms, t(147) = -0.10, p = .92, disgust scores, t(147) = 0.97, p = .33, risk-taking scores, t(147) = -0.62, p = .54, or responsibility beliefs, t(147) = -0.64, p = .52.

Primary Hypotheses

Hypothesis 1. *Free-cycling women will show an increase in contamination-based OCD symptoms, disgust sensitivity, and responsibility beliefs and a decrease in risk-taking during the luteal phase of the menstrual cycle compared to the follicular phase, whereas women taking hormonal contraceptives will show significantly attenuated effects compared to free-cycling women in terms of these dependent variables.*

Potential moderating variables will also be explored to see if subgroups of women display different patterns of behavior change cross the cycle.

A 2 × 2 (Group [Free-cyclers, hormonal contraceptive users] × Phase [follicular, luteal]) repeated measures MANCOVA was conducted across the following four dependent measures:

Table 8

Intercorrelations between the Main Four Dependent Variables Averaged across the two Time Points for all Participants (N = 223)

Dependent Variables	1	2	3	4
(1) OCD contamination symptoms	1	.42**	-.04	.29**
(2) Disgust sensitivity		1	-.32**	.14*
(3) Risk-taking			1	.08
(4) Responsibility beliefs				1

Note. * p <.05. ** p < .01. OCD = Obsessive-Compulsive Disorder.

OCD contamination symptoms (Square root transformed PI-WSUR Subscale 1 scores), disgust sensitivity (DS-R scores), risk-taking (DOSPERT scores), and responsibility beliefs (RAS scores), with age entered as a covariate.

The MANOVA assumption of homogeneity of covariance was satisfied (Box's M = 46.87, $F(36, 34634.48) = 1.21$, $p = .18$). According to Wilk's criterion, the combination of the four dependent variables did not show a significant multivariate effect in relation to group, Wilk's = .98, $F(4, 142) = .75$, $p = .56$, partial $\eta^2 = .02$, or phase, Wilk's = .97, $F(4, 142) = 1.11$, $p = .35$, partial $\eta^2 = .03$ (see Table 9 for group means). Contrary to predictions, the phase × group interaction was not significant, Wilk's = .98, $F(4, 142) = .87$, $p = .49$, partial $\eta^2 = .02$. There was also no effect of age, Wilk's = .95, $F(4, 142) = 1.88$, $p = .12$, partial $\eta^2 = .05$, nor was the phase × age interaction significant, Wilk's = .95, $F(4, 142) = 1.69$, $p = .15$, partial $\eta^2 = .05$.

Change scores were also examined between HC users and FCs in terms of the four main dependent variables using a series of ANCOVAs, with age as a covariate. Contrary to the prediction that HC users would have lower change scores across the cycle compared to FCs, there were no differences between the two groups in terms of OCD contamination symptoms, $F(1, 145) = .67$, $p = .41$, disgust sensitivity, $F(1, 145) = .39$, $p = .54$, risk-taking, $F(1, 145) = 1.69$, $p = .20$, or responsibility beliefs, $F(1, 145) = .14$, $p = .71$.

Given that high progesterone and triphasic OCs more naturally mimic a women's menstrual cycle, low dose and monophasic OC users were compared to FCs on the four main dependent variables to maximize any potential differences between FCs and OC users. A 2 × 2 (Phase [follicular, luteal] × Group [low progesterone OC users, FCs]) repeated measures MANCOVA was conducted, with age as a covariate. There was no significant main effect of phase, Wilk's = .96, $F(4, 104) = 1.10$, $p = .36$, partial $\eta^2 = .04$, group, Wilk's = .98, $F(4, 104) =$

Table 9

Group Means for the Four Main Dependent Variables, Separated by Time and Group

Dependent Variable	Group	Mean	*SD*	*N*
PI-WSUR Contamination (Follicular)	HC	8.78	5.82	98
	FC	8.88	6.07	50
PI-WSUR Contamination (Luteal)	HC	8.63	6.51	98
	FC	9.28	7.04	50
Disgust Scale-Revised (Follicular)	HC	52.24	15.15	98
	FC	49.54	14.05	50
Disgust Scale-Revised (Luteal)	HC	52.18	15.90	98
	FC	47.98	14.55	50
DOSPERT (Follicular)	HC	85.42	24.27	98
	FC	88.00	23.91	50
DOSPERT (Luteal)	HC	87.41	23.82	98
	FC	87.00	22.30	50
RAS (Follicular)	HC	3.75	0.94	98
	FC	3.85	1.05	50
RAS (Luteal)	HC	3.58	1.01	98
	FC	3.60	0.97	50

Note. HC = hormonal contraceptive users; FC = free-cycling women; PI-WSUR Contamination = Padua Inventory-Washington State University Revision, contamination obsessions and washing compulsions subscale; DOSPERT = Domain-Specific Risk-Taking scale; RAS = Responsibility Attitude Scale.

.64, p = .64, partial η^2 = .02, or phase × group interaction, Wilk's = .95, F(4, 104) = 1.41, p = .24, partial η^2 = .05.

In addition, a 2 × 2 (Phase [follicular, luteal] × Group [monophasic OC users, FCs]) repeated measures MANCOVA was conducted with age as a covariate. There was no effect of phase, Wilk's = .94, F(4, 109) = 1.77, p = .14, partial η^2 = .06, group, Wilk's = .95, F(4, 109) = 1.58, p = .18, partial η^2 = .06, or phase × group type interaction, Wilk's = .97, F(4, 109) = .86, p = .49, partial η^2 = .03.

Moderators of behaviour change across the menstrual cycle

Body mass index, relationship status, and sexual activity were examined as potential moderating variables in free-cycling women. Body mass index (BMI) was converted to a dichotomous variable using a median split, resulting in a group of women with low BMI (n = 25) and high BMI (n = 24). A 2 × 2 (BMI [low, high] × Phase [follicular, luteal]) repeated measures MANOVA was conducted, finding no significant main effect of BMI, Wilk's = .89, F(4, 44) = 1.37, p = .26, partial η^2 = .11, or BMI × phase interaction, Wilk's = .93, F(4, 44) = .84, p = .51, partial η^2 = .07.

Relationship status (single, n = 19; in a dating or long-term relationship, n = 28) was next added as a between-subjects factor to the 2 × 2 (Relationship status [single, in a relationship] × Phase [follicular, luteal]) repeated measures MANOVA. There was no main effect found for relationship status, Wilk's = .94, F(4, 42) = .63, p = .64, partial η^2 = .06, nor was the relationship status × phase interaction significant, Wilk's = .89, F(4, 42) = 1.34, p = .27, partial η^2 = .11. Thus, neither BMI nor relationship status were significant moderators of behaviour change across the menstrual cycle.

Sexual activity was added as a between-subjects factor in a 2 × 2 (Sexually active [yes, no] × Phase [follicular, luteal]) repeated measures MANOVA with the four dependent measures (OCD contamination symptoms, disgust sensitivity, risk-taking, and responsibility beliefs). There was a significant main effect of sexual activity, Wilk's = .75, $F(4, 45) = 3.72$, $p = .01$, partial $\eta^2 = .25$. Women who were sexually active in the past month had significantly higher risk-taking scores ($M = 101.06$, $SD = 19.21$, $n = 17$) than women who were not sexually active ($M = 80.52$, $SD = 20.29$, $n = 33$), $t(48) = -3.45$, $p = .001$. Women who were sexually active also had lower disgust sensitivity ($M = 43.88$, $SD = 13.64$, $n = 17$) compared to women who were not sexually active ($M = 51.27$, $SD = 13.54$, $n = 33$), although the difference was marginal, $t(48) = 1.82$, $p = .07$.

The phase × sexually active interaction was also significant, $F(4, 45) = 2.89$, $p = .03$, partial $\eta^2 = .20$. Sexual activity was found to be a significant moderator of both OCD contamination symptoms and risk-taking in free-cycling women. Univariate ANOVAs showed significant phase × sexually active interactions for both OCD contamination symptoms, $F(1, 48) = 5.41$, $p = .02$, partial $\eta^2 = .10$, and risk-taking, $F(1, 48) = 7.04$, $p = .01$, partial $\eta^2 = .13$. Contamination OCD symptoms were found to increase from the follicular phase to the luteal phase of the cycle in non-sexually active participants ($M_{changescore} = 0.16$, $SD = 0.70$, $n = 33$), whereas OCD contamination symptoms decreased across the cycle in sexually active participants ($M_{changescore} = -0.32$, $SD = 0.65$, $n = 17$), $t(48) = 2.33$, $p = .02$ (see Figure 3). Risk-taking scores increased across the cycle in women who were not sexually active ($M_{changescore} = 2.55$, $SD = 14.53$, $n = 33$), whereas women who were sexually active showed a decrease in risk-taking scores across the cycle ($M_{changescore} = -7.88$, $SD = 9.90$, $n = 17$), $t(48) = 2.65$, $p = .01$ (see Figure

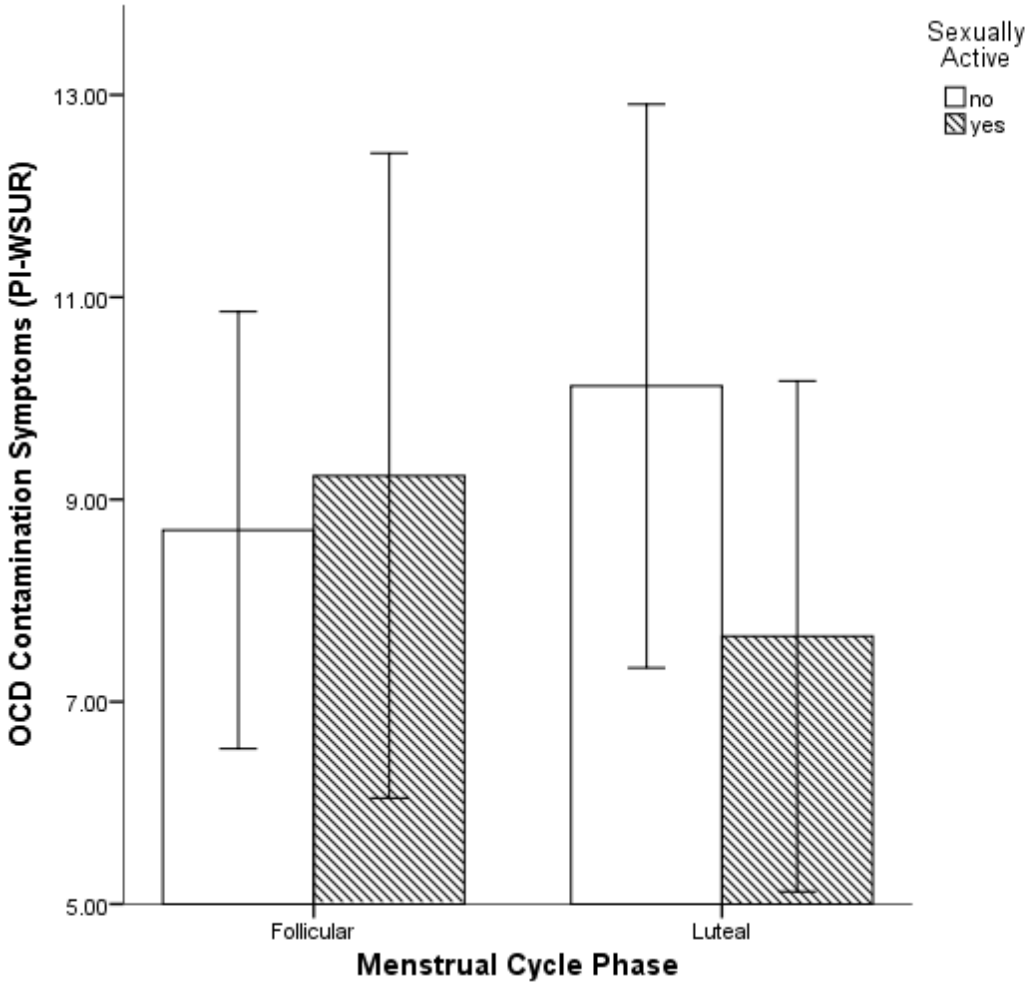

Figure 3. Significant interaction between OCD contamination symptoms across the menstrual cycle and sexual activity (p = .02). OCD contamination symptoms increased across the cycle in non-sexually active participants (n = 33) and decreased across the cycle in sexually active participants (n = 17). Error bars represent 95% CIs.

4). Note that when the MANOVA was conducted only with HC users, there was no interaction between phase and sexual activity, $F(4, 93) = .51$, $p = .73$.

Furthermore, in the current study, number of lifetime sexual partners was significantly related to OCD contamination symptoms in all women, $r(141) = -.17$, $p = .04$. However, there was no relationship between number of lifetime sexual partners and OCD contamination symptoms in men, $r(61) = -.01$, $p = .96$. Twenty-five percent of women scored a 13 or above on the contamination obsessions and washing compulsions subscale of the PI-WSUR, a cut-off score that indicates a level of symptomatology consistent with individuals diagnosed with OCD (Burns et al., 1996). These women reported a significantly lower number of lifetime sexual partners ($M = 2.43$, $SD = 2.94$, $n = 35$) compared to women with OCD contamination symptoms more similar to a non-clinical sample (i.e., a score below 13) ($M = 4.50$, $SD = 6.31$, $n = 103$), $t(123.03) = 1.87$, $p = .01$. In men, there was no significant difference between the number of lifetime sexual partners for men below ($M = 8.69$, $SD = 15.26$, $n = 49$) or above the cut-off score ($M = 7.00$, $SD = 8.91$, $n = 13$) for clinically meaningful OCD contamination symptoms, $t(60) = 0.38$, $p = .70$.

Additional exploratory analyses were conducted to determine whether there might be two distinct groups of women, one group who shows an increase in OCD contamination symptoms across the menstrual cycle and another that doesn't, and if these groups could be further differentiated. Women with increasing OCD contamination symptoms across the cycle were found to differ from women with no change in OCD contamination symptoms or a decrease in symptoms across the cycle in terms of several theoretically relevant variables, such as sexual activity, relationship status, lifetime sexual partners, health/safety risk-taking, and religion.

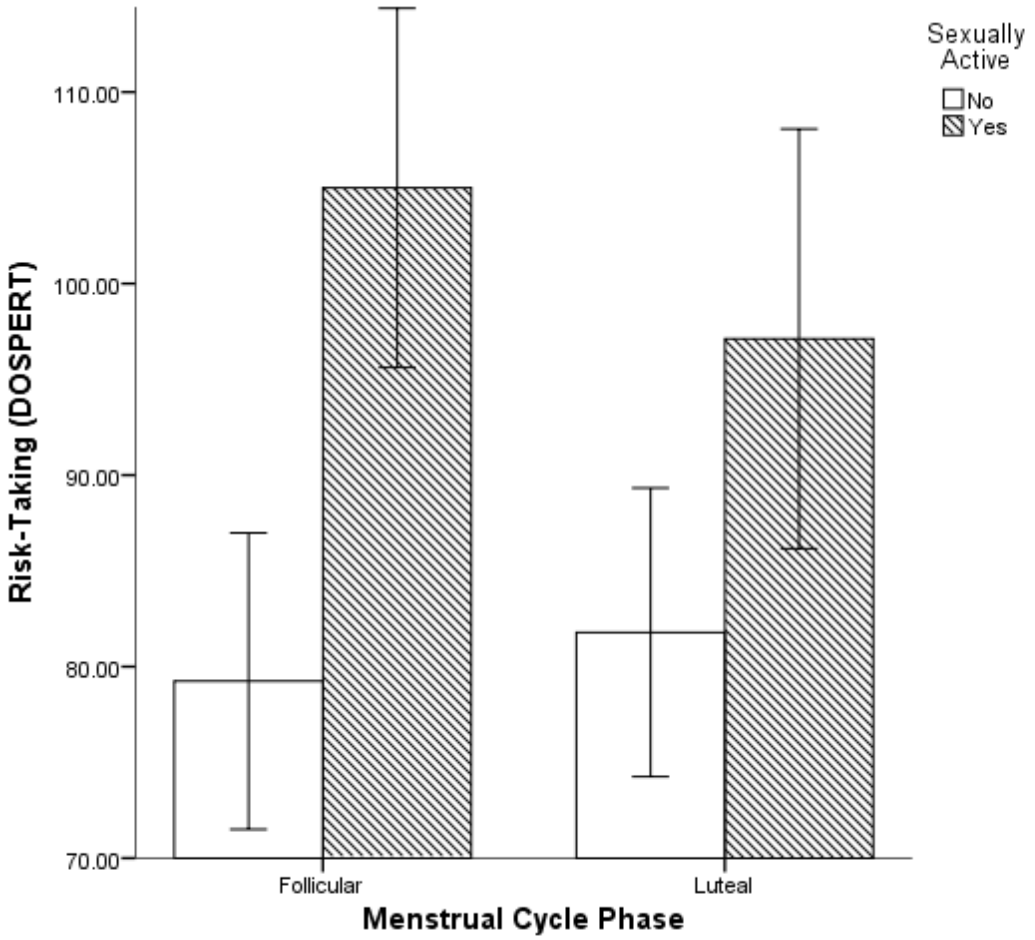

Figure 4. Significant interaction between risk-taking scores across the menstrual cycle and sexual activity (p = .01). Risk-taking scores increased across the cycle in women who were not sexually active (n = 33), and decreased across the cycle in women who were sexually active (n = 17). Error bars represent 95% CIs.

Compared to women who showed no change or decreased OCD contamination symptoms across the cycle, women with increasing OCD contamination symptoms across the cycle were significantly more likely to not be sexually active in the past month, χ^2 (1, N = 148) = 6.53, p = .01; phi = -0.21, and to be single rather than in a relationship, χ^2 (1, N = 143) = 4.40, p = .04; phi = -0.18. In addition, women with increased OCD contamination symptoms across the cycle had a significantly fewer number of lifetime sexual partners (M = 2.71, SD = 3.28, n = 59) compared to women whose OCD contamination symptoms stayed the same or decreased over the cycle (M = 4.95, SD = 6.76, n = 83), t(125.74) = 2.62, p = .01. Lower risk-taking in the health domain was also found in women whose OCD contamination symptoms increased across the cycle (M = 15.18, SD = 6.59, n = 60), compared to women whose OCD contamination symptoms remained the same or decreased over the cycle (M = 17.35, SD = 6.09, n = 88), t(146) = 2.07, p = .04. Finally, religious affiliation also differed between women with different patterns of OCD contamination symptoms across the cycle. The most common religious affiliations were Christian (n = 88, 60.7%), atheist (n = 26, 17.9%), and agnostic (n = 11, 7.6%). Thus, a dichotomous variable was created for religious affiliation comparing women who identified as Christian with those who identified as agnostic or atheist. Women with increasing OCD contamination symptoms across the cycle were more likely to be Christian compared to those who showed no change or a decrease in OCD symptoms across the cycle, χ^2 (1, N = 124) = 5.09, p = .02; phi = -.20.

Given the small number of free-cycling women with PMS (n = 11), in the late luteal phase of the cycle (n = 14), or with high contamination OCD contamination fears (n = 12), whether women met criteria for PMS, stage of luteal phase testing, and level of OCD contamination fears were examined as potential moderators across both FCs and HC users.

Whether or not women met criteria for PMS according to the PSST was added as a between-subjects factor in a 2 × 2 (PMS [yes, no] × Phase [follicular, luteal]) repeated measures MANCOVA with the four dependent measures (OCD contamination symptoms, disgust sensitivity, risk-taking, and responsibility beliefs) and age as a covariate. There was no significant phase × PMS interaction, Wilk's = .10, $F(4, 141) = .18$, $p = .95$, partial $\eta^2 = .01$, meaning PMS did not moderate behavior change across the menstrual cycle, but there was a significant multivariate between-subjects main effect of PMS, Wilk's = .88, $F(4, 141) = 5.02$, $p = .001$, partial $\eta^2 = .13$.

Women meeting criteria for PMS had significantly higher average OCD contamination scores ($M = 10.82$, $SD = 6.59$, $n = 33$) compared to women without PMS ($M = 8.29$, $SD = 5.73$, $n = 114$), $t(145) = -2.16$, $p = .03$. Women with PMS also had significantly higher average disgust sensitivity ($M = 56.12$, $SD = 14.28$, $n = 33$) compared to women without PMS ($M = 49.48$, $SD = 14.59$, $n = 114$), $t(145) = -2.31$, $p = .02$. Finally, women meeting PMS criteria also had significantly higher average responsibility beliefs ($M = 4.20$, $SD = 0.89$, $n = 33$) than women not meeting criteria for PMS ($M = 3.53$, $SD = 0.90$, $n = 114$), $t(145) = -3.80$, $p < .001$. There were no differences between average risk-taking scores in women with PMS ($M = 89.76$, $SD = 24.03$, $n = 33$) or without PMS ($M = 85.84$, $SD = 22.41$, $n = 114$), $t(145) = -0.87$, $p = .39$.

Stage of luteal phase testing was also examined as a moderator, as some women were tested in the early luteal phase (days -5 to -12, $n = 107$), while others were tested in the late luteal phase (days -2 to -4, $n = 36$). Thus, position in the luteal phase was added as a between-subjects factor in a 2 × 2 (Stage of luteal phase [early, late] × Phase [follicular, luteal]) repeated measures MANCOVA with the four dependent measures (OCD contamination symptoms, disgust sensitivity, risk-taking, and responsibility beliefs) and age as a covariate. There was no main

effect of stage of luteal phase testing, Wilk's = .99, $F(4, 137) = .61$, $p = .66$, partial $\eta^2 = .02$. The interaction between phase and position in the luteal phase was marginally significant, Wilk's = .94, $F(4, 137) = 2.25$, $p = .07$, partial $\eta^2 = .06$. Follow-up univariate ANCOVAs showed a marginally significant phase × stage of luteal phase testing interaction for OCD contamination symptoms, $F(1, 40) = 3.53$, $p = .06$, partial $\eta^2 = .03$. Whereas contamination OCD symptoms increased from the follicular phase to the late luteal phase of the menstrual cycle ($M_{changescore}$ = 0.15, $SD = 0.75$, $n = 36$), OCD contamination symptoms decreased across the cycle for women tested in the early luteal phase ($M_{changescore}$ = -0.08, $SD = 0.62$, $n = 107$), $t(141) = 1.79$, $p = .08$ (see Figure 5).

Finally, based on the cut-off scores identified by Burns and colleagues (1996), all women were separated into a low contamination fears (PI-WSUR scores < 6; $n = 60$) or high contamination fears (PI-WSUR scores > 14; $n = 32$) group. A 2 × 2 (Phase [follicular, luteal] × Contamination fear groups [low, high]) repeated measures MANCOVA was conducted across the four dependent measures (OCD contamination symptoms, disgust sensitivity, risk-taking, and responsibility beliefs), including age as a covariate. According to Wilk's criterion, the combination of the four dependent variables showed a significant multivariate, between-subjects group effect of contamination fears, Wilk's = .16, $F(4, 86) = 116.45$, $p < .001$, partial $\eta^2 = .84$, and a significant phase × contamination fears interaction, Wilk's = .85, $F(4, 86) = 3.79$, $p = .007$, partial $\eta^2 = .15$.

The between-subjects group effect of contamination fears showed that women scoring high in contamination fears had significantly higher average levels of disgust sensitivity (M = 58.13, $SD = 14.92$, $n = 32$) compared to women low in contamination fears ($M = 45.14$, SD = 13.05, $n = 60$), $t(90) = -4.32$, $p < .001$. Women with high contamination fears also had

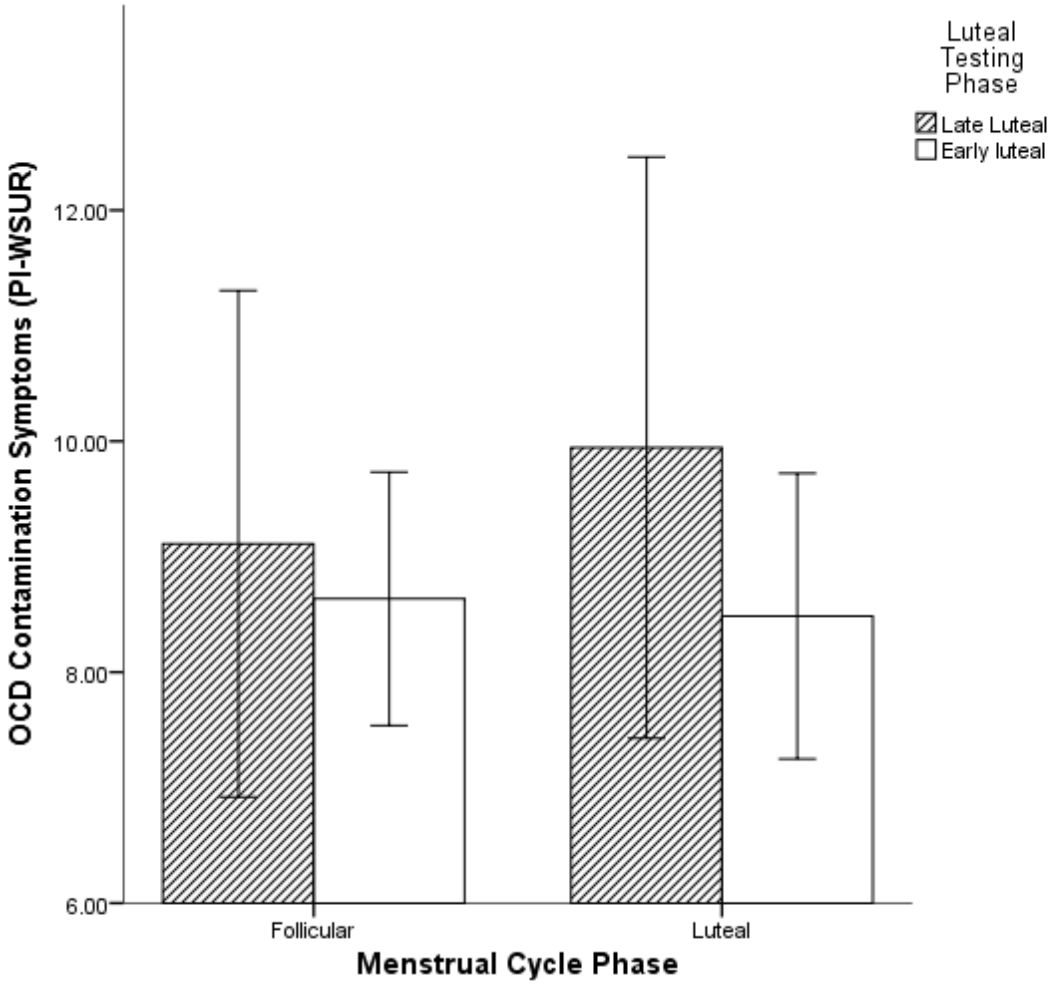

Figure 5. Interaction between OCD contamination symptoms across the menstrual cycle and stage of luteal phase testing (p = .06). Contamination OCD symptoms increased across the cycle for women tested in the late luteal phase (n = 36), and decreased across the cycle for women tested in the early luteal phase (n = 107). Error bars represent 95% CIs.

significantly higher average responsibility beliefs (M = 4.02, SD = 1.01, n = 32) than women with low contamination fears (M = 3.36, SD = 0.91, n = 60), $t(90)$ = -3.19, p = .002. In addition, as expected, women with high contamination fears clearly had higher average contamination OCD symptoms (M = 4.19, SD = 0.45, n = 32) compared to women with low contamination fears (M = 1.77, SD = 0.52, n = 60), $t(90)$= -22.32, $p < .001$.

Level of contamination fears was found to be a significant moderator of behavior change across the cycle. The univariate follow-up tests showed that the phase × contamination fears interaction was significant for both OCD symptoms, Wilk's = .91, $F(1, 89) = 8.78$, p = .004, partial η^2 = .09, and disgust sensitivity, Wilk's = .92, $F(1, 89) = 7.53$, p = .007, partial η^2 = .08. Whereas women scoring low in contamination symptoms showed a decrease in contamination OCD symptoms across the menstrual cycle ($M_{changescore}$ = -0.14, SD = 0.55, n = 60), women with high contamination fears showed an increase in symptoms from the follicular to the luteal phase of the cycle ($M_{changescore}$ = .26, SD = 0.70, n = 32), $t(90)$ = -2.99, p = .004 (see Figure 6). With disgust sensitivity, women with low contamination fears showed a decrease in disgust sensitivity across the menstrual cycle ($M_{changescore}$ = -1.92, SD = 7.39, n = 60), whereas women with high contamination fears showed an increase in disgust sensitivity across the menstrual cycle ($M_{changescore}$ = 2.94, SD = 7.65, n = 32), $t(90)$ = -2.96, p = .004 (see Figure 7).

Hypothesis 2. *Increasing salivary progesterone levels across the menstrual cycle will be associated with increased OCD symptomatology, disgust sensitivity, responsibility beliefs, and decreased risk-taking across the cycle.*

Square root transformed progesterone levels were examined in relation to the four main dependent measures using change scores (Luteal – Follicular), as we were interested in whether increases in progesterone across the cycle corresponded to subsequent changes in the dependent

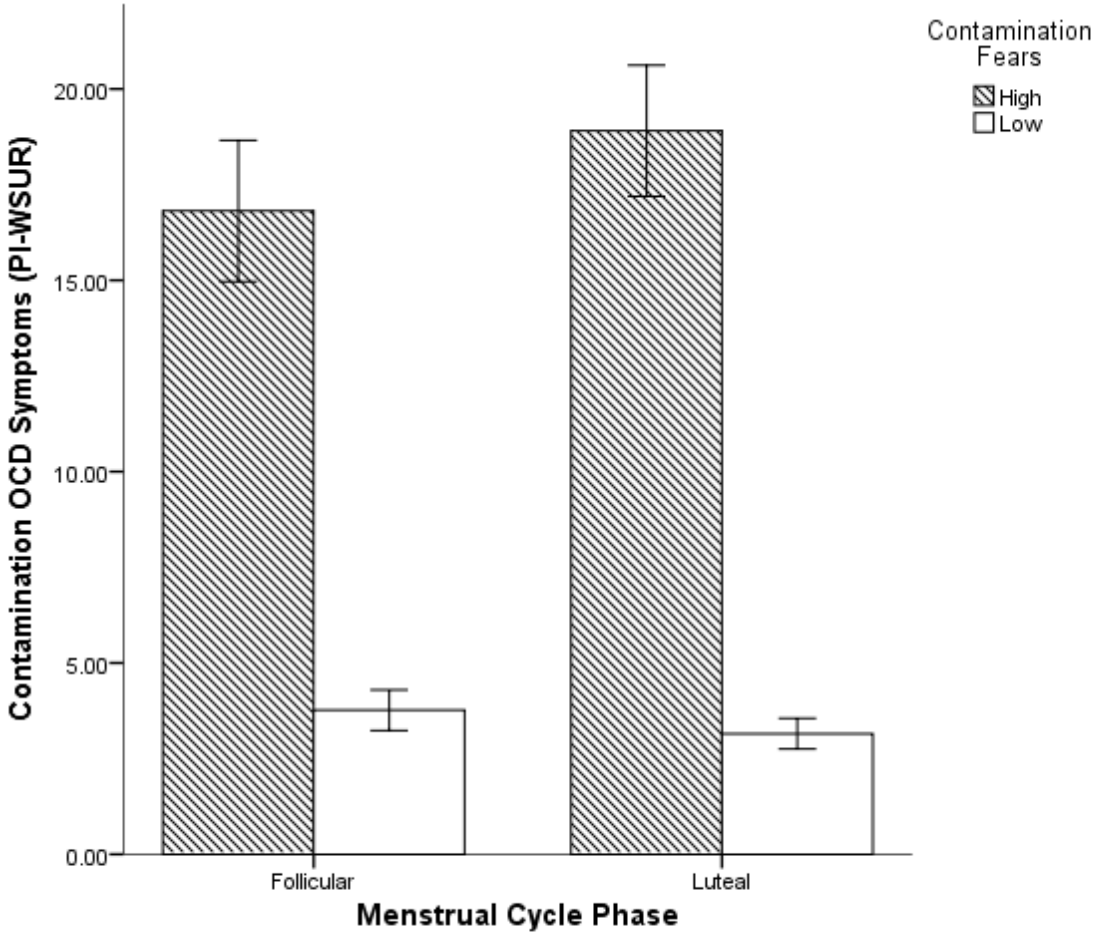

Figure 6. Significant interaction between OCD contamination symptoms across the menstrual cycle and level of contamination fears (p = .004). Contamination OCD symptoms decreased across the menstrual cycle in women with low contamination fears (n = 60), and increased across the menstrual cycle in women with high contamination fears (n = 32). Error bars represent 95% CIs.

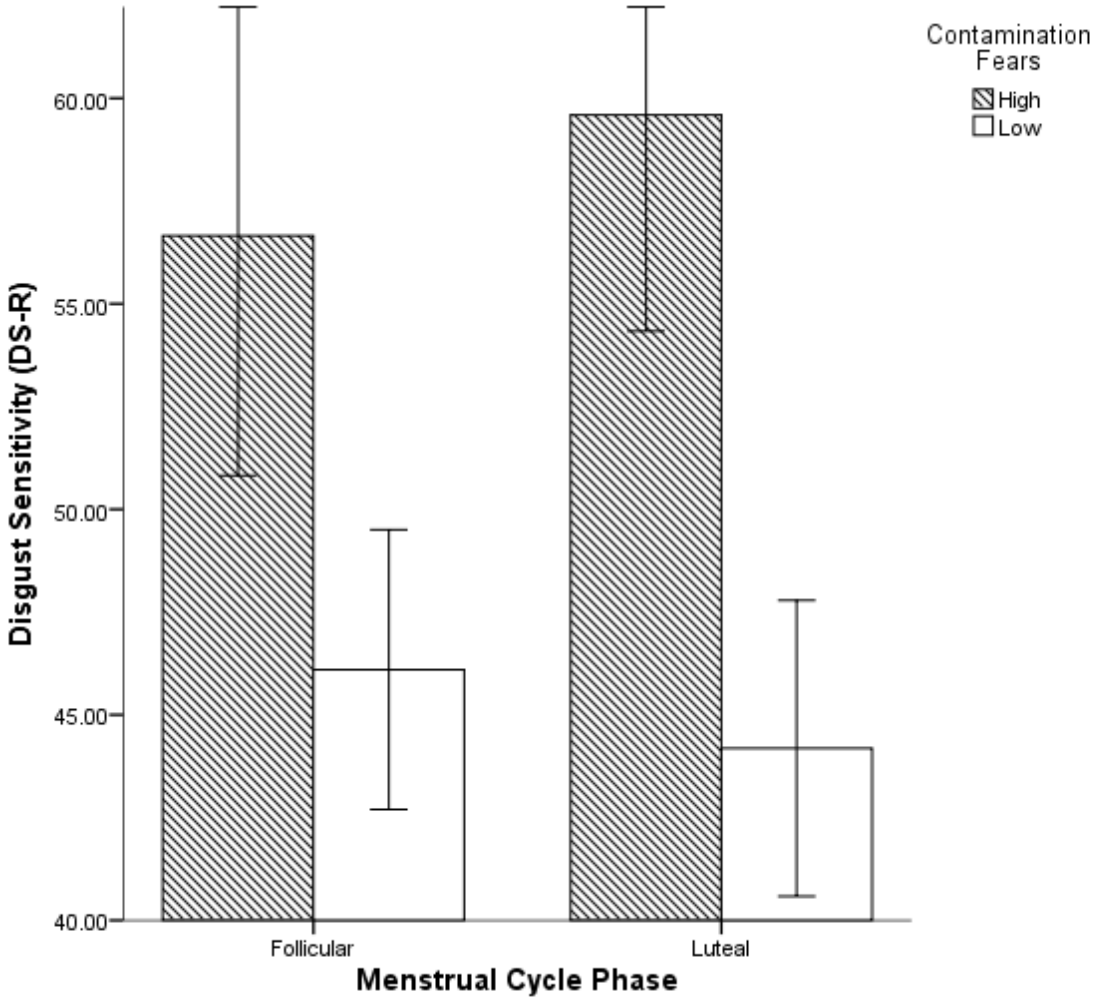

Figure 7. Significant interaction between disgust sensitivity scores across the menstrual cycle and level of contamination fears (p = .007). Disgust sensitivity scores decreased across the menstrual cycle in women with low contamination fears (n = 60), and increased across the menstrual cycle in women with high contamination fears (n = 32). Error bars represent 95% CIs.

measures (see Table 10). As hypothesized progesterone change scores were negatively associated with risk-taking (DOSPERT total difference scores), $r(33) = -.46$, $p = .006$ (see Figure 8). The individual DOSPERT subscales (social, recreational, financial, health, and ethical risk-taking) were also examined in relation to progesterone change scores (see Table 11), with the strongest correlation emerging for health/safety risk-taking (see Figure 9).

Although non-significant, progesterone change scores were also positively associated with disgust sensitivity (Disgust Scale-R total difference scores), $r(33) = .15$, $p = .38$. In contrast to the hypothesis, progesterone change scores were not significantly correlated with OCD symptoms (Square root transformed PI-WSUR difference scores), $r(33) = -.17$, $p = .32$, and were negatively correlated with responsibility beliefs (RAS mean change scores), $r(33) = -.41$, $p = .02$. Progesterone difference scores were significantly correlated with anxiety difference scores (HADS), $r(33) = .41$, $p = .01$, showing that an increase in anxiety across the cycle corresponded to an increase in progesterone levels. Controlling for vigorous exercise (more than three hours a week), age, and BMI did not significantly affect the majority of the correlations, but after controlling for exercise the correlation between progesterone change scores and responsibility beliefs was no longer significant (Table 10). Further analyses revealed that exercise was related to both progesterone change scores and responsibility belief change scores. Women who exercised vigorously three hours a week or more had significantly lower progesterone change scores across the cycle ($M = 62.31$ pg/mL, $SD = 32.41$, $n = 10$) compared to free-cycling women who exercised less than three hours a week ($M = 145.35$ pg/mL, $SD = 89.06$, $n = 26$), $t(34) = 4.10$, $p < .001$. In addition, women who exercised regularly showed an increase in responsibility beliefs across the cycle ($M_{changescore} = 0.1$, $SD = 0.50$, $n = 10$), whereas women who exercised less showed a decrease in responsibility beliefs across the cycle ($M_{changescore} = -0.44$, $SD = 0.49$, $n =$

Table 10

Correlations between Progesterone Change Scores and OCD Symptoms, Disgust Sensitivity, Risk-taking, Responsibility Beliefs, and Anxiety Change Scores in Free-Cycling Women, including Partial Correlations (n = 35)

	Progesterone Δ scores	Control. for exercise	Control. for age	Control. for BMI	Control. for all 3
OCD symptoms (PI-WSUR Δ scores)	-.17	-.17	-.13	-.16	-.12
Disgust sensitivity (DS-R Δ scores)	.15	.04	.18	.13	.02
Risk-taking (DOSPERT Δ scores)	-.46**	-.50**	-.47**	-.46**	-.52**
Responsibility Beliefs (RAS Δ scores)	-.41*	-.26	-.36*	-.41*	-.25
Anxiety (HADS Δ scores)	.41*	.41*	.47**	.43*	.47**

Note. * p <.05. ** p < .01. Control. = Controlling. BMI = body mass index; PI-WSUR = Padua Inventory-Washington State University Revision; DS-R = Disgust Scale-Revised; DOSPERT = Domain-Specific Risk-Taking scale; RAS = Responsibility Attitude Scale; HADS = Hospital Anxiety and Depression Scale.

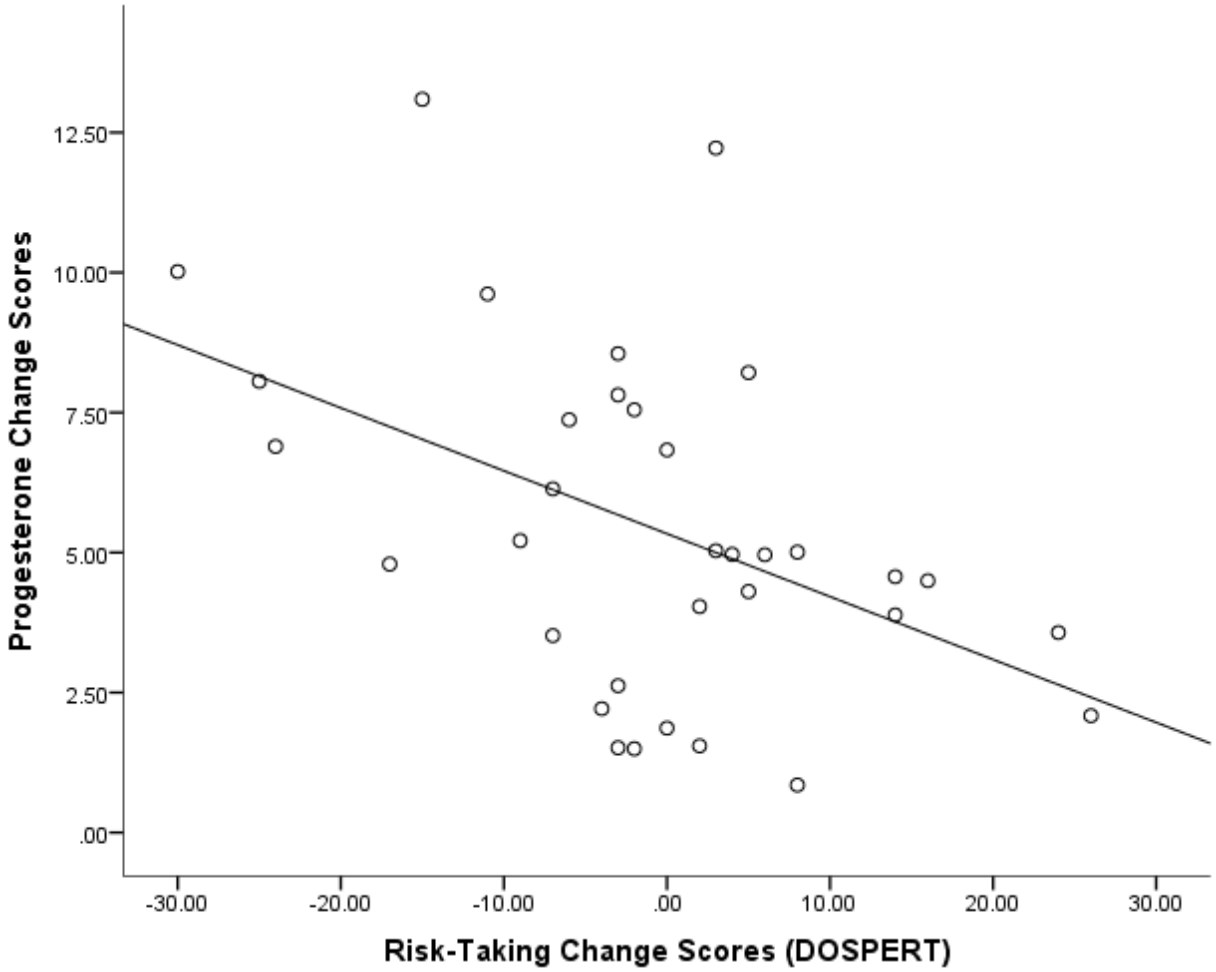

Figure 8. Scatterplot depicting the association between changes in square-root transformed progesterone levels across the menstrual cycle and changes in risk-taking across the menstrual cycle in free-cycling women (n = 35). The scatterplot indicates that increases in progesterone levels across the cycle were significantly associated with a decrease in risk-taking across the cycle.

Table 11

Correlations between Change in Risk-taking Subscales across the Cycle and Changes in Progesterone Levels (n = 35)

	Sqrt Progesterone Change Scores
Social Risk-taking Change Score	-.35*
Recreational Risk-taking Change Score	-.02
Financial Risk-taking Change Score	-.17
Health/Safety Risk-taking Change Score	-.53**
Ethical Risk-taking Change Score	-.19
Total Risk-taking Change Score	-.46**

Note. * $p < .05$. ** $p < .01$. Sqrt = square-root transformed.

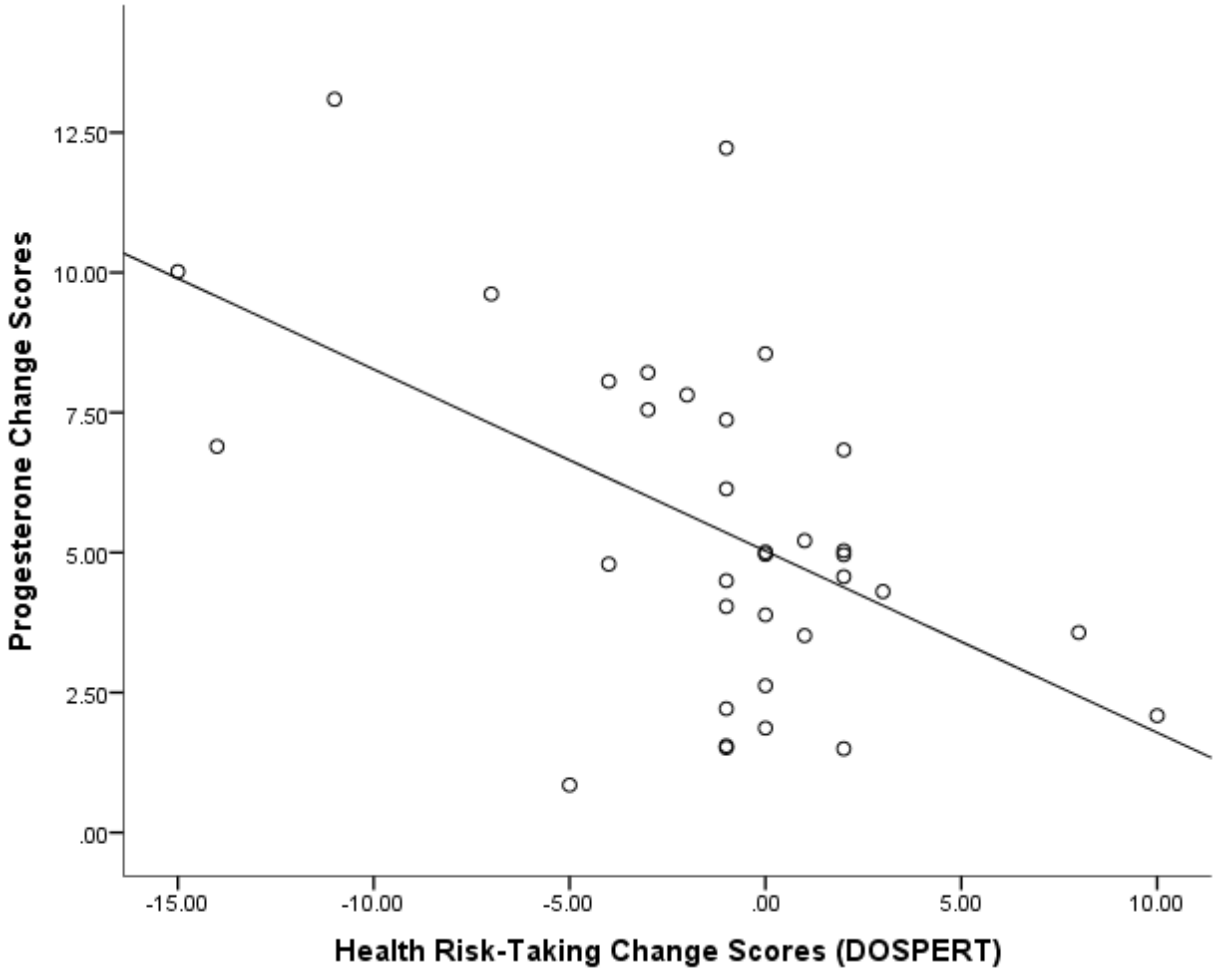

Figure 9. Scatterplot depicting the association between changes in square-root transformed progesterone levels across the menstrual cycle and changes in risk-taking in the health domain across the menstrual cycle in free-cycling women (n = 35). The scatterplot indicates that increases in progesterone across the cycle were significantly associated with decreases in risk-taking in the health domain across the cycle.

25), $t(33) = -2.91$, $p = .006$.

Hypothesis 3 (a). *Women will show increased sensitivity for identifying facial expressions of disgust compared to men.*

A 2 × 2 (Testing time [time1/follicular, time2/luteal] × Sex [male, female]) repeated-measures ANOVA was conducted. There was a significant main effect of sex, $F(1, 169) = 5.25$, $p = .023$, with women showing significantly greater sensitivity for identifying facial expressions of disgust ($M = 2.03$, $SD = 0.59$, $n = 114$) compared to men ($M = 1.79$, $SD = 0.77$, $n = 57$; see Figure 10). The testing time by sex interaction was not significant, $F(1, 169) = .71$, $p = .40$, although visual inspection of Figure 10 suggests that whereas men tend not to differ across testing sessions, women seem to show an increase in sensitivity to detecting facial expressions of disgust in the luteal phase.

Additional analyses were also conducted comparing disgust sensitivity in FCs and HC users and within subgroups of HC users. There was no significant difference found between average disgust sensitivity (d') across the cycle in FCs ($M = 2.07$, $SD = 0.63$, $n = 37$) and HC users ($M = 2.01$, $SD = 0.58$, $n = 77$), $t(112) = -0.43$, $p = .67$, nor was the difference in change scores across the cycle significant, $t(164) = -1.40$, $p = .16$. Sensitivity in detecting facial expressions of disgust was also examined as a function of progesterone dose and level of androgenic activity within OCs (see Table 12 for the average sensitivity scores for each group). Women taking OCs with high doses of progesterone showed significantly higher average sensitivity (d') ($M = 2.23$, $SD = 0.47$, $n = 18$) compared to women taking OCs with low doses of progesterone ($M = 1.90$, $SD = 0.60$, $n = 49$), $t(65) = -2.12$, $p = .04$. The newest generation of OCs (e.g., Yaz, Yasmin) contains a new progestin, drospirenone, which is the only anti-androgenic progestin (Dickey, 2010; Wharton et al., 2008). Women taking anti-androgenic OCs showed

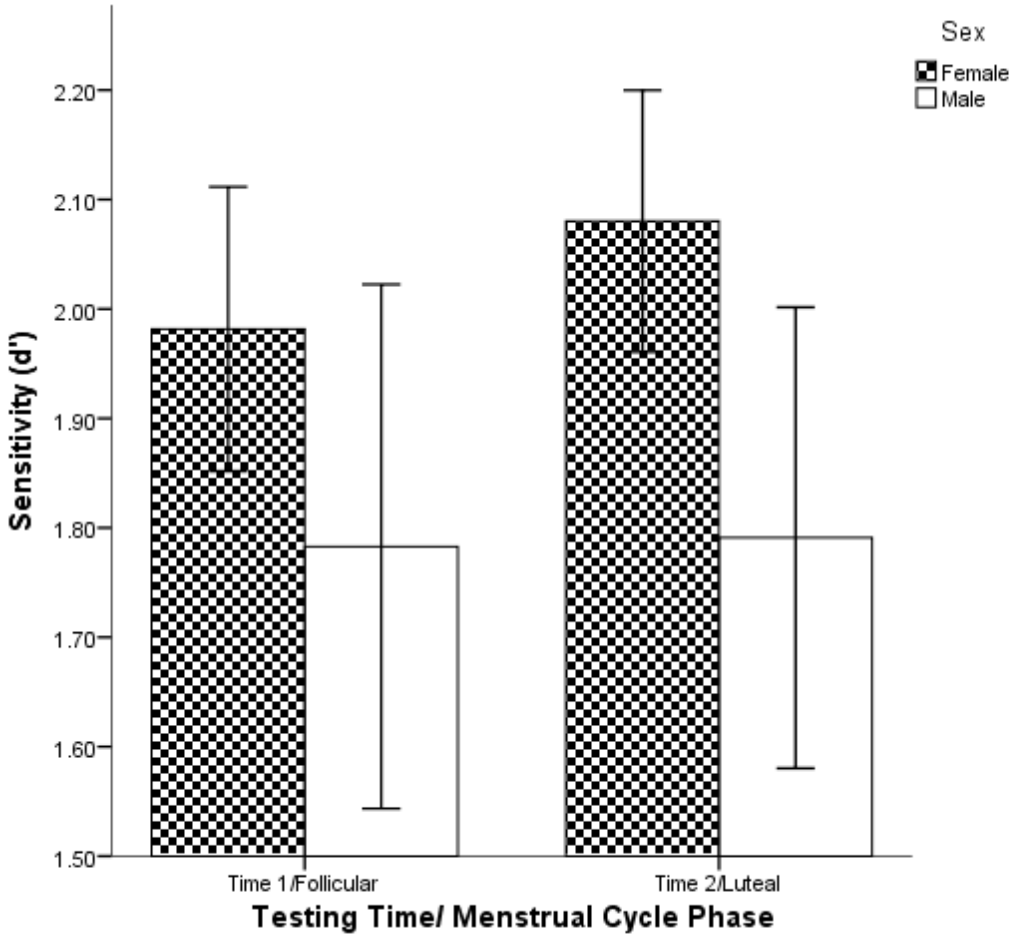

Figure 10. Mean sensitivity (*d*') scores for detecting disgust in facial expressions in men (n = 61) and women (n = 114), separated by testing time/menstrual cycle phase. There was a significant main effect of sex, with women showing significantly greater sensitivity for identifying facial expressions of disgust compared to men (p = .023). Error bars represent 95% confidence intervals.

Table 12

Sensitivity for Detecting Disgust in Facial Expressions Broken Down by Group (Men, Free-Cycling Women, Hormonal Contraceptive Users) and Subgroups (OC Progesterone and Androgen Activity)

Sensitivity (*d*')	*M (SD)*	*N*	*M (SD)*	*N*
	Time 1		Time 2	
Men	1.81 (0.90)	61	1.80 (0.79)	58
	Follicular		Luteal	
FCs	1.98 (0.70)	37	2.16 (0.69)	38
HC users	1.98 (0.70)	77	2.05 (0.62)	77
Low Progesterone OC	1.86 (0.74)	49	1.94 (0.65)	49
High Progesterone OC	2.25 (0.49)	18	2.21 (0.57)	18
Anti-androgenic OC	2.36 (0.27)	12	2.40 (0.57)	12
Low androgenic OC	1.89 (0.73)	47	1.98 (0.63)	47
Intermediate androgenic OC	1.92 (0.87)	7	1.65 (0.54)	7
High androgenic OC	1.17	1	1.43	1

Note. FCs = Free-cyclers; HC users = Hormonal contraceptive users; OC = Oral contraceptive.

significantly higher average disgust sensitivity (*d*'; $M = 2.38$, $SD = 0.36$, $n = 12$) compared to women taking OCs with low to high androgenic properties, ($M = 1.90$, $SD = 0.59$, $n = 55$), $t(25.53) = -3.63$, $p = .001$.

Hypothesis 3 (b). *Free-cycling women with a more liberal bias in terms of perceiving facial expressions of disgust will have increased levels of progesterone and pathogen disgust compared to women with a more conservative bias.*

Women with a liberal bias in detecting facial expressions of disgust had higher average pathogen disgust scores ($M = 22.83$, $SD = 7.28$, $n = 32$) compared to women with a conservative bias ($M = 16.60$, $SD = 6.24$, $n = 5$), although this difference was only marginal, $t(35) = -1.81$, $p = .08$. However, the majority of free-cycling women showed a liberal bias, thus limiting the possible range of the analysis. There were no differences in average progesterone levels across the cycle between women with a liberal bias ($M = 136.89$ pg/mL, $SD = 61.91$, $n = 30$) and those with a conservative bias ($M = 114.50$ pg/mL, $SD = 61.58$, $n = 4$) in detecting facial expressions of disgust, $t(32) = -0.68$, $p = .50$. Furthermore, changes in bias across the cycle were not correlated with changes in progesterone across the cycle, $r(34) = .06$, $p = .71$, or changes in pathogen disgust across the cycle, $r(33) = .08$, $p = .65$. Thus, this hypothesis was generally not supported.

Supplementary hypotheses

1. Sex differences will be found in disgust sensitivity and risk-taking, with women scoring higher than men in disgust sensitivity and lower in risk-taking.

As hypothesized, significant differences were found in terms of disgust sensitivity and risk-taking between men and women. Average disgust sensitivity (Disgust Scale-R total scores) was significantly higher in women ($M = 51.05$, $SD = 14.71$, $n = 148$) compared to men ($M =$

36.73, *SD* = 13.15, *n* = 66), *t*(212) = -6.79, *p* < .001. Average pathogen disgust was also significantly higher in women (*M* = 4.75, *SD* = 0.91, *n* = 147) compared to men (*M* = 4.03, *SD* = 0.96, *n* = 66), *t*(211) = -5.24, *p* < .001. Furthermore, women showed significantly lower risk-taking (DOSPERT scores; *M* = 86.78, *SD* = 22.69, *n* = 148) compared to men (*M* = 104.91, *SD* = 18.72, *n* = 66), *t*(212) = 5.68, *p* < .001.

2. *Women who are more hormonally sensitive (i.e., meet criteria for PMS) will report greater average OCD symptoms across the menstrual cycle.*

As expected, women meeting PSST criteria for PMS had significantly higher average square-root transformed OCD symptoms (*M* = 5.22, *SD* = 1.55, *n* = 33) compared to women who didn't meet criteria for PMS (*M* = 4.22, SD = 1.45, *n* = 114), *t*(145) = -3.41, *p* = .001. Given the fact that there is some commonality amongst the two scales in terms of anxiety-related items, all the individual PSST items were examined in relation to average OCD symptoms. Several of the PSST items relatively unrelated to anxiety were significantly correlated with average OCD symptoms, such as anger/irritability, overeating, hypersomnia, and physical symptoms (e.g., breast tenderness, bloating, muscle pain; see Table 13).

Exploratory Hypothesis

The ratio of the length of the second digit (index finger) to the fourth digit (ring finger), or 2D:4D, is used as a proxy measure of prenatal androgen and estradiol exposure. Digit ratios were calculated for the 261 participants who participated in the laboratory version of the study. Right hand and left hand 2D:4D were highly correlated, *r*(259) = .73, *p* < .001. As expected, digit ratio was higher in women (right 2D:4D, *M* = 0.966, *SD* = 0.03, *n* = 185) compared to men (right 2D:4D, *M* = 0.951, *SD* = 0.03, *n* = 76), *t*(259) = -3.66, *p* < .001.

Table 13

Correlations between individual items on the Premenstrual Symptoms Screening Tool (PSST) and Average OCD Symptoms in all Women (n = 148)

PSST Item	Average PI-WSUR Total Scores
1. Anger/irritability	.29**
2. Anxiety/tension	.25**
3. Increased sensitivity to rejection/ tearfulness	.11
4. Depressed mood/hopelessness	.21*
5. Decreased interest in work activities	-.03
6. Decreased interest in home activities	-.03
7. Decreased interest in social activities	.04
8. Difficulty concentrating	.04
9. Fatigue/lack of energy	.03
10. Overeating/food cravings	.19*
11. Insomnia	.08
12. Hypersomnia	.18*
13. Feeling overwhelmed/out of control	.13
14. Physical symptoms	.16*

Note. * p <.05. ** p < .01. PI-WSUR = Padua Inventory-Washington State University Revision.

The relationship between 2D:4D and obsessive-compulsive symptoms was examined as an exploratory hypothesis using Pearson product-moment correlations. Padua Inventory total scores across the two sessions were averaged and transformed as the data were positively skewed. There was no relationship between square-root transformed average PI-WSUR scores and right hand 2D:4D, $r(246) = .03$, $p = .59$, or left hand 2D:4D, $r(246) = .01$, $p = .90$.

The remaining core dependent measures in the study were also examined in association with 2D:4D. Digit ratio was also not related to average disgust sensitivity scores (Disgust Scale-R Total Scores across time 1 and time 2), RH*:* $r(248) = .02$, $p = .71$, LH: $r(248) = .03$, $p = .66$, average risk-taking scores, RH: $r(248) = -.09$, $p = .18$, LH: $r(248) = -.09$, $p = .17$, or average RAS scores across sessions, RH: $r(248) = .01$, $p = .85$, LH: $r(248) = .02$, $p = .72$.

Digit ratio was also examined in relation to sensitivity scores in the emotion discrimination task. Sensitivity scores for the fear versus disgust discrimination were averaged across the sessions to examine average sensitivity (*d*') scores. Higher, or more feminized 2D:4D was associated with greater sensitivity in detecting emotions of disgust; RH: $r(239) = .22$, $p = .001$, LH: $r(239) = .20$, $p = .002$ (See Figure 11). This likely reflects the finding that women are better at recognizing facial expressions of disgust than men. However, even when looking at women alone, higher or more feminized 2D:4D was significantly associated with greater average sensitivity in detecting facial expressions of disgust, RH: $r(166) = .17$, $p = .03$, LH: $r(166) = .20$, $p = .009$. When examining men, higher or more feminized 2D:4D was also associated with greater average sensitivity in detecting facial expressions of disgust, but the correlation was only marginally significant for the right hand, RH: $r(71) = .23$, $p = .05$, and not significant for the left hand, LH: $r(71) = .13$, $p = .29$.

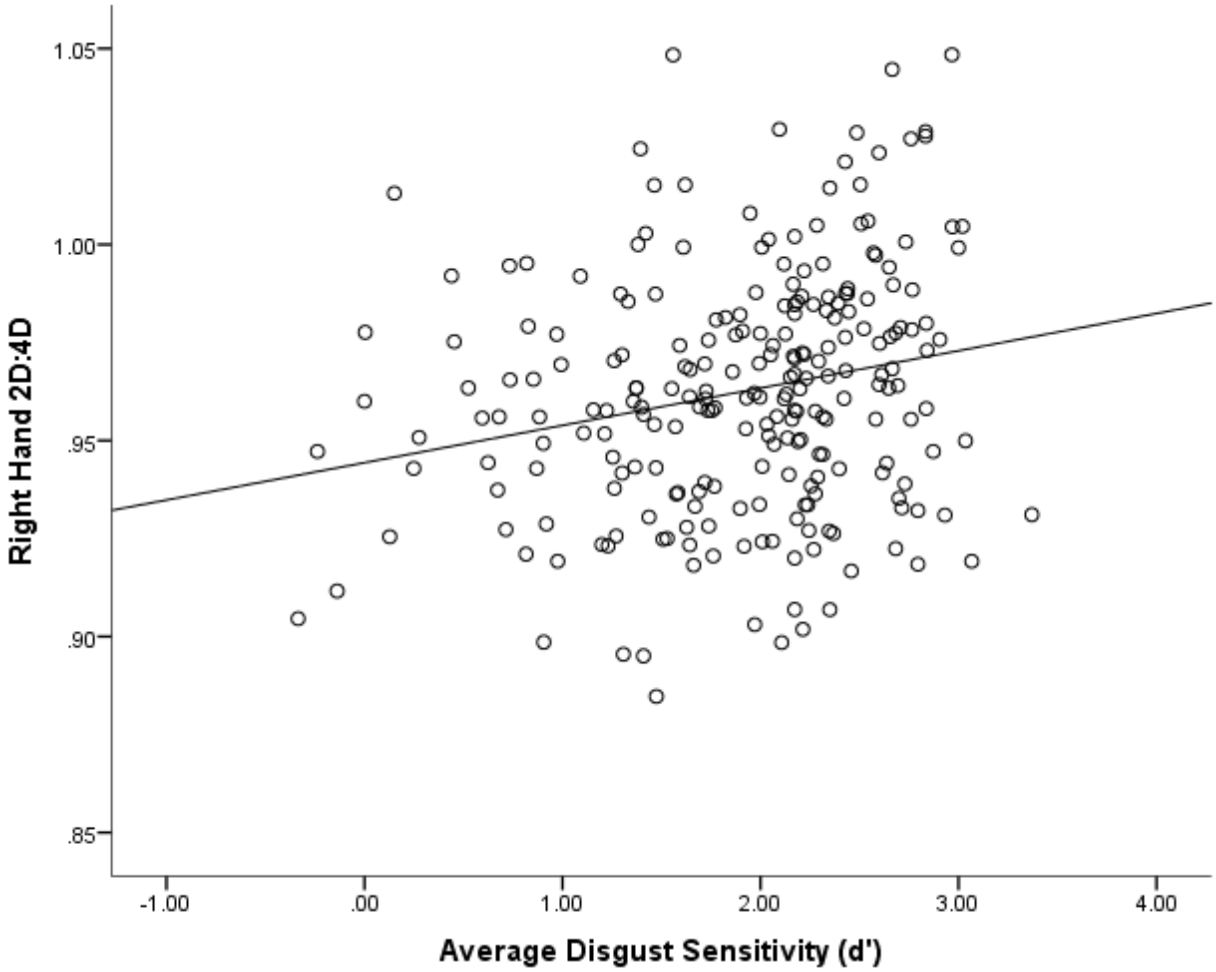

Figure 11. A scatterplot depicting the association between right hand 2D:4D and average disgust sensitivity (*d*') in men and women, $r(239) = .22$, $p = .001$.

Finally, the relationship between 2D:4D and hormonally relevant variables was assessed. Women who met criteria for PMS has significantly higher or more feminized 2D:4D (RH; M = 0.977, SD = 0.03, n = 49) than women who didn't meet criteria for PMS (RH; M = 0.963, SD = 0.03, n = 130), $t(177) = -2.65$, $p = .009$. The same finding was true for left hand 2D:4D, $t(177) = -3.03$, $p = .003$. These findings suggest that lower prenatal androgen exposure may be related to the later development of PMS. In addition, average progesterone levels across the two phases were significantly correlated with left hand 2D:4D, $r(50) = .31$, $p = .03$, and marginally correlated with right hand 2D:4D, $r(50) = .27$, $p = .05$.

Discussion

Increased contamination fears, disgust proneness, heightened responsibility, and risk-aversion are all thought to be adaptive strategies that from an evolutionary perspective would help protect a woman's offspring from threats (e.g., pathogens, accidents). The compensatory prophylaxis hypothesis posits that because high levels of progesterone suppress the immune system, disgust sensitivity and contamination fears increase to compensate for greater vulnerability to infection. Given that each menstrual cycle represents the possibility of conception and involves a rise in progesterone, changes in disease avoidant behaviour are also expected to occur at this time in addition to during pregnancy. However, in the current study, one of the main hypotheses, that women would show an increase in disgust sensitivity, obsessive-compulsive symptomatology, and responsibility beliefs, and a decrease in risk-taking across the menstrual cycle, was generally not supported. The fact that increases in precautionary behavior were generally not shown across the menstrual cycle in all women is in contrast to the idea that this represents a hard-wired evolutionary mechanism, although caution must be taken not to over interpret the findings from a single study.

Although obsessive-compulsive symptoms, disgust sensitivity, responsibility beliefs, and risk-taking did not change across the menstrual cycle commensurate with changes in progesterone as expected, increased salivary progesterone levels across the cycle were positively correlated with increased anxiety and negatively correlated with risk-taking in free-cycling women. Women with PMS showed increased OCD symptoms, disgust-sensitivity and responsibility beliefs at both phases of the menstrual cycle. In addition, the results of this study supported previous research suggesting that not all women show the same patterns of behaviour change across the cycle. Changes in behaviour across the menstrual cycle interacted with sexual activity and level of contamination fears, such that non-sexually active women and women with high contamination fears showed an increase in contamination OCD symptoms across the menstrual cycle, whereas sexually active women and women with low contamination fears showed a decrease in contamination OCD symptoms across the menstrual cycle. Women whose OCD contamination symptoms increased across the menstrual cycle may represent a distinct subgroup of women, as they were more likely to be single, not sexually active, have fewer lifetime sexual partners, have decreased risk-taking in the health/safety domain, and to identify as religious (Christian) compared to women who showed no change in contamination OCD symptoms or a decrease in symptoms across the menstrual cycle. In terms of emotion recognition, women were more sensitive to detecting facial expressions of disgust than men, a difference that appeared to be driven by increased sensitivity in the luteal phase for women compared to men. In addition, women who were taking anti-androgenic OCs and OCs with higher progesterone dosages had significantly higher sensitivity in detecting disgust. Finally, women with higher digit ratios (2D:4D) were more likely to meet criteria for PMS and had higher sensitivity to detecting facial expressions of disgust.

This was the first study to examine OCD symptoms across the menstrual cycle employing both a within-subjects design and measuring salivary hormone levels. The current findings were consistent with those reported by Fessler and Navarrete (2003), who failed to find a relationship between contamination-related disgust sensitivity and immunosuppression (based on self-reported position in the menstrual cycle). The current findings failed to replicate Avgoustinaki and colleagues (2012), who found a significant correlation between progesterone levels (on day 21) and OCD symptoms (MMPI Psychasthenia subscale). However, progesterone levels explained a small and non-significant percentage of variance in subscale scores (7%). The current findings are also inconsistent with those of Fleischman and Fessler (2011), who found a significant positive correlation between progesterone levels and OCD contamination symptoms. The authors employed the same assessment measure as used in the current study (Padua Inventory), but their study design was cross-sectional, with participants providing saliva samples and completing all measures in one sitting. Women in the present study, generally speaking, did not show an increase in OCD contamination symptoms as they progressed from a low to high progesterone phase. Thus, it cannot be ruled out that the inconsistency in findings between the two studies could be a result of differences in study design.

Gonda et al. (2008) were the only authors to use a within-subjects design when examining OCD symptoms across the menstrual cycle. These authors found that anxiety and OCD symptoms (measured by the STAI and SCL-51) increased over the menstrual cycle, with higher scores in the late luteal phase compared to the late follicular phase. Although the current study did not find a menstrual cycle phase effect in relation to anxiety (HADS) scores, change scores did show that increases in progesterone were significantly positively correlated with increases in anxiety across the menstrual cycle. Gonda and colleagues examined a very specific

time interval in the late luteal phase (2 to 3 days before the onset of menses). Consistent with their findings, the significant correlation in the present study between progesterone change scores and anxiety change scores was higher in the late luteal phase of the cycle (r = .64) compared to the early luteal phase (r = .39).

Main Hypotheses: Hypothesis 1

Free-cycling women will show an increase in contamination-based OCD symptoms, disgust sensitivity, and responsibility beliefs and a decrease in risk-taking during the luteal phase of the menstrual cycle compared to the follicular phase, whereas women taking hormonal contraceptives will show significantly attenuated effects compared to free-cycling women in terms of these dependent variables.

Potential moderating variables will also be explored to see if subgroups of women display different patterns of behavior change cross the cycle.

Contrary to the prediction, free-cycling women did not show increases in contamination OCD, disgust sensitivity, responsibility beliefs, or a decrease in risk-taking across the menstrual cycle. Given the fact that women taking hormonal contraceptive pills have lower levels of progesterone compared to free-cycling women (Fleischman et al., 2010), it was hypothesized that women taking hormonal contraceptives and free-cycling women would show different patterns in terms of contamination-based OCD symptoms, disgust sensitivity, responsibility beliefs, and risk-taking across the cycle. However, the phase by group interaction was not significant, nor were there any differences in change scores across the cycle on the four main dependent measures between FCs and HC users. Free-cycling women were also compared to women with low progesterone OCs and monophasic OCs, but no differences emerged between the dependent measures in these group comparisons.

These findings are inconsistent with previous research, which has shown that OC users do not display the same patterns as free-cycling women across the menstrual cycle in a number of areas (e.g., facial preferences, Penton-Voak et al., 1999; mate preference, Alvergne & Lummaa, 2010, Little, Jones, & Burriss, 2007; relationship jealousy, Cobey, Pollet, Roberts, & Buunk, 2011; voice attractiveness, Pipitone & Gallup, 2008). However, differences did emerge between HC users and FCs in the present study when moderator analyses were conducted. Whereas there was a significant interaction between sexual activity and change in contamination OCD symptoms across the menstrual cycle in FCs, the interaction was not significant in HC users.

Moderators of behaviour change across the menstrual cycle.

PMS. The interaction was not significant between phase of the menstrual cycle and whether or not women met criteria for PMS according to the PSST for any of the main dependent variables. A significant interaction might have been expected given that women who experience affective and physical changes pre-menstrually might also show an increase in related symptoms (e.g., OCD) pre-menstrually. Furthermore, up to nearly 50% of women with OCD report premenstrual worsening of OCD symptoms, number of PMS symptoms has been found to predict worsening of OCD symptoms in the postpartum period, and a diagnosis of OCD is often comorbid with PMS and PMDD (Labad et al., 2005; Vulink et al., 2006).

There was a significant main effect of PMS, which showed that women who met criteria for PMS had significantly higher average levels of disgust sensitivity, OCD symptoms, and responsibility beliefs compared to women not meeting criteria for PMS. These findings are consistent with Firoozi and colleagues (2012), who found that women with PMS had significantly higher levels of depression and anxiety compared to women without PMS, but that

these symptoms were higher across both phases of the menstrual cycle compared to the control group.

Level of contamination fears. Although sub-clinical contamination OCD symptoms did not increase across the cycle in all free-cycling women as hypothesized, women who scored above a cut-off score for contamination fears (similar to individuals diagnosed with OCD) on the PI-WSUR did actually show an increase in OCD contamination symptoms from the follicular to luteal phase of the cycle. This finding is in line with previous research that has shown up to 49% of women with OCD experience premenstrual worsening of OCD symptoms (Vulink et al., 2006), suggesting that hormones such as progesterone affect OCD symptomatology. It's possible that perhaps OCD symptoms have to rise to a certain level in order to be exacerbated by increased progesterone levels, or vice versa.

Stage of luteal phase testing. Different patterns of change in contamination OCD symptoms across the cycle emerged depending on whether women were tested from the follicular phase to the early luteal phase or from the follicular phase to the late luteal phase. Women tested in the late luteal phase showed an increase in contamination OCD symptoms across the menstrual cycle, women tested in the early luteal phase showed a decrease in OCD symptoms across the menstrual cycle. This finding is consistent with Gonda and colleagues (2008), who found that anxiety and OCD symptoms were greater in the late luteal phase compared to the late follicular phase of the menstrual cycle. The compensatory prophylaxis hypothesis would likely predict that disgust sensitivity (and OCD contamination symptoms) would be highest during peak progesterone levels. However, peak progesterone levels should occur in the mid-luteal phase not the late luteal phase of the cycle. In the current study progesterone levels were higher in the early luteal phase compared to the late luteal phase

(although not significantly). Perhaps late luteal symptoms are reflective of a sensitivity to the drop in progesterone that occurs from the mid to late luteal phase of the cycle.

Sexual activity. Sexual activity was also found to be an important moderator in the current study, affecting two of the four main dependent variables in free-cycling women (risk-taking and OCD contamination symptoms). A significant interaction was found between OCD contamination symptoms and menstrual cycle phase as a function of women's sexual activity. Free-cycling women who were not sexually active showed an increase in contamination OCD symptoms across the menstrual cycle, whereas women who were sexually active showed a decrease in contamination OCD symptoms from the follicular phase to the luteal phase. Furthermore, whereas risk-taking increased across the cycle in women who were not sexually active, sexually active women showed a significant decrease in risk-taking from the follicular to luteal phase of the cycle.

A decrease in OCD symptoms across the menstrual cycle in sexually active women seems contrary to the compensatory prophylaxis hypothesis, as it would predict increased contamination fears during times of increased progesterone. Furthermore, women who are sexually active and are not using birth control are most likely to get pregnant and are perhaps the most in need of disease-avoidant behaviour.

There is evidence to suggest that obsessive compulsive symptoms interfere with sexual functioning. Individuals with OCD have been found to have lower sexual satisfaction and sexual desire compared to individuals without OCD, with greater severity of OCD symptoms associated with lower levels of sexual satisfaction (Amini et al., 2014). Although women with other anxiety disorders also experience decreased sexual functioning (Van Minnen & Kampman, 2000), individuals with OCD seem to be most at risk for sexual dysfunction. For instance, Van Minnen

and Kampman (2000) found that patients with OCD were less satisfied with their sex lives and reported more sexual dysfunction compared to both patients with panic disorder and controls. Similarly, Aksaray, Yelken, Kaptanoğlu, Oflu, and Özaltin (2001) found that women with OCD were more sexually non-sensual, avoidant, and anorgasmic compared to women with GAD. Furthermore, patients who reported contamination obsessions were more sexually non-sensual and avoidant compared to patients with other types of obsessions (e.g., symmetry/exactness; Aksaray et al., 2001).

Sexual stimuli (e.g., sweat, semen, saliva) are some of the strongest elicitors of disgust imaginable, although avoidance of these contaminants would be at odds with the goal of procreation (Al-Shawaf, Lewis, & Buss, 2015; Borg & de Jong, 2012). Therefore, it is hypothesized that sexual arousal may weaken the disgust response or make individuals less avoidant of disgust-provoking stimuli (Al-Shawaf et al., 2015). In fact, in a recent study by Borg and de Jong (2012) women watched either an erotic film to induce sexual arousal, a sports clip to induce positive arousal, or a neutral film and then engaged in a series of behavioural tasks that represented various domains of disgust (e.g., sticking your finger in a bowl of seemingly used condoms). The authors found that participants in the sexual arousal condition rated sexual stimuli as less disgusting compared to participants in the positive arousal or neutral condition. The sexual arousal group also conducted the greatest percentage of tasks in comparison to the other two groups. Given that disgust sensitivity and contamination OCD symptoms are positively correlated, these findings suggest that sexual arousal or sexual activity may decrease disgust and contamination OCD symptoms. In the current study average disgust sensitivity across the two sessions was lower in women who were sexually active, although the difference was only marginally significant.

The interaction between sexual activity and menstrual cycle phase for OCD contamination symptoms is consistent with the Periovulatory Sociosexuality Tactic Shift (PSTS), for which level of sociosexuality predicted two different patterns of mating strategies across the menstrual cycle. Oinonen et al. (2008) found that restricted women became more sexual when more fertile and unrestricted women became less sexual when more fertile. Thus, restricted women may become more sexual and less concerned with contamination when more fertile, or their risk of conception is higher. However, the finding of increased risk-taking across the cycle in women who are not sexually active doesn't appear to fit with this theory, as you might expect increased risk-taking in the fertile phase of the cycle if women become more sexual and less concerned with contamination.

Previous research has shown that women who differ in sociosexuality and related constructs show different patterns of behavior change across the menstrual cycle (e.g., Edelstein et al., 2011; Oinonen et al., 2008; Scarbrough & Johnston, 2005). Therefore, the different patterns of change in OCD contamination symptoms across the cycle depending on sexual activity may represent two distinct groups of women who display different patterns across the cycle. In fact, exploratory analyses suggested that there were differences between women who showed increases in OCD contamination symptoms across the cycle and those who showed no change or a decrease in OCD contamination symptoms across the cycle. Women with increasing OCD contamination symptoms across the cycle were more likely to be single, not sexually active, to have fewer lifetime sexual partners, to have decreased risk-taking in the health/safety domain, and to identify as religious (Christian). This combination of variables seems to suggest that women who show increased OCD contamination symptoms across the cycle may be more restricted in their sociosexuality and possibly more conservative in their values.

Women who showed an increase in OCD contamination symptoms across the menstrual cycle were found to converge on a number of factors related to restricted sociosexuality (e.g., lower number of lifetime sexual partners, not currently sexually active, and not currently in a relationship), in addition to identifying with a Christian religious orientation and decreased risk-taking in the health domain. Restricted sociosexuality has been linked to both religion and disease prevalence. For instance, people who were intrinsically motivated toward religion were found to have more restricted sociosexuality (e.g., desiring less sexual partners over time; Rowatt & Schmitt, 2003). Sociosexuality and contamination fears may also be linked, as women have been found to be more restricted sexually in regions with higher parasite prevalence (Park & Schaller, 2009).

Some researchers hypothesize that high levels of disgust and contamination fears resulted in more conservative beliefs and attitudes to promote group exclusion as a form of protection against potential threats from outgroups (e.g., disease; Terrizzi, Shook, & McDaniel, 2013). For instance, disgust (which is positively correlated with contamination OCD symptoms) has been found to positively correlate with more socially conservative values (Terrizzi, Shook, & Ventis, 2010). In addition, religious conservatism was found to mediate the relationship between disgust and negative attitudes toward out-group members (Terrizzi, Shook, & Ventis, 2012). Future research is needed to replicate the finding that a subgroup of conservative women with more restricted sexuality are more likely to show increased contamination OCD symptoms across the menstrual cycle.

Hypothesis 2

Increasing salivary progesterone levels across the menstrual cycle will be associated

with increased OCD symptomatology, disgust sensitivity, responsibility beliefs, and decreased risk-taking across the cycle.

It was hypothesized that changes in progesterone levels across the menstrual cycle would be positively correlated with changes in OCD contamination symptoms, disgust sensitivity, responsibility beliefs, and negatively correlated with changes in risk-taking across the cycle. There was a significant negative association between increased progesterone levels across the menstrual cycle and decreased risk-taking across the cycle, but none of the other main dependent variables were significantly correlated with changes in progesterone levels after controlling for potential confounds. It's unclear why increased general anxiety scores (HADS) across the cycle were positively correlated with increases in progesterone but increased OCD symptoms were not.

The correlation between changes in progesterone and changes in responsibility beliefs across the cycle was in the opposite direction of the predicted relationship. Perhaps responsibility beliefs do not generally increase in the luteal phase but would be more likely to be primed in times of high progesterone given a proper stimulus. For instance, it would be interesting to examine whether participants, when presented with a scenario of possible harm to an infant, would be more likely to intervene and prevent harm in times of increased progesterone (and perhaps level of baseline responsibility beliefs would interact with behavior change). Thus, this is an area where future research is warranted in order to make stronger claims about the relationship between progesterone and responsibility beliefs.

As hypothesized, increases in salivary progesterone across the menstrual cycle were significantly associated with decreased risk-taking across the cycle. Previous findings have supported the notion that hormones affect risk-taking behaviour. Bröder and Hohmann (2003)

found that naturally cycling women reduced risky behaviours that would increase their risk of sexual assault around the time of ovulation (e.g., “walk through dimly lit area in the evening”) and increased non-risky behaviour (e.g., “visit friends”), whereas women taking hormonal contraceptives showed neither effect. Using a lottery task, Buser (2012) found that participants were twice as likely to choose a riskier payment scheme during periods of low progesterone compared to high progesterone. These findings are consistent with evolutionary theory, which posits that competitiveness is more desirable during the more fertile phase of the menstrual cycle and less desirable during high progesterone times such as the luteal phase of the menstrual cycle and pregnancy when the focus is on maintaining long-term commitment (Buser, 2012).

Increasing progesterone levels across the menstrual cycle in free-cycling women were also found to be significantly correlated with decreased risk-taking in the social domain. Progesterone is thought to play an important role in terms of affiliative behaviors, such as creating and maintaining social relationships. Just as behavioural changes that occur in the follicular phase near ovulation (e.g., greater attraction to masculine faces) are important for mating purposes, behavioural changes in the luteal phase are thought to be related to social and affiliative functions (Maner & Miller, 2014). Each rise in progesterone across the luteal phase of the menstrual cycle represents an attempt to prepare the body for pregnancy. Therefore, it is hypothesized that high progesterone levels would be associated with behaviour considered adaptive during pregnancy, such as solidifying social bonds to ensure support during pregnancy and long-term resources to help raise a child (McLean & Anderson, 2009; Schultheiss, Dargel, & Rohde, 2003).

Studies have in fact shown a link between progesterone and affiliation motives. Schultheiss and colleagues (2003) examined the relationship between salivary progesterone and

implicit motives of affiliation, as measured by the Picture Story Exercise. Participants were tested at three time points, corresponding to the early follicular, periovulatory, and luteal phases of the cycle. During the periovulatory and luteal phases, salivary progesterone levels were significantly higher in the affiliation-arousal group than the control group for normally cycling women. Average levels of progesterone were moderately positively correlated with affiliation motive for normally cycling women, but there was no relationship between progesterone and affiliation motive in women taking hormonal contraceptives. Furthermore, viewing a movie clip meant to implicitly prime motives for affiliation lead to a significant elevation in progesterone levels compared to participants who viewed movie clips that implicitly primed power motives or were neutral (Schultheiss, Wirth, & Stanton, 2004). Recent research also suggests that high levels of progesterone may prime the need for close relationships. Brown et al. (2009) found that participants who engaged in a closeness induction with a partner had significantly greater salivary progesterone levels following the task compared to those who engaged in a neutral task. Furthermore, in a second session a week later, increases in progesterone were predictive of self-reported willingness for participants to risk their life for their partner.

Of all of the subscales of the DOSPERT, decreased risk-taking in the health/safety domain was the most associated with increases in progesterone across the menstrual cycle. This finding is consistent with the compensatory prophylaxis hypothesis, which posits that increases in progesterone are accompanied by increases in disease avoidant behavior. One the items on the health/safety subscale pertains to the likelihood of engaging in unprotected sex. Being less likely to engage in unprotected sex would limit exposure to possible sexually transmitted infections. This fits with previous findings showing disease prevalence negatively correlated with openness to experience and sociosexuality (Schaller & Murray, 2008). Furthermore, by not exposing

ourselves to risky or dangerous situations we can decrease the risk of disease transmission (Schaller & Murray, 2008). Becoming more cautious with health and safety and disease avoidance during times of high progesterone may be an adaptation for pregnancy, as exposure to viruses and toxins during pregnancy can result in serious deformation in the developing fetus (Lienard, 2011; Tybur & Gangestad, 2011).

Hypothesis 3

(a). Women will show increased sensitivity for identifying facial expressions of disgust compared to men.

Consistent with previous research (e.g., Collignon et al., 2010), women were found to have significantly greater average sensitivity for identifying facial expressions of disgust compared to men. Although the testing time by sex interaction was not significant, inspection of Figure 10 suggests that women may show an increase in sensitivity to detecting facial expressions of disgust in the luteal phase of the menstrual cycle. This would be consistent with the compensatory prophylaxis hypothesis, as increased progesterone levels would be associated with greater sensitivity to cues of disgust. An alternative explanation is the possibility that men and women differed in practice effects, with women potentially benefitting more from prior experience with the task than men going into the second testing phase.

(b). Free-cycling women with a more liberal bias in terms of perceiving facial expressions of disgust will have increased levels of progesterone and pathogen disgust compared to women with a more conservative bias.

It was also predicted, based on the compensatory prophylaxis hypothesis, that during times of immunosuppression (or increased progesterone) it would be beneficial to have a more liberal bias in terms of recognizing potential signals of contamination or threat. In contrast to the

prediction, there was no significant relationship between bias in perceiving facial expressions of disgust and progesterone levels. Pathogen disgust was marginally higher in women with a liberal bias in detecting disgust compared to a conservative bias, as expected, but very few women had a conservative bias. There was also no difference in change scores between progesterone levels and pathogen disgust and bias across the cycle. However, bias scores did not change very much across the cycle and were generally quite liberal to begin with. For instance, in free-cycling women in the follicular phase 74% of participants had a negative or liberal bias, which increased slightly to 79% in the luteal phase. Perhaps if the faces were presented more quickly or the expressions were more ambiguous there might have been a stronger effect, given that individuals with OCD were more likely to perceive disgust in ambiguous facial expressions compared to controls (Jhung et al., 2010).

These findings are not consistent with previous research examining the link between hormones and emotion recognition, although research findings in this area are not consistent. Guapo and colleagues (2009) did not find any differences in facial recognition accuracy for disgust across different phases of the menstrual cycle. In contrast, other researchers have found higher emotion recognition in the follicular phase compared to the luteal phase and a negative correlation between progesterone levels and emotion recognition accuracy (Derntl, Kryspin-Exner, et al., 2008; Derntl, Windischberger, et al., 2008). However, women were more likely to misperceive other negative emotions as disgusted when in the luteal phase (Derntl, Kryspin-Exner, et al., 2008). Therefore, it may not be that women are more accurate at identifying disgust in the luteal phase, but that during times of increased progesterone (similar to pregnancy) it is important not to miss signals of disgust, or misjudge them for other emotions. However, in the present study a liberal bias in perceiving facial expressions of disgust was not related to

progesterone levels. The fact that studies in this area are so inconsistent is likely a reflection of the vast differences in methodology employed as well as the small sample sizes utilized.

From an evolutionary perspective high levels of progesterone are thought to increase attention and vigilance to social stimuli and potential threats as a mechanism to protect fetal development. In a recent study, Wolohan, Bennett, and Crawford (2013) found sex and menstrual cycle differences between participants in an eye-gaze cueing task. Participants were instructed to respond to a target that was presented next to a face with a fearful expression, with eye gaze either consistent with the target or inconsistent. Women responded significantly faster to the target in the congruent condition compared to men, and women in the luteal phase showed a significantly quicker reaction time compared to women in the follicular phase of the menstrual cycle. These findings are consistent with the current study in which women had greater sensitivity in detecting disgust compared to men, especially during the luteal phase of the menstrual cycle, and past literature showing that women were more accurate at identifying emotions that signal a threat (i.e., fear, anger, and disgust) in late pregnancy when progesterone levels were higher compared to early pregnancy (Pearson et al., 2009).

Emotion recognition was also compared between free-cycling women and women using hormonal contraceptives. Given the difference in progesterone levels between free-cycling women and hormonal contraceptive users, one might expect that hormonal contraceptive users would experience reduced emotion recognition. In fact, a recent study found that women taking OCs detected significantly fewer facial expressions of disgust compared to non-users (Hamstra, De Rover, De Rijk, & Van der Does, 2014). However, in the current study free-cycling women and women using hormonal contraceptives did not differ in mean sensitivity for detecting facial expressions of disgust. However, differences in sensitivity for detecting disgust were found

within OC users, depending on the progesterone dosage and androgenic activity of the OCs. High dose progesterone and anti-androgenic OCs were associated with significantly higher sensitivity for detecting facial expressions of disgust.

Increased androgenic activity hindering emotion recognition is consistent with the finding of lower sensitivity in detecting disgust in males versus females in the current study and fits with previous literature. A recent study conducted by Pletzer, Kronbichler, and Kerschbaum (2015) found that women taking OCs with anti-androgenic progestins had significantly better facial recognition performance compared to users of OCs with androgenic progestins or free-cycling women. Furthermore, enhanced facial recognition in anti-androgenic OC users was related to greater grey matter volume in brain structures associated with facial recognition (e.g., fusiform face area; Pletzer et al., 2015). Similarly, Van Honk and colleagues (2011) found that a single dose of testosterone administered to female participants significantly reduced their ability to infer emotions in the Reading the Mind in the Eyes Task (RMET). Furthermore, 2D:4D was found to interact with cognitive empathy, such that testosterone administration had more of an effect on women with low, or more masculinized 2D:4D ratios, suggesting that activational effects may be dependent on fetal testosterone priming (Van Honk et al., 2011). In the current study, higher, or more feminized 2D:4D was significantly associated with greater sensitivity in detecting emotions of disgust, which supports the notion that hormones modulate emotion recognition.

The reverse is also true, with women taking more androgenic OCs becoming more "malelike" in their behavior. For instance, in terms of visuospatial abilities there are large sex differences in mental rotation, with men outperforming women (see Voyer, Voyer, & Bryden, 1995 for a review). However, a study by Wharton and colleagues (2008) that found that

differences in OC androgenicity mediated performance on a mental rotation task. Whereas women taking the most androgenic OCs had the best performance on a mental rotation task, women taking Yasmin (an anti-androgenic OC) had the worst task performance. These findings speak to both the organizational (e.g., 2D:4D) and activational (e.g., current OC progestin dosage or androgenicitiy) effects of hormones on human behavior.

Neural Correlates of Negative Mood Symptoms across the Menstrual Cycle

The amygdala, located within the limbic system of the brain, is involved in the processing of emotions. Although the amygdala is often associated with fear processing, it appears to have a much broader, more integrative function (Schienle, Schäfer, Stark, Walter, & Vaitl, 2005). Hyperactivity of the amygdala appears to be a commonality across anxiety disorders (Etkin & Wager, 2007). Even in individuals without anxiety disorders, personality traits such as neuroticism and anxiety sensitivity increased amygdala responsiveness in an emotion-processing task with young adults (Stein, Simmons, Feinstein, & Paulus, 2007). In an fMRI study involving 63 healthy women who were presented with either neutral or disgusting pictures, both trait anxiety and disgust sensitivity were found to positively correlate with the activation of the right amygdala (Schienle et al., 2005).

Sex differences have been found in relation to amygdala activation. Hormones are thought to play a role in these sex differences given that the amygdala is densely populated with steroid hormone receptors (Stevens & Hamann, 2012). A recent meta-analysis of nearly 100 neuroimaging studies examined sex differences in brain activation to emotional stimuli (Stevens & Hamann, 2012). Key differences were found in the amygdala, with women showing greater activation than men in the left amygdala for negative emotions, and men showing greater activation than women for positive emotions. The authors argue that these findings suggest an

increased reactivity to negative emotional stimuli in women that may help to explain the increased prevalence of mood and anxiety disorders in women (Stevens & Hamann, 2012). Women with PMDD have also been found to show significantly increased amygdala activity in response to negative stimuli in the premenstrual phase of the cycle relative to control participants (Protopopescu et al., 2008).

Progesterone also affects amygdala activation. Women using OCs have been shown to have decreased amygdala reactivity compared to free-cycling women when presented with negative emotional stimuli (Petersen & Cahill, 2015). In a neuroimaging study, Van Wingen and colleagues (2008) found that a single dose of progesterone administered to women in their follicular phase (which increased progesterone concentrations to levels similar to the luteal phase) resulted in increased amygdala reactivity. Van Wingen and colleagues hypothesize that women with PMS/PMDD might experience a greater activation of the amygdala in response to progesterone or its main metabolite, allopregnanolone. Perhaps increased amygdala activation in response to increases in progesterone is an evolutionary adaptation for pregnancy that allows for increased vigilance to potential threats of harm to the offspring. Oxytocin, another hormone that is important during pregnancy, also affects amygdala reactivity. Lischke and colleagues (2012) found that following intranasal administration of oxytocin, amygdala reactivity increased in response to viewing threatening scenes.

The worsening of OCD symptoms observed in many women across the menstrual cycle might also involve the amygdala. Atmaca and colleagues (2008) found that patients with refractory OCD showed a reduction in amygdalar volume by 23% compared to healthy control subjects. Furthermore, a positron emission tomography (PET) study showed that OCD patients with contamination fears showed enhanced activity in the left amygdala in response to viewing

contamination-related pictures compared to a control group (van den Heuvel et al., 2004). However, a more recent study found that greater severity of aggression, checking, sexual, and religious symptom dimensions predicted greater activation of the right amygdala during an emotional face-matching task in patients with OCD compared to controls, whereas this association was not found in other symptom dimensions (e.g., contamination, symmetry/ exactness, hoarding; Via et al., 2014). Not all studies have shown increased activity in the amygdala in OCD patients compared to controls (e.g., Cannistraro et al., 2004), although responsivity to fearful versus neutral faces tends to be a common paradigm that may not show the same effects as more individualized stimuli.

Progesterone and its metabolites also alter the function of neurotransmitters, including gamma aminobutyric acid A (GABA), the main inhibitory neurotransmitter system in the brain. Negative mood symptoms in response to changes in progesterone levels may be caused by the effect of progesterone metabolites on GABA (Bäckström et al., 2011). The main metabolites of progesterone (pregnanolone and allopregnanolone) have been shown to directly influence the $GABA_A$ receptor complex (Andréen et al., 2009). As progesterone concentrations rise across the menstrual cycle and peak in the luteal phase, progesterone's metabolites also show the same increases across the cycle. Allopregnanolone has been shown to induce negative mood symptoms when in the range of concentrations similar to the luteal phase (Andréen et al., 2009). In women with PMDD associations have been found between the severity of symptoms and changes in GABA concentrations or $GABA_A$ receptor sensitivity (Andréen et al., 2009; Bäckström et al., 2011). Therefore, it appears as though a subset of women may be more sensitive to $GABA_A$ receptor modulators.

Although the hormonal sensitivity hypothesis seems to focus more exclusively on changes in estrogen across reproductive events and vulnerability for depression, these findings suggest that sensitivity to changes in progesterone should not be overlooked. In fact, a failure to adapt to changes in progesterone and its metabolites may play an important role in terms of biological support for the hormonal sensitivity hypothesis. Gordon and colleagues (2015) recently proposed a novel model which hypothesizes that vulnerability to depression for some women during the menopause transition may result from a HPA axis dysregulation as a result of a failure of the $GABA_A$ receptor to adapt to fluctuations in allopregnanolone as estrogen and progesterone levels become more erratic. It is important to continue this line of research to help better understand the etiology of the increased vulnerability to depression in some women as a result of fluctuations in both estrogen and progesterone across key reproductive events.

Limitations and Future Directions

Given the number of exclusion criteria utilized, menstrual cycle research results in a subsample of women that may not be entirely representative of the whole population of free-cycling women. Although the use of these exclusion criteria increases the internal validity of the study, it may limit the external validity, or generalizability of the findings. In the current study, 56 free-cycling women were excluded for reasons such as age over 40, pregnant or breastfeeding, irregular menstrual cycles, ovaries removed, using medications or having medical conditions affecting hormone levels, recent use of hormonal contraceptives, being outside of specified testing days, and reversed progesterone levels; thus the remaining women represented healthy women with normal menstrual cycles. The exclusion criteria also limited the number of saliva samples ultimately included in data analysis (i.e., 36 of 56), which may have reduced the power of the progesterone analyses. However, many of the exclusion criteria utilized are

necessary from a practical standpoint given that they affect hormone levels (e.g., pregnancy, age consistent with perimenopause, removal of ovaries). Furthermore, it would be difficult to schedule women with irregular and longer than average menstrual cycles within the proper testing windows. Therefore, a lack of exclusion criteria would result in an overly heterogeneous sample that would cloud interpretation of the data.

Although certain exclusion criteria are employed consistently across studies in this field (e.g., menstrual cycle length), many studies differ considerably in the specific testing days and phases of the cycle that are examined. Considerable differences are likely to be found across studies that use different testing days across the menstrual cycle, such as one particular day in the menstrual cycle (e.g., Avgoustinaki et al., 2012), a 2-3 day window (Gonda et al., 2008), or up to a 10-day window. With a larger sample size it would be possible to more closely examine changes in the main dependent variables according to more specific phases (e.g., early vs. late luteal).

It is also possible that excluding women with a mood or anxiety disorder diagnosis when looking at fluctuations in mood across the menstrual cycle is actually limiting the value of the study. By omitting women with the most severe symptoms who might also be the most likely to experience fluctuations in affect across the menstrual cycle, we might be increasing the risk of a Type II error and reducing the sensitivity of the study. For instance, Moreira and colleagues (2013) examined specific risk factors that predicted the exacerbation of OCD symptoms across the menstrual cycle. Higher levels of anxiety and depression, suicidality, and sexual/religious obsessions were found to be more common in women with pre-menstrual worsening of OCD symptoms (Moreira et al., 2013). It is common practice to exclude women with a mood or anxiety disorder, and often women with these conditions are taking medications that may

interfere with hormone levels. However, it would be interesting for future studies to examine how changes in behavior across the menstrual cycle differ in these women.

The young age of the sample may also be a potential limiting factor in relation to the hormonal analyses. Progesterone levels have been found to be lowest in 18-19 year olds and highest in 25-34 year olds (Lipson & Ellison, 1992). Thus, younger women experience a lower peak in progesterone levels during the luteal phase of the menstrual cycle. Furthermore, before women reach their mid-twenties they tend to have a relatively high proportion of anovulatory cycles (Hampson & Young, 2008). In the current study however, there was no association between age and salivary progesterone concentrations in the luteal phase. An additional concern regarding the progesterone analyses is that if progesterone levels are measured too early within the luteal phase there will not be a significant increase in progesterone concentrations relative to the follicular phase and if progesterone levels are measured too late in the luteal phase then progesterone concentrations will already be falling. This was likely an issue in the current study given that the testing days ranged over approximately a 12 day span. However, this problem is likely common in menstrual cycle research as a very large sample size is needed in order to be left with a large enough pool of participants after all of the exclusionary criteria are applied. It was also difficult to have a large enough sample size to look at moderator variables within the free-cycling subset of women.

In the current study, women were tested during days 2-13 for the follicular phase and twelve days prior to menstruation up to day 1 of menstruation for the luteal phase. These testing windows were slightly longer than initially planned, as we aimed for follicular testing during days 3 to 10 and luteal testing during days -3 to -9. A smaller testing window for each phase would have provided more consistency in hormone levels across individuals. Capturing only the

mid-luteal phase would have allowed for the highest progesterone levels, although in the present study we were able to compare women who were tested in the early luteal phase to women who were tested in the late luteal phase. However, a within-subjects design allowed for each woman to be tested during a time of relatively low and high progesterone. Finally, the two different testing orders (e.g., follicular then luteal; luteal then follicular) were not evenly counterbalanced as 75% of women were tested first in the follicular phase and second in the luteal phase. Ideally, 50% of women should have been tested across both conditions, so this represents a limitation of the study.

There are reasons to suggest that combining all women taking oral contraceptives into a single group may be problematic **(**Hampson & Young, 2008). There are numerous types of OCs differing in hormone dosage and delivery across the cycle (e.g., monophasic versus triphasic formulations). Women have also been found to differ considerably in their metabolism rate for the same dose of an OC (Hampson & Young, 2008). Furthermore, menstrual cycle research typically compares women using OCs and free-cycling women in between-subjects designs, which often doesn't account for individual variability and differences between the groups (e.g., in sexual behaviour, Little, 2013). However, in the current study every effort was made to further distinguish between the different types of OCS by progestin dosage, phasicity, and even androgenic activity. Furthermore, a within-subjects design allowed for measurement of individual changes in behavior across the cycle in both groups.

In the present study PMS was measured using the Premenstrual Symptoms Screening Tool (PSST; Steiner et al., 2003). The American College of Obstetricians and Gynecologists propose that PMS symptoms be confirmed prospectively across two menstrual cycles (Halbreich et al., 2007). Although ideally PMS would be measured prospectively using multiple

measurements, a screening tool is more practical in research settings. Furthermore, the PSST is based on *DSM-IV* criteria for PMDD and assesses functional impairment across a number of areas. The PSST did not overinflate the number of women meeting criteria for PMDD, the more serious form of PMS, as the number of women meeting PMDD criteria in the current study (4.7%) was comparable to estimates given in the literature (e.g., Steiner et al., 2003).

In hindsight, an additional limitation of the study was including only the pathogen subscale of the Three Domain Disgust scale and not the entire scale (i.e., excluding the sexual and moral disgust subscales). It would have been interesting to examine sexual disgust, especially in the context of the interaction between OCD symptoms and sexual activity. Given that sexual arousal has been found to decrease the disgust response, it would have been interesting to examine whether low levels of sexual disgust were related to decreased contamination-based OCD symptoms. Furthermore, it would have been interesting to examine whether moral disgust was positively correlated with responsibility beliefs and negatively correlated with social risk-taking.

The hormonal milieu is substantially different across reproductive events such as the luteal phase of the menstrual cycle, the postpartum period, and perimenopause (Altemus et al., 2014). Although the luteal phase of the menstrual cycle is often compared to pregnancy due to the rise in progesterone, progesterone levels differ significantly across these time points. For instance, in the current study progesterone levels increased an average of 280% across the menstrual cycle (*SD* = 385.39), representing a 2-3 fold increase. In comparison, during pregnancy progesterone levels increase 10-fold over maximum menstrual cycle levels (Bloch et al., 2003). Furthermore, the postpartum period, which is accompanied by a significant drop in progesterone levels, is arguably a time of greater risk for experiencing OCD than pregnancy

(Russell et al., 2013). Furthermore, although the present study focused primarily on progesterone, changes are seen across multiple hormones and hormone metabolites during these major reproductive events (Altemus et al, 2014). Arguably, for some women it may not be the absolute levels of hormones but the fluctuations in hormones or their sensitivity to hormonal change that is important.

The current study was primarily focused on the role of progesterone in attempting to explain the association between reproductive events and OCD and related symptoms. However, reproductive events are also associated with fluctuating estrogen levels. As previously discussed, estrogen's effects on mood are very well documented. Estrogen has been found to modulate several neurotransmitter systems and has been examined as a treatment for postnatal and perimenopausal depression. Therefore, the fact that estrogen levels were not measured in the current study represents a potential limitation. Estrogen levels would have differed considerably between women tested in the early follicular phase compared to the late follicular phase, which would have introduced further noise in hormonal profiles across women, potentially reducing the power to detect changes related to the effects of progesterone. Further research should examine how estrogen and progesterone might interact to affect OCD symptoms across reproductive events. The exclusive focus on progesterone in the current study was mainly based upon specific predictions from the compensatory prophylaxis hypothesis. Given the fact that progesterone and estrogen have different effects on the immune system, it would be interesting to see what type of predictions might be made about the effects of estrogen on symptoms of OCD according to the compensatory prophylaxis hypothesis. For instance, deficiencies in estrogen in male mice have been found to increase compulsive behaviors (Hill et al., 2007). Therefore, an important area for

future work will be to attempt to disentangle the interaction between changes in estrogen and progesterone on mood and anxiety across reproductive events.

The theory of hormonal sensitivity, or the idea that major reproductive events represent periods of particular vulnerability for some women is an important area for future research (e.g., Pope, Oinonen, Mazmanian, & Stone, 2015). Women who experience mood fluctuations over the menstrual cycle seem to be at risk for experiencing mood fluctuations during pregnancy and the postpartum period, and other major reproductive events. For instance, Forray, Focseneanu, Pittman, McDougle, and Epperson (2010) found that women whose OCD symptoms either began during pregnancy or were exacerbated during this time were more likely to have experienced a premenstrual exacerbation of their OCD symptoms compared to women whose OCD symptoms were unaffected by pregnancy or did not begin during this time. Future research is needed to determine which women are likely to experience fluctuations in mood or anxiety across the menstrual cycle, and which factors predict whether or not women will go on to experience an exacerbation of symptoms in pregnancy or the postpartum period. Long-term prospective studies are needed to follow a large sample of women throughout multiple reproductive events. Further studies are also needed to examine the effect of prenatal hormone exposure in relation to the hormonal sensitivity hypothesis. In the current study, meeting criteria for PMS was associated with higher 2D:4D, an indicator of lower prenatal androgen exposure. This is consistent with findings from Oinonen, Jarva, and Mazmanian (2008), who found that previous oral-contraceptive users had higher 2D:4D than current users or non-users, suggesting that there may be a link between higher 2D:4D and discontinuation of oral-contraceptives due to negative side effects (e.g., mood change) [but see Oinonen (2009)].

Critics of the compensatory prophylaxis hypothesis suggest that it may be too narrow in focus as other factors unrelated to progesterone fluctuations can also predict greater disgust sensitivity (Al-Shawaf & Lewis, 2013). For instance, it would be adaptive for disgust sensitivity to increase in response to high levels of stress, as stress suppresses the immune system. In a study with over 500 participants, stress (single item measure) was a significant predictor of disgust sensitivity (DS-R; Al-Shawaf & Lewis, 2013). However, this finding is not that surprising given the interrelatedness of stress, anxiety, and disgust sensitivity. Anxiety scores have reliably been found to be positively associated with disgust sensitivity (e.g., Thorpe, Patel, & Simonds, 2003). Although anxiety and stress have been found to represent different constructs, they are highly correlated (e.g., $r = .74$, Crawford & Henry, 2003). Therefore, the relationship between stress and increased disgust sensitivity would be expected. In the present study anxiety scores as measured by the HADS were significantly positively correlated with disgust sensitivity as well. However, Al-Shawaf and Lewis (2013) do raise an important point- many factors can lead to increased disgust sensitivity. For instance, in the current study women with PMS had greater levels of anxiety, disgust sensitivity, OCD symptoms, and responsibility beliefs.

Future neuroimaging work may help to tie together currently divergent lines of research. Trait anxiety, disgust sensitivity, and progesterone are all associated with increased activation of the amygdala; women with PMDD show increased amygdala reactivity to negative stimuli; and individuals with OCD show heightened amygdala activation in response to symptom-provocation. Future studies could combine measurement of amygdala reactivity with measures of $GABA_A$ receptor sensitivity to try and predict which women might be most likely to experience mood fluctuations across the menstrual cycle.

Clinical Implications

In this broad area of literature there are a number of potentially important clinical implications that are worth discussion. First, it is important that clinicians are aware of the fact that reproductive events including menarche, the premenstrual phase of the menstrual cycle, pregnancy, postpartum, and perimenopause can be associated with either the onset or exacerbation of mood and anxiety disorders. For practitioners who provide longer-term counselling, it is important to be cognizant of changes in mood or anxiety disorders across reproductive events. Symptoms of OCD may be exacerbated during situations where the safety of close relationships are threatened, such as illness, death of a relative, or martial problems (Feygin, Swain, & Leckman, 2006), or during periods of increased responsibility (e.g., leaving home, starting a new job, or pregnancy). In terms of clinical assessment, mood fluctuations could be linked to symptoms of PMS or negative mood side effects in response to HC use. For clinicians who are looking for a comprehensive assessment tool to explore menstrual, contraceptive, perinatal, and perimenopausal history, Martini, Wittchen, Soares, Rieder, and Steiner (2009) created a new women specific platform that can be added into the World Health Organization-Composite International Diagnostic Interview (WHO-CIDI).

It is important for clinicians to be aware of the fact that intrusive thoughts are very common in pregnancy and the postpartum period, and to be able to distinguish between "normal" or adaptive anxiety versus clinically significant symptoms. Furthermore, women who present with OCD in the postpartum period may be reluctant to report intrusive thoughts about harming their child as they are afraid of the consequences. Clinicians can be reassured that there has never been a case of "pure OCD" where a woman has intentionally harmed her child. Women with OCD find these thoughts to be extremely distressing, ego-dystonic, unwanted, and go to great

lengths to avoid acting on them. In contrast, infanticide is extremely rare and generally occurs in cases of postpartum psychosis. In such cases there is typically a lack of insight, no fear or anxiety associated with the thoughts, and other symptoms are present that necessitate emergency psychiatric hospitalization (Abramowitz et al., 2003; Ross & McLean, 2006).

Conclusions

Although several previous studies have suggested that sub-clinical OCD symptoms increase across the menstrual cycle in relation to changes in progesterone in free-cycling women, the current study failed to show such a relationship, although increases in progesterone were found to be related to increased anxiety more generally. This was the first study to combine both a within-subjects design and direct measurement of hormones. Thus, it is currently unclear whether or not all free-cycling women experience an increase in subclinical OCD symptoms across their menstrual cycles, as there are substantial methodological differences across the studies completed to date. The current findings suggest that perhaps not all women experience an increase in precautionary behaviour across the menstrual cycle, but that distinct subgroups of women may exist who show different patterns of behaviour change across the cycle. This is an important area for further research given that women who do experience menstrual cycle changes in precautionary behaviour appear to be at risk for the onset or exacerbation of anxiety-related disorders in pregnancy and the postpartum period.

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Appendix A: Emotions and Mood Covering Letter A

Dear Potential Participant,

You are invited to participate in the Emotions and Mood Study at Lakehead University. This study is being conducted by Emily Fawcett (Psychology Doctoral student) under the supervision of Dr. Dwight Mazmanian (Associate Professor) at Lakehead University. The purpose of the study is to examine the impact of reproductive hormones on emotion and mood.

Participation in this phase of the study involves completing an online questionnaire that will take approximately 5 to 10 minutes to complete. The questionnaire will include questions such as demographic information (e.g., age, sex, education), health information, and reproductive history. If you provide your phone number or email address, you will be contacted to participate in the next phase of this study which involves coming into the Health, Hormones, and Behaviour (HHAB) Lab at Lakehead University on two occasions over the course of a month for approximately one hour each. Your contact information (e.g., phone number or email address) will only be used to schedule appointments, will be stored separately from your questionnaire responses, and will be destroyed after the study is completed so that your data will be anonymous. Your data will be kept in a secure manner by Dr. Dwight Mazmanian at Lakehead University for at least five years, as per university requirements. Only the researchers will be able to access your information. If the research findings are published, there will be no information which could identify you. At the end of storage, all paper files will be shredded and all computer files will be deleted.

Participation in this study is completely voluntary and you may withdraw from the study at any time without penalty. There are no known physical or psychological risks associated with this study. However, answering questions about oneself can sometimes lead to slight discomfort or interesting insights. You can choose not to answer any questions that make you feel uncomfortable. To thank you for your participation in the laboratory component of this study, you will be given a $5 Tim Horton's gift certificate for each session (for a maximum of $10). Individuals enrolled in Introductory Psychology can choose between receiving a bonus point per laboratory session (i.e., a maximum of 2 bonus points), or the Tim Horton's gift certificates.

If you have any questions or concerns about this study please contact Ms. Fawcett at emotionsandmood@lakeheadu.ca, or Dr. Mazmanian by phone at (807) 343-8257. Other collaborators involved in this study include Dr. Kirsten Oinonen (Associate Professor of Psychology at Lakehead University). If you have any questions about your rights as a research subject or concerns about this study please contact Susan Wright (Research Ethics and Administration Officer) at the Lakehead University Research Ethics Board at (807) 343-8283.

Sincerely,

Emily Fawcett, M.A. (Doctoral Candidate)
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Appendix B: Consent Form A

The purpose of the study is to examine the impact of reproductive hormones on emotion and mood. This study is being conducted by Emily Fawcett (Psychology Doctoral student) under the supervision of Dr. Dwight Mazmanian (Associate Professor) at Lakehead University.

- Your participation in this study will involve completing an online questionnaire that will take approximately 5 to 10 minutes to complete. The questionnaire will include topics such as demographic information (e.g., age, sex, education), health information, and reproductive history.
- If you provide your phone number or email address, you will be contacted to participate in the next phase of this study which involves coming into the Health, Hormones, and Behaviour (HHAB) Lab at Lakehead University on two separate occasions over the course of a month for approximately one hour each.
- There are no known physical or psychological risks associated with this study.
- You may decline to answer any question you wish.
- Your participation is voluntary, you may refuse to participate in any part of the study, and you may withdraw from the study at any time without penalty.
- Potential benefits of participating in this research include advancing research on men's and women's health and learning a greater understanding of the research process.
- All of the data collected in this study will be kept completely confidential.
- Your information will be kept in a secure manner at Lakehead University for at least five years as stated by university rules. Only the researchers will have access to your information.
- If the research findings are published, there will be no information which could identify you.
- You may contact the researchers if you would like a summary of the results of the study when it is completed.

I have read and understood the cover letter and consent form, and agree to participate in this study under these conditions. I also confirm that I am 17 years of age or older.

Name: _____

Date: _____

Email address (if preferred method of contact):_____

Phone Number (if preferred method of contact):_____

- If you have any questions or concerns regarding this study please contact Emily Fawcett (emotionsandmood@lakeheadu.ca) or the supervisor of this study, Dr. Dwight Mazmanian (phone: (807) 343-8257, email: dwight.mazmanian@lakeheadu.ca). Other collaborators in this study include Dr. Kirsten Oinonen (Associate Professor of Psychology at Lakehead University). If you have any questions about your rights as a research subject, please contact the Lakehead University Research Ethics Board at (807) 343-8283.

Appendix C: Background Information Questionnaire

Background Information Questionnaire

1) Today's date: _____ _____ _____

Day of Week (e.g., Monday)	Day of Month (e.g., 5th)	Month: (e.g., May)

2) Age:_____

3) Sex : **Male** ☐ **Female** ☐

4) Height: _____ (feet & inches) **or** _____ (cm)

5) Weight: _____ (pounds) **or** _____ (kg)

6) Marital status:

Married/common law ☐
Divorced/separated ☐
Widowed ☐
Single ☐

If you are NOT married, are you:

In a dating relationship? Yes ☐ No ☐
In a long-term relationship? Yes ☐ No ☐
Other (please specify): _____

7) What is your ethnic background?

Caucasian/White	☐	European	☐
African Canadian/Black	☐	Middle Eastern	☐
Native-Canadian/Aboriginal	☐	East Indian	☐
Hispanic/Latino	☐	Asian	☐

Other (please specify): _____

8) What is your religious affiliation?

Christian ☐
Denomination? (Catholic, Baptist, Anglican, Latter Day Saints, etc.):_____
Agnostic ☐
Jewish ☐
Buddhist ☐

Muslim ☐
Atheist ☐
Other (please specify): _____

9) Strength of Religious Beliefs (please circle):

1	2	3	4	5	6	7
Not strong						Very strong

10) Sexual Orientation (Circle the letter or number that best describes you):

X Asexual (i.e., lack of interest in either sex)

0 Exclusively heterosexual

1 Predominantly heterosexual, only incidentally homosexual

2 Predominantly heterosexual, but more than incidentally homosexual

3 Equally heterosexual and homosexual

4 Predominantly homosexual, but more than incidentally heterosexual

5 Predominantly homosexual, only incidentally heterosexual

6 Exclusively homosexual

11) What is the highest level of education that you have achieved? (please check)

Some elementary school	_____	College diploma/ certificate	_____
Elementary school	_____	Some university	_____
Some high school	_____	Undergraduate degree	_____
High school diploma	_____	Master's degree	_____
Some college	_____	Doctorate degree	_____

12) Total years of education (grade 1-12 + any university or college years): _____ years

13. a) Are you currently taking any medications? YES ☐ NO ☐
b) If YES, what medications are you taking? (Please list):

_____

_____

_____

14) Please list any medical or psychological conditions which you have been diagnosed with (e.g., hypothyroidism, depression, asthma, cancer, diabetes, etc.).

_____

_____

15) Have your parents or siblings ever been diagnosed or treated for a mental illness?
Yes ☐ No ☐ Unsure ☐

16) If YES, please check any that apply to your parents or siblings:

Depression	☐	Bipolar disorder	☐
Schizophrenia	☐	Panic disorder	☐
Obsessive-compulsive disorder	☐	Social Phobia	☐
Posttraumatic Stress Disorder	☐	Phobia (e.g., blood, needles)	☐
Generalized Anxiety Disorder	☐	**Other** (please specify):_____	

<u>THE FOLLOWING QUESTIONS ARE FOR MALES ONLY:</u>

1. How old were you when you:

a) first shaved? _____years and _____months old

b) began growing pubic hair? _____years and _____months old

c) voice changed? _____years and _____months old

d) had your growth spurt? _____years and _____months old

e) first experienced nocturnal emission (i.e., "wet dream")? _____years and _____months old

2. How confident are you of the estimations above (please circle your answer):

1	2	3	4	5	6	7
Very unsure						Very sure

3. Have you been sexually active (i.e., had sexual intercourse) in the past 6 months?
Yes ☐ No ☐

4. With how many different partners have you had sex (sexual intercourse) in your entire lifetime?_____

<u>THE REST OF THE QUESTIONS ARE FOR FEMALES ONLY:</u>

1) How old were you when you first started menstruating (i.e., got your period)?
_____years and _____months old

2) How old were you when your breasts started developing?
_____years and _____months old

3) How old were you when you first noticed pubic hair growth?
_____years and _____months old

4) Are you currently pregnant? YES ☐ NO ☐ MAYBE ☐

5) Have you ever been pregnant? Yes ☐ No ☐ **If YES, how many times? _____**

6) How many children have you given birth to in your lifetime? (as opposed to adopted or foster children)? _____

7) If you have children, how old are they? _____

8) Have you had surgery to have one or both of your ovaries removed?

No	☐
I don't know	☐
Yes, unknown number were taken out	☐
Yes, part of an ovary was taken out	☐
Yes, one was removed	☐
Yes, both were removed	☐

9) In the past month, has your weight changed (i.e., increased or decreased) by 5 or more pounds? Yes ☐ No ☐

10) Do you exercise vigorously (e.g., running) for more than 3 hours a week?
Yes ☐ No ☐

11) Have you been sexually active (i.e., had sexual intercourse) in the past 6 months?
Yes ☐ No ☐

12) With how many different partners have you had sex (sexual intercourse) in your entire lifetime?_____

13) Are you currently taking hormonal contraceptives (i.e., birth control, patch, injection)?

YES ☐ NO ☐

14) IF YOU ARE CURRENTLY TAKING HORMONAL CONTRACEPTIVES, please put an X beside the type of hormonal contraceptive you are currently taking.
Oral contraceptives:

Alesse	____	Min-Ovral	____
Apri	____	MinEstrin 1/20	____
Aviane	____	Norinyl	____
Brevicon 0.5/35	____	Norlestin 1/50	____

Brevicon 1/35	____	Ortho 0.5/35	____
Celesta	____	Ortho 1/35	____
Cerazette (progesterone only)	____	Ortho 7/7/7	____
Cyclen	____	Ortho 10/11	____
Cyestra 35	____	Ortho-Cept	____
Demulen 30	____	Ortho-Novum 1/50	____
Demulen 50	____	Ovral	____
Diane 35	____	Portia	____
Gianvi	____	Synphasic	____
Linessa	____	Tri-Cyclen	____
Loestrin	____	Tri-Cyclen Lo	____
Marvelon	____	Triphasil	____
Microgynon	____	Triquilar	____
Microlite	____	Yasmin	____
Micronor (progesterone only)	____	Yaz	____

Other _____ Name: _____

Injected contraceptives:

Depo-Provera ____ Lunelle ____

Other _____ Name: _____

Contraceptive patch:

Ortho-Evra ____ Other _____ Name: _____

Implant (in the upper arm):

Implanon ____

Vaginal Ring:

NuvaRing ____ Other _____ Name: _____

Extended use Oral Contraceptives (3 or 4 periods per year):

Seasonique ____ Seasonale ____

Barrier Methods:

Copper ____ Mirena ____ Diaphragm ____

Cervical cap ____ Other: ____ Name: _____

If you use any other type of birth control not listed above, please list it here:

_____

OR, I am taking hormonal contraceptives, but I'm not sure of which type ☐

15) IF YOU ARE CURRENTLY TAKING HORMONAL CONTRACEPTIVES, how long have you been taking hormonal contraceptives? _____ years _____ months

16) IF YOU ARE CURRENTLY TAKING ORAL CONTRACEPTIVES, what phase of your oral contraceptives are you currently in?

☐ Week 1 of active pills
☐ Week 2 of active pills
☐ Week 3 of active pills
☐ Pill-free/Inactive/Sugar pill week (when most women have their period)
☐ I take my pills continuously so I don't get my period

17) IF YOU ARE CURRENTLY TAKING HORMONAL CONTRACEPTIVES, do you have any intentions of discontinuing the use of oral contraceptives within the next few weeks? YES ☐ NO ☐ MAYBE ☐

18) If you are NOT currently taking oral contraceptives, have you ever taken oral contraceptives before? YES ☐ NO ☐

19) If you have previously taken oral contraceptives but are not taking them right now, how many years and months has it been since you last took oral contraceptives?

_____ years and _____ months

20) If you are not currently taking oral contraceptives, would you say that you are currently practicing some form of contraception (i.e., are you using some physical or chemical method to prevent pregnancy)? YES ☐ NO ☐

21) Which statement best describes your menstrual cycle?

☐ I do not experience a menstrual period
☐ I have not had my period in the past three months.
☐ Some months I get my period and some months I don't.
☐ I usually get my period every month, but it is irregular and I cannot predict when it will start.
☐ I usually get my period within two to three days of when I expect it.
☐ My period is like clockwork and the same number of days elapse between periods each month.

22) On average, what is the typical length (in days) of your menstrual cycle (i.e., how many days are there from the first day of one period to the first day of your next period)? Most people range between 25 and 35 days. Women on standard birth control pills have a 28-day cycle.

_____days

23) On average, how many days does your period last for? (Most people's periods last between 1 and 10 days).

_____ days

24) Are you menstruating (i.e., on your period) today? Yes ☐ No☐

IF YES, for how many days (including today) have you been menstruating (i.e., on your period)? _____ days

25) Using the calendars below as a reference, please indicate the FIRST day of your LAST menstrual period (i.e., the day your last period started). Please also indicate the day that you believe your next menstrual period will start (i.e., the day when you expect your next period). If you are not sure, please make your best guess.

SEPTEMBER '12

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

OCTOBER '12

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

NOVEMBER '12

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

DECEMBER '12

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

26) How confident are you that the above circled day was the first day of your last period? (Circle the best response)

0 1 2 3 4 5 6 7 8
0% 25% 50% 75% 100%

27) How confident are you that the above day with an X is the day that you will next get your period? (Circle the best response)

0 1 2 3 4 5 6 7 8
0% 25% 50% 75% 100%

PSST

Do you experience some or any of the following premenstrual symptoms ***which start*** the week before your period and ***stop*** within a few days of bleeding? (please mark an "X" in the appropriate box)

Symptom	**Not at all**	**Mild**	**Moderate**	**Severe**
1. Anger/irritability				
2. Anxiety/tension				
3. Tearful/increased sensitivity to rejection				
4. Depressed mood/hopelessness				
5. Decreased interest in work activities				
6. Decreased interest in home activities				
7. Decreased interest in social activities				
8. Difficulty concentrating				
9. Fatigue/lack of energy				
10. Overeating/food cravings				
11. Insomnia				
12. Hypersomnia (needing more sleep)				
13. Feeling overwhelmed or out of control				
14. Physical symptoms: breast tenderness, headaches, joint/muscle pain, bloating, weight gain				

Have your symptoms, as listed above, interfered with:

	Not at all	**Mild**	**Moderate**	**Severe**
A. Your work efficiency or productivity				
B. Your relationships with coworkers				
C. Your relationships with your family				
D. Your social life activities				
E. Your home responsibilities				

Appendix D: Debriefing Form A

Thank you for participating in the Emotions and Mood Study. This study is examining the effects of reproductive hormones on emotion and mood. This research is a part of Emily Fawcett's doctoral dissertation and is being supervised by Dr. Mazmanian of the Department of Psychology at Lakehead University. You will be contacted shortly by the phone number or email address you provided in order to participate in the laboratory component of this study. Please be assured that your all of your responses will be coded to conceal your identity and your data will remain completely anonymous. Furthermore, your contact information (e.g., phone number or email address) will only be used to schedule appointments, will be stored separately from your questionnaire responses, and will be destroyed after the study is completed.

Participation in this study involves attending two laboratory sessions at the Health, Hormones, and Behaviour Lab at Lakehead University. The two sessions will be scheduled over the course of a month and will take approximately one hour each. To thank you for your participation in the laboratory component of this study, you will be given a $5 Tim Horton's gift certificate after each session (for a maximum of $10). Individuals enrolled in Introductory Psychology will be able to choose between receiving a bonus point per laboratory session (i.e., a maximum of 2 bonus points), or the Tim Horton's gift certificates. Thank you again for your participation.

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Appendix E: Emotions and Mood Covering Letter B

Dear Potential Participant,

You are invited to participate in the Emotions and Mood Study at Lakehead University. This study is being conducted by Emily Fawcett (Psychology Doctoral student) under the supervision of Dr. Dwight Mazmanian (Associate Professor) at Lakehead University. The purpose of the study is to examine the effects of reproductive hormones on emotion and mood.

Participation in this phase of the study involves partaking in two laboratory sessions at the Health, Hormones, and Behaviour Lab at Lakehead University. The two sessions will be scheduled over the course of a month and will take approximately one hour each. Each session will involve completing a computerized emotion identification task, completing several questionnaires, and having your hands scanned. Questionnaires will ask about your mood, experiences of unwanted and repetitive thoughts and behaviour, risk-taking, the degree of disgust you feel in various situations, and your beliefs surrounding responsibility for causing or preventing harm. Finally, females will be asked to give a saliva sample for measurement of reproductive hormone levels. Your contact information (e.g., phone number or email address) will only be used to schedule appointments, will be stored separately from your questionnaire responses, and will be destroyed after the study is completed. Your data will be kept in a secure manner by Dr. Dwight Mazmanian at Lakehead University for at least five years, as per university requirements. Only the researchers will be able to access your information. If the research findings are published, there will be no information which could identify you. At the end of storage, all paper files will be shredded and all computer files will be deleted.

Participation in this study is completely voluntary and you may withdraw from the study at any time without penalty. There are no known physical or psychological risks associated with taking part in this study. However, you can choose not to answer any questions that make you feel uncomfortable. To thank you for your participation in this study, you will be given a $5 Tim Horton's gift certificate for each laboratory session you attend (for a maximum of $10). Individuals enrolled in Introductory Psychology can choose between receiving a bonus point per laboratory session (i.e., a maximum of 2 bonus points), or the Tim Horton's gift certificates.

If you have any questions or concerns about this study please contact Ms. Fawcett at emotionsandmood@lakeheadu.ca, or Dr. Mazmanian by phone at (807) 343-8257. Other collaborators involved in this study include Dr. Kirsten Oinonen (Associate Professor of Psychology at Lakehead University). If you have any questions about your rights as a research subject or concerns about this study please contact Susan Wright (Research Ethics and Administration Officer) at the Lakehead University Research Ethics Board at (807) 343-8283.

Sincerely,

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Appendix F: Consent Form B

The purpose of the study is to examine the effects of reproductive hormones on emotion and mood. This study is being conducted by Emily Fawcett (Psychology Doctoral student) under the supervision of Dr. Dwight Mazmanian (Associate Professor) at Lakehead University.

Please read the following points about this study:

- Your participation in this study will involve coming into the Health, Hormones, and Behaviour Lab on two separate occasions, for approximately one hour each.
- You will complete a computerized task involving facial expression recognition, answer several questionnaires, have your hands scanned, and a number of eligible women will be asked to provide a saliva sample for measurement of reproductive hormone levels.
- Questionnaires will ask about your mood, experiences of unwanted and repetitive thoughts and behaviour, risk-taking, the degree of disgust you feel in various situations, and your beliefs responsibility for causing or preventing harm.
- There are no known physical or psychological risks associated with taking part in this study. However, some people may find that certain questions lead to feelings of disgust or discomfort. You may decline to answer any question you wish.
- Your participation is voluntary, you may refuse to participate in any part of the study, and you may withdraw from the study at any time without penalty.
- Potential benefits of participating in this research include advancing research on men's and women's health and learning a greater understanding of the research process.
- All of the data collected in this study will be kept completely confidential.
- Your information will be kept in a secure manner at Lakehead University for at least five years as stated by university rules. Only the researchers will have access to your information. If the research findings are published, there will be no information which could identify you.
- You may contact the researchers if you would like a summary of the results of the study when it is completed.

I have read and understood the cover letter and consent form, and agree to participate in this study under these conditions. I also confirm that I am at least 17 years of age.

Name: _____

Date: _____

Email address (if preferred method of contact):_____

Phone Number (if preferred method of contact):_____

- If you have any questions or concerns regarding this study please contact Emily Fawcett (emotionsandmood@lakeheadu.ca) or the supervisor of this study, Dr. Dwight Mazmanian (phone: (807) 343-8257, email: dwight.mazmanian@lakeheadu.ca). Other collaborators in this study include Dr. Kirsten Oinonen (Associate Professor of Psychology at Lakehead University). If you have any questions about your rights as a research subject, please contact the Lakehead University Research Ethics Board at (807) 343-8283.

Appendix G: Phase 1 Questionnaire

Participant #: _____

Phase 1 Questionnaire

1) Today's date: _____ _____ _____

Day of week (e.g., Monday)	Day of Month (e.g., 5th)	Month: (e.g., May)

2) Sex: Male ☐ Female ☐

3) Age: _____

PI-WSUR

The following statements refer to thoughts and behaviours which may occur to everyone in everyday life. For each statement, choose the reply which best seems to fit you **within the past 48 hours** and the degree of disturbance which such thoughts or behaviours may create.						
1	I feel my hands are dirty when I touch money.	Not at All	A little	Quite A Lot	A Lot	Very Much
2	I think even slight contact with bodily secretions (perspiration, saliva urine, etc.) may contaminate my clothes or somehow harm me.	Not at All	A little	Quite A Lot	A Lot	Very Much
3	I find it difficult to touch an object when I know it has been touched by strangers or by certain people.	Not at All	A little	Quite a Lot	A Lot	Very Much
4	I find it difficult to touch garbage or dirty things.	Not at All	A little	Quite a Lot	A Lot	Very Much
5	I avoid using public toilets because I am afraid of disease and contamination.	Not at All	A little	Quite a Lot	A Lot	Very Much
6	I avoid using public telephones because I am afraid of contagion and disease.	Not at All	A little	Quite a Lot	A Lot	Very Much
7	I wash my hands more often and longer than necessary.	Not at All	A little	Quite a Lot	A Lot	Very Much
8	I sometimes have to wash or clean myself simply because I think I may be dirty or "contaminated".	Not at All	A little	Quite a Lot	A Lot	Very Much
9	If I touch something I think is "contaminated", I immediately have to wash or clean myself.	Not at All	A little	Quite a Lot	A Lot	Very Much
10	If an animal touches me, I feel dirty and immediately have to wash myself or change my clothing.	Not at All	A little	Quite a Lot	A Lot	Very Much

11	I feel obliged to follow a particular order in dressing, undressing, and washing myself.	Not at All	A little	Quite a Lot	A Lot	Very Much
12	Before going to sleep, I have to do certain things in a certain order.	Not at All	A little	Quite a Lot	A Lot	Very Much
13	Before going to bed, I have to hang up or fold my clothes in a special way.	Not at All	A little	Quite a Lot	A Lot	Very Much
14	I have to do things several times before I think they are properly done.	Not at All	A little	Quite a Lot	A Lot	Very Much
15	I tend to keep on checking things more often than necessary.	Not at All	A little	Quite a Lot	A Lot	Very Much
16	I check and recheck gas and water taps and light switches after turning them off.	Not at All	A little	Quite a Lot	A Lot	Very Much
17	I return home to check doors, windows, drawers, etc., to make sure they are properly shut.	Not at All	A little	Quite a Lot	A Lot	Very Much
18	I keep on checking forms, documents, checks, etc., in detail to make sure I have filled them in correctly.	Not at All	A little	Quite a Lot	A Lot	Very Much
19	I keep on going back to see that matches, cigarettes, etc, are properly extinguished.	Not at All	A little	Quite a Lot	A Lot	Very Much
20	When I handle money, I count and recount it several times.	Not at All	A little	Quite a Lot	A Lot	Very Much
21	I check letters carefully many times before posting them.	Not at All	A little	Quite a Lot	A Lot	Very Much
22	Sometimes I am not sure I have done things which in fact I knew I have done.	Not at All	A little	Quite a Lot	A Lot	Very Much
23	When I read, I have the impression I have missed something important and must go back and reread the passage at least two or three times.	Not at All	A little	Quite a Lot	A Lot	Very Much
24	I imagine catastrophic consequences as a result of absent-mindedness or minor errors which I make.	Not at All	A little	Quite a Lot	A Lot	Very Much
25	I think or worry at length about having hurt someone without knowing it.	Not at All	A little	Quite a Lot	A Lot	Very Much
26	When I hear about a disaster, I think it is somehow my fault.	Not at All	A little	Quite a Lot	A Lot	Very Much
27	I sometimes worry at length for no reason that I have hurt myself or have some disease.	Not at All	A little	Quite a Lot	A Lot	Very Much
28	I get upset and worried at the sight of knives, daggers, and other pointed objects.	Not at All	A little	Quite a Lot	A Lot	Very Much
29	When I hear about a suicide or a crime, I am upset for a long time and find it difficult to stop thinking about it.	Not at All	A little	Quite a Lot	A Lot	Very Much

30	I invent useless worries about germs and disease.	Not at All	A little	Quite a Lot	A Lot	Very Much
31	When I look down from a bridge or a very high window, I feel an impulse to throw myself into space.	Not at All	A little	Quite a Lot	A Lot	Very Much
32	When I see a train approaching, I sometimes think I could throw myself under its wheels.	Not at All	A little	Quite a Lot	A Lot	Very Much
33	At certain moments, I am tempted to tear off my clothes in public.	Not at All	A little	Quite a Lot	A Lot	Very Much
34	While driving, I sometimes feel an impulse to drive the car into someone or something.	Not at All	A little	Quite A Lot	A Lot	Very Much
35	Seeing weapons excites me and makes me think violent thoughts.	Not at All	A little	Quite a Lot	A Lot	Very Much
36	I sometimes feel the need to break or damage things for no reason.	Not at All	A little	Quite a Lot	A Lot	Very Much
37	I sometimes have an impulse to steal other people's belongings, even if they are of no use to me.	Not at All	A little	Quite a Lot	A Lot	Very Much
38	I am sometimes almost irresistibly tempted to steal something from the supermarket.	Not at All	A little	Quite a Lot	A Lot	Very Much
39	I sometimes have an impulse to hurt defenseless children or animals.	Not at All	A little	Quite a Lot	A Lot	Very Much

IN1 Scale

1) I try to get at least some sleep every night
True ☐ False ☐

2) I have attended school at some time during my life
True ☐ False ☐

3) I have never had any hair on my head
True ☐ False ☐

4) I have never ridden in an automobile
True ☐ False ☐

D1 Scale

Please indicate how much you agree with each of the following statements, or how true it is about you within the past 48 hours. Please write a number (0-4) to indicate your answer:

0 = Strongly disagree (very untrue about me)

1 = Mildly disagree (somewhat untrue about me)

2 = Neither agree nor disagree

3 = Mildly agree (somewhat true about me)
4 = Strongly agree (very true about me)

____1. I might be willing to try eating monkey meat, under some circumstances.
____2. It would bother me to be in a science class, and to see a human hand preserved in a jar.
____3. It bothers me to hear someone clear a throat full of mucous.
____4. I never let any part of my body touch the toilet seat in public restrooms.
____5. I would go out of my way to avoid walking through a graveyard.
____6. Seeing a cockroach in someone else's house doesn't bother me.
____7. It would bother me tremendously to touch a dead body.
____8. If I see someone vomit, it makes me sick to my stomach.
____9. I probably would not go to my favorite restaurant if I found out that the cook had a cold.
____10. It would not upset me at all to watch a person with a glass eye take the eye out of the socket.
____11. It would bother me to see a rat run across my path in a park.
____12. **I would rather eat a piece of fruit than a piece of paper**
____13. Even if I was hungry, I would not drink a bowl of my favorite soup if it had been stirred by a used but thoroughly washed flyswatter.
____14. It would bother me to sleep in a nice hotel room if I knew that a man had died of a heart attack in that room the night before.

In the past 48 hours, how disgusting would you find each of the following experiences? Please write a number (0-4) to indicate your answer:

0 = Not disgusting at all
1 = Slightly disgusting
2 = Moderately disgusting
3 = Very disgusting
4 = Extremely disgusting

____15. You see maggots on a piece of meat in an outdoor garbage pail.
____16. **You see a person eating an apple with a knife and fork**
____17. While you are walking through a tunnel under a railroad track, you smell urine.
____18. You take a sip of soda, and then realize that you drank from the glass that an acquaintance of yours had been drinking from.
____19. Your friend's pet cat dies, and you have to pick up the dead body with your bare hands.
____20. You see someone put ketchup on vanilla ice cream, and eat it.
____21. You see a man with his intestines exposed after an accident.
____22. You discover that a friend of yours changes underwear only once a week.
____23. A friend offers you a piece of chocolate shaped like dog-doo.
____24. You accidentally touch the ashes of a person who has been cremated.
____25. You are about to drink a glass of milk when you smell that it is spoiled.
____26. As part of a sex education class, you are required to inflate a new unlubricated

condom, using your mouth.
____27. You are walking barefoot on concrete, and you step on an earthworm.

D2 Scale

The following items describe a variety of concepts. Please rate how *disgusting* you find the concepts described in the items(within the past 48 hours), where 0 means that you do not find the concept disgusting at all and 6 means that you find the concept extremely disgusting.

	Not at all disgusting						Extremely disgusting
1. Stepping on dog poop	0	1	2	3	4	5	6
2. Sitting next to someone who has red sores on their arm	0	1	2	3	4	5	6
3. Shaking hands with a stranger who has sweaty palms	0	1	2	3	4	5	6
4. Seeing some mold on old leftovers in your refrigerator	0	1	2	3	4	5	6
5. Standing close to a person who has body odor	0	1	2	3	4	5	6
6. Seeing a cockroach run across the floor	0	1	2	3	4	5	6
7. Accidentally touching a person's bloody cut	0	1	2	3	4	5	6

Please rate the extent to which you agree to the following statement:

When completing the disgust-related questions on the past two pages, I experienced a physical reaction to the questions (e.g., grimacing/contorting of the face, furrowing of the eyebrows, wrinkling of the nose, etc.).

1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐

Not at all Extremely

IN2 Scale

1) I could easily count from one to twenty-five

True ☐ False ☐

2) I have never talked to anyone by telephone

True ☐ False ☐

3) I make all my own clothes and shoes

True ☐ False ☐

4) Things with sugar in them usually taste sweet to me

True ☐ False ☐

DOSPERT Scale

For each of the following statements, please indicate the likelihood that you would engage in the described activity or behaviour if you were to find yourself in that situation in the **next 48 hours.** Provide a rating from *Extremely Unlikely* to *Extremely Likely* by circling the corresponding number.

1. Admitting that your tastes are different from those of a friend.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

2. Going camping in the wilderness. (assuming it is summer)

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

3. Betting a day's income at the horse races.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

4. Investing 10% of your annual income in a moderate growth mutual fund.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

5. Drinking heavily at a social function.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

6. Taking some questionable deductions on your income tax return.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

7. Disagreeing with an authority figure on a major issue.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

8. Betting a day's income at a high-stake poker game.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

9. Having an affair with a married man/woman.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

10. Passing off somebody else's work as your own.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

11. Going down a ski run that is beyond your ability.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

12. Investing 5% of your annual income in a very speculative stock.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

13. Going whitewater rafting at high water in the spring. (assume it is spring now).

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

14. Betting a day's income on the outcome of a sporting event.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

15. Engaging in unprotected sex with a stranger.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

16. Revealing a friend's secret to someone else.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

17. Driving a car without wearing a seat belt.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

18. Investing 10% of your annual income in a new business venture.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

19. Taking a skydiving class.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

20. Riding a motorcycle without a helmet.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

21. Choosing a career that you truly enjoy over a more secure one.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

22. Speaking your mind about an unpopular issue in a meeting at work.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

23. Sunbathing without sunscreen.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

24. Bungee jumping off a tall bridge.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

25. Piloting a small plane.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

26. Walking home alone at night in an unsafe area of town.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

27. Moving to a city far away from your extended family.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

28. Starting a new career in your mid-thirties.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

29. Leaving your young children alone at home while running an errand.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

30. Not returning a wallet you found that contains $200.

1	2	3	4	5	6	7
Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not sure	Somewhat Likely	Moderately Likely	Extremely Likely

31. Have you been sexually active (i.e., had sexual intercourse) in the past 7 days?

Yes ☐ No ☐

IN3 Scale:

1) I usually wear something warm when I go outside on a very cold day

True ☐ False ☐

2) Sometimes I see cars near my home

True ☐ False ☐

3) I have never bought anything from a store

True ☐ False ☐

4) I can run a mile in less than four minutes

True ☐ False ☐

RAS

This questionnaire lists different attitudes or beliefs which people sometimes hold. Read each statement carefully and decide how much you agree or disagree with it. For each of the attitudes, show your answer by putting a circle round the words which BEST DESCRIBE HOW YOU THINK. Be sure to choose only one answer for each attitude. Because people are different, there is no right answer or wrong answer to these statements.

To decide whether a given attitude is typical of your way of looking at things, simply keep in mind what you have been like MOST OF THE TIME **over the past 48 hours.**

1. **I often feel responsible for the things which go wrong.**

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

2. **If I don't act when I can foresee danger, then I am to blame for any consequences if it happens.**

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

3. **I am too sensitive to feeling responsible for things going wrong.**

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

4. **If I think bad things, this is as bad as <u>doing</u> bad things.**

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

5. **I worry a great deal about the effects of things which I do or don't do.**

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

6. **To me, not acting to prevent disaster is as bad as making disaster happen.**

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

7. **If I know that harm is possible, I should always try to prevent it, however unlikely it seems.**

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

8. **I must always think through the consequences of even the smallest actions.**

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

9. **I often take responsibility for things which other people don't think are my fault.**

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

10. **Everything I do can cause serious problems.**

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

11. I am often close to causing harm.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

12. I must protect others from harm.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

13. I should never cause even the slightest harm to others.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

14. I will be condemned for my actions.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

15. If I can have even a slight influence on things going wrong, then I must act to prevent it.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

16. To me, not acting when disaster is a slight possibility is as bad as making that disaster happen.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

17. For me, even slight carelessness is inexcusable when it might affect other people.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

18. In all kinds of daily situations, my inactivity can cause as much harm as deliberate bad intentions.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

19. Even if harm is a very unlikely possibility, I should always try to prevent it at any cost.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

20. Once I think it is possible that I have caused harm, I can't forgive myself.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

21. Many of my past actions have been intended to prevent harm to others.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

22. I have to make sure other people are protected from all of the consequences of things I do.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

23. Other people should not rely on my judgment.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

24. If I cannot be certain I am blameless, I feel that I am to blame.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

25. If I take sufficient care then I can prevent any harmful accidents.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

26. I often think that bad things will happen if I am not careful enough.

Totally Agree	Agree very much	Agree Slightly	Neutral	Disagree Slightly	Disagree very much	Totally disagree

SD Scale:

1) I am never able to do things as well as I should.

True ☐ False ☐

2) I believe people tell lies any time it is to their advantage.

True ☐ False ☐

3) I would be willing to do something a little unfair to get something that was important to me.

True ☐ False ☐

4) I did many very bad things as a child.

True ☐ False ☐

5) I often question whether life is worthwhile.

True ☐ False ☐

6) My daily life includes many activities I dislike.

True ☐ False ☐

7) Many things make me feel uneasy.

True ☐ False ☐

8) I find it very difficult to concentrate.

True ☐ False ☐

9) I am quite able to make correct decisions on difficult questions.

True ☐ False ☐

10) My life is full of interesting activities.

True ☐ False ☐

11) If someone gave me too much change I would tell him.

True ☐ False ☐

12) I get along with people at parties quite well.

True ☐ False ☐

13) I am glad I grew up the way I did.

True ☐ False ☐

14) I am always prepared to do what is expected of me.

True ☐ False ☐

15) I am one of the lucky people who could talk with my parents about my problems.
True ☐ False ☐
16) I am careful to plan for my distant goals.
True ☐ False ☐

HADS

Read each statement and mark the box that comes closest to how you have been feeling in the **past 48 hours**. Your immediate reaction will probably be more accurate than a long, thought-out response.

1. I feel tense or 'wound up':
☐ Most of the time
☐ A lot of the time
☐ Time to time. Occasionally.
☐ Not at all

2. I still enjoy the things I used to enjoy:
☐ Definitely as much
☐ Not quite so much
☐ Only a little
☐ Hardly at all

3. **I get a sort of frightened feeling as if something awful is about to happen**:
☐ Very definitely and quite badly
☐ Yes, but not too badly
☐ A little, but it doesn't worry me
☐ Not at all

4. I can laugh and see the funny side of things:
☐ As much as I always could
☐ Not quite so much now
☐ Definitely not so much now
☐ Not at all

5. Worrying thoughts go through my mind:

- ☐ A great deal of the time
- ☐ A lot of the time
- ☐ From time to time but not too often
- ☐ Only occasionally

6. I feel cheerful:

- ☐ Not at all
- ☐ Not often
- ☐ Sometimes
- ☐ Most of the time

7. I can sit at ease and feel relaxed:

- ☐ Definitely
- ☐ Usually
- ☐ Not often
- ☐ Not at all

8. I feel as if I am slowed down:

- ☐ Nearly all the time
- ☐ Very often
- ☐ Sometimes
- ☐ Not at all

9. I get a sort of frightened feeling like "butterflies" in the stomach:

- ☐ Not at all
- ☐ Occasionally
- ☐ Quite often
- ☐ Very often

10.I have lost interest in my appearance:

- ☐ Definitely
- ☐ I don't take so much care as I should

☐ I may not take quite as much care

☐ I take just as much care

11.I feel restless as if I have to be on the move:

☐ Very much indeed

☐ Quite a lot

☐ Not very much

☐ Not at all

12.I look forward with enjoyment to things:

☐ As much as I ever did

☐ Rather less than I used to

☐ Definitely less than I used to

☐ Hardly at all

13.I get sudden feelings of panic:

☐ Very often indeed

☐ Quite often

☐ Not very often

☐ Not at all

14.I can enjoy a good book or radio or TV programme:

☐ Often

☐ Sometimes

☐ Not often

☐ Very seldom

IN4 Scale

1) I have never brushed or cleaned my teeth
True ☐ False ☐

2) I have travelled away from my home town
True ☐ False ☐

3) I have never felt sad
True ☐ False ☐

4) Sometimes I feel thirsty or hungry
True ☐ False ☐

THE FINAL QUESTIONS ARE FOR FEMALES ONLY:

1) Are you menstruating (i.e., on your period) today? Yes ☐ No ☐

IF YES, for how many days (including today) have you been menstruating (i.e., on your period)? _____ days

2) Using the calendars below, please circle the **first** day of your **last** menstrual period. If you are not completely sure, please estimate the day that you believe you started menstruating on. Also, please put an X on the day that you believe your **next** period will start.

SEPTEMBER '12

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

OCTOBER '12

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

NOVEMBER '12

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

DECEMBER '12

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

3) How confident are you that the above circled day was the first day of your last period? (Circle the best response)

0 1 2 3 4 5 6 7 8
0% 25% 50% 75% 100%

4) How confident are you that the above day with an X is the day that you will next get your period? (Circle the best response)

0	1	2	3	4	5	6	7	8
0%		25%		50%		75%		100%

Appendix H: Debriefing Form B

Thank you for participating in the Emotions and Mood Study at Lakehead University. The purpose of this study was to examine the impact of reproductive hormones on anxiety symptoms and disgust sensitivity across the menstrual cycle in women. Men were also included in this study for comparison purposes. However, there may be unique findings related to men as well. Research has shown that women are at greater risk for developing anxiety disorders across major reproductive events such as puberty, across the menstrual cycle, the postpartum period, and menopause. Coincidentally, these times also correspond to fluctuations in reproductive hormone levels. Past research has also shown that females have higher disgust sensitivity compared to males and that hormones may be a factor in this sex difference.

The questionnaires that were completed in the laboratory during this study measured mood, obsessive thinking and compulsive behaviour, disgust sensitivity, risk-taking, and beliefs surrounding responsibility for causing or preventing harm. Furthermore, your hands were scanned in order to measure the ratio of the length of your 2nd digit to your 4th digit (i.e., 2D:4D) and saliva samples were obtained from eligible participants in order to measure reproductive hormone levels. For females, the dates that you participated in this study corresponded to two phases of the menstrual cycle: the follicular phase and the luteal phase.

Please be assured that all of your responses will be coded to conceal your identity and your data will remain completely anonymous. If you would like a summary of the results of this study, please email emotionsandmood@lakeheadu.ca and we will send you a summary of the study when it is completed. If you have become in any way distressed from completing this study, or have any mental health concerns, please do not hesitate to contact the following services:

- Thunder Bay Crisis Response (available 24 hours) at (807) 346-8282
- Lakehead University's Student Health and Counselling Centre at (807) 343-8361
- Thunder Bay Regional Health Sciences Centre Walk in Clinic at (807) 768-1333

Below we have listed two articles if you are interested in learning more about the influence of reproductive hormones on emotions and mood. Thank you for taking part in this study.

Recommended Readings:

Fleischman, D. S., & Fessler, D. M. (2011). Progesterone's effects on the psychology of disease avoidance: Support for the compensatory behavioural prophylaxis hypothesis. *Hormones and Behaviour, 59*, 271-275.

Sigmon, S. T., & Schartel, J. G. (2008). Anxiety, anxiety disorders, and the menstrual cycle. In M. J. Zvolensky & J. A. Smits (Eds.), *Anxiety in health behaviours and physical illness* (pp. 181-205). New York, NY: Springer.

- If you have any questions or concerns regarding this study please contact Emily Fawcett (emotionsandmood@lakeheadu.ca) or the supervisor of this study, Dr. Dwight Mazmanian (phone: (807) 343-8257, email: dwight.mazmanian@lakeheadu.ca). Other collaborators in this study include Dr. Kirsten Oinonen (Associate Professor of Psychology at Lakehead University). If you have any questions about your rights as a research subject, please contact the Lakehead University Research Ethics Board at (807) 343-8283.