Memory, Perception, and Evaluation of Emotional Stimuli: The Effects of Oral Contraceptive Use, Sex, and Gender

Dissertation

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Abstract

Little research has examined if oral contraceptive (OC) mood side effects might be due to OC-related effects on affective judgements or memory for emotional stimuli. Previous studies on sex differences in emotional processing have rarely examined continuous gender (e.g., masculinity) or OC-related sources of variation. In this lab-based study, OC users, free-cycling women (i.e., nonusers), and men rated the emotional valence and intensity of emotional stimuli across three sensory modalities (e.g., visual, auditory, olfactory) to assess their immediate perception, evaluation, and memory for the stimuli. Differences in ratings were examined as a function of sex, masculinity, and OC use. In terms of emotional memory, OC users recalled more positive and less negative information than nonusers (i.e., relatively more positive than negative words, fewer negative objects and negative words). In terms of valence ratings, OC users and nonusers differed in their overall perception of stimuli, but the direction was stimulus-specific. Compared to non-users, OC users were more likely to perceive odours as positive and words as negative, and more likely to perceive negative facial expressions and negative words as negative. In terms of affective intensity ratings, OC users evaluated stimuli overall as more intense than nonusers, with this group effect being driven by olfactory intensity ratings. There was no evidence that gender (i.e., self-reported masculinity or measured voice pitch) explained a significant amount of variance in women's affective valence or intensity ratings of stimuli, although women's voice pitch was positively correlated with their olfactory intensity ratings. The OC-related emotional memory effect, stimulus-specific valence bias, and enhanced affective intensity bias are discussed in relation to findings from previous studies examining hormonal factors in emotional processing.

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Introduction

Research has suggested that women on average experience greater emotional intensity than men (Fujita et al., 1991; Gohm, 2003). In addition, a recent meta-analysis suggests that the majority of sex differences in brain activation to emotional stimuli favoring women (i.e., where women have greater activation) are observed for negative emotion, whereas the majority of sex differences in brain activation favoring men are observed for positive emotion (Stevens & Hamann, 2012). In addition to sex differences, other hormonal factors such as oral contraceptive (OC) use, have been found to influence emotional processing. A recent study in our laboratory found that OC users were less likely to remember negative stimuli than nonusers and recalled a higher ratio of positive to negative stimuli (Person & Oinonen, 2020). The present study sought to replicate these findings. Furthermore, additional exploratory analyses found that OC users rated stimuli as more intense than men, and men were more likely to categorize stimuli as positive than OC users or nonusers (Person & Oinonen, 2016). Thus, the second aim of the present study was to examine possible OCs effects on stimuli perception and evaluation across sensory modalities.

Previous studies on emotional memory and stimuli perception and evaluation have rarely examined the effects of OCs. Of the studies that do examine hormones and emotional processing, most have looked at changes across the menstrual cycle (e.g., Sander & Gordon, 2023). The findings from Person and Oinonen (2016; 2020) are in line with the aforementioned studies looking at sex differences in emotional processing. The findings suggest that OC use may amplify sex differences in the affective response to emotional stimuli but decrease sex

differences in terms of emotional memory. Moreover, previous studies have rarely considered ways in which we might reduce the risk of misinterpreting or misrepresenting sex differences. As Maney (2016) states, the factor of sex should be viewed as an imperfect and temporary proxy for yet-unknown factors such as hormones or sex-linked genes, that explain variation better than sex. In addition to looking at hormonal factors such as OC use, the present study will also look at continuous gender measures that reflect within-sex gender (i.e., self-reported masculinity and measured voice pitch) to better understand relevant sources of variation in sex. In other words, our study attempted to reveal the extent to which OCs and continuous gender aspects of sex explain variation in emotional processing rather than whether the sexes "differ."

Overall, this study explored the integration of emotion and cognition to examine how they affect an individual's memory, perception, and evaluation (i.e., response) to emotional stimuli with respect to OC use, sex, and gender. This area of research may help us to understand the sex, gender, and hormone-related individual difference factors that play a role in explaining why individuals come to experience strong or mild emotional responses when exposed to the same affect-provoking experiences/stimuli. The findings may have implications for sex differences in the development of the various psychological disorders (e.g., depression, PTSD) that are more commonly diagnosed in women as opposed to men.

Hormonally Relevant Factors

Sex steroids are closely linked to both women's emotional well-being (e.g., Balzer et al., 2015; Barth et al., 2015; Derntl et al., 2008; Gordon et al., 2016; Graham et al., 2018; Pletzer & Kerschbaum, 2014; Roberts et al., 2012; Sander et al., 2021; Sundstrom Poromaa & Gingnell, 2014; Toffoletto et al., 2014; van Wingen et al., 2011) and cognitive functioning (e.g., Courvoisier et al., 2013; Egan & Gleason, 2012; Gogos, 2013; Grummisch et al., 2023;

Hampson, 2018; Hampson et al., 2016; Hampson & Morley, 2013). Understanding the cognitive and affective impact of sex steroids is critical, as women experience changes across the lifespan with respect to endogenous levels (e.g., the menstrual cycle and menopause) as well as exogenous levels through exposure to synthetic analogues (e.g., the use of OCs during reproductive years and/or hormone replacement therapy in later life). Both the menstrual cycle and oral contraceptive use are paradigms that have been used to examine hormonal effects in women. In addition, the average speaking fundamental frequency (f0) of voice pitch is another paradigm that has hormonal connections of interest to the current study. Given that voice pitch largely depends on sex (Williamson, 2006) and is linked to testosterone (Fitch & Giedd, 1999; Harries et al., 1997), it can be a strong marker of gender identification (Pernet & Belin, 2012). Although not typically used in this way, voice pitch allows researchers to examine the continuum of within-sex gender differences from a more biological perspective.

When discussing sex steroids, it is important to note the distinction between gonadal versus brain-derived steroids. Neurosteroids are endogenous or exogenous steroids that rapidly alter neuronal excitability through interactions with ligand-gated ion channels and other cell surface receptors (Paul & Purdy, 1992). They can be synthesized in the brain or synthesized by the endocrine gland and then readily pass the blood-brain barrier through the bloodstream (i.e., they are highly lipophilic) to exert effects on brain function (Baulieu, 1981). Certain endogenous steroids of interest to the current study, such as progesterone and estradiol, are also neurosteroids that are synthesized by steroid precursors (Baulieu & Schumacher, 2000; Srivastava et al., 2011; Thomas & Pang, 2012). Generally, the density of neurosteroids is greater than gonadal hormones (i.e., they are produced in the brain in higher concentrations than typically found in the blood or cerebral fluid; Baulieu, 1981). Although the roles and functions of brain-derived steroids have

received less attention (Brann et al., 2021), it has been known for decades that there are brain-derived neurosteroids, including estrogens, in many subcortical tissues that can have direct effects on neural function (Taber et al., 2001). The effects of neurosteroids include modulation of neural plasticity (Benarroch, 2007), learning and memory processes (Vallée et al., 2001), as well as responses to depression (Frye, 2009; Girdler & Klatzkin, 2007). It is also thought that fluctuations in the levels of inhibitory neurosteroids during the menstrual cycle and pregnancy play an important role in conditions such as premenstrual syndrome, premenstrual dysphoric disorder, postpartum depression, and postpartum psychosis (Bäckström et al., 2003; Finocchi & Ferrari, 2011). While the interplay between gonadal and brain derived steroids is unclear, the steroid receptor density (e.g., estrogen, estradiol, progesterone) is very similar in the brains of human females and males, with the exception of the hypothalamus (Takahashi et al., 2018). Thus, the effects of variation in sex steroids (including exogenous steroids) on neural functioning should be contextualized as there may likely be some effects but they may be restricted to a subset of neural functions (e.g., hypothalamus) rather than having a general neural impact on emotional processing (Brann et al., 2021, 2022; Lu et al., 2019).

The Menstrual Cycle

An understanding of the human female menstrual cycle and the fluctuations in hormone levels throughout different phases is important in understanding how hormonal fluctuations may affect women's cognitive and emotional functioning. First, a hormone is a chemical substance that is secreted by endocrine glands that can exert physiological control over other cells (Neave, 2008). Across the menstrual cycle, physical and biochemical changes occur in the mature female body that make it possible to conceive. The normal cycle lasts 25 to 35 days but most literature refers to a standard 28-day cycle. The exact phase definitions differ across studies, but generally

the menstrual cycle is divided into two main phases (follicular and luteal), which can be further sub divided up into a total of six distinct phases, each associated with particular physical and hormonal changes (e.g., Hawkins & Matzuk, 2008). The follicular phase typically consists of days 1 to 14, with day 1 being the first day of menses. The luteal phase consists of days 15 to 28, with day 28 being the day before next menses. In the sub divided 28-day cycle, days 1 to 5 are referred to as the early follicular phase, or the menstrual phase; days 6 to 10 are considered the middle follicular phase; days 11 to 14 comprise the late follicular phase, ovulatory phase, or periovulatory phase; and days 15 to 28 are regarded as the luteal phase. Within the luteal phase, days 15-19 are regarded as the early luteal phase, 20 to 24 as the midluteal phase, and 25 to 28 as the late luteal phase (Hawkins & Matzuk, 2008).

Hormonal Changes Across the Menstrual Cycle. In the first phase, early follicular or menstrual phase, the uterus sheds the uterine lining, a layer of blood-enriched tissue that enables pregnancy through successful implantation of a fertilized egg (Lessey, 2000). If the woman did not become pregnant in the previous cycle the lining is shed through the process of menstruation. All hormone levels (i.e., estradiol, progesterone, LH, FSH) are low during this phase of the menstrual cycle (Carlson, 1991; Hampson & Young, 2008).

In the second phase, often called the mid-follicular phase, estrogen and progesterone are still at their lowest during the beginning of the phase. Later on in the phase, estrogen levels start to rise, while progesterone levels remain low. The pituitary gland begins to increase production of follicle stimulating hormone (FSH), which causes ovarian follicles to begin maturing. The mid-follicular phase is sometimes called the postmenstrual phase, and is characterized by low hormone levels, with FSH being slightly elevated (Carlson, 1991; Hampson & Young, 2008).

In the third phase, late follicular or ovulatory phase, ovulation occurs wherein the follicle wall ruptures, and the ovum is released (Schnatz, 1985). During the beginning of the phase, the maturing follicles begin to secrete estradiol due to a rise in luteinizing hormone (LH), which inhibits further secretion of FSH from the pituitary gland. The increase in estradiol and other estrogens signals the thickening of the uterine lining in preparation for possible conception. A decrease in FSH slows the growth of ovarian follicles until the eventual death of all but one follicle that secretes inhibin to further suppress FSH production. The surviving follicle continues to mature while secreting estradiol which then triggers the release of a surge in LH (Havez, 1979). The high levels of LH signal ovulation and the fact that conception is most likely to occur, providing that the time of intercourse coincides. However, it is worth noting that only about 30% of women have their fertile windows fall entirely within days 10 to 17 as identified by clinical guidelines (Wilcox et al., 2000). Most women will reach their fertile window shortly before or after these days. In addition to the high levels of LH, other hormones such as FSH and estrogen are at increased levels during ovulation, with LH and estrogen being particularly high (Carlson, 1991; Hampson & Young, 2008). It is worth noting that FSH, LH, and estradiol all reach cyclical peaks during the ovulatory phase and that these hormone levels are not consistently high across the phase.

In the luteal phase (further divided into early, mid, and late luteal), the released follicle, now called the corpus luteum, secretes large amounts of progesterone and estrogens. Increased progesterone helps create an environment that is ready for the implantation of a fertilized egg. In the mid-luteal phase, estradiol levels are moderate, progesterone levels peak, and pituitary secretion of LH and FSH diminishes. If pregnancy/conception does not occur, the corpus luteum perishes while progesterone and estradiol levels decline, causing menstrual flow and the

reoccurrence of the menstrual cycle. As noted above, the luteal phase can be further divided into early, mid, and late luteal phases, as hormone levels are significantly different throughout. In the early luteal phase, also referred to as the postovulatory phase (days 15 to 19), estrogen, LH, and FSH all drop rapidly following ovulation, while progesterone starts to rise. In the mid luteal phase (days 19 to 24), LH and FSH levels are low and slowly dropping, estrogen levels rise slightly to moderate levels, and progesterone levels rise and then level out at their peak. In the late luteal phase, sometimes referred to as the "premenstrual" phase (days 25 to 28 or more generally one week prior to menses), LH and FSH are very low and slowly drop, estrogen levels drop back down, and progesterone levels drop rapidly. Thus, the six menstrual cycle phases show distinct hormonal differences.

Phase Delineation in Menstrual Cycle Research. Researchers have used the phases of the menstrual cycle to explore how cognitive performance and mood/affect change with fluctuations in endogenous hormones. However, it is important to note the disparity that exists in how phases have been delineated across studies. Some researchers examine different sub-phases within each phase such as the mid-luteal phase (e.g., Maki et al., 2002) while others examine the phase as a whole such as the luteal phase (e.g., Nielsen et al., 2013). Some researchers prospectively assign women to groups based on cycle days and phases and then test them during those phases (e.g., Jarva & Oinonen, 2007) while other researchers test women regardless of cycle day and retrospectively assign them to cycle phases (e.g., Lens et al., 2012). Both of these designs define cycle phase according to day of cycle and rely either on the insight or accuracy of the participant and a calendar counting method. The forward counting method is commonly used to calculate the menstrual phase (days 1 to 5) while the backwards counting method is commonly used to identify the latter phases of the menstrual cycle, being the periovulatory (-15 to -19) and

luteal (-5 to -14) phases (e.g., Anderson et al., 2010). The backwards counting method is more accurate for these phases given evidence that the length of the luteal phase is much less variable across women than is the length of the follicular phase (Treloar et al., 1967). Thus, per Treloar et al. (1967), counting backwards from the next menses better determines cycle phase or cycle day than using the forward count. However, the best designs determine cycle day/phase using both day of cycle calculations based on a participant's self-report and also include other measures like body temperature, hormonal assays, or ovulation kits to validate menstrual cycle day/phase (e.g., Andreano et al., 2008; Solis-Ortiz & Corsi-Cabrera, 2008). A potential confound in this type of research is the high incidence of anovulatory cycles (i.e., no ovulation) in young women (e.g., rates are as high as 26.9%; Lopez et al., 2010) while methodological challenges such as high dropout rates or participants not falling within the cycle phase that they were expected to (e.g., Mordecai, 2006) leave researchers with smaller data sets, and as a result, greater difficulty in detecting effects.

Researchers have frequently examined cognition and emotion in women during certain menstrual cycle phases as it serves as a useful noninvasive model to study modulatory effects of sex hormones. To maximally capture hormonal differences, women are studied in the early follicular phase when estrogen and progesterone levels are at their lowest (days 2 to 5) and the midluteal phase (days 19 to 24) when estrogen and progesterone levels are higher (Mordecai, 2008). Researchers most interested in the effects of progesterone frequently compare the midluteal phase with any of the follicular phases (with recognition that estrogen differs amongst them). Researchers interested in the effects of estrogen often compare the late follicular phase (i.e., high estrogen) or even the midluteal phase (with recognition that both estrogen and progesterone are high) with the early follicular phase. Although the lowest hormone levels are

found in the menstrual or early follicular phase, one consideration that needs to be kept in mind when making comparisons is that women experience pain and other physical symptoms related to menstruation during this time. Given that physical symptoms can cause distress and affect cognition and perception, researchers should assess and control for these symptoms when examining the low hormone phase.

Oral Contraceptives

OCs, also known as 'birth control pills', are medications that prevent pregnancy and interfere with the natural processes of the menstrual cycle described above. According to Mosher and Jones (2010), 82% of women between the ages of 15 and 44 in the United States have taken OCs during their lifetime while an estimated 1.3 million women aged 15 to 49 have used OC in Canada (Rotermann et al., 2015). Furthermore, nearly half (48.3%) of sexually active 15- to 24-year-olds report using OCs in Canada (Rotermann & McKay, 2020). Thus, it is important to investigate any possible effects of OCs on women's health, functioning, and well-being. The majority of women taking OCs are prescribed hormonal preparations (i.e., pills) containing synthetic forms of estrogen and progesterone but progestin-only pills are also available. There are several types of combination OCs, including monophasic, biphasic, or triphasic.

Effects on Endogenous and Exogenous Hormones. OCs impact the natural processes of the menstrual cycle by disrupting normal hormone fluctuations. The synthetic hormones contained in OCs suppress LH and FSH levels, impeding follicular development and ovulation to prevent pregnancy. Consequently, the expected natural surges in endogenous estrogens and progesterone during the follicular and luteal phases do not occur (Fleischman et al., 2010). Circulating levels of these two hormones are estimated to be significantly less in OC users than those found in naturally cycling women (Gordon & Lee, 1993; Paoletti et al., 2004). Production

of testosterone is also diminished in users (Coenen et al., 1996; Liening et al., 2010; Zimmerman et al., 2014). Therefore, with OC use, the natural production of hormones is inhibited by synthetic versions of estrogen and/or progesterone, essentially eliminating the typical menstrual-cycle variability for monophasic users during days of pill use. In general, OCs have a stabilizing effect on hormone levels by reducing levels and fluctuations in endogenous hormones across the menstrual cycle.

OC use also results in different blood levels of exogenous hormones depending on the type of OC. In terms of the different types of OCs, monophasic OCs deliver the same amount of estrogen and progesterone every day while biphasic OCs deliver the same amount of estrogen every day for the first 21 days of the cycle, but varying levels of progesterone during the active pill phase (i.e., low progesterone to estrogen ratio during the first half of the cycle and a higher ratio during the second half). Triphasic OCs have either constant or changing estrogen concentrations with varying progesterone concentrations that change three times across the cycle (i.e., each week of the active pill phase). Overall, OCs alter women's hormonal profile by (1) substantially suppressing endogenous levels of sex steroids through the inhibition of the hypothalamic-pituitary-ovarian axis and (2) by adding effects of synthetic steroid hormones (D'Arpe et al., 2016). Thus, OCs can exert effects on cognition and emotion from suppression of endogenous hormones or from the addition of exogenous hormones through their synthetic compounds.

Side Effects. The high percentage of women taking OCs every day, and in most cases over many years, necessitates research on possible physical, emotional, and cognitive side effects of OC use. In fact, Rosenberg and Waugh (1998) found that 59% of women who discontinue OCs in favour of another contraceptive method do so because of side effects. More recent

research continues to suggest similar rates of discontinuation due to side effects (e.g., Hall et al., 2012; Huber, 2006). Various physiological effects such as nausea, weight gain, and increased risks for more serious health problems, such as stroke, have been identified as possible effects that OC use can have on women's bodies (e.g., Seibert et al., 2003). Behavioural or emotional side effects have also been reported, such as emotional lability, worsened mood, and decreased sexual desire (Battaglia et al., 2012; Sanders et al., 2001). A recent study found that OC usage early in life can predict lasting vulnerability to depression in adulthood (Anderl et al., 2020) and adverse effects of OC use on psychological health among adolescent girls has been reported (Skovlund et al., 2016; Zettermark et al., 2018). Given that some women report mood change, there is the possibility that OCs may also affect women's perception, evaluation, and memory for emotional stimuli. In fact, such effects might even explain OC-related mood change. It is important for women to be informed of the possible side effects of OC use and the effects OCs might have on their overall well-being and functioning, especially considering the widespread use of OCs and the evidence that side effects are a major complaint for many women. Furthermore, OC use is often initiated at a pubertal age (Daniels et al., 2014; Rashed et al., 2015) when young women's brains are in a crucial developmental stage, making informed decision-making even more imperative.

Oral Contraceptives and Brain Changes. According to a number of studies, there appear to be effects of OC use on brain structure, function, and behavioural output. A recent systematic review of the neuroimaging literature on OC-related brain differences identified structural and functional changes in regions associated with affective and cognitive functioning such as memory and emotional processing, including the amygdala, hippocampus, prefrontal cortex and cingulate gyrus (Brønnick et al., 2020). OC use in general, is linked to increased

prefrontal brain activation during working memory processing for negatively arousing stimuli (Petersen & Cahill, 2015). In adolescence, OC use is also associated with altered brain activation during working memory processing and a blunted stress response (Sharma et al., 2020). Taken together, these findings highlight that OC use induces changes to brain structure and function and can alter stress reactivity. This may be a potential mechanism for increased vulnerability to mood-related disorders in women after OC use (see mood and affect discussion below).

Of note, it has been found that OC users with previous negative mood side effects show reduced left insula reactivity in BOLD responses to an emotion processing task when compared to placebo users (Gingnell et al., 2013). The left insula plays an important role in processing the anticipation and subjective experience of aversive stimuli (Paulus & Stein, 2010) but is also activated by positive emotional feelings (Bartels & Zeki, 2004; Johnstone et al., 2006; Takahashi et al., 2008). In addition, Gingnell et al. (2013) compared two groups of women (previous OC users) with negative mood side effects: one group was re-exposed to OCs whereas the other group was exposed to a placebo. They found that women with a previous history of OC-induced adverse mood side effects showed the following changes when re-exposed to OC use in a double-blind placebo-controlled design: lower reactivity to emotional faces in the left insula, left middle frontal gyrus, and bilateral inferior frontal gyri compared to women with a previous history of OC-induced adverse mood exposed to placebo. It was also found that the OC group had decreased reactivity bilaterally in the inferior frontal gyri while the placebo group had decreased reactivity in the right amygdala between the pretreatment (baseline) and OC treatment cycles. This decrease in reactivity in the right amygdala was absent in OC users. Given that OC users had unaltered amygdala reactivity between baseline and treatment cycles, it is possible that placebo users developed a habituation between trials or that OC users experienced a slower

habituation to emotional stimuli. According to the study's authors, the slower habituation among OC users with OC-induced adverse mood side effects could suggest that the administration of exogenous ovarian steroid hormones such as OCs reduces habituation of the amygdala, leading to a higher level of vigilance to emotional stimuli in OC users, which could also be related to their mood deterioration.

Overall, emerging evidence suggests that OC use may elicit structural and functional brain changes and lead to differences in brain activation in response to a wide array of tasks and stimuli. In turn, this may induce changes in behavioural output. For a recent systematic review of the effects of hormonal contraceptives on the brain please see Brønnick and colleagues (2020). According to neuroimaging studies that compare OC users to nonusers, OC users generally show blunted stress reactivity (Kirschbaum et al., 1999; Kumsta et al., 2007; Roche et al., 2013; Rohleder et al., 2003), region-specific increases or decreases in grey matter volume (Lisofsky et al., 2016; Pletzer et al., 2010; Pletzer et al., 2015), decreases in white matter integrity (De Bondt et al., 2013), and cortical thickness (Petersen & Cahill, 2015). OC users also demonstrate differences in brain function at rest (Lisofsky et al., 2016; Petersen et al., 2014; Pletzer et al., 2016) and during tasks related to memory, reward, and emotion compared to nonusers (Bonenberger et al., 2013; Gingnell et al., 2013; Marečková et al., 2012; Mareckova et al., 2014; Miedl et al., 2018; Petersen & Cahill, 2015). Of note, research has suggested that OC use may be associated with important structural and functional changes in the brain areas important for various cognitive and affective functions such as face recognition (e.g., Bonenberger et al., 2013; Pletzer et al., 2015) and affective processing (e.g., Petersen & Cahill, 2015). This is not surprising given that brain structures related to emotions and cognitive functions (e.g., hypothalamus, hippocampus, frontal cortex, amygdala) are dense with estradiol and progesterone

receptors (Osterlund et al., 2000). There is the possibility that the natural cyclicity of estradiol may be key in these changes and/or activational differences. It is also possible that endogenous estradiol may have a different or more efficacious influence on brain network activation compared to synthetic estradiol.

The research discussed above emphasizes the importance of considering the hormonal levels of female participants in studies and whether women are naturally cycling or whether they are using OCs when examining sex differences. A failure to consider these variables may contribute to or account for discrepancies between studies that find sex differences and those that do not when examining a certain area of interest (e.g., affect intensity, perception, evaluation). This is one of the reasons why differences between naturally cycling women, OC users, and men were examined in the present study.

Oral Contraceptives and Research Considerations. Given that women taking OCs do not experience hormonal fluctuations like free-cycling women do, they can serve as a useful control group to assess whether physical or behavioural changes that are presumed to occur across the menstrual cycle are specifically related to endogenous hormonal influences. Also, OCs may cause physical, emotional, or cognitive side effects due to the lack of normal endogenous hormonal fluctuation, reduced hormone levels, or the presence of exogenous hormones. Thus, researchers have examined such side effects of OC use. However, like studies assessing changes over the menstrual cycle, there are some difficulties surrounding this research. Because of the wide variety of OCs available to women it is sometimes difficult to compare results across studies since all OCs do not contain the same type of hormones, the same amount of hormones, or have the same pattern of administration (e.g. monophasic versus biphasic versus triphasic OCs). OCs can contain different types of progestogens (e.g., progesterone, norgestimate,

norgestrel, medroxyprogesterone, levonorgestrel, and drospirenone) and a few different types of estrogens, but most commonly contain ethinyl estradiol. Pills can contain both estrogen and progestogens (combined pill) or they can contain only progestogen (progestogen-only pills). In addition, some progesterones can be more androgenic (e.g., levonorgestrel, methyltestosterone, norgestrel) while others can be more anti-androgenic (e.g., drospirenone, norethynodrel, norgestimate) (Sitruk-Ware & Nath, 2013). There is also the problem of whether women participating in studies are taking their pills every day at the same time as prescribed. Some women may forget to take a pill or take them at varying times (e.g., Potter et al., 1996; Rosenberg et al.,1995), which can influence hormone levels, the effectiveness of the pill and, as a result, influence the outcome of studies.

Overall, several reasons exist for inconsistencies seen across studies that examine the effects of OCs. This includes the heterogeneity among OC users in the sample of a study given the wide variety of OCs available (e.g., Gogos, 2013) and the fact that details of OC usage are often inconsistently reported or not reported. As discussed in Pletzer and Kerschbaum (2014), OC formulations have also changed since they first became available to the public (e.g., higher EE doses and progestins characterized by stronger androgenic activity in the past) and also differ between countries (e.g., androgenic OCs are more popular in America versus Europe). Studies can also be affected by the temporal course of OCs. Regardless, further research on OCs is vital to our understanding of hormonal influences and the effects that OCs can have on women's behaviours, emotions, and cognition. Thus, studies investigating the effects of OCs on women's well-being need to be more rigorous and specific in their designs. When possible, placebo-controlled double-blind trials or randomized controlled trials (RCTs) would be ideal. However,

such studies can only be justified after initial correlational research demonstrates associations between OC use and particular experiences.

Voice Pitch

Of particular interest to the present study, is an objective measure of masculinity (i.e., not self-report). Acoustic analysis of voice recordings has the potential to be used to explore gender differences in the perception and evaluation of emotional stimuli. When considering which acoustic characteristics might reveal variables of potential relevance to masculinity, most researchers have focused on fundamental frequency (f0) which equates to voice pitch. As noted by Fracarro and colleagues (2012), fundamental frequency is tied to the rate of vibration of the vocal folds and shows evidence of hormonal connections. Of note, testosterone at puberty stimulates an increase in the length of the vocal folds and a disproportionate growth of the larynx (Fitch & Giedd, 1999; Harries et al., 1997). Together, these two changes give men's voices their lower pitch (Simmons et al., 2011). Thus, vocal tract length can differ as a function of levels of testosterone in the body. The average length of the adult female vocal tract is about 14.5 cm, while the average male vocal tract is 17 to 18 cm long (Simpson, 2009). Within men, those with higher testosterone have longer tracts (Simpson, 2009). Thus, there is evidence that men have longer vocal tracts than women and that length is associated with testosterone. Accordingly, measuring the length of the vocal tract (i.e., the distance between the lips and the vocal folds) can help determine an individual's masculinity, with a longer vocal tract indicating more masculine pitch. This requires measuring the acoustic length of a voice recording using acoustic analysis and specific formulas that give an estimate of the length of the vocal tract of the speaker.

A second possibility, and more common method of measuring masculinity, is to measure the fundamental frequency (F0) of voice pitch. Lower F0 values correspond with deeper, more

masculine pitch and timbre (Hill et al., 2013). According to Pepiot and colleagues (2014), the voice pitch of an average male is about 90hz lower than the average female. In an article by Williamson (2006), the mean pitch of males was found to be 128hz while the mean pitch of females was 225hz. There is also evidence that females have a greater range in their speaking fundamental frequency. Williamson found that the minimum pitch for females was 155hz while the maximum pitch was 334hz (range = 179). For men, the minimum pitch was 85hz while the maximum pitch was 196hz (range = 111). Thus, it is generally the case that, on average, men have a lower voice pitch and a smaller voice pitch range than women with very little overlap in their f0 distributions (e.g., 4% according to Williamson, 2006).

Further research suggests that voice pitch is sexually dimorphic. For example, when presented with higher pitched female voices, men perceive the women as younger (Collins, 2003) more attractive (Borkowska et al., 2011; Pisanski et al., 2012), more feminine (Feinberg et al., 2008), and more desirable as spouses (Apicella et al., 2009). In fact, men will visualize younger women with more attractive and feminine features when exposed to higher-pitched female voices (Roder et al., 2013). Similarly, when women are presented with lower pitched male voices, they rate the voices as more masculine and attractive (e.g., Feinberg et al., 2005) Thus, higher pitched female voices are perceived as more feminine by men and lower pitched male voices are perceived as more masculine by women. Furthermore, Banai (2017) noted that F0 can change in women over the course of their menstrual cycle. The lowest F0 minimum was recorded in the menstrual phase (low estrogen) and the highest F0 minimum in the late follicular phase (high estrogen) in a sample of free-cyclers (Banai, 2017). Thus, higher minimum pitch was observed in the fertile phase. The authors speculated that higher estrogen levels may lead to higher pitched voices due to a proliferative effect on laryngeal mucus. Overall, examining

fundamental frequency may be a meaningful continuous biological measure of masculinity or gender when considering sex/gender differences.

Affect, Mood, and Cognition

Affect, Mood, Cognition, and Sex Differences

It is a common belief that women on average are the "more emotional sex," with a greater tendency to experience, express, and dwell on their emotions (Barrett & Bliss-Moreau, 2009; Brody, 1993; Brody & Hall, 2008; Deaux & Major, 1987; Fabes & Martin, 1991; Fischer & Manstead, 2000; LaFrance & Banaji, 1992; Shields, 1987). According to Dimberg and Lundquist (1990) this difference is based more on an expressive than on an experiential difference. For example, women are more superficial with emotion language (Fugate et al., 2009), show their tears five times more often (Walter, 2006), and tend to smile more (LaFrance et al., 2003). In comparison, men are viewed as having a greater tendency to suppress or avoid the experience and expression of their emotions (Nolen-Hoeksema, 2012). When men express emotion, it is often through actions such as aggression, as men on average have been shown to experience anger more frequently and be more aggressive than women (Biaggio, 1980; 1981). Overall, it appears as though women tend to express their emotions more (e.g., through facial expression and interpersonal communication) than men. However, given that men on average experience more anger than women, women may not be *generally* more emotional than men but instead it may be dependent on the emotion and situation. Indeed, the view that women are the more emotional sex is so pervasive that even preschool children believe that women experience and express more emotion (e.g., Birnbaum & Croll, 1984; Birnbaum et al., 1980), and these beliefs continue into adulthood (e.g., Grossman & Wood, 1993; Lutz, 1990; Shields, 1987). This belief seems to hold true even when emotionality is defined as a global disposition that is stable

and largely independent of social context. Women consistently describe themselves as more emotionally intense than do men (e.g., Diener et al., 1985; Fujita et al.,1991; Grossman & Wood, 1993). Socialization likely plays a role in these findings, but it is also likely that biological factors may play a role as well. For these reasons, the examination of sex and voice pitch (i.e., biological factors) and self-rated masculinity and femininity (i.e., social factors) are included in the present study.

The greater emotional responsiveness experienced on average by women compared to men has also been documented in self-reports of specific emotions. For example, in terms of positive emotions, women report greater overall warmth, emotional expressiveness, and concern for others than men (Spence & Helmreich, 1978) as well as greater levels of happiness and life satisfaction (Wood, Rhodes, & Whelan, 1989). In the realm of negative emotions, women report higher levels of negative affect and depression than men (Noble, 2005; Nolen-Hoessema, 1987), in addition to greater fear and sadness (Scherer, Walbotlin, & Summerfield, 1986). Self-reports of anger have yielded inconsistent results with some studies finding that men report more frequent anger than women (Biaggio, 1980; Biagio 1981; Doyle & Biaggio, 1981) while others have failed to find significant sex differences (Averill, 1982; Wintre et al., 1990). In general, women frequently report more intense emotions but also more negative emotions than men (e.g., Tobin et al., 2000; Vrana & Rollock, 2002).

On a related note, is the idea of emotional understanding and awareness. It has been found that women show greater understanding of what emotions they or others would feel across different scenarios and furthermore, what the sources of these emotions would be (Barrett et al., 2000; Joseph & Newman, 2010). Furthermore, women self-report as more empathetic compared to men (Eisenberg & Lennon, 1983; Hoffman, 1977; Rueckert & Naybar, 2008). In fact, when it

comes to the emotions of others, it has been found that women are more aware of and concerned with the emotions of others than men are (Brody & Hall, 2008; McClure, 2000). It has also been found that women encode events and recall memories more in terms of their emotional content than men do (Davis, 1999; Seidlitz & Diener, 1998). Again, these findings suggest that women on average are more aware and attentive to emotion. According to Barrett et al. (2000), women also show more complex and differentiated conceptualizations of emotional experiences than men do, even when controlling for gender differences in verbal intelligence. This finding suggests that the sex difference in the display of emotional awareness is a stable and highly generalizable effect. However, according to experience-sampling studies and laboratory emotion-induction paradigms, men are experiencing emotions as much as women are (Barret et al., 1998). Thus, it is likely not the case that women experience more emotions than men and are thus the "more emotional sex" but instead, in line with the above research, it may be that women due in part to socialization have greater awareness, attentiveness, and understanding of the emotions they experience compared to men and in turn are more likely to express such emotions (i.e., the "more emotionally able sex").

The question that comes to mind is why are women the more "emotionally able sex" and why are they more emotionally attentive, understanding, and complex than men? Perhaps it is the way in which women react to emotional experiences/stimuli or the way they are socialized. It has been theorized that women are more emotionally reactive to negative events than men because they appraise such events as more stressful (Ge et al., 2001; Hyde et al., 2008; Rudolph & Hammen, 1999). In fact, women show stronger physiological reactions to negative images as evidenced by greater amygdala activation (Klein et al., 2003) and stronger defensive reactions to aversive images as evidenced by prolonged eye-blink startle reactions (Gard & Kring, 2007).

This generally enhanced emotional responding has been proposed as a predisposing factor for greater stress levels in women, which might contribute to their higher rate of depression (Hammen, 2005). Overall, it has been suggested that compared to men, women are more vulnerable to mood disorders (Noble, 2005; Seney & Sibille, 2014) and post-traumatic stress disorder (Olff, 2017). The female predisposition to mood disorders is hypothesized to be influenced by hormonal fluctuations, as they may affect brain structures related to emotions (Noble, 2005) and alter emotional processing (Henningsson et al., 2015).

One question is whether these sex differences in mood and affect translate to sex differences in performance on emotion-related tasks. In a review by McClure (2000) it was concluded that there is a small yet reliable enhancement in performance on emotion tasks in females relative to males across development. Thus, there may be a female advantage when it comes to emotion-related tasks such as facial expression processing and emotion recognition. However, according to McClure it is still not clear if this is true for all emotions or all situations as there are conflicting findings in the literature.

In terms of cognition, several differences between the sexes have been documented in the literature. Although sex differences in cognition can depend on the type of task, on average, women generally perform better on verbal (Andreano & Cahill, 2010) and delayed memory tasks (Gogos, 2013), while men generally perform better on visuospatial tasks (Boone & Hegarty, 2017; Parsons et al., 2004). Cognitive differences between the sexes may be influenced by factors such as sex-dependent strategy use (Whittle et al., 2011) or to a larger extent, organizational and activational effects of sex hormone levels that have the potential to affect various brain structures as previously mentioned. In fact, this underlying factor (i.e., differing

hormonal milieu and sex steroids) may explain between-sex and within-sex variations better than "sex" alone when looking at both cognitive and emotional differences between the sexes.

Affect, Mood, Cognition, and Hormones

Research indicates that gonadal hormones can influence the regulation of emotional responses and affective states through actions on the central nervous system (see Kret & De Gelder, 2012). Sex hormones are known to directly influence the hypothalamus and hippocampus and these brain areas are implicated in the interpretation of sensory information, emotional processing, and perception and memory (Barth, Villringer, & Sacher, 2015; Hines, 2010). There is also evidence from electrophysiological studies that suggest sex steroid fluctuations during the menstrual cycle can modify emotional stimuli processing (e.g., Lusk et al., 2015. 2017; Munk et al., 2018; Sander & Gordon, 2023; Zhang et al., 2013a/b). Thus, gonadal hormones may mediate some of the sex differences in affect, mood, and cognition (i.e., emotional processes) discussed above. For comprehensive reviews of the effects of hormones on affect and mood see Fernandez-Guasti and colleagues (2012), Oinonen and Mazmanian (2002), and Steiner and colleagues (2003). In addition, there are numerous studies citing mood changes during sensitive periods of hormonal change such as menarche (e.g., Born et al., 2002), the premenstrual phase (e.g., Bäckström et al., 2003), menopause (e.g., Freeman et al., 2006; Gordon et al., 2015), and in pregnancy and the post-partum period (e.g., Schiller et al., 2015). One theory suggests that some women may be more hormonally sensitive and be more likely to experience mood and physical symptoms during these hormonal events (Pope et al., 2017). Moreover, estrogens can modulate cognitive functions and emotions, as the brain is an important target organ for estrogens (McEwen & Alves, 1999). Relatedly, hormone replacement therapy within a critical period after menopause can have beneficial effects on cognitive ability in women (see

reviews in Henderson 1997; Ryan et al., 2008). Overall, research does show a link between hormones, both endogenous and exogenous, and mood and/or cognitive change. For this reason, it follows that OCs may also mediate some of the sex differences that are seen in emotional processes. Given the high rates of OC use by women, it is critical that research fully examine this possibility.

Affect, Mood, Cognition, and Oral Contraceptives

Although most research has focused on differences between OC users and nonusers in *level* of mood or affect, other studies tend to suggest that there is less mood *variability* or reactivity in OC users compared to nonusers (see review in Oinonen & Mazmanian, 2002). OC-related mood changes, including mood reactivity and mood variability, are possible side effects of OC use. However, more research is needed to examine possible specific differences between users and nonusers. The finding of reduced mood variability in OC users is plausible for two reasons. First, mood change during times of hormonal fluctuation in women is a well-documented phenomenon (for a review see Steiner et al., 2003). Second, OC use tends to have a stabilizing effect on hormonal fluctuations and thus should reduce variability in mood. It is possible that OCs affect mood variability as opposed to overall mood levels. Mood variability can be examined between menstrual cycle phases, day-to-day, or within-day. Studying the variability of mood in OC users may help in gaining a better understanding of whether OCs act on mood stability.

Results have been inconsistent in studies examining the possibility of OC-related mood level changes. That is, some studies have found no differences (e.g., Natale & Albertazzi, 2006) while some studies have found differences in mood level with OC use (e.g., Graham et al., 2007; Poromaa & Segebladh, 2012). According to Oinonen and Mazmanian (2002) this may be partly

due to different research designs, differences in OC formulation, or the survivor effect. In a review of the literature, Oinonen and Mazmanian (2002) noted some evidence for the possibility that OCs exert a stabilizing effect on affect. Of the studies they reviewed, four studies suggested that OC users demonstrated less variability in affect than nonusers (Graham & Sherwin, 1993; Paige, 1971; Sutker et al., 1983; Walker & Bancroft, 1990). Only one study (McFarlane et al., 1988) found no significant differences in affect variability between OC users and nonusers. Given study limitations (e.g., survivor effect; Kutner & Brown, 1972) and OC formulation differences, further research is needed to draw any conclusions regarding the day-to-day stabilizing effect of OCs on mood.

With respect to persistent mood (i.e., depression), a large nationwide study examined the effect of OCs on the risk for depression in a prospective cohort design. The study found that OC use was associated with subsequent antidepressant use and a first diagnosis of depression (Skovlund et al., 2016). This was especially true among adolescents. This study suggests that depression may be a potential adverse mood effect of OC use. Similarly, in a recent population-based cohort study, the use of OCs, particularly during the first two years, was associated with an increased risk of depression (Johansson et al., 2023). In the same study, previous OC use was associated with a higher rate of depression, with adolescent OC users driving the increased risk. Other studies examining the association between OC use and depression have found that adolescent users of progestin-only contraception were more frequent users of antidepressants than nonusers of OCs (Wiréhn et al., 2010; Lindberg et al., 2012), OC users were significantly more depressed than a matched group of nonusers (Kulkarni, 2007), and that OC use in adolescence predicts lasting vulnerability to depression in adulthood (Anderl et al., 2020). In the postpartum period, risk of depression and antidepressant use has been found to vary with the type

of OC used (Roberts & Hansen, 2017). In contrast to the studies that found significant associations between OC use and depressed mood and/or antidepressant use, three studies found no association between OC use and more severe depressive symptoms or higher prevalence of mood disorders (Duke et al., 2007; Morssinkhof et al., 2021; O'Connell et al., 2007), three studies found that OC use is associated with better mood (Keys et al., 2013; Toffol et al., 2011; Toffol et al., 2012), and one study showed an altered symptom trajectory with OC use in adolescence whereby OC users showed a stable level of depressive symptoms in late adolescence while never users showed an increase (Doomweerd et al., 2022). Overall, research suggests OC use can be associated with higher rates of depressed mood but also no association or even better mood. The inconsistency highlights the need for further research with rigorous study designs to determine individual-difference and OC-related variables that predict mood side effects.

The relationship between affect level (positive and negative) and OC use has also been examined. In terms of the differential effects OCs may have on negative affect (NA), Oinonen and Mazmanian's (2002) review indicated that the majority of studies have found no group differences between users and nonusers across the entire menstrual cycle (Almagor & Ben-Porath, 1991; Marriott & Faragher, 1986; Oinonen & Mazmanian, 2001; Paige, 1971; Wilcoxon et al., 1976). However, group differences have been found at specific cycle phases. For example, four studies found that OC users experienced less NA than nonusers during the menstrual phase (Boyle & Grant, 1992; Paige, 1971; Sutker et al., 1983; Wilcoxon et al., 1976), whereas one study found higher levels of NA for monophasic OC users, but not for triphasic users (Walker & Bancroft, 1990). In contrast, four studies found no group differences in NA during the menstrual phase (Alexander et al., 1990; Almagor & Ben-Porath, 1991; Graham & Sherwin, 1993; Natale & Albertazzi, 2006). With respect to differential effects OCs may have on positive affect (PA),

no consistent group differences in PA have been found at any of the menstrual cycle phases (Almagor & Ben-Porath, 1991; Boyle & Grant, 1992; McFarlane et al., 1988; Walker & Bancroft, 1990) while Oinonen & Mazmanian (2001) found that both OC users and nonusers experienced less positive affect variability (day-to-day) during the menstrual phase than during the other cycle phases. Randomized controlled trials or studies minimizing the survivor effect are needed to draw firm conclusions surrounding the effects that OCs may have on affect level across or during certain menstrual cycle phases.

Mood reactivity is another area of study where researchers typically examine mood responses to an event or stimulus by measuring the difference in affect before and after exposure. However, there have been very few studies looking at differences between OC users and nonusers in terms of mood reactivity. Interestingly, one study by Jarva and Oinonen (2007) found that OCs may reduce the degree of positive affect change that women experience in response to environmental events. These results indicate that OCs may have a stabilizing effect on PA. In addition, Jarva and Oinonen (2007) found that OCs may reduce the level of positive affect change that women experience in response to environmental events, suggesting the possibility of a positive affect stabilization in the evaluations of emotional stimuli in OC users as compared to nonusers. Furthermore, in a subgroup of OC users who did not report pre-menstrual syndrome, no negative mood change was found (Hamstra et al., 2017). In fact, these women scored more favourably (i.e., lower) on measures associated with depression and showed reduced affect variability (i.e., fewer mood shifts between depression and elation), indicating a possible emotional blunting effect. The suggestion that OCs are associated with reduced mood fluctuations in OC users seems plausible given the reduced hormonal fluctuations in OC users across the menstrual cycle when compared to naturally cycling women. A blunted cortisol

response in OC users (Cornelisse et al., 2011) or a decreased cortisol receptor sensitivity in OC users (Kuhlmann & Wolf, 2005) may be other possible explanations for this effect, resulting in fewer fluctuations in positive affect.

Despite the evidence reviewed suggesting that OCs may provide some affect stabilization when women are examined as a group, there has always been a subgroup of women who report distinct increases in negative affect (e.g., depression, irritability) with OC use (e.g., Kulkarni, 2007). Given the hypothesis that some women may be more sensitive to mood side effects of OCs than other women (Pope et al., 2017), recent research has moved towards examining women who have a history of such hormonal sensitivity. For example, in a study by Gingnell et al. (2013), using a randomized, double-blind, placebo-controlled trial, women on OCs with a history of negative OC mood side effects had significantly increased scores of depressed mood, mood swings, and fatigue, whereas a similar group of women taking placebos had virtually unchanged mood scores. In addition, women in the OC group had significantly higher scores of self-rated depression during the last week of OC exposure compared to their pretreatment ratings. The major findings from Gingnell et al. (2013) were that women with subjective reports of previous OC-induced mood deterioration exhibited depressive mood and mood swings when re-exposed to OCs. Furthermore, the intensity of these symptoms was significantly enhanced compared to the women randomized to the placebo group. The methodological strengths of this study provide strong evidence that OCs may induce mood deterioration in a sub-group of hormonally sensitive women. In a similar study, Lundin and colleagues (2017) found that combined OC use was associated with mood side effects in the inter-menstrual phase (i.e., between menstrual periods) and this association was driven by a subgroup of women who suffered from OC-related side effects.

Overall, most of the research in this area of mood, affect, and OC use has looked at the broad relationship between OC use and mood and the evidence has been inconclusive. The above review primarily focused more narrowly on the relationship between OC use and affect as this is most relevant to the present study in terms of the affective judgement of valence and intensity (i.e., affect is usually caused by specific events or stimuli while mood is usually sustained and caused by non-specific stimuli). While most of the studies are confounded by the survivor effect, the findings seem to suggest that OC use may have a stabilizing effect on PA. Also, there is no evidence to suggest consistent differences between users and nonusers in NA, yet there appear to be a subgroup of women predisposed to negative mood change with OCs.

Studies have also explored OC-related differences in cognitive functions that, likewise, have resulted in inconclusive conclusions. For a recent systematic review of the effects of OCs on cognition please see Gurvich and colleagues (2022). Studies reveal that cognitive performance can be both enhanced for OC users in areas such as visuospatial performance (e.g., Gurvich et al., 2020; Wharton et al., 2008), working memory (e.g., Gravelsins et al., 2021), verbal memory (e.g., Mordecai et al., 2008; Rosenberg & Park, 2002), semantic memory (e.g., Petersen et al., 2015) or topographic learning (Bianchini et al., 2018); and inhibited in areas such as emotional memory (e.g., Nielsen et al., 2011; Person & Oinonen, 2020), verbal fluency (Griksiene & Ruksenas, 2011), and mental rotation (e.g., Griksiene & Ruksenas, 2011; Peragine et al., 2020). Some studies have also found no differences in cognitive performance, including verbosequential and visuospatial tests (Gordon & Lee, 1993) verbal fluency (Mordecai et al., 2008), and visuospatial abilities (Mordecai et al., 2008; Rosenberg & Park, 2002). The review by Gurvich and colleagues (2022) found that OC use was associated with some differences in performance on all cognitive domains examined except for basic auditory attention and

psychomotor performance. The review speaks to several important factors that may account for the inconsistent associations between OCs and cognitive performance. For example, task-related factors, such as difficulty, may modulate how OCs affect cognition while the type of OC and the menstrual cycle phase of the control group are important factors to consider when exploring the influence of OCs on cognition (Gurvich et al., 2022).

Emotional Memory

It is well established that emotionally arousing experiences are more memorable than neutral experiences (Cahil & McGaugh, 1995; Canli et al., 2002; Hamann et al., 1999). For example, there is enhanced memory for traumatic relative to mundane events (Christianson & Lftus, 1987) and for emotional relative to neutral words (LaBar & Phelps, 1998) and pictures (Bradley et al., 1992). Overall, individuals seem to remember emotional experiences/stimuli better (whether they are positive or negative) when compared to neutral experiences/stimuli. However, it seems that negative emotional events are remembered best (see review in Kensinger, 2007). There is also evidence that stimuli are more memorable when they are mood-congruent. For example, in a meta-analytic review of mood-congruent recall of emotional stimuli it was determined that clinically depressed, induced depressed, and induced elated individuals displayed mood congruent recall (Matt et al., 1992). This research suggests that both valence and mood can influence memory performance.

Emotional Memory and Sex Differences

There is evidence that memory for emotional stimuli and experiences differs between the sexes (Canli et al., 2002; Fujita et al., 1991; Seidlitz & Diener, 1998). For example, on average, women recall more emotional autobiographical events than men, women produce memories more quickly and with greater emotional intensity in response to cues than men, and women

report more vivid memories than their spouses for emotional events such as their first date, recent argument, or last vacation (Herz & Cupchick, 1992; Robinson, 1976; Ross & Holmberg, 1990). One theory behind the sex difference in memory performance is the "affect-intensity" hypothesis. This hypothesis proposes that women have better memory because they experience emotional events more intensely than men and thus may better encode these events into memory (Fujita et al., 1991). A second theory is the "cognitive-style" hypothesis, which proposes that there are differences between men and women in how they encode, rehearse, or think about their emotional experiences or in how they generate responses (Seidlitz & Diener, 1998).

Interestingly, in a functional MRI study by Canli et al. (2002) several interesting sex differences were found with respect to emotional memory. Behaviourally, women rated a greater proportion of emotional stimuli (e.g., pictures) as highly negative compared to men. Stimuli rated as highly negative by both men and women were remembered best but remembered better by women. Activationally, significantly more brain areas were activated in women by subjective emotional experience and by successful encoding of that experience into long-term memory compared to men. In other words, women had significantly more regions than men in which greater activation correlated with both emotional intensity ratings and enhanced recognition memory for the most emotionally intense pictures (Canli et al., 2002). These findings may suggest that women's enhanced memory for emotional pictures is due to greater overlap (i.e., better integration) of brain processes associated with emotional experiences and encoding of those experiences into memory (i.e., a neural mechanism for emotions to enhance memory more powerfully in women than men).

Overall, there are documented group differences between men and women in their emotional experience and memory for emotional information (e.g., enhanced recall of emotional

autobiographical events or stimuli, more vividness, quicker recall). Aside from the two theories mentioned above (i.e., "affect-intensity" and "cognitive style") it is also possible that hormones may be playing a role in the differences observed between sexes. For example, estradiol may enhance memory in women due to its ability to facilitate dendritic spine growth and neuroplasticity in the CA1 of the hippocampus (see review in Frankfurt & Luine, 2015). It is also of interest to mention the body of literature which suggests that hormone replacement therapy within a critical period after menopause may reduce Alzheimer's disease rates and increase cognitive ability in women (see reviews in Henderson 1997; Ryan et al., 2008). This provides evidence that exogenous hormones such as estrogens have the potential to affect cognition. Given this hormonal explanation, it is perhaps not surprising that some studies have found emotional memory differences between OC users, women, and men.

Emotional Memory and Oral Contraceptives

Few published studies, a total of seven, have examined the effects of OCs on emotional memory (Mordecai et al., 2017; Nielsen et al., 2014; Neilsen et al., 2011; Nielsen et al., 2013; Person & Oinonen, 2020; Petersen et al., 2014; Spalek et al., 2019). Given that research suggests that OCs can affect both emotion and cognition, it follows that OCs may have maximal effects on cognitive tasks that involve emotional stimuli. One study by Neilsen and colleagues (2011), examined the effects of OCs on memory for an emotional story. The authors specifically looked at memory for central story information (gist) versus peripheral details for both an emotionally arousing and closely matched neutral story. This was based on previous work that had shown a significant sex-related influence on memory for the gist (i.e., any story element that could not be changed or altered without changing the fundamental story line) versus detail (i.e., all other recalled elements) of these stories (Cahill & van Stegeren, 2003; Cahill et al., 2004), which was

later replicated by Nielsen and colleagues (2013). Nielsen et al. (2011) found that, similar to men and participants with high masculinity scores in past studies, OC users had enhanced memory for gist but not detail in the emotional story condition compared with neutral story condition. The opposite was true for free-cycling women, as they showed enhanced memory for detail but not gist in the emotional compared with neutral story conditions. This is the pattern typically seen for women versus men (or those with high masculinity scores; Cahill et al., 2004) on this emotional memory task. The Nielsen and colleagues (2011) study suggests a 'masculinization' of emotional memory with OC use (i.e., OC user performance was similar to men or participants with more masculine BEM Sex-Role Inventory scores). The authors postulated that it is plausible that OC use alters emotional memory by disrupting normal sex/stress hormone interactions involved in memory formation.

Nielsen and colleagues (2013) found evidence that OC use alters stress responses and emotional memory. They found that women taking OCs displayed a significantly blunted endogenous cortisol response to the Cold Pressure Stress test when compared to naturally cycling women. OC women also showed significantly blunted overall noradrenergic response to emotional images when compared to naturally cycling women. OC women who experienced noradrenergic activation at encoding and no cortisol activation while viewing the stimuli showed enhanced recall of emotionally negative information. The opposite was found for enhanced recall of positive images in OC women (i.e., only when cortisol was released post training in the absence of noradrenergic activation at encoding). No emotional memory enhancement for negative or positive images was seen for naturally cycling women, regardless of noradrenergic response and cortisol release. These results suggest that in OC users, norepinephrine at encoding and cortisol release post-training do not interact to enhance emotional memory. Instead, it seems

that for women using OCs, stress hormones seem to act independently to enhance memory for emotional material depending on the valence of the stimulus.

A third study by Nielsen and colleagues (2014) explored how a post-learning stressor might modulate the influence of OC status on memory for gist and detail in an emotional versus neutral story condition. Similar to Nielsen et al. (2011) OC users and nonusers viewed a brief narrated story containing either emotionally-arousing or neutral elements. However, immediately after exposure, a cold pressor stress (CPS) or a control procedure was administered. One week later, a surprise free recall test was administered to participants. It was found that nonusers exhibited greater cortisol increases to the CPS procedure compared to OC users. Nonusers who viewed the emotional version of the story and were administered the CPS procedure recalled the most details overall and more gist from the emotional compared to neutral story version. However, in OC users, the CPS procedure did not affect memory for gist or detail from the emotional or neutral story in any way. Similar to Nielsen et al. (2011), OC users and nonusers did not significantly differ on measures of attention and arousal. The findings suggest that post-learning stress differentially affects memory for gist and detail from an emotional story depending on OC status. Again, this study demonstrates that retention of emotional information differs in OC users and nonusers, and perhaps that OC status interacts with post-learning stress to modulate memory for emotional information.

Mordecai and colleagues (2017) examined the effects of a psychosocial stressor versus a control condition on cortisol responsivity and emotional memory retrieval of emotional words in OC users during their active or inactive pill phase. Following the stressor (Trier Social Stress Test), self-reported stress and anxiety were significantly increased for both pill phases. They found that emotional recall did not differ between active and inactive pill phases (i.e., similar

patterns of emotional recall). They also found that stress differentially diminished recall of negative words compared with positive or neutral words, but cortisol levels were unrelated to memory performance. The authors found it striking that the recall of negative stimuli was diminished despite no increase in cortisol level given past research that showed enhanced recall of negative stimuli for young men and women who lacked a cortisol response following a stressor (Buchanan & Tranel, 2008). These results raise the possibility that OCs provide protection against the enhancement of negative recall and could play a protective role against the recall of negative memories in mood and anxiety-related disorders (Mordecai et al., 2017). Overall, these findings indicate that OC users have distinct cortisol and memory responses to stress that do not depend on whether they are in the active pill phase.

Spalek and colleagues (2019) found that OC users outperformed nonusers in terms of their recall of emotional pictures. Participants were presented with 24 pictures per valence category (negative, positive, neutral) followed by an unannounced free recall task after a 10-minute delay. Participants were asked to describe the pictures with short keywords and to describe as many as possible. Overall, emotional pictures (positive, negative) were better remembered than neutral pictures. In terms of group differences, OC users recalled significantly more positive and negative pictures compared to nonusers while there was no group difference in the recall of neutral pictures. Mediation analyses were also conducted to examine whether the association between OC status and memory performance was mediated by observed differences in picture valence ratings. For negative pictures, the association was significantly mediated by the negative picture valence ratings. Likewise, for positive pictures, the association was partially, albeit nominally significant, mediated by the positive picture valence ratings. These results suggest that the established memory enhancing effect of emotion (i.e., emotional information is

better remembered than neutral; McGaugh, 2003) is more pronounced in OC users compared to nonusers. In addition, the findings suggest emotional valence perception explains, to a certain extent, memory performance differences between women.

Lastly, Petersen and colleagues (2014) found that OC use was associated with decreased susceptibility to false memories related to negative emotional situations using a misinformation paradigm. The results indicated that OC users incorporated fewer misinformation details into the original narrative than did nonusers during the misinformation stage. This suggests that OC use may be associated with changes to emotional memory processing mechanisms, leading to an overall decrease in false memories. The authors offer two possible interpretations. The first is that OC users may have stronger or more accurate memory for details of the original story (GIST) and the misinformation stage that allowed them to reject the misinformation instead of forming a false memory. The alternative is that OC users may have weak memory for the misinformation details that led to a failure to integrate them into the original memory. Peterson and colleagues favoured the later interpretation and this is also supported by Nielsen et al. (2011). This is the first study to show that OC use is associated with a reduction in false memories related to negative emotional situations.

Past research in our lab (Person & Oinonen, 2020) has found that OC users remembered relatively more positive than negative objects compared to nonusers and men on a visual spatial memory task. This effect was driven by OC users recalling fewer negatively-valenced objects than the free-cycling women. The findings held even after statistically controlling for affect. The results indicate that OCs may decrease immediate recall of negative emotional stimuli. These findings are somewhat similar to the findings from Petersen and colleagues (2014) where OC use was associated with a reduction in negatively-valenced false memories and the findings from

Mordecai and colleagues (2017) who found diminished recall of negative stimuli following a stressor. However, our findings are not necessarily consistent with the finding that OC use is associated with improved memory for negative stimuli when in a stressed state (Nielsen et al., 2014).

In summary, research has indicated that OCs can interact with stress hormones, such as cortisol, to alter stress responses and memory. A recent focus has been on emotional memory where studies indicate that OCs may alter memory for an emotional story, stress hormones may act independently of OCs to enhance memory for emotional material depending on the valence of the stimulus, OCs may enhance the recall of emotional stimuli with a link to emotional valence perception, and OCs may decrease susceptibility to negatively valenced false memories. These findings need to be replicated before they can be accepted, and additional studies are needed to examine any effects of OCs on short-term and long-term recall of positive, negative, and neutral stimuli both with and without exposure to a stress induction paradigm. It is also important to explore any sex differences in specific emotional memory modalities and whether OCs may have an influence on the perception, evaluation, and memory of emotional stimuli pertaining to certain sensory modalities such as visual, auditory, and olfactory modalities. The role of gender is also important to examine given that gender (i.e., masculinity) can be examined on a continuum and looking at the effects of gender within one sex can eliminate the effects of sex differences in role socialization.

Emotional Valence

Now that differences in affect, mood, and cognition have been discussed (both in terms of sex, hormones, and OC use) a more in depth look at emotional valence, intensity, and memory will follow given that they are of particular interest to the present study. In psychology, valence

denotes the intrinsic attractiveness/pleasantness (i.e., positive valence), aversiveness/ unpleasantness (i.e., negative valence), or indifference (i.e., neutral valence) of an event, object, or situation. The term valence is often used in relation to emotions (e.g., affect and mood) and can be used to categorize specific emotions. According to Larsen et al. (1987), valence appears to be largely determined by the specific stimulus that elicits the emotional response but may also be influenced by individual differences in perception. Thus, valence plays an important role in affective judgments.

Valence has been found to affect emotional reactions and brain sensitivity. Research indicates that emotions elicited from negative film clips are more distinct (i.e., readily distinguishable) than emotions due to positive film clips (Hagemann et al., 1997). One study investigated brain sensitivity to valence differences in emotionally negative and positive stimuli (i.e., images ranging from extremely to moderately positive or negative, as well as neutral) by recording event-related potentials (Yuan et al., 2007). They found that extremely negative stimuli elicited more negative deflections then the moderately negative stimuli while there were no differences in amplitude or latency during the positive conditions. The results from Yuan and colleagues (2007) suggest that the human brain is only sensitive to valence differences in negative stimuli. However, in another study individuals viewed images (positive vs. negative valence) that varied in arousal level (high vs. low) while undergoing fMRI (Garavan et al., 2001). They found that amygdala activation significantly increased for both positively and negatively valenced stimuli and did not differ for these two valences. These results suggest that the human brain (i.e., the amygdala specifically) plays a role in processing emotional stimuli that extends beyond negative valence to include positively valenced stimuli as well.

The valence hypothesis acknowledges the right hemisphere's role in emotional processing but contends that it is mainly focused on the processing of negative emotions whereas the left hemisphere processes positive emotions (Davidson, 1992, 1995). Consistent with this theory, Dolcos and colleagues (2004) found that specific regions in the left dorsolateral prefrontal cortex (PFC) were more activated for positive than for negative picture evaluation, whereas the right ventrolateral PFC showed the opposite pattern. It was also found that activity in the ventromedial PFC was sensitive to positive valence. Thus, the human brain also shows certain activational patterns associated with the valence of stimuli.

Emotional Valence and Sex Differences

A number of sex differences in response to valence have been found. For example, men are more responsive to positive images than women, especially to erotic images (Wrase et al., 2003). Men also show a brain pattern (e.g., greater activation in the bilateral amygdala and the left fusiform gyrus) that reflects greater attention to cues of aggression (i.e., negative valence) than females do (Schienle et al., 2004). Although these findings suggest men can be more responsive to both positive and negative stimuli, a meta-analysis found that the majority of sex differences in brain activation to emotional stimuli favoring men (i.e., men showing greater activity) are observed for positive emotion, whereas the majority of sex differences favoring women are observed for negative emotion (Stevens & Hamann, 2013). Overall, amygdala activation can differ in both direction and magnitude for men and women depending on the valence of the expression (Wagner et al., 2003). These neuroimaging studies are important as they contribute objective data which give a better understanding of sex differences in emotional behaviour as the research is largely based on more subjective measures. These neuroimaging

studies also illustrate the potential importance of considering valence and sex differences when investigating emotional processing.

Although many studies have examined differences in brain activation and behavioural output in response to valence (i.e., by including positive, negative, and neutral stimuli in their study designs) or included stimulus ratings by valence category (i.e., pleasantness/unpleasantness, arousal etc.) no studies were identified that looked at sex/gender differences in the perception of valence [i.e., whether a participant is more likely to categorize stimuli as more positive, more negative, or equally positive and negative (i.e., neutral)]. One study has examined OC-related differences in the valence perception of emotional stimuli (Spalek et al., 2019). Spalek and colleagues (2019) had participants rate 24 positive, 24 negative, and 24 neutral pictures during a laboratory session. Participants rated the pictures according to valence (negative, neural, positive) on a three-point scale. Overall, emotional pictures (positive, negative) were rated more extremely compared to neutral pictures (i.e., the positive and negative stimuli had larger z-transformed valence ratings). In terms of group differences, OC users rated the valence of negative and positive pictures as more extreme than nonusers (i.e., OC users rated the valence of negative pictures as more negative and positive pictures as more positive rather than more neutral). In addition, OC users rated the valence of neutral stimuli as more neutral than nonusers while nonusers rated them towards a positive valence perception. The observation of more extreme emotional valence ratings in OC users and the greater tendency to evaluate neutral stimuli as neutral suggests a more polarized perception of both negative and positive stimuli but not when it comes to non-emotional stimuli (i.e., they are more likely to be rated as neutral).

Emotional Intensity

Emotional intensity (or "affect intensity") can be defined as individual differences in the strength with which individuals experience their emotions (Larsen & Diener, 1987). Thus, along with valence, intensity plays an important role in affective judgments. According to Larsen and Diener (1987), individual differences in affect intensity are highly stable over time and highly consistent across situations. Within the literature there are studies examining affect intensity and arousal models (Larsen & Diener, 1987) and age and sex correlates (Diener et al., 1985). The relationship between emotional intensity and frequency of mood change (Larsen, 1987; Diener et al., 1985) as well as daily life events (Larsen et al., 1986) have also been studied. In addition, there is research addressing the relationship between emotional intensity, temperament, and personality (Bachorowski & Braaten, 1994; Larsen & Ketelaar, 1991; Mc Fatter, 1998), information style (Dritschel & Teasdale, 1991; Larsen et al., 1996; Larsen et al., 1987), and facial responses (Keltner & Ekman, 1996).

In a longitudinal study examining emotional intensity and emotional responses to day-to-day events, Larsen et al. (1986) found that individuals characterized as high in emotional intensity tended to report stronger emotional responses to day-to-day events than individuals characterized as low in emotional intensity. This difference was consistent across high and low levels of emotional stimulation and occurred regardless of the valence of the eliciting event (e.g., positive or negative). In addition, those individuals characterized as high on emotional intensity rated their emotional responses as more intense regardless of whether the eliciting event was mild, moderate, or severe, and regardless of whether it was pleasant or unpleasant. This study suggests that both valence and intensity are separate and important factors to consider when looking at differences in emotional perception (i.e., affective judgements).

Overall, emotional intensity plays an important role in how individuals experience their emotions and, accordingly, it can influence affective judgments. With regards to the measurement of emotional intensity, factor analyses of emotional intensity items have often revealed separate positive and negative affect factors (Meyer & Shack, 1989; Williams, 1989). Thus, when considering the relationship between any variable and emotional intensity, the question of whether positive intensity is related in the same way as negative intensity to that variable must be addressed (McFatter, 1998). Given the separate positive and negative affect factors and the potential for differential effects, future research could have participants rate stimuli on both a positive intensity scale and a negative intensity scale.

Emotional Intensity and Sex Differences

Based on self-reports of emotions, women report more intense experience of emotions than men and more intense expression (Allen & Haccoun, 1976; Balswick & Avertt, 1977; Fujita et al., 1991; Gohm, 2003; Larsen & Diener, 1987), particularly for specific types of stimuli. For example, women show a stronger affective response to viewing infants than men (Proverbio et al., 2006a; Proverbio et al., 2006b) or listening to infant vocalizations (Sander et al., 2007). Women also show more intense responses towards aversive stimuli (e.g., fear and disgust) while men show a greater sympathetic reactivity towards erotic stimuli (Sabatinelli et al., 2004; Wager et al., 2003). According to Diener, Sandvik, and Larsen (1985), sex differences in intensity of emotional experience occur across the lifespan (e.g., in adolescents as well as middle-aged adults).

Sex differences in emotional intensity can also be viewed according to gender role theory. This interpretation involves gender as opposed to sex and can have important implications. According to gender role theory, women have greater emotional intensity

compared to men due to normative expectations for sex differences that occur because of different social roles for men and women (Eagly, 1987). In a study by Grossman and Wood (1993) sex differences in the intensity of emotional experience was tested using a social role interpretation. They found that endorsement of normative expectations for sex differences was associated with sex difference in participants' own emotions. That is, self-reports of emotional response corresponded to participants' stereotypic beliefs. More specifically, women who endorsed the stereotypic belief that women are more intensely sad, fearful, joyous, and in-love than men reported experiencing heightened emotions themselves while men who endorsed the same stereotypic belief reported a relatively subdued emotional response. The researchers then manipulated social role expectations and found that when instructions rendered normative expectations comparable for men and women there were no sex differences in emotion self-reports. That is, men and women instructed to be especially responsive to the emotional stimuli indicated more extreme emotions to both positive and negative stimuli in comparison with the no-instruction condition. The men and women instructed to be unresponsive reported slightly (though non-significantly) less extreme emotions in comparison with the no-instruction condition. Thus, when sex-differentiated normative expectations were muted by the experimental instructions, men and women did not differ in their emotion self-reports. This suggests that gender-related expectations may contribute to sex differences in self-report. Or it may be that women have the skills necessary to inhibit emotions when instructed to do so.

Grossman and Wood (1993) utilized an electromyograph physiological (EMG) measure and found that women evidenced more extreme responding than men. It was found that women demonstrated greater emotional intensity reactions to negative stimuli (e.g., emotion-inducing slides) than men on the physiological measure as well as on a self-report measure. There were no

sex differences in EMG reaction to the positive stimuli. This study shows that women demonstrated heightened emotional reactions to negative experiences when compared to men, across multiple measures. When instructions were changed to render normative expectations for men and women (i.e., social role expectations for responsiveness were manipulated), no sex differences were obtained on the emotional self-report measure. However, women still evidenced more extreme responding on the EMG measure, suggesting general sex difference in emotion beyond self-report. While these findings suggest a physiological reason for women's more intense emotional responses, they do not rule out the possibility that gender socialization played a role in the acquisition of such hard-wiring.

The above research speaks to emotional intensity as a trait characteristic or affective response. In a study by Biele and Grabowska (2006), sex differences in the perception of emotion intensity in dynamic and static facial expressions were examined. The aim of the study was to investigate if ratings of intensity are sex-dependent and if ratings of perceived intensity differ between static and dynamic facial expression of emotion (e.g., pictures vs. animations of anger and happiness displayed by both men and women). It was found that emotion on angry faces was judged as more intense than on happy faces and intensity of emotion of dynamic faces was judged as more intense than static faces. However, these effects were sex-dependent. Women judged anger as more intense than happiness, and dynamic expressions as more intense than static, while men rated dynamic expression as more intense than static only for the expression of anger but not happiness. In another study by Schienle and colleagues (2004), it was found that women displayed more intense responses than males to disgusting and fear-eliciting images as indicated by self-report data. Together, these results suggest that there are sex

differences in the affective judgments of emotional states and that dynamics enhance emotional expression and play an important role in the perception of emotional intensity.

With respect to OC-related differences in intensity ratings of emotional stimuli, only two studies were identified (Gamsakhurdashvili et al., 2021; Spalek et al., 2019), both of which were published after this study was proposed. Spalek and colleagues (2019) had participants rate 24 positive, 24 negative, and 24 neutral pictures during a laboratory session. The pictures were rated according to arousal (low, middle, high) on a three-point scale. It is important to note that arousal is slightly different from affective intensity evaluation (i.e., both are measuring the extent or degree, but arousal can be seen as more of a biological bodily reaction). In terms of group differences, OC users rated neutral pictures as less arousing compared to nonusers while there were no group differences in the arousal ratings for positive and negative pictures. Although not the main focus of the study by Gamsakhurdashvili and colleagues (2021), participants rated 20 positive, 20 negative, and 20 neutral pictures during a laboratory session. It was found that the OC group consistently rated negative pictures as more aversive than free-cycling women across the menstrual cycle (i.e., in both the mid-cycle and later cycle).

Research Questions

As reviewed earlier, research has demonstrated sex differences in various emotional constructs (e.g., intensity, reactivity). Several studies have found that hormones and hormonal change can alter emotional memory and processing. Research also shows that there is an increase in the prevalence rates of mood disorders for women in hormonal transition phases (e.g., puberty, premenstrual phase, post-partum, menopause). These hormonal findings suggest that the intake of OCs may influence emotional processing and related mood disorders as well. However, previous studies on emotional processing (i.e., stimuli perception and evaluation) rarely examine

the effects of hormones, especially OC use. Furthermore, the influence of gender has not been fully examined in relation to observed sex differences in emotional processing.

In addition to emotional memory, the present study focused on two primary affective dimensions of emotional processing: valence (i.e., stimuli perception) and affective intensity (i.e., stimuli evaluation). We were interested in whether individuals differ in (1) their perception of a stimulus as either positive, negative, or equally positive and negative (i.e., neutral) and (2) the extent to which they evaluate a stimulus as affectively positive and negative. The study consisted of an online questionnaire and laboratory session that evaluated how sex, gender (i.e., masculinity and femininity), and hormonal status (e.g., OC use) affect the immediate perception of, evaluation of, and memory for emotional stimuli across visual, olfactory, and auditory sensory modalities.

Hypotheses

Hypothesis 1: Valence, Emotional Memory, and OC Use. OC users will recall relatively more positive than negative stimuli than nonusers and men when short-term memory is tested (H1). OC users recalling fewer negative stimuli than nonusers will drive this effect. This hypothesis was based on findings from Person and Oinonen (2020) and looked at the replicability of these findings.

Hypothesis 2: Valence, Sex, Masculinity, and OC Use. It was hypothesized that men will: (a) be more likely to categorize or perceive the emotional stimuli as positive and be less likely to perceive the emotional stimuli as negative than either OC users or nonusers (H2a). This hypothesis was based on findings from Person and Oinonen (2016) that showed this relationship as well as the finding that most sex differences in brain activation to emotional stimuli favouring men are observed for positive emotion while those favouring women are observed for negative

emotion (Stevens & Hamann, 2013). To extend these findings, it was hypothesized that (b) within each sex, those scoring high on masculinity and/or low on femininity will be more likely to perceive the emotional stimuli as positive and less likely to perceive the emotional stimuli as negative than those scoring low on masculinity and/or high on femininity (H2b). This allowed us to use a more continuous measure of sex (i.e., masculinity) versus a dichotomous measure of sex (i.e., male, female) to differentiate sex versus masculinity differences as this would allow examination of whether masculinity/femininity or an adherence to societal gender role may explain some or even much of the inter-individual differences.

Hypothesis 3: Intensity, Sex, Masculinity, and OC Use. OC users and nonusers (i.e., women) will (a) show greater emotional intensity in their ratings for emotional stimuli compared to men, regardless of valence (H3a), and (b) this sex difference will be stronger between OC users and men than nonusers and men (H3b). These hypotheses were based on findings that women experience greater emotional intensity than men (e.g., Fujita, Deiner, & Sandvik, 1991; Gohm, 2003) and that OC use may amplify this sex difference (Person & Oinonen, 2016). To extend these findings, it was hypothesized that (c) within each sex, those scoring high on masculinity and/or low on femininity will show less emotional intensity in their ratings than those scoring low on masculinity and/or high on femininity (H3c).

Method

Participants

The final sample consisted of 105 participants (38 OC users, 41 nonusers, 26 men) who were university students and community volunteers recruited from the university, local community, and internet community. They completed the study between May 2018 and December 2019. University students were 16 years of age or older and community participants

were 18 years of age or older. The majority of participants were Caucasian (82%) and current college or university undergraduate students (86%) with a mean age of 20.72 (SD = 2.97). Descriptive statistics of the final sample can be found in Tables 1 and 2. Incentives for participation included bonus points for Lakehead University students in eligible psychology courses and a random prize draw for one of two $50 VISA gift cards. This study received ethical approval from Lakehead University's Research Ethics Board (see Appendix A).

Initially, 608 participants (279 OC users, 240 nonusers, 89 men) completed an initial online questionnaire. Of those who completed the online questionnaire, 191 participants (83 OC users, 67 nonusers, 41 men) completed a laboratory study. To ensure all participants were of reproductive age, a maximum age of 45 years was used as a cut-off given that the average age at natural menopause is 51 years (Gold et al., 2001; Palacios et al., 2010). There were no initial inclusion/exclusion criteria prior to participating in the online questionnaire or laboratory session. However, the following post-hoc exclusion criteria were applied, resulting in the final sample of 105 participants: (a) age under 16 or older than 45 (n = 1), (b) use of mood-altering medications, other than OCs (e.g., antidepressants, lithium, benzodiazepines; n = 42), (c) current mood disorder (n = 36), (d) brain injury (n = 7), (e) diagnosed memory problem (n = 4), (f) more than one alcoholic drink within 24 hours prior to the laboratory session (n = 8) and (g) use of recreational drugs within 24 hours prior to the laboratory session (n = 10). For female participants, additional exclusion criteria included: (a) current pregnancy or lactation/breastfeeding (n = 0), (b) hysterectomy or menopausal status (n = 1), and (c) non-oral hormonal contraceptive use (e.g., intrauterine device, implant, patch etc.; n = 9). In addition, all women classified in the OC user group had used OCs for at least two months while women classified in the nonuser group must have discontinued OCs for at least two months.

Table 1

Demographic Characteristics of Final Sample

Variable	Frequency (%)
Sex	
Female	79 (75.2)
Male	26 (24.8)
Oral Contraceptive Status (Women)	
Nonusers	41 (51.9)
Users	38 (48.1)
Ethnicity	
White/European American	86 (81.9)
Asian/Pacific Islander	6 (5.7)
Black/African American	6 (5.7)
Indigenous	3 (2.9)
Multiple Ethnicity	1 (1.0)
Highest Education	
Current undergraduate student	90 (85.7)
Graduated high school	9 (8.6)
Graduated university or college	5 (4.8)
In graduate school	1 (1.0)

Note: $N = 105$.

Table 2

Oral Contraceptive Type for OC Users

Variable	Frequency (%)
Oral Contraceptive Type (OC users)	
Alesse (Alysena)	15 (39.5)
Aviene	1 (2.6)
Cyclen	1 (2.6)
Freya	1 (2.6)
Marvelon	4 (10.5)
Min-Ovral	1 (2.6)
Mirvala	2 (5.3)
Seasonique	1 (2.6)
Tri-Cyclen	4 (10.5)
Triquilar	1 (2.6)
Tricira Lo	1 (2.6)
Yasmin	2 (5.3)
Unsure	4 (10.5)

Note. $n = 38$.

Measures and Tasks

Initial Questionnaire

The initial online questionnaire (see Appendix B) contained questions about demographics (e.g., age, sex, ethnicity), memory issues (e.g., history of a concussion or brain injury), mental health history, and a variety of factors that were hypothesized to have potential effects on perception and memory such as stress, sleep, alcohol and caffeine consumption, medications, medical and psychological conditions, exercise, and diet. There were also questions about menstrual cycle phase and OC use (yes/no, OC type, duration of use) for female participants to determine group membership. Many of the questions were developed within the Health, Hormones, and Behaviour Laboratory and have been used in numerous previous studies (e.g., Oinonen, 2009; Person & Oinonen, 2020). Additional measures of mood (described below) were included as possible covariates or to provide additional information about participant mood (e.g., reactivity, regulation). The initial questionnaire included the following measures: Toronto Empathy Questionnaire (TEQ; Spreng et al., 2009; item 36 in Appendix B), Toronto Alexithymia Scale (TAS-20; Bagby et al., 1994; item 37 in Appendix B), Perth Emotional Reactivity Scale (PERS; Becerra et al., 2017; item 38 in Appendix B), Reduced Emotional Intensity Scale (EIS-R; Bachorowski & Braaten, 1994; items 39 in Appendix B), Emotion Regulation Questionnaire (ERQ; Gross & John, 2003; item 40 in Appendix B), Affect Intensity Measure – Short Form (AIM; Larsen, 1984; item 41 in Appendix B), Symptom Checklist 90 Revised – Depression Subscale (SCL-90-R; Derogatis, 1994; item 42 in Appendix B), Bem Sex Role Inventory - Short Form (BSRI; Bem, 1981; item 43 in Appendix B), Personal Attributes Questionnaire (PAQ; Spence & Helmriech, 1978; items 44 in Appendix B), BIS/BAS Scale (Carver & White, 1994; item 45 in Appendix B), and the Social Desirability Scale-17 (SDS-17;

Stober, 1999; item 46 in Appendix B). The measures that were used in the analyses are described in more detail below. Details on the remaining measures can be found in Appendix C.

Bem Sex Role Inventory (BSRI). The Bem Sex Role Inventory provides independent assessments of masculinity and femininity (Bem, 1981). This 60-item self-report questionnaire measures stereotypically masculine and feminine personality characteristics. The inventory consists of three scales, each containing 20 items: masculine (i.e., items reflecting traits that are traditionally believed to be more common in men such as being aggressive, independent, willing to take risks), feminine (i.e., items believed to be more common in women such as being affectionate, compassionate, eager to soothe hurt feelings), and gender-neutral (e.g., secretive, adaptable, conventional). Participants are asked to rate themselves on how well each personality characteristic describes them on a seven-point Likert scale ranging from 1 (*never or almost never true*) to 7 (*always or almost always true*). The BSRI has demonstrated adequate internal consistency, with coefficient alphas of .87 for the masculinity and .78 for the femininity scales (Bem, 1981). The inventory has also demonstrated high test-retest reliability (Bem, 1981). Only items on the masculinity and femininity subscales (i.e., 40 items) were included in the present study to assess differences in participants' self-perceived femininity and masculinity. This measure was used to examine within-sex continuous gender differences (i.e., masculinity, femininity), as opposed to categorical sex differences (i.e., man, woman), in the perception and evaluation of the emotional stimuli.

Personal Attributes Questionnaire (PAQ). The PAQ is a measure of gender specific personality characteristics (Spence & Helmriech, 1978). It is a 24-item self-report questionnaire that includes three scales, each containing eight characteristics. The three scales with examples of some of their characteristics include: masculinity (e.g., active, competitive), femininity (e.g.,

emotional, gentle), and androgyny (e.g., worldly, confident). Participants were asked to indicate the extent to which they would characterize themselves in terms of the various personal qualities on a five-point continuum between two extremes (e.g., *not at all aggressive* to very *aggressive*). The internal consistency of the masculinity and femininity scales are acceptable, with alpha coefficients ranging from .74 and .83 (Hill et al., 2000). Only items on the masculinity and femininity subscales (i.e., 16 items) were included in the present study to measure participants' gendered attitudes and self-perceived masculinity and femininity.

Social Desirability Scale-17 (SDS-17). The Social Desirability Scale-17 (SDS-17) is a measure of social desirability that is independent of psychopathology (Stober, 1999, 2001). The SDS-17 is a reliable and valid measure of social desirability for adults aged 18 to 80 years. It shows high sensitivity toward social desirability, excellent test-retest reliability (r = .80 over two to four weeks), moderate to high convergent validity (r = .52 to .85), and good divergent validity (r = -.14 to .38) (Stober, 1999, 2001). A measure of social desirability was included to examine the potential for socially desirable responding since the tendency to respond in a socially desirable way may be related to social norms and how men and women express and describe their emotions, react to emotional objects/situations, perceive, and/or evaluate emotional stimuli.

Attention (Choice Reaction Time Accuracy)

The choice reaction time test is one subtest of the California Computerized Assessment Package (CalCap). The CalCap is a measure of attention that assesses reaction time, speed of information processing, rapid visual scanning, form discrimination, brief memory, and divided attention (Miller, 1990). The abbreviated version was used in the laboratory session. This version takes 10 minutes to administer and uses only those measures from the standard test battery that are most sensitive to cognitive decline. The abbreviated test battery consists of four tasks: Simple

Reaction Time, Choice Reaction Time, Serial Pattern Matching 1, and Serial Pattern Matching 2. The CalCap was used to assess whether there were any group differences in terms of basic attention abilities or motivation/effort. In particular, the d prime score (a measure of discriminability) from the Choice Reaction Time test was used to examine group differences in attention. The Choice Reaction Time instructs participants to press a key as soon as they see a specific number on the screen, adding a simple element of working memory and selective attention to the task. The Choice Reaction Time test was chosen as the internal consistency is quite high, and it includes a measure of d prime, a sensitive indicator of performance on the attention task that provides an index of an individual's ability to accurately discriminate target stimuli from distractor stimuli using both hits and false alarms. Overall, the CalCap has very high internal consistency reliability (r = .77 to .96), indicating that the constructs show uniform assessment across the trials of each task. In terms of the Choice Reaction Time measures, the six-month test-retest reliability (r = .43 to .68) is comparable to other similar conventional neuropsychological tests. Internal consistency reliability for the Choice Reaction Time measures is also quite high (r = .81 to .96; Miller, 1990).

Valence and Intensity Measures

To examine individual differences in the perception and evaluation of emotional stimuli, participants used two scales developed for this project to rate the valence and affective intensity of the respective stimuli (see Appendix D). These measures were used to evaluate stimuli in five tasks (noted below). All tasks used the same rating scales to assess valence and intensity. Participants were asked to indicate the extent to which they perceive each stimulus as positive, negative, or neutral by evaluating each stimulus using two continuous scales: a positive scale and negative scale that denote affective intensity and valence. Response options ranged from 0 (*not*

at all positive) to 10 (*extremely positive*) for the positive scale and from 0 (*not at all negative*) to 10 (*extremely negative*) for the negative scale. These two separate scales were chosen so that participants could rate each stimulus according to both positive and negative dimensions given that some participants may not always perceive the stimuli as either strictly positive or strictly negative (i.e., some stimuli might be perceived as both positive and negative). In addition, a categorical measure (i.e., forced choice) was obtained by asking participants to directly categorize each stimulus as either positive, negative, or neutral. Thus, three questions were asked about each stimulus.

Emotional Spatial Memory Test

The Emotional Spatial Memory Test (Person & Oinonen, 2020) assesses memory for stimuli with positive, negative, and neutral emotional valence in addition to assessing the location of each stimulus on a grid. However, the spatial location of the stimuli was not assessed in the current study given that spatial memory was not of interest (i.e., interested in valence effects). During this test of emotional visual memory, participants are presented with a tray containing 30 objects or stimuli (e.g., artificial flower, toy gun, button). Please see Appendix E for a complete list of objects. The tray is divided into 30 small equal sections, with one item found in each section, and the same item always occupying the same spot on the tray. The stimuli include 10 emotionally positive, 10 emotionally negative, and 10 emotionally neutral objects as determined through a pilot study that verified the emotional valence of each item (see Person & Oinonen, 2020). Participants are instructed to look at each item on the tray for a total of 60 seconds and think about how each of the objects make them feel. This instruction is given to both enhance the emotional value of the stimuli and to provide the participants with a common activity that maximizes the likelihood that the objects are attended to. After 60 seconds a towel is

placed over the tray and the tray is removed from the participant's view. The immediate free recall test followed, where participants are asked to list aloud as many objects as they can remember. The total number of positive, negative, and neutral objects recalled was recorded. This task was completed during the laboratory session. Correlations between overall memory scores for the Emotional Spatial Memory Test and other memory tasks included in the study indicate that the different memory tasks are measuring a common construct (i.e., memory) (see Table 3), and provide some evidence for construct/ convergent validity. Not surprisingly, the Emotional Spatial Memory Test was most strongly correlated with the Emotional Picture Task, r (74) = .42, p = <.001 (i.e., both measure visual memory). The means, standard deviations, and percent correct scores are reported in Table 4.

Emotional Picture Task

Positive, negative, and neutral images from the International Affective Picture System (IAPS; Lang et al., 2008) were used to create an emotional picture rating task. The task consisted of 30 pictures of various objects, nature scenes, and human experiences (10 positive, 10 negative, 10 neutral). Details can be found in Appendix E. The IAPS is widely used to investigate emotional processes, as it allows for systematic selection of images that range in emotional intensity and content (Lang et al., 2008). There are standardized ratings for valence and arousal which allows researchers to replicate published findings using a specific selection of images, aid interpretation, and allow conclusions to be drawn from multiple studies using this task. Images were selected based on evolutionary relevance as well as those that had the most extreme or neutral ratings. The standardized IAPS ratings range from 1 (*very negative*) to 10 (*very positive*). According to the official normative ratings of the IAPS images, the positive images selected for the study had a mean rating of 7.86 (*SD* = 0.35), the neutral images selected had a mean of 4.94

Table 3

Pearson Correlations Between Overall Memory Scores

	VSMT	WL	PT	FT
Spatial Memory Task (VSMT)		.30**	.42**	.22*
Word List (WL)	.30**		.09	.19
Picture Task (PT)	.42**	.09		.30**
Facial Task (FT)	.22*	.19	.30**	

Note. $n = 79$ (except for image variables where $n = 74$). The Emotional Spatial Memory Test and Emotional Word List are recall tasks while the Emotional Picture Task and Emotional Facial Task are recognition tasks.

* $p < .05$; ** $p < .01$

Table 4

Unadjusted Means (SDs) and Percent Correct for Memory Variables

	Mean (SD)	% Correct
Overall Memory Scores		
Object Recall (/30)	13.57 (2.95)	45.23
Face Recognition (/12)	9.15 (1.60)	76.25
Word Recall (/45)	8.65 (3.23)	19.22
Image Recognition (/30)	28.03 (3.53)	93.60
Positive Memory Scores		
Object Recall (/10)	4.34 (1.55)	43.40
Face Recognition (/4)	3.24 (0.71)	81.00
Word Recall (/15)	3.02 (1.56)	20.13
Image Recognition (/10)	9.39 (1.25)	93.90
Negative Memory Scores		
Object Recall (/10)	5.58 (1.44)	55.80
Face Recognition (/4)	3.37 (0.87)	84.25
Word Recall (/15)	3.11 (1.63)	20.73
Image Recognition (/10)	9.47 (1.21)	94.70
Neutral Recall/Recognition		
Object Recall (/10)	3.65 (1.57)	36.50
Face Recognition (/4)	2.54 (0.99)	63.50
Image Recognition (/10)	9.18 (1.48)	91.80
Positive to Negative Memory Ratio		
Object Recall	0.84 (0.28)	n/a
Face Recognition	1.03 (0.48)	n/a
Word Recall	1.19 (1.04)	n/a
Image Recognition	1.00 (0.10)	n/a

Note. $N = 105$ (except for image variables where $n = 96$). The Emotional Word List did not contain neutral words. Ratios were calculated using the following formula: (positive recall/recognition +1) / (negative recall/recognition +1).

(*SD* = 0.10), and the negative images selected had a mean of 2.32 (*SD* = 0.40; see Appendix F). Participants in the current study viewed each image on a computer screen for three seconds and rated the valence and affective intensity of each image as per the three rating scales described above. Immediately following this rating task, short-term memory for the images was tested using a recognition task that consisted of the original 30 images as well as 30 new (but similar) images/foils (10 positive, 10 negative, 10 neutral). Participants indicated whether they had previously viewed the image using a YES/NO response format. This task was completed during the laboratory session. Mean valence and affective intensity scores in addition to recognition scores were calculated for this task. Again, correlations between overall memory scores for the Emotional Picture Task and other memory tasks included in the study can be seen in Table 3. The means, standard deviations, and percent correct scores are reported in Table 4 while the mean valence and affective intensity scores are reported in Table 5 and Table 6 under the Data Reduction section of the Results.

Emotional Facial Task

Facial stimuli were also included in the present study, as the perception of emotional facial expressions may show interesting sex and emotion/valence-dependent differences. The Emotional Facial Task was developed using faces from the Karolinska Directed Emotional Faces (KDEF) database from the Emotion Lab at Karolinska Institute (e.g., Garrido & Prada, 2017). Both databases are composed of digitized colour photos of adult male and female volunteers. The photos consisted of frontal views and profile rotations up to 180 degrees. The present task included an equal number of positive, negative, and neutral expressions (12 positive, 12 negative, 12 neutral). The emotionality of the faces included the portrayal of happiness or surprise for positive expressions while negative expressions portrayed fear, disgust, anger, or

sadness. The neutral facial expressions exhibited a neutral expression. In addition, an equal number of male and female photographs were used both overall (18 males, 18 females) and within each condition (e.g., for positive facial expressions there were 6 male and 6 female faces). Participants first viewed each facial photo for 3 seconds in a slideshow until all 36 faces were viewed. Short-term memory for the images was then tested using a recognition task that consisted of 24 faces: 12 original facial photos (targets: 4 positive, 4 negative, 4 neutral) and 12 new previously unseen facial photos (foils: 4 positive, 4 negative, 4 neutral). To control for serial position effects, every second face from the original 36 facial photos was selected to comprise the 12 original facial photos in the recognition task (e.g., every second positive face, every second negative face, every second neutral face). Photos were shown in the same randomized order for each participant. Participants indicated whether they previously viewed the image using a YES/NO response format. An overall recognition score was calculated to reflect all of the correctly identified faces ("yes" responses) and foils ("no" responses) with a possible range of 0 to 24. Participants later rated the valence and affective intensity of each original face as per the rating scales described above. This task was completed during the laboratory session. Mean valence and affective intensity scores in addition to recognition scores were calculated for this task. Again, correlations between overall memory scores for the Emotional Facial Task and other memory tasks included in the study can be seen in Table 3. The means, standard deviations, and percent correct scores are reported in Table 4 while the mean valence and affective intensity scores are reported in Table 5 and Table 6 under the Data Reduction section of the Results.

Emotional Word List

The Emotional Word List was created using words from a previous study by Perry (2014). The words were originally used in an emotional Stroop Task but were used as a word list

here. The present study used the words from their negative affect, positive affect, and premenstrual symptom categories. The premenstrual symptom category of words (e.g., cramp, nausea, tearful, temper) was created by Perry and colleagues and was utilized in the present study to explore any potential differences in the response to these words. There were 15 words in each category (45 in total; please see Appendix E for a complete list of words). The words across groups were matched for written frequency, imageability, word length, and number of syllables using the MRC psycholinguistic database (Wilson, 1988). In the present study, participants viewed each word presented in a slideshow for three seconds followed by an immediate and surprise free recall test. Participants were then asked to rate the valence and affective intensity of each word as per the rating scales described above. This task was completed during the laboratory session. Mean valence and affective intensity scores in addition to recall scores were calculated for this task. Again, correlations between overall memory scores for the Emotional Word List and other memory tasks included in the study can be seen in Table 3. The means, standard deviations, and percent correct scores are reported in Table 4 while the mean valence and affective intensity scores are reported in Table 5 and Table 6 under the Data Reduction section of the Results.

Emotional Auditory Task

This audio task consisted of a selection of sounds obtained from freesound.org. The sounds were positive (e.g., laughter, upbeat instrumental music), negative (e.g., crying/yelling, car crash), or neutral (e.g., faucet dripping, breathing) in valence. Please see Appendix E for a complete list of sounds. The task consisted of listening to 30 individual sounds (10 positive, 10 negative, 10 neutral) for approximately 3 seconds each. Participants listened to each sound (embedded in a PowerPoint slide show) and rated the affective intensity and valence of that

sound as per the rating scales described above. The volume on the computer was always set to the same setting. Participants were not allowed to replay the sounds. This task was completed during the laboratory session. Mean valence and affective intensity scores are reported in Table 5 and Table 6 under the Data Reduction section of the Results.

Olfactory Task

The Olfactory Task used Burghart sniffin' sticks (Burghardt ®, Wedel, Germany) which are pen-like devices filled with odourant instead of ink. The sticks have been used in previous studies that found odour performance was affected by menstrual cycle phase, duration of OC use, and sex (i.e., better odour discrimination and identification in females vs. males) (e.g., Bogdan et al., 2021; Derntl et al., 2012; Stanić et al., 2021). The odour identification task consists of 16 common odours: orange, shoe leather, cinnamon, peppermint, banana, lemon, licorice, turpentine, garlic, coffee, apple, clove, pineapple, rose, anethole, and fish. The Burghart sniffin' sticks have been found to have high test-retest reliability for odour discrimination ($r = 0.80$), odour identification ($r = 0.88$), and odour threshold ($r = 0.92$; Haehner et al., 2009). For the purpose of this study, participants were not asked to identify the smell but instead to rate each odour for valence and affective intensity using the valence and intensity measures described above. During the rating process, the cap was removed from the stick and the participant smelled the tip of the stick for 3 seconds before giving their ratings for that odour. All participants smelled and rated the sticks in the same order. Mean valence and affective intensity scores are reported in Table 5 and Table 6 under the Data Reduction section of the Results.

Voice Recordings

To include a more objective non-self-report and continuous measure of sex/gender/masculinity, voice recordings were taken to later analyze and determine voice pitch.

Participants were recorded reading the following phrase out loud, “a, e, i, o, and u” as in previous studies examining changes in voice pitch across the menstrual cycle (e.g., Banai, 2017) or vocal attractiveness/masculinity preferences of voice pitch (e.g., Borkowska, 2010; Feinberg et al., 2006; Feinberg et al., 2008; Fraccaro, 2012). Participants were asked to read the phrase clearly at a normal rate and rhythm in their usual voice. The voice recordings were saved, labelled with the appropriate participant code, and later analyzed using the Praat 4.0 software to determine voice pitch and fundamental frequency in hertz (Hz). The process for calculating these two variables is described in the Data Reduction section of the Results.

Laboratory Questionnaire

This questionnaire was completed at the end of the laboratory session and contained questions pertaining to a variety of factors that were theorized to be potentially relevant and to have potential effects on perception, memory, and performance including: sleep, alcohol and caffeine consumption, tobacco use, medications, hunger, fatigue, boredom, and interest. The laboratory questionnaire can be found in Appendix G. It included the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988; item 17 in Appendix G) and some additional measures for female participants: OC Side Effects Questionnaire (OCQ; Oinonen & Bird, 2012; items 25-28 in Appendix G), Menstrual Distress Questionnaire (MDQ; Moos, 1991; item 29 in Appendix G), Pregnancy Experiences Questionnaire (PEQ; Stone et al., 2013; items 30-31 in Appendix G), and the Menopause-Specific Quality of Life Questionnaire (MENQOL; Hilditch et al., 1996; item 39 in Appendix G). The measures that were used in the dissertation are described in more detail below. Details on the remaining measures mentioned above can be found in Appendix H.

Positive and Negative Affect Schedule (PANAS). The PANAS consists of 20 adjectives that describe affective states with 10 items for negative affect and 10 items for positive affect (Watson et al., 1988). Participants rated the degree to which they experienced each emotion at the time of testing (i.e., present moment). They were instructed to read each item and indicate to what extent they currently felt that way. Response options ranged from 1 (*very slightly or not at all*) to 5 (*extremely*). Watson and colleagues reported that the coefficient alphas for the positive affect (PA) and the negative (NA) subscales are .89 and .87, respectively. The PANAS was used to assess affect level during the study. Scale means as a function of group are presented below in the Group Equivalency section.

Procedure

Recruitment

Potential participants were invited to take part in "The Emotional Perception Project", which involved the completion of several brief questionnaires online followed by the completion of several lab tasks during a laboratory session. The study was advertised as a psychology study looking at individual differences in how we perceive emotional stimuli (i.e., why do people perceive and respond to the world differently?). In order to reduce any potential confounds or effects of gender socialization (Grossman & Wood, 1993), the focus on sex, gender, and other hormonal factors (e.g., OCs, the menstrual cycle) was not explicitly stated. At Lakehead University, participants were recruited primarily from psychology classes through classroom visits, class-wide email (see Appendix I), and an online recruitment tool for psychology research called SONA. General recruitment included the use of posters (see Appendix J), online advertisements (see Appendix K), personal email invites (see Appendix L), and a booth at the local farmer's market.

Data Collection

Data collection took place over three phases between September 2018 to January 2020. The first phase of data collection occurred online after participants provided informed consent. Participants individually completed the self-report measures outlined in the Measures and Tasks section (i.e., the Initial Questionnaire). The second phase occurred during a laboratory session after participants completed part 1 and signed up for an available laboratory session. Participants completed the laboratory tasks and the self-report measures outlined in the Measures and Tasks section (i.e., Laboratory Questionnaire). The third phase consisted of a very brief follow-up questionnaire that was sent to all women who participated in the laboratory session to confirm their next menstrual cycle start date.

Part I: Initial Questionnaire. Interested participants were directed to an online initial questionnaire where they were presented with a Cover Letter (Appendix M) and Consent Form A (Appendix N). Participants read and agreed to the information in the Consent Form to continue with the study. All participants completed the initial questionnaire online, which took approximately 40 minutes. Once the initial questionnaire was completed, participants were provided with Debriefing Form A (Appendix O). Participants participating in eligible Psychology courses were automatically given one bonus point through the SONA system for completing the initial questionnaire.

Part II: Laboratory Session. Participants who completed Part I were invited to participate in a laboratory session at Lakehead University. Interested participants signed up for available timeslots through the SONA system. Part II consisted of a laboratory session that involved completing tasks and questionnaires in the lab. All laboratory sessions were conducted in the Health, Hormones, and Behaviour Lab at Lakehead University and were approximately 1.5

to 2 hours long. Once in the lab, participants were presented with Consent Form B (Appendix P) and they read and agreed to the information in the Consent Form to continue with the study. The tasks were then completed in the following order: (1) CalCap; (2) Emotional Spatial Test exposure and immediate recall; (3) Emotional Picture Task exposure and immediate recognition; (4) Emotional Facial Task and immediate recognition, (5) Emotional Word List exposure and immediate recall; (6) Emotional Auditory Task exposure and ratings; (7) Olfactory Task exposure and ratings; (8) Emotional Picture Task, Emotional Facial Task, and Emotional Word List ratings; (9) laboratory questionnaire; and (10) voice recording. Once the laboratory session was complete, participants were provided with Debriefing Form B (Appendix Q) and eligible participants in the Psychology pool were given bonus points (a maximum of 2.5 bonus points towards their course: 1 for the initial questionnaire, and 1.5 for the laboratory session). Once data collection was complete all data was linked and downloaded into a Statistical Package for Social Sciences (SPSS) Program. Participant codes were deleted so that all data remained anonymous and confidential.

Data from the two sessions were linked through anonymous participant codes which participants were asked to generate at the end of the initial questionnaire, re-enter at the beginning of the lab session, and re-enter during the women's follow-up questionnaire. Participants did not have to remember this code as the same questions were asked at all three time points to elicit the same code again. A code combination was chosen that reduced both wrong input (e.g., asking for size in cm which may be measured as 180 on one day and 181 another day) and too much overlap between people (e.g., asking for the last character in a mother's first name, which is likely to be a vowel). The method chosen appears to be reliable (Damrosch et al., 1986) and has been used when collecting potentially sensitive information

(Garvey-Wilson et al., 2010). Although one can expect losses of 20-30% with this method (Schnell et al., 2010), the anonymity and confidentiality of the participants was considered a priority. With the current study only one participant was unable to be matched as two different codes were entered at the two time points.

Follow-Up Questionnaire. A follow-up questionnaire was sent to the female participants several weeks after the laboratory session to collect menstrual cycle data. Women were asked the same participant code and to enter the date they started their most recent menstruation (i.e., to verify the date they estimated within the laboratory questionnaire). This information was collected via an automatic email that contained a link to Survey Monkey to input the data. The information was used to confirm the day of menstrual cycle on which the lab session was completed. This data was not used in the current study as many of the participants did not complete the questionnaire.

Data Reduction

Memory Ratios

Positive to negative memory ratios were calculated to denote the relative recall or recognition of the two types of emotional stimuli (positive/negative). Total scores (number of stimuli recalled or recognized) overall and by valence category were also calculated for each task. Percent correct was also calculated. Overall means are found in Table 4 above.

Valence and Affective Intensity Scores

Mean valence and affective intensity variables were calculated using the emotional ratings for each task. Each participant had a positive intensity rating for each item on the positive continuous scale (range 0 to 10), a negative intensity rating for each item on the negative continuous scale (range 0 to 10), and a categorical valence rating (-1, 0, +1) for each stimulus

rated. Mean valence scores were calculated in two ways. An explicit valence score was obtained from the response to the forced choice categorical valence rating [(positive (-1), neutral (0), or negative (1)]. An implicit valence score was denoted from the corresponding dimension of the highest score between the positive and negative scales (e.g., if the value on the negative scale was higher, the stimulus was scored as "negative" (-1); if the value on the positive scale was higher, the stimulus was scored as "positive" (1); if both values were the same, the stimulus was scored as "neutral" (0). Affective intensity scores were also calculated in two ways: (a) the mean rating across the positive and negative scales and (b) the value of the highest score between the two scales. Overall, each participant had two valence scores (one continuous and one categorical) and two affective intensity scores (both continuous) associated with each task.

Only one of the valence scores and one of the affective intensity scores were used in the main analyses presented here (i.e., implicit valence score, mean intensity score). However, findings were similar, regardless of the score used. The two valence scores were moderately to strongly correlated, with Pearson correlation coefficients ranging from .57 for facial ratings to .90 for olfactory ratings, all $p < .001$ (see Appendix R for details). The two intensity scores were strongly correlated, with Pearson correlation coefficients ranging from .91 for word ratings to .95 for image ratings, all $p < .001$ (see Appendix R for details). Given the strong correlation between the two ways of calculating intensity, the mean affective intensity scores were chosen given that they captured both how positive and negative the stimuli were evaluated to be. This was considered a unique aspect of this study (i.e., most studies do not differentiate between positive and negative intensity as it is often an overall rating of how intense the stimulus is evaluated as). Taking the mean rating across the positive and negative scales allowed us to capture the overall intensity a participant feels across stimuli in a manner that examines both positive and negative

intensity. This way, participants were required to think about and evaluate both aspects of a stimulus as opposed to basing their rating on general intensity which may be biased by the valence of the stimulus. The implicit valence scores that were used were also unique in that they capture whether stimuli are categorically perceived as more positive, equally positive and negative, or more negative, as opposed to the perception of positive, neutral, and negative. That is, a stimulus could be evaluated as both highly positive and highly negative but would be scored as "equal/neutral (0)" if the scores are identical. Valence and intensity scores were calculated overall (across all stimuli) and as a function of valence category for supplementary analyses (i.e., separate scores for positive stimuli, negative stimuli, and neutral stimuli). The valence scores are presented in Table 5 and the affective intensity scores are presented in Table 6.

Acoustic Analysis: Praat v4.0 Software

The Praat v4.0 is a robust audio analysis tool for speech analysis in phonetics (Boersma & Weenink, 2020). The Praat software was used to analyze the acoustic characteristics of each voice recording. Vowels were isolated from the vowel phrase and analyzed separately using the software. Fundamental frequency (pitch) was measured using Praat's autocorrelation algorithm and documented in hertz (Hz). Male fundamental frequencies were searched for between 65 to 300 Hz while female fundamental frequencies were searched for between 100 to 600 Hz. These values were chosen based on past research (e.g., Feinberg et al., 2006) and guidelines provided by the developers of Praat (Boersma & Weenink, 2020). For each vowel, the maximum, minimum, mean, and median pitch in hertz were measured and recorded. Consistent with past research (Banai, 2017; Bryant & Haselton, 2007; Borkowska, 2010; Feinberg et al., 2006; Feinberg et al., 2008; Fraccaro, 2012; Vogel et al., 2008), we calculated the mean fundamental

Table 5

Unadjusted Means (SDs) for Implicit Valence Scores as a Function of Task

Task	All Stimuli	Positive Stimuli	Negative Stimuli	Neutral Stimuli
Facial Task	-.06 (.11)	.96 (.08)	-.89 (.15)	-.18 (.18)
Picture Task	.05 (.11)	.93 (.09)	-.97 (.08)	.07 (.20)
Word List	-.23 (.08)	.91 (.09)	-.77 (.17)	n/a
Auditory Task	.11 (.12)	.88 (.15)	-.93 (.10)	.22 (.29)
Olfactory Task	-.04 (.30)	n/a	n/a	n/a

Note. $N = 105$. The Emotional Word List did not contain neutral words as it contained PMS words instead. This explains the more negative overall mean for all stimuli in the Emotional Word list. The Olfactory Task did not have smells predesignated to valence categories. Scores can range from -1 (negative) to +1 (positive).

Table 6

Overall Unadjusted Means (SDs) of Affective Intensity Scores as a Function of Task

Task	All Stimuli	Positive Stimuli	Negative Stimuli	Neutral Stimuli
Facial Task	3.15 (0.88)	4.01 (0.54)	6.26 (1.69)	2.33 (1.59)
Picture Task	3.44 (0.82)	4.17 (0.56)	4.37 (0.50)	1.77 (1.86)
Word List	3.61 (0.71)	3.87 (0.68)	3.45 (0.81)	n/a
Auditory Task	3.84 (0.74)	4.12 (0.63)	4.14 (0.62)	3.26 (1.27)
Olfactory Task	3.70 (0.81)	n/a	n/a	n/a

Note. $N = 105$. Scores can range from 0 to 10, with 10 being the greatest intensity rating. However, given that affective intensity ratings represent the mean of the positive rating and the negative rating, and that the stimuli were generally chosen because they would be evaluated highly on only one of these scales, a rating between 0 and 5 is more likely. The Emotional Word List did not contain neutral words. The Olfactory Task did not have smells predesignated to valence categories.

frequency score across the individual vowel sounds (i.e., an overall mean score using the mean pitch of each vowel). However, given the tendency for participants to intonate the vowel "u" with a downward inflection, we calculated the mean fundamental frequency across all vowels except "u", consistent with Simmons et al. (2011). We also calculated the mean range of the fundamental frequency across the vowel sounds (excluding "u") using the maximum and minimum pitch values. Due to some technical difficulties during the initial lab sessions, voice data were only collected from a subset of participants (n = 105; n = 58 after exclusion criteria). Please refer to the Data Reduction section below for the mean fundamental frequency and range of voice pitch for women and men who participated in the study.

Results

Data Screening and Statistical Considerations

IBM SPSS Statistics (Version 27) was used to perform all statistical analyses. Data entry was assessed for accuracy and any errors were corrected. For all analyses, a significance level of $< .05$ was chosen. A significance level of $< .10$ was chosen to represent nonsignificant trends. Pillai's trace criterion was used to evaluate multivariate significance while significant MANCOVAs were followed-up with univariate ANCOVAs and pairwise comparisons. The Bonferroni adjustment was used for follow-up pairwise comparisons to reduce Type I errors. All means reported are untransformed unadjusted means, unless otherwise indicated (i.e., figures represent adjusted means and their standard errors). Covariates for all multivariate and univariate analyses of covariance included typical drug use, nicotine use, and hours of sleep (see the Examination of Group Equivalency section below). When 3-group (OC users, nonusers, and men) MANCOVAs/ANCOVAs were significant or showed a nonsignificant trend, follow-up 2-group (OC users, nonusers) MANCOVAs and ANCOVAs were also run to maximize power and

determine the effect size of any OC effects (the effects of most interest). The importance of any effect was assessed using partial eta squared (i.e., η^2). Partial eta squared values were interpreted as either a small effect size (.01), medium effect size (.06), or large effect size (.14 or higher) (Tabachnik & Fidell, 2013).

Missing Data

Given that the results of any statistical analysis can only be as good as the quality of data, data relevant to the outcome variables of each hypothesis were examined for missing data prior to the analyses. Past research has shown that the application of missing data methods to individual item scores (versus total scores) results in a substantial gain for power, and for this reason, should always be preferred (see review in Eekhout et al., 2014). Furthermore, such studies have demonstrated that the limitations of mean imputation are almost absent if less than 10% of the data is missing and when the correlation between variables are low (e.g., Bono et al., 2007; Downey & King, 1998; Raymond, 1986; Tsikriktis, 2005). Since less than 5% of the data was missing for any given item rating, the method of mean imputation at the item level was chosen for its simplicity and conservativeness (Tabachnik & Fidell, 2013). For likert scale ratings, missing responses were substituted using the mean rating for that item across all participants (ranging from 0 to 10). However, the categorical ratings required a different approach, and the missing responses were replaced with the median response for that item (-1, 0, or 1). Mean imputation was also used for missing items from the BEM sex role inventory.

Before missing data was replaced with any values, it was confirmed that the data was missing at random with a Missing Completely at Random (MCAR) analysis (i.e., Little's MCAR test; Little, 1988). The positive ratings, negative ratings, and categorical ratings were examined separately from each emotional task to look for any interrelations potentially relevant to missing

at random. An MCAR analysis was also performed on the BEM sex role inventory data. The results indicated that all missing data were missing completely at random, confirming that the missingness was unrelated to any observed data (i.e., no relationship between whether a data point was missing and any values in the data set). Thus, mean imputation was considered an unbiased estimate and conservative approach, appropriate for participants missing < 10% of data, which our data satisfied (<5%).

Assessing Statistical Assumptions

Data was assessed to ensure that statistical assumptions were met for each analysis. The distribution of scores for the outcome variables were examined as a function of group to check for potential outliers. Outliers were identified as any z score exceeding an absolute value of 3.29 (Tabachnik & Fidell, 2013). For the emotional memory ratios, the following outliers were identified: Emotional Facial Task (n = 1), Emotional Word List (n = 2), and Emotional Picture Task (n = 1). For the mean affective intensity scores, one outlier was identified on the Olfactory Task. For the direct valence scores, one outlier was identified on the Olfactory Task and another outlier on the Emotional Facial Task. For indirect valence scores, one outlier was identified on the Emotional Word Task and another on the Emotional Auditory Task. These outliers were deemed to be sampled from our target populations, and thus, remained in the analyses with steps taken to reduce their impact. Outliers were replaced with a raw score that was one unit larger or smaller than the next most extreme score in the distribution for the corresponding variable (Tabachnick & Fidell, 2013). This method was chosen so that the outlier remined deviant, but not as deviant as it was originally.

Normality assumptions were examined as a function of group with the new values. Skewness and kurtosis were examined using the following formulas: skewness divided by the

standard error of skewness <3; kurtosis divided by the standard error of kurtosis<3 (Tabachnik & Fidell, 2013). There were still some minor issues with skewness and kurtosis (i.e., values were not below 3 for two outcome variables: word indirect valence score and smell indirect valence score). However, according to a review by Kline (1998), normality is not problematic unless skewness is >3 and kurtosis is >8, which was satisfied. In addition, visual inspection of the distributions looked reasonably normally distributed.

To ensure that the population variances and covariances among the dependent variables were the same across all levels of the independent variable, we conducted a Levene's Test for Equality of Variances and Box's Test for Equivalence of Covariance Matrices with all multivariate analyses. Homogeneity tests confirmed that the homogeneity assumption was met for almost all analyses (i.e., a significant Box's M test for H1 showed a significant Levene's test for the word ratio; a significant Box's M test for H3 exploratory analysis examining negative stimuli showing a significant Levene's test for the word ratings). As a conservative approach, Pillai's trace criterion was used for all multivariate tests as this test statistic is recommended when the assumptions of a MANOVA are violated (Tabachnick & Fidell, 2013).

Examination of Group Equivalency

The three groups (OC users, nonusers, men) were examined for equivalency in the following variables from the online questionnaire: age, ethnicity, education, grade point average, diagnosis of an attention problem (e.g., Attention Deficit and Hyperactivity Disorder), past diagnosis/treatment for a mood disorder, nicotine use, typical caffeine use, typical drug use, typical alcohol use, and social desirability scores. Group equivalency was also examined on several variables from the laboratory session, including number of caffeine servings in the past 24 hours, medication use in the past two hours, sleep, fatigue, interest, boredom, and attention.

Univariate ANOVAs and chi-squares were used to examine group equivalency and results are presented in Tables 7 and 8, respectively. The groups only differed in typical drug use [F (2, 102) = 4.369, p = .015], nicotine use [X^2 (2, N = 105) = 11.972, p = .003], and hours of sleep prior to the lab session [F (2, 102) = 4.851, p = .010]. Pairwise comparisons and follow-up chi-square tests revealed that men used recreational drugs more frequently than OC users (p = .024) but not nonusers (p = 1.00) while there was a trend for OC users and nonusers to differ in their frequency of recreational drug use (p = .070). Men were also more likely to use nicotine products compared to OC users (p = .050) and nonusers (p = .050). Lastly, OC users reported significantly more sleep than nonusers the night before the lab session (p = .016). It is important to note that (a) drug consumption could have residual effects and influence an individual's attention, memory, and perception (see review in Vik et al., 2004), (b) nicotine can have a cognitive enhancing effect (e.g., attention and memory tasks; see review in Rezvani & Levin, 2001) while nicotine withdrawal can adversely affect attention, and (c) hours of sleep can affect cognitive and emotional brain processes (see review in Walker, 2009). Thus, all three variables (i.e., typical drug use, nicotine use, and hours of sleep the night prior to the lab session) were determined to violate the assumption of group equivalence at baseline and were included as covariates in analyses examining group differences between OC users, nonusers, and men.

Preliminary Analyses

Prior to running the main analyses, several analyses were conducted to explore the validity of our measures. These are explained below. Another important aspect was confirming that social desirability did not play a role in participant ratings. Scores on the SDS-17 were not correlated with the main outcome variables, (rs < .11 for all) nor were there any group differences in social desirability scores between OC users (M = 7.84; SD = 3.48), nonusers (M =

Table 7

Examination of Group Equivalency Between OC Users, Nonusers, and Men (ANOVAs): Means (SDs)

Variable	OC users (n = 38)	Nonusers (n = 41)	Men (n = 26)
Age (years)	19.89 (1.61)	20.93 (4.16)	21.62 (5.67)
University Average (%)	77.05 (9.25)	79.27 (10.22)	78.92 (10.19)
Typical alcohol use score [a]	1.97 (0.43)	1.98 (0.65)	2.04 (0.77)
Typical drinks per occasion	3.24 (1.95)	2.83 (1.91)	3.08 (2.78)
Typical drug use [a]*	1.11 (0.39)[y]	1.78 (1.42)	2.00 (1.85)[y]
Typical caffeine use [a]	4.32 (1.47)	4.32 (1.49)	4.00 (1.41)
Social desirability (SDS-17)	7.84 (3.48)	8.58 (3.20)	9.12 (3.64)
Lab # of caffeine servings [b]	0.46 (0.64)	0.40 (0.64)	0.48 (0.65)
Lab hours of sleep *	7.26 (1.50)[y]	6.41 (1.22)[y]	7.19 (1.17)
Lab fatigue	2.37 (0.73)	2.62 (0.63)	2.22 (0.90)
Lab interest	3.34 (0.63)	3.05 (0.63)	3.23 (0.82)
Lab boredom	1.66 (0.63)	1.88 (0.75)	1.80 (0.76)
Lab stress	2.74 (0.86)	2.83 (0.77)	2.42 (0.86)
Lab attention (self-rating)	3.89 (0.73)	3.80 (0.71)	3.88 (0.43)
Lab attention (d'prime)	0.99 (0.01)	1.00 (0.01)	1.00 (0.01)
Lab negative affect (PANAS)	12.71 (3.26)	12.54 (0.48)	13.56 (0.89)
Lab positive affect (PANAS)	26.06 (6.21)	24.27 (7.14)	27.62 (6.99)
Lab alertness (PANAS)	3.00 (1.07)	2.77 (0.94)	3.08 (1.16)
Lab excitement (PANAS)	2.18 (0.90)	2.10 (1.02)	2.35 (1.02)

Note. [a] variable refers to the frequency of use per week. [b] variable refers to experience during the past 24 hours. [x] group difference between the indicated group and the other two groups. [y] group difference between the two indicated groups.

* $p < .05$

Table 8

Examination of Group Equivalency between OC users, Nonusers, and Men (Chi-Square Tests): Frequencies (Percentages)

Variable	OC users (n = 38)	Nonusers (n = 41)	Men (n = 26)
Ethnicity			
White/European American	35 (92.1)	33 (80.5)	18 (69.2)
Asian/Pacific Islander	2 (5.3)	1 (2.4)	3 (11.5)
Black/African American	0 (0.0)	4 (9.8)	2 (7.7)
Middle East	0 (0.0)	1 (2.4)	2 (7.7)
Indigenous	1 (2.6)	1 (2.4)	1 (3.8)
Multiple Ethnicity	0 (0.0)	1 (2.4)	0 (0.0)
Highest Education			
Graduated high school	1 (2.6)	6 (14.6)	2 (7.7)
Current undergraduate	36 (94.7)	31 (75.6)	23 (88.5)
Graduated post-secondary	1 (2.6)	3 (7.3)	1 (3.8)
Graduate school	0 (0.0)	1 (2.4)	0 (0.0)
Attention disorder diagnosis			
No	38 (100.0)	38 (95.0)	25 (96.2)
Yes	0 (0.0)	2 (5.0)	1 (3.8)
Past mood disorder diagnosis			
No	37 (97.4)	33 (82.5)	23 (88.5)
Yes	1 (2.6)	7 (17.5)	3 (11.5)
Nicotine use *			
No	37 (97.4)	41 (100)	21 (80.8)[x]
Yes	1 (2.6)	0 (0.0)	5 (19.2)[x]
Lab medication consumed [a]			
No	36 (94.7)	39 (95.1)	26 (100.0)
Yes	2 (5.3)	2 (4.9)	0 (0.0)
Lab caffeine consumed [b]			
No	24 (63.2)	27 (65.9)	15 (57.7)
Yes	14 (36.8)	14 (34.1)	11 (42.3)

Note. [a] variable refers to experience in the past 2 hours. [b] variable refers to experience in the past 24 hours. [x] group difference between the indicated group and the other two groups.

* $p < .05$

8.68; *SD* = 3.20), and men (*M* = 9.12; *SD* = 3.64), or between men and women (*M* = 8.26; *SD* = 3.35) (all $p > .05$).

Validity Checks on Stimuli Valence Categories

The valence of the stimuli was confirmed as belonging to their respective category (i.e., positive, negative, or neutral) by looking at the mean explicit valence score for each category from the Emotional Facial, Picture, and Auditory tasks as well as the Emotional Word list. Data are not reported for the Emotional Spatial Memory Test and Olfactory Task as the valence of the stimuli in the Emotional Spatial Memory Test were validated in a previous study (Person & Oinonen, 2020) and the stimuli in the Olfactory Task were not formally designated to positive, negative, or neutral categories. Given that stimuli ratings were scored using positive = 1, negative = -1, and neutral = 0, mean scores near those values were expected. All scores were close to their respective benchmarks lending to the validity of the emotional tasks. Repeated measures ANOVAs indicated that mean valence ratings for the three types of stimuli differed significantly for each of the tasks (all $p < .001$; see Table 9).

Validity Checks on Continuous Gender Variables

The validity of four continuous measures of gender was examined by first checking for sex differences. To confirm that voice pitch and range (biological gender variables) show a sex difference, we conducted independent samples *t*-tests. Women (*M* = 187.62; *SD* = 28.83) had a significantly higher voice pitch than men (*M* = 119.70; *SD* = 19.50), $t(56) = 7.690$, $p = < .001$. Furthermore, women (*M* = 67.00; *SD* = 37.21) had a significantly larger voice pitch range than men (*M* = 35.35; *SD* = 31.50), $t(56) = 2.701$, $p = .009$. We also examined four social gender variables. For the Bem Sex Role Inventory, women (*M* = 92.97; *SD* = 11.07) had significantly

Table 9

Differences in Mean Explicit Valence Scores as a Function Valence Category for Four Tasks

Task	Positive Stimuli	Negative Stimuli	Neutral Stimuli	Repeated Measures ANOVA
Facial Task	.96 (0.08)	-.89 (0.15)	-.18 (0.18)	$F(2, 103) = 5834.25$, $p = <.001$
Picture Task	.93 (0.09)	-.97 (0.08)	.07 (0.20)	$F(2, 103) = 11001.94$, $p = <.001$
Word List	.91 (0.09)	-.77 (0.17)	n/a	$F(1, 104) = 4503.45$, $p = <.001$
Auditory Task	.88 (0.15)	-.93 (0.10)	.22 (0.29)	$F(2, 103) = 5182.22$, $p = <.001$

Note. $N = 105$. The ANOVA examining the Emotional Word List only compared differences in mean valence scores between the negative and positive stimuli as this task did not contain a neutral category.

higher femininity scores than men (M = 87.55; SD = 6.99), $t(103) = 2.343$, $p = .021$. Likewise, men (M = 95.08; SD = 13.41) had significantly higher masculinity scores than women (M = 86.30; SD = 14.58), $t(103) = -2.715$, $p = .008$. In terms of the Personal Attribute Questionnaire, women (M = 23.53; SD = 4.63) had significantly higher femininity scores than men (M = 21.23; SD = 3.69), $t(101) = 2.299$, $p = .024$; but men's (M = 19.36; SD = 4.23) higher masculinity scores were not significantly different than women's (M = 17.90; SD = 3.69), $t(101) = -1.663$, $p = .099$.

Regression analyses were then conducted with the four social and two biological gender variables to see whether the variables predict sex, which were unique predictors; and to determine which ones to use in the main analyses to reflect within-sex gender. The regression analysis examining the biological gender variables revealed that participant voice pitch and range together predicted sex (12 men, 46 women), adjusted $R^2 = .570$, $F(2, 55) = 38.765$, $p = < .001$, and accounted for 57% of the variance in it. Furthermore, both voice pitch ($p < .001$) and voice pitch range ($p = .003$) were unique predictors of biological sex. The regression analysis examining the four social gender variables revealed that self-reported masculinity and femininity also predicted sex (30 men, 81 women), adjusted $R^2 = .107$, $F(4, 96) = 3.986$, $p = .005$, but only accounted for 10.7% of the variance in sex. The masculinity ($p = .05$) and femininity ($p = .05$) scales of the Bem Sex Role Inventory (BSRI) were both unique predictors of biological sex while the masculinity ($p = .83$) and femininity ($p = .38$) scales of the Personal Attribute Questionnaire (PAQ) were not. Based on these analyses and the ones above, four measures of gender were used in the main analyses: the masculinity and femininity scales of the BSRI (social measures) and voice pitch and range (biological measures).

Main Analyses

Hypothesis 1: Valence, Emotional Memory, and OC Use

It was hypothesized that OC users would recall relatively more positive than negative stimuli than nonusers and men on short-term memory tasks. To test this hypothesis, a MANCOVA was conducted to examine group differences (OC users, nonusers, men) in relative memory for positive and negative stimuli. Dependent variables included the ratio of positive to negative stimuli remembered from the: (a) Emotional Picture Task, (b) Emotional Facial Task, (c) Emotional Spatial Memory Test, and (d) Emotional Word List.

The 3-group MANCOVA examining group differences in relative memory did not reveal a statistically significant group difference across the four tests [F (6, 196) = 1.533, p = 0.169; η^2 = .045], suggesting that OC users, nonusers, and men do not differ in their overall relative memory for positive to negative stimuli (see means and SDs in Table 10). However, given that this was a weak nonsignificant trend for overall relative memory (with a small-medium effect size), the follow-up univariate ANCOVAs were conducted and are reported in Table 11. There was a significant group difference for the Emotional Word List, F (2, 99) = 3.161, p = .047; η^2 = .060. As illustrated in Figure 1, OC users recalled a higher ratio of positive to negative words than nonusers (p = .046), with no differences between OC users and men (p = 1.000) or nonusers and men (p = .383). The 2-group MANCOVA also showed a nonsignificant trend for relative memory across tasks, F (3, 72) = 2.073, p = 0.111; η^2 = .080, showcasing a medium-large effect size. Similarly, there was a group difference for the Emotional Word List, F (1, 74) = 5.794, p = .019; η^2 = .073. Again, please also see Table 11 for all ANCOVA results.

Hypothesis 1 Follow-up. Further analyses were conducted to explore differences in the number of positive and negative stimuli remembered in each task given our previous finding that

Table 10

Hypothesis 1: Unadjusted Means (SDs) for the Relative Recall of Positive to Negative Stimuli as a Function of Task for OC Users, Nonusers, and Men

Task	OC users (n = 38)	Nonusers (n = 41)	Men (n = 26)
Spatial Memory Test (recall)	0.88 (0.24)	0.83 (0.28)	0.78 (0.31)
Facial Task (recognition)	1.02 (0.31)	0.99 (0.30)	1.02 (0.30)
Picture Task (recognition)	1.01 (0.09)	1.00 (0.10)	0.96 (0.08)
Word List (recall)*	1.24 (0.70)[y]	0.96 (0.54)[y]	1.13 (0.33)

Note. While data reported here are unadjusted for covariates, the ANCOVAs controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. [x] group difference between the indicated group and the other two groups. [y] group difference between the two indicated groups.

* $p < .05$

Table 11

Hypothesis 1: ANCOVA Results for the Relative Recall of Positive to Negative Stimuli as a Function of Task for OC Users, Nonusers, and Men

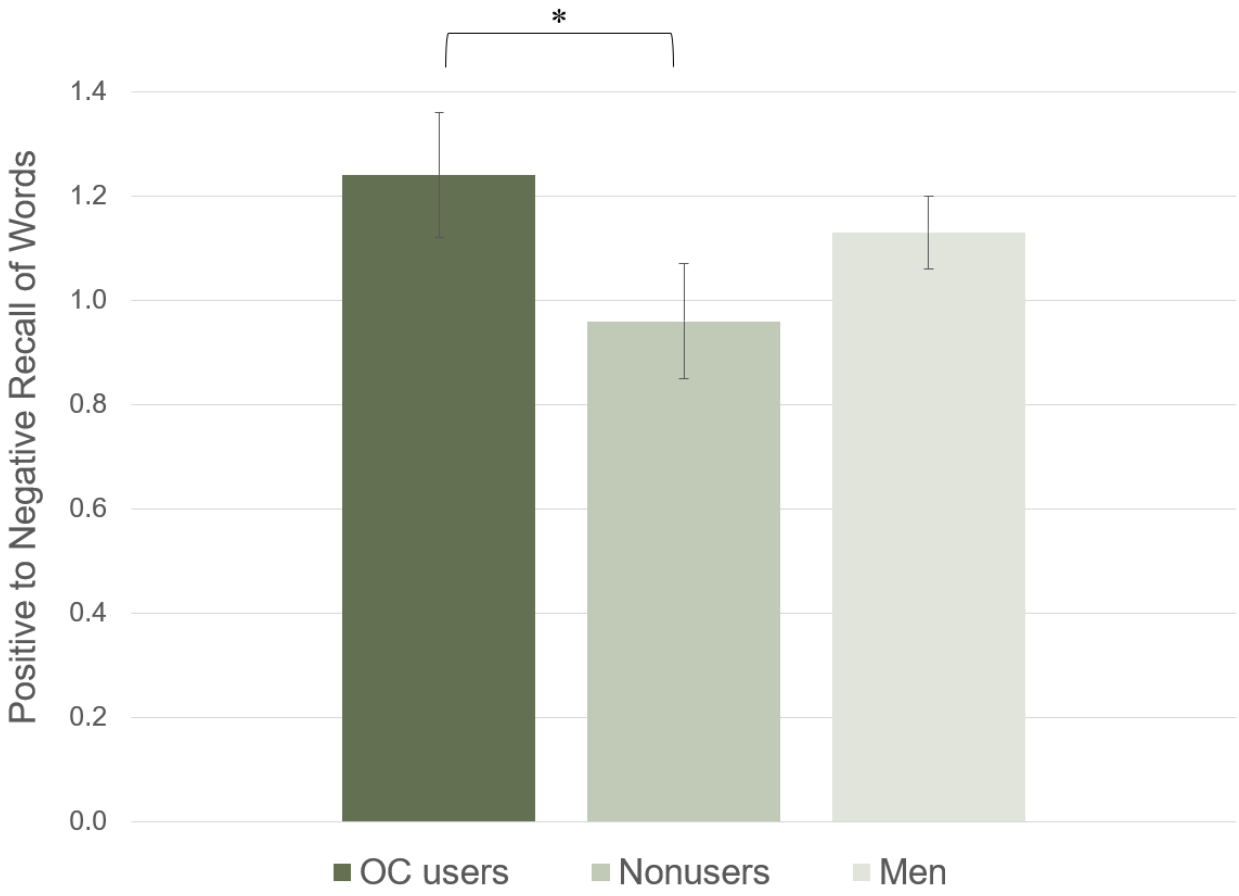
Relative Memory (Positive: Negative Stimuli)								
	3 groups (OC users, Nonusers, Men)				2 groups (OC users, Nonusers)			
Stimuli	df	*F*	*p*	η^2	df	*F*	*p*	η^2
Objects	2, 99	1.714	.185	.033	1, 74	1.641	.204	.022
Images	2, 90	2.260	.110	.048	1, 69	0.022	.883	.000
Faces	2, 99	0.104	.901	.002	1, 74	0.012	.912	.000
Words	2, 99	3.161	.047*	.060	1, 74	5.794	.019*	.073

Note. ANCOVAs controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. The ANCOVA results for the 3-group analyses are presented on the left, and the 2-group analyses are presented on the right.

* $p < .05$

Figure 1

Group Differences in Relative Memory (Positive: Negative): OC Users Recalled Relatively More Positive Words than Nonusers



Note. There was a significant group difference for the Emotional Word List, F (2, 99) = 3.161, p = .047; η^2 = .060. OC users recalled a higher ratio of positive to negative words than nonusers (p = .038; η^2 = .073 in the 2-group ANCOVA). Error bars represent ± SEM.

* $p < .05$

OC users recalled fewer negative objects than nonusers (Person & Oinonen, 2020). Due to missing data from the Emotional Facial Task, it was not included in the overall MANCOVA to maintain our sample size and increase power. The overall 3-group MANCOVA for the positive stimuli showed a nonsignificant trend, F (6, 196) = 2.121, p = .053; η^2 = .061, indicating a trend for the three groups to differ in their recall and/or recognition of the positive stimuli (see means and SDs in Table 12). Follow-up 3-group ANCOVAs revealed a nonsignificant trend for groups to differ in their recall of positive objects in the Emotional Spatial Memory Test [F (2, 99) = 2.753, p = .069; η^2 = .053], with a nonsignificant trend for OC users to recall more positive objects than men (p = .096). The remaining univariate tests revealed no significant group effects for positive stimuli, and this was also the case for the 2-group multivariate and univariate analyses (see Table 13).

There was a weak nonsignificant trend for group differences in participant memory for negative stimuli in the overall 3-group MANCOVA, F (6, 196) = 1.808, p = .099; η^2 = .052. A follow-up ANCOVA showed a significant group difference for the Emotional Spatial Memory Test, F (2, 99) = 4.613, p = .012; η^2 = .085, with nonusers recalling more negative objects compared to OC users (p = .038) and men (p = .030), and no differences between OC users and men (p = 1.000) (see Figure 2). The remaining 3-group ANCOVAs showed no significant group effects for recall of negative stimuli (see Table 14). The 2-group MANCOVA was significant, indicating that OC users and nonusers differed in their memory for negative stimuli across tasks, F (3, 72) = 3.181, p = .029; η^2 = .117. This effect was largely driven by OC users' poorer memory for negatively valanced objects and words as demonstrated by their performance on the Emotional Spatial Memory Test, F (1, 74) = 6.194, p = .015; η^2 = .077, and Emotional Word

Table 12

Memory Scores by Valence Category as a Function of Task for OC Users, Nonusers, Men: Unadjusted Means (SDs)

Valence Category	OC users (n = 38)	Nonusers (n = 41)	Men (n = 26)
Positive Stimuli[t]			
Objects (/10)[t]	4.50 (1.52)[x]	4.56 (1.38)[x]	3.77 (1.75)
Faces (/4)	3.24 (0.75)	3.17 (0.70)	3.35 (0.69)
Words (/15)	2.97 (1.38)	2.85 (1.64)	3.35 (1.70)
Images (/10)	9.62 (0.59)	9.32 (1.73)	9.09 (1.06)
Negative Stimuli*			
Objects (/10)*	5.34 (1.32)	6.02 (1.49)[y]	5.23 (1.39)
Faces (/4)	3.34 (0.85)	3.39 (0.80)	3.38 (1.02)
Words (/15)*	2.79 (1.63)[x]	3.49 (1.68)[x]	3.00 (1.47)
Images (/10)	9.57 (0.80)	9.35 (1.70)	9.50 (0.74)
Neutral Stimuli			
Objects (/10)	3.42 (1.50)	3.88 (1.65)	3.62 (1.55)
Faces (/4)	2.58 (1.00)	2.59 (1.00)	2.42 (0.99)
Images (/10)	9.35 (1.09)	9.00 (1.99)	9.18 (1.01)

Note. While data reported here are unadjusted for covariates, the analyses controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. The Emotional Word List did not contain neutral words. Significant differences reflect those found in either the 2-group or 3-group MANCOVAs or ANCOVAs. [x] group difference between the two indicated groups. [y] group difference between the indicated group and the other two groups.
[t] $p < .10$ * $p < .05$

Table 13

Hypothesis 1 Follow-up: ANCOVA Results for Memory of Positive Stimuli as a Function of Task for OC Users, Nonusers, and Men

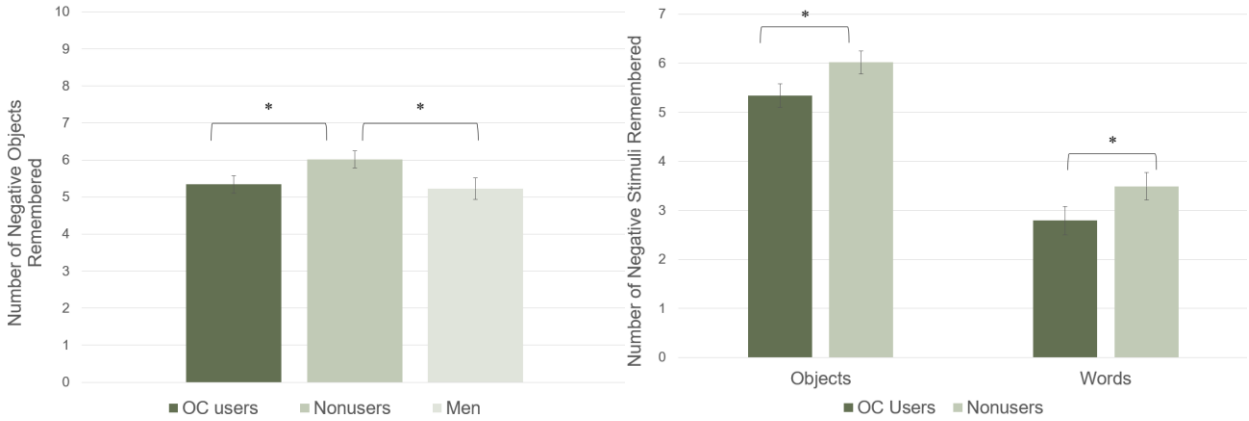
Memory for Positive Stimuli								
	3 groups (OC users, Nonusers, Men)				2 groups (OC users, Nonusers)			
Stimuli	df	*F*	*p*	η^2	df	*F*	*p*	η^2
Objects	2, 99	2.753	.069[t]	.053	1, 74	0.000	.993	.000
Images	2, 90	1.699	.189	.036	1, 69	2.341	.131	.033
Faces	2, 99	0.871	.422	.017	1, 74	0.043	.836	.001
Words	2, 99	1.990	.142	.039	1, 74	0.365	.548	.005

Note. ANCOVAs controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. The ANCOVA results for the 3-group analyses are presented on the left, and the 2-group (OC users vs. nonusers) analyses are presented on the right.

[t] $p < .10$.

Figure 2

Group Differences in Memory for Negative Stimuli: OC Users Remember Fewer Negative Objects and Words than Nonusers



Note. As indicated in the left panel, there was a significant group difference in recall of negative objects on the Emotional Spatial Memory Test, F (2, 99) = 4.613, p = .012; η^2 = .085. Nonusers recalled significantly more negative objects then OC users (p = .04; η^2 = .077 in the 2-group ANCOVA) and men (p = .03). As reflected in the right panel, OC users also recalled significantly fewer negative words than nonusers on the Emotional Word List, F (1, 74) = 5.342, p = .024; η^2 = .067. Results for the 3-group comparison are presented on the left, and the 2-group comparisons are presented on the right. Negative memory scores can range from 0 to 10 for Objects and 0 to 15 for Words. Error bars represent ± SEM.

* $p < .05$

Table 14

Hypothesis 1 Follow-Up: ANCOVA Results for Memory of Negative Stimuli as a Function of Task for OC Users, Nonusers, and Men

Memory for Negative Stimuli								
	3 groups (OC users, Nonusers, Men)				2 groups* (OC users, Nonusers)			
Stimuli	df	*F*	*p*	η^2	df	*F*	*p*	η^2
Objects	2, 99	4.613	.012*	.085	1, 74	6.194	.015*	.077
Images	2, 90	0.643	.528	.014	1, 69	1.784	.186	.025
Faces	2, 99	0.045	.956	.001	1, 74	0.022	.882	.000
Words	2, 99	1.877	.158	.037	1, 74	5.342	.024*	.067

Note. Analyses controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. Only the 2-group MANCOVA was significant, indicating that OC users and nonusers differed in their memory for negative stimuli across tasks, F (3, 72) = 3.181, p = .029; η^2 = .117. The ANCOVA results for the 3-group analyses are presented on the left, and the 2-group analyses are presented on the right.

* $p < .05$.

List, F (1, 74) = 5.342, p = .024; η^2 = .067 (see Table 14). On these tasks, OC users recalled fewer negative objects (p = .015) and fewer negative words (p = .024) than nonusers.

Based on the significant valence-dependent memory findings from the Emotional Spatial Memory Test, memory for emotional objects remembered (i.e., the sum of positive and negative stimuli) and overall memory (i.e., the sum of positive, negative, and neutral stimuli) were examined (see Table 15 for means and SDs). The 3-group ANCOVA revealed a significant group difference for the number of emotional objects remembered, F (2, 99) = 4.20, p = .018; η^2 = .078, with nonusers recalling more emotional objects than men (p = .014) but not OC users (p = .491). There was no difference between OC users and men (p = .305; see Figure 3). The 3-group ANCOVA for overall memory also showed a significant group difference in the number of objects remembered, F (2, 99) = 3.498, p = .034; η^2 = .066, with nonusers recalling more objects than men (p = .031) but not OC users (p = .378). There was no difference between OC users and men (p = .651).

Hypothesis 2: Valence, OC use, and Masculinity

It was hypothesized that: (a) men would be more likely to categorize or perceive stimuli as positive and less likely to perceive the stimuli as negative than either OC users or nonusers (H3a), and (b) this sex difference will be stronger between OC users and men than between nonusers and men (H3b). Within each sex (c), those scoring high on masculinity or low on femininity would be more likely to perceive the stimuli as positive and less likely to perceive the stimuli as negative than those scoring low on masculinity/high on femininity (H3c).

Hypothesis 2a. For H2a a MANCOVA was conducted with three groups (OC users, nonusers, men) and multiple dependent variables (valence scores from the emotional tasks) to

Table 15

Unadjusted Means (SDs) of Scores for Emotional and Overall Memory of Objects

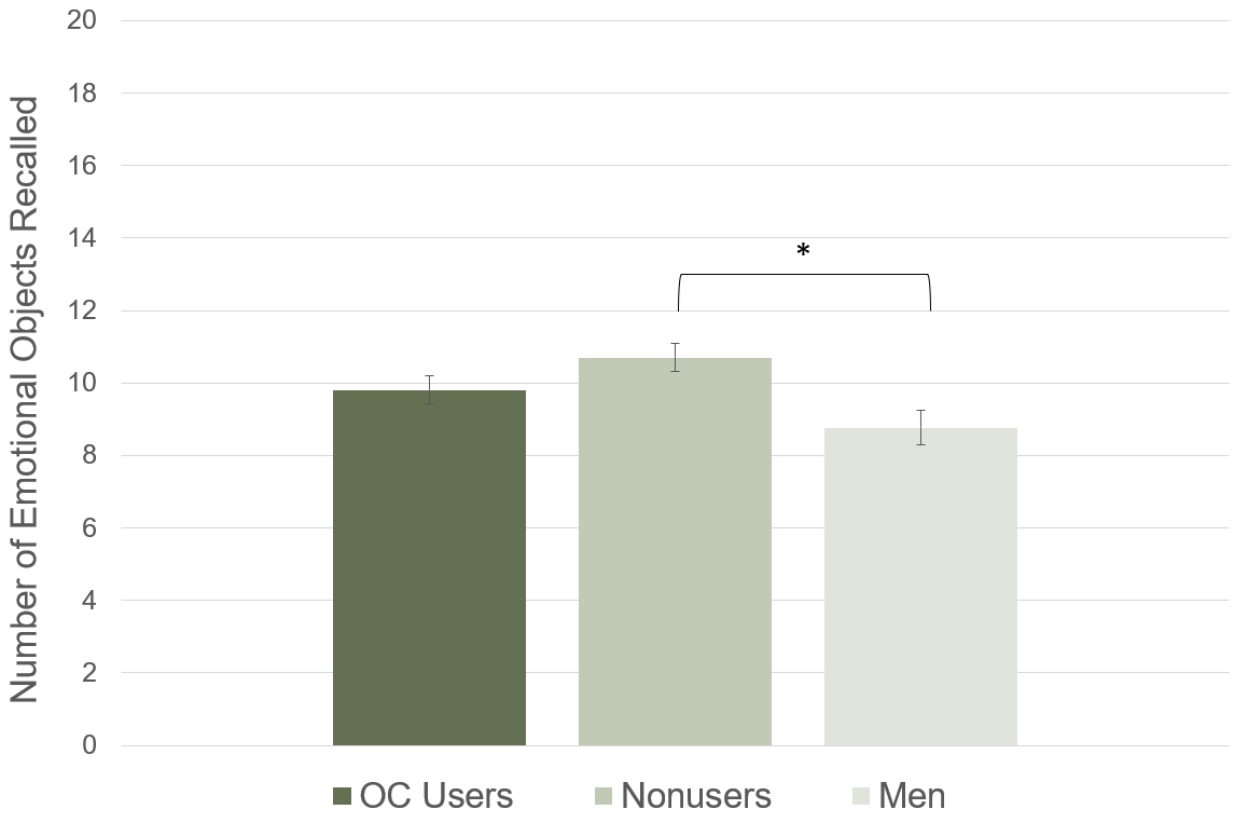
Task	OC users (n = 38)	Nonusers (n = 41)	Men (n = 26)
Spatial Memory Test (recall)			
Emotional Objects (/20) *	9.81 (2.47)	10.70 (1.97)[x]	8.77 (2.76)[x]
All Objects (/30)*	13.24 (2.89)	14.51 (2.60)[x]	12.59 (3.54)[x]

Note. While data reported here are unadjusted for covariates, the analyses for hypothesis 1b controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. [x] group difference between the two indicated groups.

[t] $p < .10$ * $p < .05$

Figure 3

Group Differences in Memory for Emotional Stimuli: Nonusers Remember More Emotional Objects than Men



Note. There was a significant group difference in the recall of emotional stimuli from the Spatial Memory Test, F (2, 99) = 4.201, p = .018; η^2 = .078. Nonusers recalled significantly more emotional objects then men (p = .014). The recall of all objects (positive, negative, and neutral) showed the same significant pattern. The full scale of the y-axis can range from 0 to 20 for emotional objects. Error bars represent ± SEM.

* $p < .05$

examine group differences in perception (i.e., whether they viewed the stimuli as positive, negative, or neutral). The groups were compared on mean valence scores for five dependent variables: (a) Emotional Picture Task, (b) Emotional Facial Task, (c) Emotional Word List, (d) Emotional Auditory Task, and (e) Olfactory Task.

The 3-group MANCOVA examining group differences in implicit valence scores revealed that the groups differed in their valence perception of the stimuli [F (10, 192) = 2.799, p = .003; η^2 = .127] (see means and SDs in Table 16). The three groups differed in their implicit valence ratings for the Olfactory Task [F (2, 99) = 6.739, p = .002; η^2 = .120] and the Emotional Word List [F (2, 99) = 5.928, p = .004; η^2 = .107] (see Figure 4). Pairwise comparisons between the three groups revealed that nonusers significantly differed from OC users (p = .002) and men (p = .029) on the Olfactory Task, whereby nonusers were more likely to categorize the smells as negative while there was no difference between OC users and men (p = 1.000). In contrast, OC users were more likely to categorize the words as negative compared to nonusers (p = .004). There was a nonsignificant trend between OC users and men in the same direction (p = .080) and no difference between nonusers and men (p = 1.00). The univariate tests for the remaining tasks did not reveal differences between the three groups.

The 2-group MANCOVA using only OC users and nonusers also indicated that OC users and nonusers significantly differed in their valence perception of the stimuli across tasks [F (5, 70) = 5.978, p = <.001; η^2 = .299]. The two groups differed in their implicit valence ratings for the same two tasks, being the Olfactory Task [F (1, 74) = 15.277, p = <.001; η^2 = .171] and the Emotional Word List [F (1, 74) = 12.392, p = <.001; η^2 = .143]. The OC user and nonuser differences were both large. Table 17 provides the results of both the 3-group and 2-group ANCOVAs.

Table 16

Hypothesis 2a: Implicit Valence Scores for All Stimuli (Positive, Negative, and Neutral) as a Function of Group (OC Users, Nonusers, Men): Unadjusted Means (SDs)

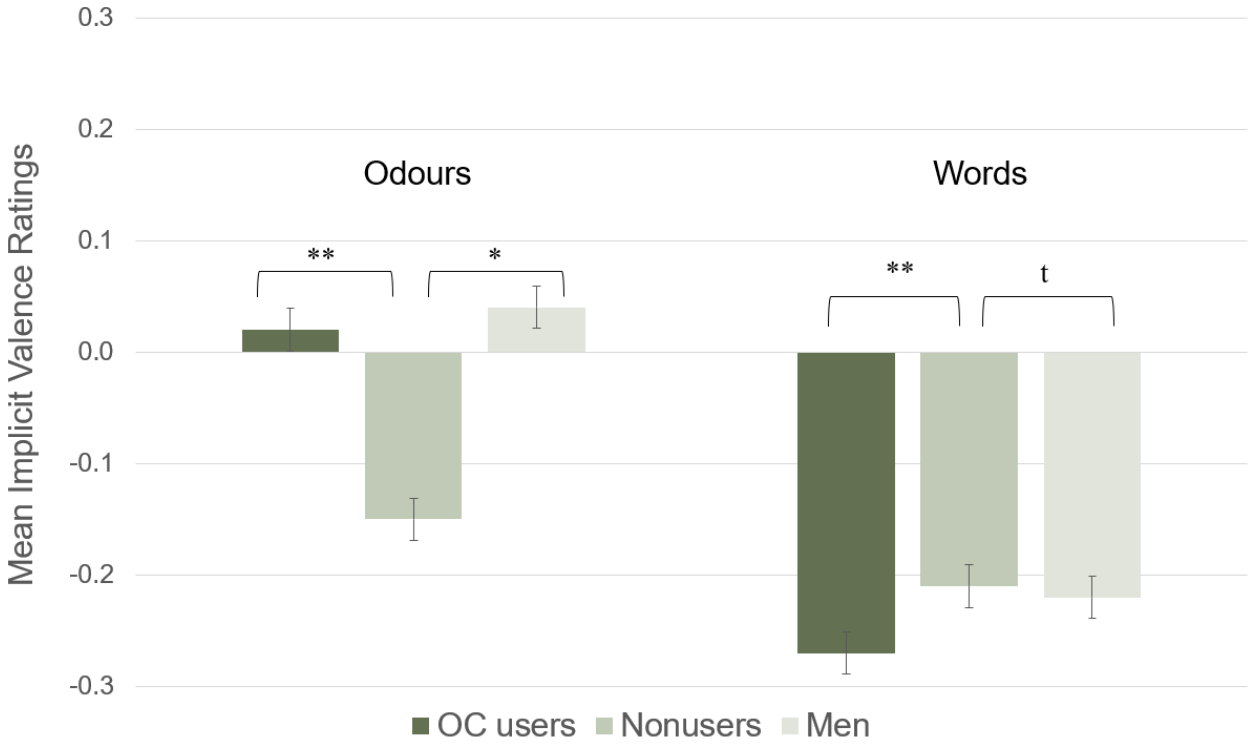
Task	OC users (n = 38)	Nonusers (n = 41)	Men (n = 26)
Facial Task	-0.07 (0.10)	-0.06 (0.11)	-0.06 (0.12)
Picture Task	0.04 (0.08)	0.07 (0.12)	0.06 (0.13)
Word List *	-0.27 (0.06)[x]	-0.21 (0.09)[x]	-0.22 (0.08)
Olfactory Task *	0.02 (0.30)	-0.15 (0.29)[y]	0.04 (0.29)
Auditory Task	0.12 (0.11)	0.10 (0.12)	0.12 (0.12)

Note: Means above zero reflect more positive valence evaluations while means below zero reflect more negative valence evaluations. The Emotional Word List contained more negative than positive words (i.e., a PMS category and no neutral category). While data reported here are unadjusted for covariates, the analyses for hypothesis 2a controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. [x] group difference between the two indicated groups. [y] group difference between the indicated group and the other two groups.

* $p < .05$

Figure 4

Group Differences in Mean Valence Ratings: Stimulus-Dependent OC-Related Effects



Note. There were significant group differences in mean valence ratings between the three groups for the Olfactory Task [F (2, 99) = 6.739, p = .002; η^2 = .120] and the Emotional Word List [F (2, 99) = 5.928, p = .004; η^2 = .107]. Nonusers were more likely to perceive the smells as negative compared to OC users (p = .002; η^2 = .171 in the 2-group ANCOVA) and men (p = .029); whereas OC users were more likely to perceive the words as negative compared to nonusers (p = .004; η^2 = .143 in the 2-group ANCOVA). The full scale of valence ratings can range from -1 to +1, with negative values reflecting negative valence and positive values reflecting positive valence. Error bars represent ± SEM.

* $p < .05$, ** $p < .01$, $^{t}p < .10$

Table 17

Hypothesis 2a: ANCOVA Results for Valence Perception as a Function of Task for OC Users, Nonusers, and Men

Valence Ratings								
	3 groups** (OC users, Nonusers, Men)				2 groups*** (OC users, Nonusers)			
Stimuli	df	*F*	*p*	η^2	df	*F*	*p*	η^2
Images	2, 99	0.826	.441	.016	1, 74	0.530	.469	.007
Faces	2, 99	0.476	.623	.010	1, 74	0.763	.385	.010
Words	2, 99	5.928	.004**	.107	1, 74	12.392	<.001***	.143
Odours	2, 99	6.739	.002**	.120	1, 74	15.277	<.001***	.171
Sounds	2, 99	0.559	.573	.011	1, 74	0.560	.457	.008

Note. Analyses controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. The 3-group [F (10, 192) = 2.799, p = .003; η^2 = .127] and 2-group [F (5, 70) = 5.978, p = <.001; η^2 = .299] MANCOVAs indicated that groups differed in their perception of valence across all tasks. The ANCOVA results for the 3-group analyses are presented on the left, and the 2-group analyses are presented on the right.

* p < .05. ** p < .01. *** p < .001.

Hypothesis 2a Follow-up. Additional analyses were conducted based on a study published while the current study was underway (Spalek et al., 2019). They found that OC users rated the valence of neutral pictures as more neutral than nonusers (nonusers rated the neutral pictures more positively). Thus, we examined whether groups differed in valence ratings as a function of the valence category of the stimuli (i.e., separate MANCOVAs for positive, negative, and neutral stimuli). The Olfactory Task was not included in these analyses given that the smells were not predesignated to positive, negative, and neutral categories as in the other tasks. Visual examination of the pattern of all the means (see Table 18) suggested that OC users were generally more likely overall to categorize stimuli into the expected categories (e.g., a negative stimulus as negative and a positive stimulus as positive). The overall MANCOVA examining negative stimuli indicated that the three groups differed in their overall perception of the negative stimuli, F (8, 194) = 2.051, p = .043, η^2 = .078, with the pattern in the means across all tasks suggesting that OC users were most likely to evaluate negative stimuli as negative and men were least likely to evaluate negative stimuli as negative (see Table 18).

Follow-up 3-group ANCOVAs showed a significant group difference for the Emotional Facial Task, F (2, 99) = 5.749, p = .004, η^2 = .104. OC users were more likely than men to perceive the negative facial expressions as negative (p = .003) (see Figure 5). There was a nonsignificant trend for men to also differ from nonusers (p = .093) while nonusers and OC users did not differ from each other (p = .559). The remaining tasks did not show any significant group differences for the perception of negative stimuli (see Table 19). The 3-group MANCOVAs conducted to examine group differences in implicit valence scores revealed no group differences for positive stimuli, F (8, 194) = 0.904, p = .51, or neutral stimuli F (6, 196) = 0.801, p = .57.

Table 18

Hypothesis 2a Follow-up: Implicit Valence Scores for Positive, Negative, and Neutral Stimuli as a Function of Group (OC Users, Nonusers, Men): Unadjusted Means (SDs)

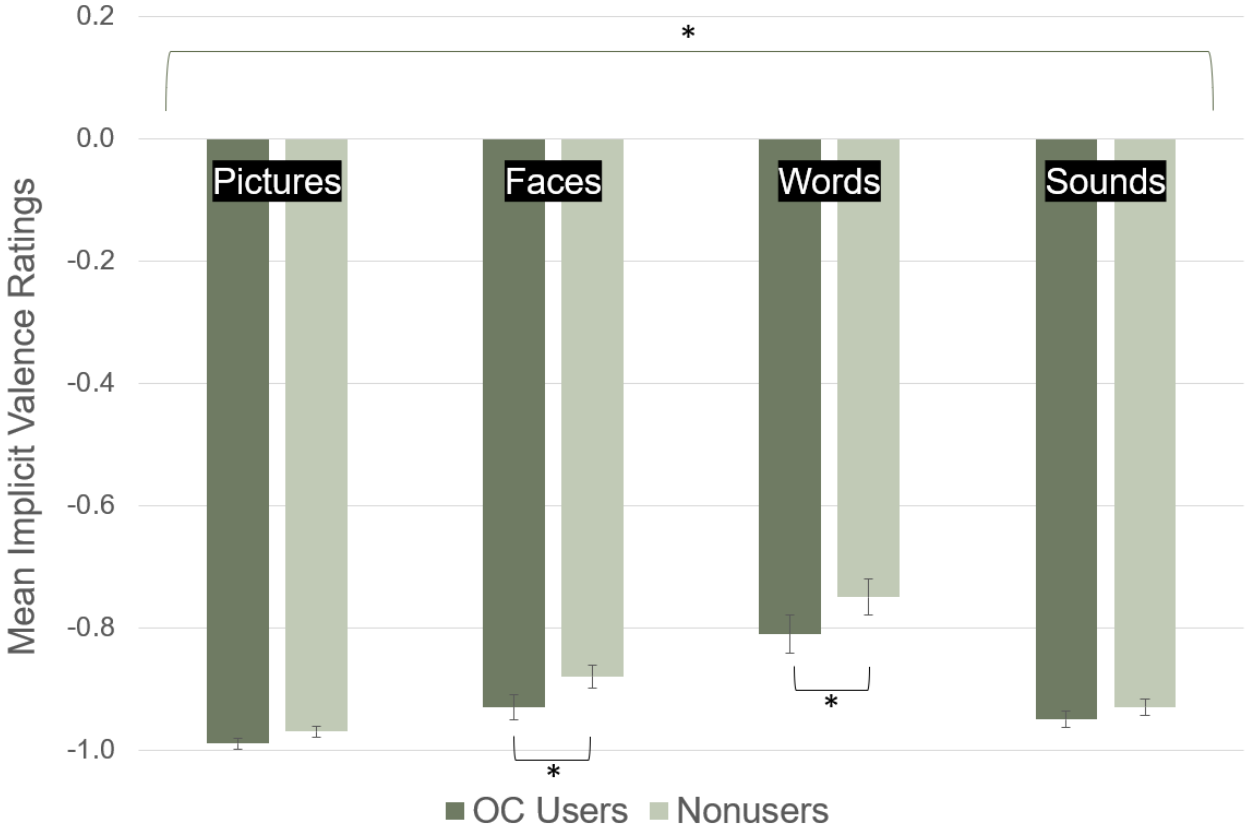
Stimuli Category	OC users (n = 38)	Nonusers (n = 41)	Men (n = 26)
Negative Stimuli *			
Auditory Task	-0.95 (0.06)	-0.93 (0.10)	-0.90 (0.15)
Facial Task *	-0.93 (0.08)[y]	-0.88 (0.14)	-0.83 (0.20)
Picture Task	-0.99 (0.03)	-0.97 (0.06)	-0.94 (0.12)
Word List *	-0.82 (0.18)[x]	-0.75 (0.18)[x]	-0.75 (0.16)
Positive Stimuli			
Auditory Task	0.90 (0.14)	0.87 (0.16)	0.86 (0.15)
Facial Task	0.98 (0.05)	0.95 (0.11)	0.96 (0.08)
Picture Task	0.94 (0.07)	0.95 (0.90)	0.91 (0.10)
Word List	0.92 (0.11)	0.91 (0.09)	0.90 (0.08)
Neutral Stimuli			
Auditory Task	0.24 (0.31)	0.19 (0.27)	0.23 (0.30)
Facial Task	-0.14 (0.16)	-0.19 (0.20)	-0.24 (0.19)
Picture Task	0.06 (0.17)	0.08 (0.22)	0.07 (0.21)

Note. The Emotional Word List did not contain neutral words. While data reported here are unadjusted for covariates, the analyses controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. Significant differences reflect those found in either the 2-group or 3-group MANCOVAs or ANCOVAs. [x] group difference between the two indicated groups. [y] group difference between the indicated group and the other two groups.

* $p < .05$

Figure 5

Group Differences in Mean Valence Scores for Negative Stimuli: An OC-Related Negativity Bias for Faces and Words



Note. The 2-group MANCOVA revealed that OC users perceived negative stimuli as more negative than nonusers overall [F (1, 74) = 5.342, p = .024; η^2 = .067]. This was especially true for the perception of negative faces [F (1, 74) = 3.942, p = .050; η^2 = .051] and words [F (1, 74) = 4.507, p = .037; η^2 = .057]. Valence rating scores can range from -1 to +1. Error bars represent ± SEM.

* $p < .05$

Table 19

Hypothesis 2a Follow-up: ANCOVA Results for Valence Perception of Negative Stimuli as a Function of Task for OC Users, Nonusers, and Men

Valence Ratings for Negative Stimuli								
	3 groups* (OC users, Nonusers, Men)				2 groups* (OC users, Nonusers)			
Stimuli	df	*F*	*p*	η^2	df	*F*	*p*	η^2
Images	2, 99	2.009	.128	.041	1, 74	2.495	.118	.033
Faces	2, 99	5.749	.004**	.104	1, 74	3.942	.050*	.051
Words	2, 99	2.163	.120	.042	1, 74	4.507	.037*	.057
Sounds	2, 99	0.632	.533	.013	1, 74	0.170	.681	.002

Note. The Olfactory Task did not have predesignated valence categories and thus was excluded. Analyses controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. The 3-group [F (8, 194) = 2.051, p = .043, η^2 = .078] and 2-group [F (4, 71) = 2.505, p = .050; η^2 = .124] MANCOVAs indicated that groups differed in their valence perception of the negative stimuli across all tasks. The ANCOVA results for the 3-group analyses are presented on the left, and the 2-group analyses are presented on the right.

* $p < .05$. ** $p < .01$.

Thus, the three groups did not differ in their perception of the valence of either the positive or neutral stimuli.

The MANCOVA for negative stimuli was repeated using only OC users and nonusers and there was a medium-large effect size difference in their overall perception of the negative stimuli [F (4, 71) = 2.505, p = .050; η^2 = .124]. It is noteworthy that the more powerful 2-group ANCOVAs comparing only the OC users and nonusers on their valence perception of the negative stimuli indicated that OC users perceived negative stimuli as more negative on the Emotional Word List [F (1, 74) = 4.507, p = .037, η^2 = .057] and Emotional Facial Task [F (1, 74) = 3.942, p = .050, η^2 = .051].

Hypothesis 2b. For H2b two multiple regressions were conducted using only women to examine whether the continuous gender variables were also associated with valence scores. Due to a small sample of men with voice samples, the regression could not be completed for men based on power and sample size guidelines for regression analysis (Tabachnik & Fidell, 2013). The predictor variables in the regressions were the biological (e.g., voice pitch and range) and social masculinity measures (e.g., BSRI scores). The dependent variable was originally planned to be a composite of the mean valence score from each task that showed a significant group difference in part (a) of the hypothesis. However, given that OC users and nonusers performed in opposite ways on the two tasks showing group differences, a composite score was not created (although men did evaluate the stimuli as more positive for both tasks). Instead, the regression analyses were conducted separately for the Olfactory Task and Emotional Word List to examine whether gender/masculinity would predict within-sex differences in the valence scores.

Bivariate Pearson correlations between the gender variables and Olfactory Task valence ratings are found in Table 20. The regression found that the four gender variables did not

together explain a significant amount of variance in women's valence ratings on the Olfactory Task, adjusted R^2 = -.052, $F(4, 41) = 0.447$, $p = .77$. Further, none of the gender variables were unique predictors of valence: mean voice pitch ($p = .20$), voice pitch range ($p = .63$), BSRI femininity ($p = .92$), and BSRI masculinity ($p = .81$). To increase the sample size for the analysis with women, a separate regression analysis was conducted using only the social gender variables given the larger number of women with data available for these variables. The results remained non-significant for women, adjusted R^2 = -.024, $F(2, 76) = 0.100$, $p = .91$. Similarly, the social gender variables were not unique predictors of valence, even when using a larger sample size: BSRI femininity ($p = .92$) and BSRI masculinity ($p = .69$).

There was also no evidence that individual differences in gender predicted women's perception of valence in emotional words on the Emotional Word List, adjusted R^2 = -.021, $F(4, 41) = 0.772$, $p = .55$, and none of the gender variables were unique predictors: mean voice pitch ($p = .26$), voice pitch range ($p = .61$), BSRI femininity ($p = .99$), and BSRI masculinity ($p = .30$). See Table 20 for the Pearson correlations between the gender variables and Emotional Word List valence ratings. None of the correlations were significant, but voice pitch showed a nonsignificant trend such that higher voice pitch was associated with more negative valence ratings of the word stimuli ($r = -.20$, $p = .090$). A regression analysis with the social gender variables was also non-significant for women, adjusted R^2 = -.018, $F(2, 76) = 0.300$, $p = .74$. None of the social variables were unique predictors of valence in this analysis: BSRI femininity ($p = .94$) and BSRI masculinity ($p = .47$).

Table 20

Hypothesis 2b and 3c: Pearson Correlations between Gender Measures and Outcome Variables in Women.

Gender Variable	Olfactory Valence	Word Valence	Olfactory Intensity
Voice Pitch	.188	-.201[t]	.244*
Voice Pitch Range	.031	.105	-.033
BSRI Femininity	.000	.019	.123
BSRI Masculinity	-.033	.159	.149

Note. $N = 46$. BSRI = BEM Sex-Role Inventory.

[t] $p < .10$ * $p < .05$

Hypothesis 3: Affective Intensity, OC use, and Masculinity

It was hypothesized that **(**a) OC users and nonusers (i.e., women) would show greater emotional intensity in their ratings than men for emotional stimuli, regardless of valence, and (b) this sex difference would be strongest between OC users and men than nonusers and men. Also, (c) within each sex, those scoring high on masculinity or low on femininity will show less emotional intensity in their ratings than those scoring low on masculinity/high on femininity, regardless of valence.

Hypothesis 3a & 3b. For H3a and H3b, a MANCOVA was conducted with three groups (OC users, nonusers, men) and five dependent variables (intensity scores from the emotional stimuli) to examine group differences in evaluation (i.e., how intense they rated the stimuli or the degree to which they rated the stimuli as positive or negative). The groups were compared on mean affective intensity scores for five dependent variables: (a) Emotional Picture Task, (b) Emotional Facial Task, (c) Emotional Word List, (d) Emotional Auditory Task, and (e) Olfactory Task.

The 3-group MANCOVA revealed an overall group difference in mean affective intensity scores [F (10, 192) = 1.887, p = .049; η^2 = .089], indicating that the groups differed in their affective intensity evaluations of the stimuli, with the general pattern being that OC users had the highest intensity scores (see means and SDs in Table 21). Visual examination of group means showed that OC users had higher affective intensity scores than nonusers and men on four of the five tasks. Follow-up 3-group ANCOVAs showed a significant group difference in mean affective intensity scores for only the Olfactory Task, F (2, 99) = 4.066, p = .020; η^2 = .076. OC users rated the smells as more intense than nonusers (p = .039) and showed a nonsignificant trend to have more intense scores than men (p = .077), while men (p = 1.000) did not differ from

Table 21

Hypothesis 3a/b: Mean Affective Intensity Scores for Stimuli as a Function of Group (OC Users, Nonusers, Men: *Unadjusted Means (SDs)*

Task	OC users (n = 38)	Nonusers (n = 41)	Men (n = 26)
Facial Task	3.24 (0.89)	3.08 (0.93)	3.14 (0.82)
Picture Task	3.47 (0.81)	3.53 (0.89)	3.25 (0.72)
Word List	3.68 (0.63)	3.59 (0.78)	3.52 (0.70)
Olfactory Task*	3.97 (0.60)[x]	3.54 (0.87)[x]	3.55 (0.94)
Auditory Task	3.99 (0.65)	3.80 (0.81)	3.69 (0.73)

Note. While data reported here are unadjusted for covariates, the analyses for hypothesis 3a/b controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. Significant differences reflect those found in either the 2-group or 3-group MANCOVAs or ANCOVAs. [x] group difference between the two indicated groups.

* $p < .05$

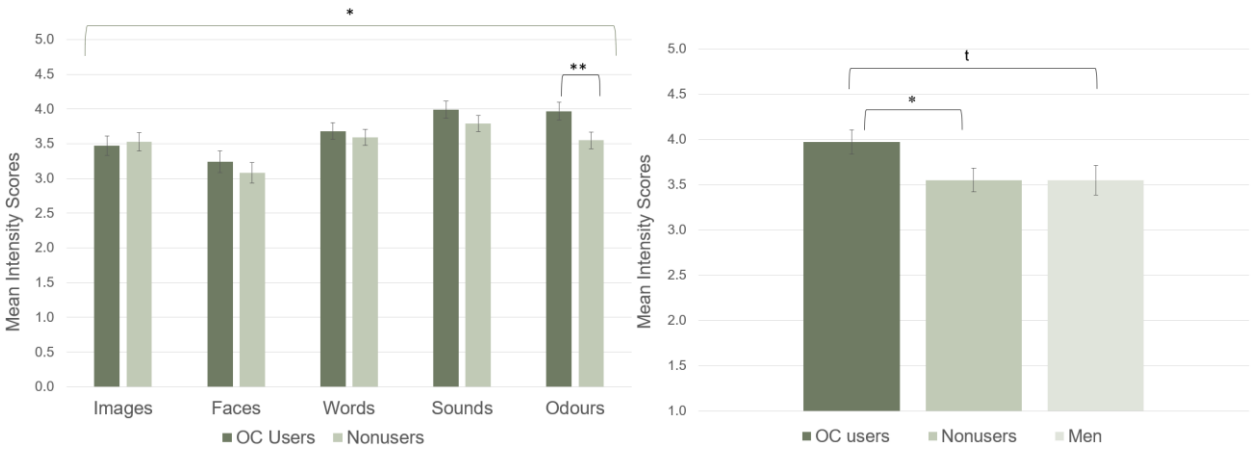
nonusers in their affective intensity ratings for the smells (see Figure 6). The univariate tests for the remaining tasks showed no significant group differences in affective intensity ratings (see Table 22).

The MANCOVA for affective intensity evaluation was repeated with two groups to determine the effect size of any differences between OC users and nonusers. There was a large effect size group difference in mean affective intensity evaluations across the stimuli [F (5, 70) = 2.875, p = .020; η^2 = .170] as demonstrated in Figure 6. The 2-group ANCOVAs comparing only the OC users and nonusers on their mean affective intensity scores showed the same pattern of results, with a significant medium-large effect size group difference on the Olfactory Task, F (1, 74) = 6.889, p = .011, η^2 = .085.

Further post-hoc analyses were conducted to look at differences in intensity ratings for the positive, negative, and neutral stimuli separately to examine potential affective intensity differences by valence category. The Olfactory Task was not included in the analyses given that the smells were not predesignated to positive, negative, and neutral categories like the other tasks. Means and SDs are found in Table 23. A 3-group MANCOVA examining group differences in mean affective intensity scores for positive stimuli [F(8, 194) = 0.812, p = .593, η^2 = .032], negative stimuli [F(8, 194) = 1.172, p = .318, η^2 = .046] and neutral stimuli [F(6, 196) = 1.222, p = .297, η^2 = .036] were nonsignificant, indicating that the three groups did not differ in their evaluation of the stimuli based on valence category.

Figure 6

Group Differences in Mean Affective Intensity Scores: OC Users Rate Odours as More Intense than Nonusers



Note. As is reflected in the left panel, the 2-group MANCOVA demonstrated that OC users and nonusers significantly differed in their affective intensity evaluations across tasks [F (5, 70) = 2.875, p = .020; η^2 = .170], with OC users generally showing more intensity than nonusers. There was a significant group difference for mean affective intensity ratings with the Olfactory Task, F (2, 99) = 4.066, p = .020; η^2 = .076. As indicated in the right panel, OC users rated the smells as more intense than nonusers (p = .01; η^2 = .085 in the 2-group ANCOVA) with a trend to differ from men (p = .08; 3-group ANCOVA) in the same direction. Intensity ratings can range from 0 to 10. Error bars represent ± SEM.

^{t} $p < .10$, * $p < .05$, ** $p < .01$

Table 22

Hypothesis 3: ANCOVA Results for Intensity Evaluation as a Function of Task for Oral Contraceptive Users (OC), Nonusers, and Men

Intensity Ratings								
	3 groups* (OC users, Nonusers, Men)				2 groups* (OC users, Nonusers)			
Stimuli	df	*F*	*p*	η^2	df	*F*	*p*	η^2
Images	2, 99	1.262	.287	.025	1, 74	0.949	.333	.013
Faces	2, 99	0.438	.646	.009	1, 74	0.172	.679	.002
Words	2, 99	0.526	.593	.011	1, 74	0.042	.839	.001
Odours	2, 99	4.066	.020*	.076	1, 74	6.889	.011**	.085
Sounds	2, 99	2.097	.128	.041	1, 74	1.334	.252	.018

Note. Analyses controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session. The 3-group [F (10, 192) = 1.887, p = .049; η^2 = .089] and 2-group [F (5, 70) = 2.875, p = .020; η^2 = .170] MANCOVAs indicated that groups differed in their evaluations of affective intensity across the tasks. The ANCOVA results for the 3- group analyses are presented on the left, and the 2-group analyses are presented on the right.

* $p < .05$. ** $p < .01$.

Table 23

Mean Affective Intensity Scores for Positive, Negative, and Neutral Stimulus Categories as a Function of Group (OC Users, Nonusers, Men): Unadjusted Means and SDs

Valence Category	OC users (n = 38)	Nonusers (n = 41)	Men (n = 26)
Negative Stimuli			
Auditory Task	4.20 (0.55)	4.18 (0.73)	3.96 (0.53)
Facial Task	6.45 (1.63)	6.01 (1.87)	6.36 (1.50)
Picture Task	4.38 (0.50)	4.45 (0.48)	4.22 (0.50)
Word List	3.54 (0.70)	3.40 (0.94)	3.39 (0.75)
Positive Stimuli			
Auditory Task	4.25 (0.53)	4.05 (0.69)	4.04 (0.65)
Facial Task	4.02 (0.52)	4.01 (0.60)	3.99 (0.50)
Picture Task	4.19 (0.51)	4.21 (0.62)	4.08 (0.57)
Word List	3.90 (0.66)	3.91 (0.68)	3.77 (0.74)
Neutral Stimuli			
Auditory Task	3.52 (1.15)	3.16 (1.34)	3.05 (1.32)
Facial Task	2.48 (1.68)	2.23 (1.56)	2.26 (1.56)
Picture Task	1.83 (1.91)	1.92 (1.95)	1.46 (1.67)

Note. The Emotional Word List did not contain any neutral words. While data reported here are unadjusted for covariates, the analyses for hypothesis 3a controlled for typical drug use, nicotine use, and hours of sleep the night prior to attending the lab session.

* $p < .05$

Hypothesis 3c. Two multiple regressions were conducted using data from the women to examine whether the gender/masculinity variables predict differences in affective intensity ratings. A similar regression analysis was not completed with male participants as the sample with voice pitch data was too small to ensure sufficient power. The predictor variables were the biological (voice pitch, voice pitch range) and social (BSRI masculinity, BSRI femininity) masculinity measures. The outcome variable was the Olfactory Task as it was the only emotional task that showed a significant group difference in part a/b of the hypothesis. See Table 20 above for the Pearson correlations between the gender variables and Olfactory Task affective intensity ratings. Bivariate correlations indicate that voice pitch was correlated with olfactory affective intensity ratings such that higher voice pitch was associated with higher affective intensity ratings (r = .24 , p = .05). However, for the regression, the four gender variables did not significantly predict mean affective intensity rating scores on the Olfactory Task in women, adjusted R^2 = .007, $F(4, 41) = 1.082$, p = .38, and there were no significant unique predictors: mean voice pitch (p = .10), voice pitch range (p = .73), BSRI femininity (p = .50), and BSRI masculinity (p = .36). To increase the sample size for the analysis with women, the regression was repeated using only the social gender variables. The results remained non-significant for women, adjusted R^2 = .013, $F(2, 76) = 1.52$, p = .23. Similarly, the social variables were not unique predictors of olfactory affective intensity: BSRI femininity (p = .95) and BSRI masculinity (p = .10).

Discussion

In the present study we found group differences between OC users, nonusers, and men in the recall, perception, and evaluation of stimuli across various sensory modalities. For emotional memory, OC users recalled more positive information than nonusers (e.g., relatively more

positive than negative words as well as less negative objects and words). Significant findings were observed for valence ratings (i.e., emotional perception of stimuli) with the direction of the findings being stimulus-specific. OC users and nonusers differed in their perception of valence across tasks. OC users were more likely to categorize words as negative compared to nonusers, whereas OC users and men were more likely to categorize odours as positive than nonusers. Furthermore, OC users perceived negative stimuli as more negative than nonusers across tasks, and this group effect was significant for negative words and facial expressions. OC users were also more likely to perceive negative facial expressions as negative compared to men. For affective intensity ratings, there was a large effect size indicating that OC users evaluated stimuli as more affectively intense than nonusers across all stimuli, and this group effect was largely driven by the same effect with odours. Furthermore, women with higher voice pitch evaluated odours as more intense than those with lower voice pitch. Overall, there were group differences for the Emotional Spatial Memory Test, Emotional Facial Task, Olfactory Task, and Emotional Word List. In contrast, there were no group differences for the Emotional Image Task and Emotional Auditory Task. The group differences offer some support for all hypotheses, albeit not across all tasks/stimuli.

Emotional Memory

OC Users Recall More Positive and Less Negative Information

Relative Memory: OC Users Recalled Relatively More Positive than Negative Words than Nonusers. A medium effect size group difference between OC users and nonusers was found in the ratio of positive to negative words recalled on the Emotional Word List. OC users recalled relatively more positive than negative words (or relatively less negative than positive words) compared to nonusers, but not men, for immediate recall. Thus, there was

evidence to support hypothesis 1, indicating a group difference between OC users and nonusers in relative recall of positive and negative stimuli. Men did not differ from either group of women. The OC group difference only emerged for the recall of words, and not any of the other stimuli/tasks. This finding is consistent with results from the previous study conducted by Spalek and colleagues (2019) who found that OC users recalled more positive pictures than nonusers on a picture memory task. It is also consistent with our previous finding of OC users recalling more positive than negative stimuli on an emotional spatial memory test (Person & Oinonen, 2020).

Emotional Stimuli: Nonusers Recalled More Emotional Objects than Men. There was a significant group difference between nonusers and men for the recall of emotional items on the Emotional Spatial Memory Test with a medium effect size. These results suggest that nonusers recalled more emotional stimuli compared to men, but not OC users, when short-term memory was assessed. This finding is consistent with past research that suggests women on average encode events and recall memories more in terms of their emotional content than men do (Davis, 1999; Seidlitz & Diener, 1998) and recall more emotional autobiographical events than men (Robinson, 1976). However, there was no difference between men and OC users, suggesting that a defeminization of emotional memory eliminated the sex difference for OC users. Defeminization can refer to the suppression of female-typical anatomical and behavioural characteristics that differentiate the sexes (Wallen, 2017). Accordingly, we suggest that OC use may suppress the female advantage for emotional memory due to the loss of female processes (i.e., ovulation, normal hormone fluctuations).

Negative Stimuli: OC Users Recalled Fewer Negative Objects and Words than Nonusers. Across all tasks, OC users and nonusers significantly differed in their memory for negative stimuli (medium-large effect size). OC users and men recalled fewer negative objects

compared to nonusers when short-term memory was assessed (with a small-medium effect size between OC users and nonusers). OC users also recalled fewer negative words than nonusers (medium effect size). The former result replicates the findings from Person and Oinonen (2020) along with the relative memory finding above, although within a different memory modality (i.e., words versus 3D objects). This suggests that any effect of OCs on recall of emotional objects may be stronger for negatively-valenced than positively-valenced objects, with OCs possibly decreasing recall of objects with a negative valence.

Overall, these results suggest that OC users recall more positive and less negative information than nonusers. We also found that nonusers recalled more emotional stimuli overall than men. This suggests that nonusers appear to have better memory for emotional information overall when compared to men, with OC users falling in the middle. Thus, OC use may reduce the female memory advantage and also bias women to recall relatively more positive and less negative information. It also suggests that OC users may be more masculine or less feminine in terms of overall memory findings (i.e., their performance was closer to men than nonusers). In terms of implications, OC use may reduce women's memory advantage (i.e., have a defeminizing effect) and bias users to see the world through "rose-coloured" glasses.

Given that this was not a randomized placebo-controlled design, one can only speculate about the possible reasons why OC users recalled relatively more positive than negative words than nonusers and fewer negative 3D visual objects and negative words than nonusers. It may be that women who are inclined to use OCs have a pre-existing bias towards relatively lower recall of negative information and higher recall of positive information. It is not clear why that would be. It could be that OC users looked at or attended to significantly fewer negative words and objects during encoding, or the study period. Alternatively, we previously proposed that higher

endogenous hormone levels in free cyclers (e.g., estradiol and progesterone) play a role in enhancing memory for negative stimuli and that OCs reduce both endogenous hormone levels which dampens memory for negative stimuli (Person & Oinonen, 2020). Thus, OC-related hormonal suppression may be responsible for a memory reduction and both estradiol and progesterone could play a role. OC users would show less estrogen-enhancement of attention to negative stimuli (discussed below) and less progesterone enhancement of amygdala reactivity to negative stimuli (both discussed below). Evidence to support these possibilities will be examined below.

Nonusers, being free-cyclers, would have had higher hormone levels (especially during certain phases of the menstrual cycle) than OC users given that OC use reduces hormone levels (e.g., testosterone, progesterone, and estrogen) across the menstrual cycle (Coenen et al., 1996; Fleischman et al., 2010). The finding that nonusers had better recall of negative stimuli than OC users in the Emotional Spatial Memory Test fits with the findings from Solis-Ortiz and Corsi-Cabrera (2008) who found evidence that high levels of estrogen may enhance visuospatial memory during a modified version of a Localization Test (although the stimuli in their study were not negative). Also like the findings from the current study, Phillips and Sherwin (1992) found delayed recall of visual stimuli to be significantly higher in the luteal phase (higher estrogen) compared to menses. There is also evidence that estrogen treatment during menopause can have beneficial effects on overall memory, which suggests a neuroprotective effect (i.e.., a reduction in dementia risk) when taken early (see review in Rocca et al., 2011). These previous studies suggest that high levels of estrogen may enhance memory, particularly visuospatial memory, which is consistent with the current findings (although we did not assess memory for location, the 3D objects were laid out spatially on a grid). Estradiol has been found to be

positively associated with other types of cognition, such as verbal fluency (Maki et al., 2002). Perhaps most relevant to the current results are the findings from Mordecai and colleagues (2008) that describe improved verbal memory in the active versus inactive OC pill phase, when exogenous hormones are being administered. These findings are complemented by findings from Epperson and colleagues (2013) who found a decline in verbal memory with menopause, when endogenous hormones are reduced.

A related estrogen-mechanistic explanation as to why nonusers recalled significantly more negative objects and negative words than OC users might involve the higher levels of estradiol and the effect of estrogen on acetylcholine. Estrogen is known to facilitate synthesis of acetylcholine, known for its role in memory, through estrogen-induced increases in choline acetyltransferase (McEwen & Parsons, 1982). This may be a possible mechanism by which estrogens or estradiol can improve memory function. Given that OC use decreases endogenous estrogen levels (Flelschman et al., 2010) we might predict poorer memory in OC users than nonusers, which may explain our finding that OC users recalled significantly fewer negative objects and negative words than nonusers. Moreover, research has shown estradiol to increase spine density in the hippocampus in region CA1, where dendritic spines have been implicated in spatial and non-spatial memory function (Gould et al., 1990; Luine et al., 2006; MacLusky et al., 2005; Woolley, 1998). Murphy and Segal (1996) found that hippocampal neurons, known for their involvement in memory, grown in culture for 2 to 3 weeks showed a twofold increase in dendritic spine density after being exposed to 17-β-estradiol. These findings suggest that estrogens may also play a major role in neuronal plasticity and that this may enhance memory. Thus, higher estradiol in nonusers may facilitate recall of visuospatial material, possibility through facilitation of dendritic spine growth in CA1 with estradiol. It is feasible to hypothesize

that the difference in memory between OC users and nonusers could be influenced by the dampening effect of OC use on circulating levels of estradiol and the potential influence of estradiol on neuronal plasticity and the synthesis of acetylcholine. Since nonusers are likely to have higher estrogen levels and given that OC use decreases endogenous estradiol levels, it is not surprising that we found nonusers to have better short-term memory (i.e., for negative stimuli) and that nonusers recalled more emotional stimuli overall than men (with OC users being in the middle).

While an estrogen-memory-enhancement effect could explain why nonusers have better recall, it is not clear why estrogen would selectively enhance recall of negative versus positive stimuli. One explanation is that estrogen enhances attention to negative stimuli (Lungu et al., 2015) which would enhance later recall of those negative stimuli. Another possibility is that there is more adaptive value for estradiol to be associated with recall of negative stimuli versus positive stimuli (e.g., avoidance of noxious stimuli to maximize survival). Thus, women may have evolved to better remember negative stimuli (e.g., aggressive men or dangerous situations), and possibly avoid such stimuli, when estrogen levels are high, as the highest estrogen levels occur when women are more likely to conceive or when they are pregnant (Berkane et al., 2017). Somewhat consistent with this suggestion, in the present study, we also found that nonusers had better overall recall of emotional stimuli compared to men (with OC users being in the middle). This suggests the possibility that OCs may slightly dampen women's emotional memory advantage (but OC users and nonusers did not differ significantly). It is also not clear why the findings are so much stronger for visuospatial information versus other types of stimuli. Perhaps 3D objects are greater threats than the other types of stimuli (e.g., sounds), and/or the effect of estradiol on memory for negative information may be specific or stronger for the visual system

(i.e., significant effects for 3D objects and visually presented words). It is also possible that the Emotional Spatial Memory Test and the Emotional Word List Task were more sensitive in terms of assessing memory. The percent of stimuli remembered overall for each task (Emotional Word List, 19%; Emotional Spatial Memory Test, 45%; Emotional Facial Task, 76%; Emotional Picture Task, 93%) suggests that both the Emotional Word List and Emotional Spatial Memory Test were the harder tasks, and likely more sensitive in terms of not having ceiling effects. The higher difficulty level also allows for greater opportunity to observe individual differences in memory.

The second explanation (i.e., an OC-related reduction in estradiol and progesterone) not only addresses the endogenous hormone-related enhancement of memory (i.e., general memory) but also explains the OC-related reduction in recall of negative stimuli. A potential reason why nonusers recalled significantly more negative objects than OC users might involve both the presence of higher progesterone levels in nonusers and the hippocampus and amygdala being more reactive to emotional images during high progesterone periods. Nonusers have higher progesterone levels compared to OC users given that OC use causes a reduction and stabilization of hormone levels, such as progesterone, across the menstrual cycle (Arnold et al., 1980; Basu et al., 1992; Thorneycroft & Stone, 1972). Andreano and Cahill (2010) found that women in the mid-luteal phase, when progesterone is high, had significantly enhanced activity in the hippocampus and amygdala in response to negative images as compared to those in the early follicular phase. Similarly, van Wingen et al. (2008) demonstrated that high levels of synthetic progesterone (400 mg of micronized progesterone administered orally) significantly increased amygdala responses to negative emotional images (angry and fearful faces) compared to neutral ones. Thus, higher levels of progesterone in some nonusers may be associated with enhanced

activity in the amygdala when viewing emotionally negative stimuli, which in turn results in better memory or recall of the negative information. It has also been found that women in the luteal phase (high progesterone) have increased heart rates while viewing negative videos (Ossewarrde et al., 2010). This may indicate an enhanced reaction to the negative stimuli which would also facilitate better memory for stimuli with negative valence in nonusers who likely have higher progesterone levels than OC users. In another study, Ferree et al. (2011) looked at spontaneous intrusive recollections (SIRs), which are known to follow emotional events in clinical and nonclinical populations, after exposure to emotional films. They found that SIR frequency significantly correlated with salivary progesterone levels in free-cycling women, and that women in the luteal phase (higher progesterone levels) reported significantly more SIRs than women in the follicular phase. These findings suggest that SIRs may be more common during heightened levels of progesterone (i.e., during the luteal phase) in nonusers. Given that OC use stabilizes hormone levels, resulting in nonusers having higher progesterone levels (Coenen et al., 1996; Fleischman et al., 2010), it is not surprising that the current study found nonusers to have better recall of emotionally negative stimuli possibly due to progesterone's influence on enhanced activity in the amygdala when viewing negative stimuli, enhanced heart rates while viewing negative stimuli, or the frequency of SIRs after viewing negative stimuli. It is also possible that both higher levels of estrogens and progesterone work together to enhance memory for negative stimuli in free cyclers. This possibility makes sense from an evolutionary perspective, as there would be adaptive pressure to fuel memory for negative stimuli.

Valence Perception

Overall Valence

OC Users Perceive Words as more Negative, but Odours as More Positive than Nonusers. Across all tasks, the three groups significantly differed in their overall perception of the stimuli (large effect size), and OC users and nonusers significantly differed in their perception of the stimuli overall (even larger effect size). OC users and men were less likely to perceive odours as negative than nonusers, and the difference between OC users and nonusers indicated a large effect size. In contrast, OC users were more likely to perceive words as negative compared to nonusers, and this was also a large effect size. The direction of the findings are consistent with our hypothesis that men tend to perceive the stimuli as less negative compared to the two groups of women (i.e., a significant difference for smells and a trend for words) and fits with the past meta-analysis discussed in the introduction (e.g., greater brain activation to emotional stimuli is observed for positive stimuli in men, but for negative stimuli in women; Stevens & Hamann, 2012).

Our finding that OC users evaluated odours more positively than nonusers is a new finding. No previous published study appears to have examined effects of OCs, sex, or gender, on the emotional valence perception of stimuli. Previous olfaction investigations focused on gender differences have reported that women on average outperform men in olfactory tasks (see review in Doty & Cameron, 2009). More specifically, women on average, are more sensitive to a range of odours and have greater accuracy in odour-identification. According to Doty and Cameron (2009), some studies attributed the female superiority in odour identification to hormonal factors that enhanced their sensitivity to smell (e.g., during regular hormonal fluctuations within the menstrual cycle) while others indicated that the superiority was thought to

be the result of better verbal abilities impacting olfactory identification as opposed to odour perception.

When looking at our two groups of women, there are other hormonal reasons why OC users would perceive the smells as more positive than nonusers. Research looking at olfactory fluctuations across the menstrual cycle tend to report that women become more sensitive to odours during the ovulatory phase of the menstrual cycle and it has been suggested that inconsistent findings are due to differences in the type of odours used in the studies (see review in Doty and Cameron, 2009). Given that many participants reported that most of the odours used in our study smelled unpleasant, it may be that the effect arose due to having a subset of nonusers in the ovulatory phase of the menstrual cycle when olfactory sensitivity is reported to be higher. Women taking OCs do not ovulate, thus, the increased olfactory sensitivity would not be observed. Thus, it is possible that the tendency for OC users to perceive smells as more positive may be due to a reduced sensitivity to odours as a result of ovulation-suppression. However, our OC users also reported perceiving the odours as significantly more emotionally intense than nonusers, which may contradict the hypothesis that OC users experience a lower sensitivity to odours overall. Another explanation for why OC users perceived odours as more positive than nonusers pertains to the adaptive value of olfaction. For example, non-pregnant or fertile women need to be more careful or cautious about who they mate with. Thus, rating all smells as more negative makes them more selective and cautious in choosing a partner. Similarly, women not ovulating or those with low hormones post-pregnancy (also not ovulating) likely do not need to worry about this and may benefit from perceiving all smells as more positive (i.e., for bonding purposes with their baby who has many smells related to diaper changing etc.). Given that OC users experience a suppression of ovulation (and associated lower

hormones), this may explain why they are less selective and more positive when it comes to odour ratings.

While OC users perceive smells more positively than nonusers, the opposite pattern was seen when evaluating words (i.e., OC users perceived words more negatively). There are several possible explanations for why OC users perceived the words as more negative than nonusers. As mentioned previously, there is evidence that OC users experience negative mood side effects (Gingnell et al., 2013) and increased rates of depression (Anderl et al., 2020; Johansson et al., 2023; Kulkarni, 2007; Skovlund et al., 2016). Mood, in turn, can influence the perception of stimuli in terms of producing mood-congruent effects (e.g., Matt et al., 1992). Perhaps the OC users in our study were more likely to be in a negative mood, and thus, more likely to categorize the stimuli as negative. However, there were no group differences in self-reported negative affect during the laboratory session, so this explanation is unlikely. Research also supports a negativity bias in emotion recognition and reactivity in OC users, although, the research on emotion recognition is inconsistent. The literature shows that OC users demonstrate an attentional bias to negative emotions (i.e., better recall of negative information and better recognition of negative emotions; Hamstra et al., 2014; 2015; 2017). Consistent with this finding, our OC user group may have paid more attention to the negative words than nonusers, leading to an increased sensitivity to the negative valence of the negative stimuli. In terms of emotional reactivity, one study suggests that women taking OCs show a negativity bias as evidenced by reduced BOLD responses to negative stimuli in brain regions associated with processing positive emotions (Gingnell et al., 2013) while there are enhanced BOLD responses in brain regions associated with processing negative emotions (Merz et al., 2012; Miedl et al., 2018). Thus, it is possible that OC use specifically impacts the early stages of emotion processing through these differences in

emotional reactivity networks within the brain. Although these previous studies examined face stimuli, the general finding is consistent with our results. Accordingly, our OC user group may have been more emotionally reactive to the negatively valanced words and less reactive when it came to evaluating the positive words than nonusers. While this explanation does not explain why we did not also see this same pattern with the Emotional Facial Task, this task may have been too easy in terms of the facial expressions being obviously negative or positive (i.e., a ceiling effect and less variability). Words also tend to be more subjective, which might have made OC users more inclined to rely on an early stage of emotional processing and/or make the task more sensitive. The task also included a higher number of negative words as the PMS category (which replaced the neutral category) was largely negative in valence (e.g., nausea, cramps), making the task more sensitive to negative categorizations. However, we did see this tendency to categorize stimuli as negative with the negative faces from the Emotional Facial Task (discussed below). Overall, there is research noted above that points to negative mood side effects, higher vigilance towards negative emotional stimuli, and therefore biased attention towards negative stimuli in OC users that may help to explain why OC users were more likely to perceive stimuli as negative compared to nonusers. This effect may be stronger with more ambiguous situations or stimuli.

Post-Hoc Valence Findings for Positive, Negative, and Neutral Stimuli

Negative Stimuli: OC Users Are More Likely to Perceive Negative Stimuli as Negative Compared to Nonusers (e.g., Words, Facial Expressions). Across all tasks, the three groups significantly differed in their perception of the negative stimuli (medium effect size) and OC users and nonusers significantly differed in their perception of the negative stimuli overall (approaching a large effect size). OC users consistently had higher negative valence scores for all

tasks (i.e., more likely to perceive negative stimuli as negative; see Table 18), but it was only the negative facial expressions that they perceived as more negative compared to men. This result is consistent with the finding that women demonstrate greater emotional intensity reactions to negative stimuli compared to men on both physiological and self-report measures, while they demonstrate no difference in reaction to positive stimuli (Grossman & Wood, 1993). The pattern suggests that OC use may be amplifying any sex differences that exist in the perception of negative facial expressions (i.e., a femininization of the valence perception of negative faces). When just comparing OC users and nonusers, the OC users were significantly more likely to perceive the negative facial expressions and negative words as negative. The overall finding that OC users were more likely to perceive negative stimuli as negative compared to nonusers is also consistent with the above group difference (i.e., OC users more likely to perceive all categories of words as negative than nonusers) and the relevant explanations related to negative mood side effects, increased rates of depression, and negativity bias in OC users (see above). It is also consistent with the findings of Gamsakhurdashvili and colleagues (2021) who found that OC users consistently rated negative pictures as more aversive than nonusers. Our study appears to be the first study to examine whether valence perception of emotional faces or words differ with sex or OC use. Previous facial studies have looked at group differences in emotion recognition. Thus, there is a difference between the current study design and the research discussed below that pertains to differences in recognizing emotions. Emotion recognition is not entirely equivalent to what participants were asked to do in the current study. Instead, participants were asked whether they perceived the face as positive, negative, or neutral (i.e., they were not identifying what emotion was being portrayed on the face). Nonetheless, results are discussed in relation to the existing literature.

The finding that OC users were more likely to perceive negative facial expressions as negative compared to men (and nonusers) is consistent with the female advantage when it comes to emotion-related tasks such as facial expression processing and emotion recognition that McClure (2000) commented on. The research consistently shows that women on average are better at identifying facial affect (see review in Kret & Gelder, 2012). Having better facial emotion recognition skills would likely be consistent with women perceiving negative facial expressions as more negative due to the accuracy effect of categorizing facial expressions appropriately. Accordingly, some studies suggest that this sex difference depends on the type of emotion. More specifically, women in general, are better at recognizing facial expressions of fear and sadness (Mandal & Palchoudhury, 1985; Nowicki & Hartigan, 1988), while men are better at identifying anger (Mandal & Palchoudhury, 1985; Rotter & Rotter, 1988; Wagner, 1986). Given that these three emotions have a negative valence, one could postulate that the OC users were more likely to perceive the negative facial expressions as negative compared to men because there were more negative facial expressions for which females show an advantage for (as there were equal images of fear, sadness, and anger). The fact that OC users were the most likely group (as opposed to nonusers, who are also women) to view negative faces as negative may be related to the research discussed above that found women using OCs demonstrate an attentional bias to negative emotions (e.g., Hamstra et al., 2014; 2015; 2017). Thus, it is possible that OC users were more inclined to rate the negative facial expressions as more negative as they were more focused on the negativity of the faces than nonusers, again suggesting that OC use may be amplifying a sex difference.

The sex difference findings contrast with research showing reduced emotion recognition during OC use. For example, basic and complex facial emotion recognition was repeatedly found

to be lower in OC users compared to nonusers (Hamstra et al., 2014, 2015, 2017; Pahnke et al., 2019), especially for negative emotions including anger, sadness, and disgust (Hamstra et al., 2014, 2015, 2017). It is possible that OC use has a depressogenic effect on emotion recognition. In other words, OC users may experience a bias to perceive negative facial expressions as more negative as opposed to an accuracy effect. Safety-wise, it makes sense to err on the side of caution (i.e., perceive a face as more negative) if/when one has lower emotion recognition abilities. It is also possible that our finding that OC users perceive negative faces more negatively, may help explain reduced facial emotion recognition performance in OC users. However, there are studies that do not report differences in emotion recognition performance between OC users and nonusers (Gamsakhurdashvili et al., 2021b; Radke & Derntl, 2016; Shirazi et al., 2020). Consistent with this, we did not see a significant difference between OC users and nonusers in terms of the categorization of negative facial expressions.

Overall, the valence findings suggest that OC use may affect valence perception such that smells are perceived more positively and many negative stimuli (e.g., words, faces, and negative stimuli overall) are perceived more negatively. Based on visual examination of the means (see Table 18), it also appears that OC users were the group most likely to categorize the stimuli in line with the expected category (i.e., negative as negative, positive as positive, neutral as neutral). Interestingly, the pattern was most prominent for the valence categorizations of negative stimuli, especially for negative facial expressions as just discussed above. This does not necessarily mean that OC users had greater accuracy in their perception as we cannot be certain that the stimuli were truly positive, negative, or neutral. Instead, it may be that OC users tend to be more concrete in their thinking (i.e., an inclination to categorize things into “boxes”), especially when it comes to the perception of negative events or stimuli. This may translate into

OC users having more "black and white thinking" instead of seeing shades of grey, particularly when evaluating negative stimuli. It is not clear why this may be. However, if replicated, the findings might help to explain studies suggesting higher rates of depression in OC users (e.g., Skovlund et al., 2016). Any increase in the tendency to evaluate something (especially faces) as negative versus positive would increase the likelihood of having negative thoughts and feelings, which also then affects how one views oneself, others, and the future (e.g., Dozois & Beck, 2008). Individuals who are depressed also tend to think in absolutes (i.e., demonstrate "all or nothing" or "black and white" thinking; see Clark et al., 2000). Thus, the finding that OC users tend to evaluate stimuli (other than odours) as more negative suggests the possibility that either this effect could increase rates of depression or that this effect could be caused by another OC-related mechanism for higher rates of depression.

Valence Findings & Gender

Within women, there were no significant associations between measures of gender (masculinity, femininity, voice pitch/range) and valence perception of smells or words. Thus, there was no support for the hypothesis that within sex, gender would predict valence ratings for the tasks that showed significant group differences in our main analyses. However, there was a nonsignificant trend showing a negative correlation between voice pitch and the valence ratings for words in women, indicating that higher voice pitch in women was associated with lower valence scores on the Emotional Word List (i.e., greater tendency to perceive the words as negative). To our knowledge, this is the first study to look at associations between masculinity (using both self-report social and observed biological continuous measures) and valence perception of stimuli. There are several possible reasons for the nonsignificant association between gender and valence perception of smells or words. It is possible that our sample size for

the voice variables was too small to produce any significant results (i.e., low power). An important missing variable was the inclusion of men in our regression analyses. However, this was due to the small number of men who had acoustic data. Including both men and women in the analyses would likely provide more variation in voice pitch and voice pitch range. It may be that our female participants were too similar in their pitch to detect whether gender predicts a difference in valence ratings. Although there were no significant findings, the current study provides a starting point for future research to build on given our finding that the voice pitch, voice pitch range, and BSRI masculinity and femininity continuous gender measures differed as a function of sex and were unique predictors of sex (see Directions for Future Research for a full discussion below).

Intensity Evaluation

Overall Affective Intensity Ratings

OC Users Rated Stimuli (e.g., Smells) as More Affectively Intense than Nonusers. Overall, across the five tasks, OC users evaluated stimuli as more affectively intense than nonusers and the effect size was large. While OC users had higher mean affective intensity scores than nonusers for four of the five tasks, the effect only reached significance for odours on the Olfactory Task. There was a similar nonsignificant medium effect size trend for OC users to also differ from men in their affective intensity evaluations of odours. This finding suggests that OC use may at least partly account for any sex difference that exists in olfactory affective intensity evaluations given that OC users evaluated the smells as most intense overall. The finding provides support for our hypothesis that OC users evaluate stimuli as most affectively intense, followed by nonusers, and then men. It also fits with the "affect-intensity" hypothesis that proposes that women, on average, experience emotional events more intensely than men

(Fujita et al., 1991) and suggests that OC use may be associated with a feminization of affective intensity mechanisms. This is the first report of an enhanced olfactory affective intensity effect in OC users, as no previously published studies have examined whether OC use may affect olfactory affective intensity ratings. However, our finding is consistent with Spalek and colleagues' (2019) finding in the visual sensory modality that OC users rated images as more emotional than nonusers.

The finding that OC users perceive stimuli as higher in affective intensity was present across the tasks but was largely due to the medium-large group effect size for olfaction. The tasks with stimuli perceived through other sensory modalities did not show group effects, although there were small and small-medium effect sizes for images and sounds, respectively. These effect sizes suggest that the study was not powerful enough to detect significance and further study of these modalities with larger samples is worthwhile. There may be hormonal explanations at play in terms of OCs inducing a mechanism that strengthens the link between olfaction and affect (e.g., perhaps exogenous hormones like estradiol bind better to olfactory receptors, OCs upregulate estradiol receptors in olfaction-related areas, or the absence of ovulation is relevant). The link between olfaction and gustation (Dalton et al., 2000) may also be an important consideration given that odours can relate to tastes/foods (and many of the smells in the study were food odours). This evolutionary perspective could explain why olfaction may be more tightly linked to hormones and endocrine modulation (Martin et al., 2009) compared to the other stimuli included in this study. It may also be that the strength of the odours (i.e., potency) was more salient to participants than the other types of stimuli, resulting in greater task sensitivity and intensity evaluations. The other stimuli in our study may not have offered this level of sensory strength or sensitivity and this may at least partly explain the lack of significant

group differences. It is noteworthy that OC users did rate three of the four other types of stimuli as non-significantly more intense than nonusers (large effect size), and there was a weak nonsignificant trend (approaching a medium effect size) towards an enhanced auditory intensity effect in OC users (see Table 21). This pattern suggests that OC use may increase the perceived emotional intensity of stimuli overall, with the greatest effect occurring for odours. This overall pattern is consistent with research showing that OC use may reduce habituation of the amygdala, leading to a higher level of vigilance or reactivity to emotional stimuli in OC users who show OC-induced adverse mood side effects (Gingnell et al., 2013). The greater intensity effect for odours may be partly due to the above valence findings where OC users were more likely to perceive the odours as positive. This positive valence bias for odours may have inflated the odour intensity scores (i.e., if OC users valence ratings are more positive this would increase their overall intensity ratings on average). Thus, these two findings may be interlinked.

There are several possible explanations for why a difference was found between OC users and nonusers in their evaluation of the affective intensity of smells. Explanations all relate to the olfactory system being sensitive to changes in estrogen, or hormones in general. This relationship is not surprising given that estrogens regulate early embryonic development of the olfactory sensory system (Takesono et al., 2022). Furthermore, OC intake has been shown to alter the nasal physiology (Wolstenholme et al., 2006). For example, studies show modified bacterial compositions (Pelikan, 1978; Stubner et al., 1999) and changes in estrogen receptor distribution (Millas et al., 2011) in the nasal mucosa with OC use.

The first explanation is that estrogen levels affect olfactory intensity perception and that the hormonal milieu of OC users can enhance odour intensity and perception. In terms of the possibility that the introduction of exogenous estradiol provides an estrogen-enhancement effect,

there is evidence that postmenopausal women who receive hormone replacement therapy (HRT) demonstrate improved odour memory (Doty et al., 2015). Relatedly, endogenous estrogens show a similar enhancement effect as olfactory ability is significantly heightened in the first trimester of pregnancy when estrogen levels are at their peak (LeMay, 2014). Furthermore, a meta-analysis on the association between the menstrual cycle and olfactory sensitivity reported that olfactory thresholds were significantly lower during the fertile phase (i.e., olfactory function is best when endogenous estradiol levels are at their peak; Nováková et al., 2014). In terms of OC use, women are likely to have higher exogenous estradiol but lower endogenous estrogen. Several studies have examined differences between OC users and nonusers in terms of olfactory performance (e.g., identification, discrimination). Landis and colleagues (2004) found that OC users had better smell identification compared to nonusers whereas the results of another study (Kollndorfer et al., 2016) suggest that ethinyl estradiol (EE) dose has a major impact on olfactory performance. They found that women who used OCs with lower EE doses achieved higher olfactory discrimination scores compared to OC users with higher EE doses. Another study found a significant reduction in odour discrimination during the OC withdrawal period (i.e., inactive pill week), suggesting poorer discrimination ability when contrasted with the contraceptive period in the same women (Endevelt-Shapira et al., 2020). The authors speculated that the decrease in olfactory discrimination of body odours during withdrawal days may be related to a sudden decrease in exogenous estrogen and/or progesterone levels associated with the pause in intake. Given that exogenous estrogen levels are elevated with OC use during active pill days, this finding is in line with the research showing that elevated estrogen is associated with improved olfaction. Overall, an OC-related improvement in olfaction ability appears dependent on the dose of EE and the timing of the contraceptive period (e.g., improvement

observed with lower EE does and during the active pill phase). These improvements were seen for odour identification and discrimination, and it is not clear if this directly relates to affective intensity evaluation of odours. Although olfactory intensity should theoretically correlate with thresholds of odour detection, it may be that odour identification and discrimination is very different from the way we perceive the intensity of the odour. The lack of research on olfactory intensity emphasizes the need for further research that differentiates between odour intensity perception and odour discrimination abilities in OC users and nonusers.

A related explanation may be due to differences between OC users and nonusers in their sensitivity to odours. This is related to evidence suggesting that the olfactory system is very sensitive to hormonal change. Several studies show olfactory changes with hormonal change. For example, Caruso and colleagues (2001) found that women's olfactory thresholds were significantly higher after beginning an OC regimen. These findings are likely contradictory to ours as higher thresholds indicate decreased olfactory sensitivity, and thus, likely indicate reduced intensity evaluations of odours. Other studies have found OC-related reductions in sensitivity to social chemosignals (Lundstrom et al., 2006; Renfo & Hoffmann, 2013). For example, Renfo and colleagues (2013) found that nonusers in the periovulatory phase were significantly more sensitive to androstenone, androsterone, and musk than women taking OCs. Although these findings suggest odour-specific hormonal modulation of olfaction, they do not suggest that the enhanced affective intensity effect for odours is due to enhanced olfactory sensitivity in OC users as OC users seem to have lower discrimination abilities (i.e., less sensitivity) and higher sensory thresholds. Thus, this explanation can likely be ruled out as plausible.

A subset of studies has focused on the potential impact of OCs on the perception and preference for social chemosignals and body odours with relatively consistent results. Research suggests that women's preferences for men's body odours vary across the menstrual cycle. As fertility increases, olfactory preferences increase for odours of men who are perceived as dominant (Havlicek et al., 2005), symmetrical (Gangestad & Thornhill, 1998; Rikowski & Grammar, 1999), and who have dissimilar MHC (Wedekind et al., 1995). These preferences are not present in non-fertile phases of the menstrual cycle, nor are they observed in women using OCs (Gangestad & Thornhill, 1998; Roberts et al., 2008; Wedekind et al., 1995). These studies measured odour attractiveness ratings, which has some similarity to the positive and negative rating scales used in the current study but is ultimately different from our affective intensity measure (i.e., the extent to which the smell was evaluated as both positive and negative). While the preference studies are possibly more relevant than odour sensitivity or discrimination studies as they have an affective/preference component, the results are not consistent with the current findings given that past findings suggest stronger odour preferences in higher fertility or higher periods of higher endogenous estrogen. However, the findings from preference studies would only be relevant if we were looking at how intensely positive the stimuli are rated, and are much less relevant given that our measure of intensity includes both negative and positive affective intensity. Overall, the findings suggest that OC use (and type) in female participants should be considered when examining odour perception as there are documented effects on discrimination, sensory thresholds, preferences, and now affective intensity.

Affective Intensity Ratings & Gender

There were no overall associations between the measures of gender and olfactory affective intensity ratings. Women's self-perceived masculinity and femininity and their

measured voice pitch and voice pitch range did not together predict affective intensity ratings of smells. However, in women there was a positive correlation between voice pitch and their intensity ratings for smells. Given that higher voice pitch is found in women, is considered more feminine, and is associated with lower testosterone (Evans et al., 2008; Dabbs & Mallinger, 1999), this correlation is in line with our hypothesis that women are more intense in their affective evaluation of the stimuli and is consistent with our hypothesis that individuals low on masculinity and/or high on femininity will show more emotional intensity in their ratings. Although the smells were not chosen because they fit exclusively into a positive or negative affective framework, it is plausible to assume that they evoked some sort of emotional response as there is literature to support the notion that odour can be strongly tied to emotion (see review in Kontaris et al., 2020). In fact, visual examination of the affective intensity means across tasks (see Table 6) suggest that the smells were rated just as affectively intense or higher than stimuli from the other tasks. Ehrlichman and Bastone (1992) discuss several propositions connecting olfaction to emotion, with the most relevant to this project being that the experience of odours is inextricably linked to hedonic tone, or in other words, the most salient aspect of odour is its pleasantness or unpleasantness. In terms of affective intensity, the current study found that OC users perceive odours as being more emotionally intense and that more feminine women (i.e., those with higher voice pitch) report perceiving odors as having higher affective intensity. These findings suggest a feminization of affective intensity evaluation with OC use.

Given that voice pitch also has a hormonal connection, it is not surprising that it was significantly correlated with olfaction ratings (see above for discussion on olfaction and its relationship to estrogen). Voice pitch is positively associated with average levels of estrogen in women (Feinberg et al., 2006) while it is negatively correlated with testosterone levels in men

(Evans et al., 2008; Dabbs & Mallinger, 1999). Several studies have also demonstrated the presence of sex hormone receptors (e.g., progesterone and estrogen) on human vocal folds (Kirgezen et al., 2017; Voelter et al., 2008; Brunings et al., 2013). Furthermore, the quality of a women's voice is observed to be the best during the ovulatory phase when estrogen is at its highest (Raj et al., 2010). This is likely because (1) estrogen promotes increased secretion of mucus by the glandular cells above and below the vocal fold edges, resulting in better mucosal viscosity and (2) high estrogen levels improve permeability of the blood vessels and capillaries of the vocal folds resulting in better tissue oxygenation (Abitbol et al., 1999).

The positive correlation between voice pitch and odour intensity ratings provides some evidence that there is a possible hormonal/biological explanation for why women might demonstrate higher affective intensity ratings for odours that may be more substantial than social roles or expectations (i.e., a tendency to be more affectively intense in odour judgements is not simply due to social factors). This correlation also suggests that biological measures of gender are superior to social variables when predicting odour intensity ratings. Again, this significant finding is likely because of the observed relationship between voice pitch and sex hormones. One could postulate that social variables are more variable because they rely so heavily on an individual's social environment. Thus, one could argue that biological characteristics may be a better continuous measure of sex/gender than are social/personality/behaviour characteristics. Overall, this finding suggests that researchers should consider using voice pitch when looking for a continuous measure of sex or gender.

Limitations

One limitation of the present study, as in most non-RCT OC studies, is that our findings may be influenced by the survivor effect (Kutner & Brown, 1972). Women who experience

negative OC effects would likely have already discontinued their use and would therefore not be included in the sample of OC users, leaving an unrepresentative sample of women (i.e., a sample who do not experience adverse mood-related effects). There is also the possibility that our sample of OC users contained women who have Polycystic Ovary Syndrome (PCOS), which would differentially affect the hormonal milieu of these women. Relatedly, the study is also limited in fully demonstrating the effect of OCs on emotional memory, perception, and evaluation because the OC users were self-selected users (i.e., not randomly assigned). A randomized placebo-controlled trial would be ideal to address this issue as there may be differences between women who choose to take OCs and those who do not. However, studies such as the present one are important as they help to justify the need for placebo-controlled trials to be conducted to look at these research questions. With correlational studies such as this one, pre-existing differences may play a role in the group differences found. That is, while unlikely, it is possible that women who choose to take OCs may be women who are less likely to recall negative stimuli and more likely to recall positive stimuli, who evaluate stimuli as more intense (particularly smells), who perceive negative stimuli as more negative (particularly words and faces), and who perceive smells as more positive to begin with. Thus, such preexisting differences could potentially result in an overestimate of our findings between OC users and nonusers while other preexisting differences could mean that the observed effects are underestimates.

Another caveat to our study is that women differed in terms of where they were at across the menstrual cycle or across the active versus inactive pill days and we did not control for this. Research has shown differences in cognitive function and emotion processing during certain times in the natural cycle (e.g., ovulation versus other days; see review in Sundstrom-Poromaa &

Gingnell, 2014) and differential memory effects in OC users that were in "on" and "off" weeks (e.g., enhanced verbal memory during the active pill phase; Mordecai et al., 2008). Differences in performance on cognitive tasks have also been observed in relation to the androgenicity of the type of combined OCs used (e.g., Warren et al., 2014; Pletzer et al., 2015). Our sample was primarily monophasic users, and this also limits the generalizability of our results to other types of OCs. The most common type of monophasic OC used in the present study (~40%) consisted of a low-dose combined OC with 0.02 mg ethinyl estradiol and 0.10 mg of a synthetic progestin called levonorgestrel. We do not have any evidence that cycle phase, active versus inactive pill phases, or OC type are related to memory for positive stimuli, memory for negative stimuli, valence ratings, or affective intensity ratings. It is also likely that our participants were equally distributed across the cycle and non-pill days. Nonetheless future studies should consider this possibility and control for these factors.

Other potential limitations of the current study relate to the stimuli and tasks. It may be that some of the chosen emotional stimuli were not emotionally charged enough to produce maximal effects. This may account for the failure to find valence and affective intensity group differences on the Emotional Picture Task or Emotional Auditory Task (only two tasks to not show any significant findings) and could mean underestimates of effect sizes with the picture and auditory stimuli. Given ethical considerations, using very emotionally charged stimuli was not possible. However, it is important to note that the emotional stimuli in the current study were rated as more intense than the neutral stimuli, indicating that the emotional stimuli were evaluated as more intense in terms of positivity or negativity (see Appendix R). A possibility for the lack of significant memory effects on the Emotional Picture Task and Emotional Facial Task is that the two recognition tasks were too easy to reveal any significant differences between

groups (i.e., a ceiling effect) as only the two recall tasks (Emotional Word List and Spatial Memory Task) showed significant memory findings. In fact, participants had lower percent correct scores for the recall of objects and words versus the recognition of faces and images, providing support for this hypothesis. Future studies should include recall (versus recognition) tasks or more difficult recognition tasks that can allow for greater variability in memory scores and better resemblance to daily life memory demands (i.e., many things to remember).

A few other potential limitations are worth mentioning. Although the present study examined hormonally relevant factors, we had no direct measure of endogenous hormone levels in our female participants and thus cannot directly link endogenous hormones to affective intensity, valence, or affective memory. However, OC use is an objective measure of exogenous hormone exposure and there are typical changes to endogenous hormone levels with OC use. Although we measured attention, we had no measure of arousal, which can be hypothesized to influence subsequent memory and the ratings of the stimuli. However, we did have self-report measures of excitement and alertness within the PANAS that measure somewhat similar constructs (e.g., excitement, alertness). Scores on these items did not differ between OC users, nonusers, and men (see Table 7). Lastly, a limitation of the present study concerns group equivalency and power (i.e., the number of participants). There were some small-medium effect sizes that were not accompanied by significant group differences, suggesting that power was an issue. It will be important that findings be replicated with a larger sample to increase power and generalizability.

Strengths

This study has several strengths. First, this study is unique in that it sought to both replicate and extend past hormone research on cognition and emotion by examining how

hormones affect an individual's experience of, response to, and memory for emotional stimuli. Past research has tended to only focus on how hormones and sex affect mood or cognition and not necessarily how they also affect the perception and evaluation of stimuli. As far as the researchers are aware, this is the first study to examine whether OC use is associated with differences in women's perception of emotional stimuli across several different perceptual modalities (i.e., perception of visual, auditory, and olfactory stimuli). The inclusion of men also allowed for the exploration of sex differences in emotional memory, perception, and evaluation. Additionally, this study extended the research on both hormones and sex by examining OC use and continuous measures of gender and their associations with emotional memory, affect intensity and valence ratings of stimuli. That is, few studies that look at sex differences have considered the effects of OC use in their female participants, the social impact of the gender continuum (i.e., masculinity), or the biological continuum of gender (e.g., voice pitch) in their participants. This study emphasizes the importance of considering such variables (e.g., hormonal and continuous gender measures) in research designs. Failing to control for or measure these variables may contribute to or account for discrepancies between research studies that find sex differences and those that do not.

This study included several controls to rule out other extraneous factors/confounds. We measured attention to ensure group equivalency so that a group difference in attention was not a potential confound (due to either sampling bias or an OC effect). We also measured and controlled for nicotine use, drug consumption in the 24 hours prior to the laboratory session and hours of sleep the night prior to attending the laboratory session, given group differences on these variables. These are strengths of the study given that these variables could have potential effects on perception and cognition and influence performance on the laboratory tasks and

subsequent results of the study. In addition, we had very strict exclusion criteria. Although the exclusion criteria significantly reduced our final sample size from 191 to 105 participants, these exclusions were important to obtain a sample with the least amount of potential bias from extraneous variables (e.g., pregnancy, menopause, drug use, mood-altering medications). While a larger sample would have provided higher statistical power (e.g., trends becoming significant), our final sample did produce some significant findings with medium-large effect sizes.

The attempt to replicate our previous findings of altered memory for emotional stimuli in OC users was an important task. Although we did not fully replicate our exact previous finding that OC users recalled relatively more positive than negative stimuli on the Emotional Spatial Memory Test (Person & Oinonen, 2020), there was a weak trend with a small-medium effect size, suggesting that a larger sample size could have led to a significant effect. Further, we did extend this finding on a different task (i.e., with words). We also replicated a related finding, as OC users recalled fewer negative objects compared to nonusers on the Emotional Spatial Memory Test. This replication provides support to the hypothesis that OCs increase immediate recall of positive stimuli, decrease immediate recall of negative stimuli (particularly negative visual stimuli), and suggests that this is one way through which OC use may alter the emotional experience of women. In addition to this important replication, this was the first study to examine whether OC use is associated with altered perception and evaluation of odours, words, sounds, and faces (e.g., altered ratings of the affective valence and intensity of the stimuli). Spalek and colleagues (2019) were the first to publish findings in this area, but their study only examined OC-related differences in the valence and arousal (not intensity) ratings of pictures. Thus, the present study extends to other sensory modalities and types of stimuli, in addition to,

considering sex/gender differences based on biological and social continuous measures of gender.

Implications

This study expands knowledge about the potential non-contraceptive benefits and side-effects of OCs. More specifically, it extends our knowledge about the relationship between OC use and emotional perception, evaluation, and memory performance. Lifetime use of OCs by women is about 82% in the United States (Mosher & Jones, 2010) while in Canada, an estimated 1.3 million women aged 15 to 49 have used OCs (Rotermann et al., 2015) and nearly half (48.3%) of sexually active 15- to 24-year-olds report using OCs (Rotermann & McKay, 2020). Given this high prevalence of use and the fact that 59% of women who discontinue OCs do so because of side effects (Rosenberg & Waugh, 1998), this research is of importance and necessitates the need for further research on the potential emotional and cognitive side effects of OC use. This information can improve informed consent for women choosing to take "the pill". When making such a decision, it would be helpful for women to know that taking OCs may affect their experience of emotional stimuli by: (a) reducing memory (or relative memory) for negative stimuli (i.e., words, objects); (b) increasing memory (or relative memory) for positive stimuli (i.e., words); and if replicated (c) perceiving stimuli differently overall, largely driven by an increased tendency to evaluate some stimuli as negative (i.e., emotional words) and others as positive (i.e., smells), (d) increasing the tendency to evaluate negative stimuli as negative (e.g., a more negative evaluation of negative emotional faces) and (e) evaluating stimuli as more affectively intense overall (strongest effect for odour ratings). Furthermore, a better understanding of OC effects can provide academic insight and have clinical implications for disorders related to emotional perception, evaluation, and memory, such as depression and PTSD

that differentially affect women (i.e., how sex hormones may influence these disorders and cognitive complaints in women and/or potentially provide hormonal treatment options). Overall, the present study adds to knowledge about factors affecting women's emotional-cognitive health and well-being that (a) can provide more structured recommendations for clinicians when prescribing and advising on birth control and (2) empower women to make better-informed decisions related to OC usage.

The current study's finding that nonusers recall more negative objects than OC users and men (and OC users recall fewer negative objects and negative words than nonusers) when short-term memory is tested could have important implications in terms of OC use and sex differences. First, this suggests that men and women may process information in different ways or remember certain information differently depending on the emotional valence of that information. Knowing how memory for emotional events differs on average between men and women may have important implications for understanding how emotional disorders, such as depression or posttraumatic stress disorder (PTSD) exhibit a gender-related susceptibility. Women are significantly more likely to suffer from depression (Kendler et al., 2001) and PTSD (Breslau et al., 1997; Tolin & Foa, 2006) after a trauma than men are. This suggests that the greater prevalence of these disorders in women versus men may not be due to the trauma itself but perhaps a differential sensitivity or different way of processing the event. With that said, our findings suggest that OCs could have a protective effect on gender-related susceptibility to PTSD if OC users are recalling less negative information than males and nonuser females (Person & Oinonen, 2020). The fact that this pattern was also observed when just examining negative stimuli in our current and past study, could be seen as further evidence to suggest a protective effect of OC use against the retention of aversive or negative information. This possibility fits

with the finding that victims of sexual assault who received a combined emergency contraception pill (i.e., containing estrogen and progesterone) directly after the traumatic event reported fewer symptoms of post-traumatic stress compared to victims who took a progesterone-only emergency contraception pill or those who did not take any emergency contraception (Ferree et al., 2012). Accordingly, Ferree and colleagues (2012) also speak to the potential protective effect that contraception use may have on post-traumatic stress. Further investigation into the sex-, gender-, and OC-related-differences in recall of emotional stimuli is warranted for these reasons. This line of research is important because it may uncover possible side effects of OC use on emotional processing and possible explanations for emotional disorders that exhibit gender-related susceptibility.

This study also lends insight into the relationship of gender (e.g., masculinity) to emotional perception and evaluation. Most studies have only examined sex differences whereas our study examined the possible effects of the full continuum of social and biological measures of gender within women. Examining the full continuum of gender using biological and social measures can help us better understand how both sex and gender affect emotional memory, and affective valence and intensity ratings of stimuli. Differentiating between gender and sex can have important implications for understanding the social and biological factors that help to explain individual differences in behaviour.

Future Directions

Given that the current study replicated our previous finding of an altered memory response to emotional stimuli in OC users (i.e., reduced recall of the ratio of positive to negative objects), a first important task would be to replicate the new findings of altered perception and evaluation of stimuli (i.e., the OC-related stimulus-specific valence bias and enhanced affective

intensity effects). A second task would be to attempt to determine the mechanistic cause(s) of the memory, perception, and evaluation alterations. One could examine casual factors by examining whether emotional processing is differentially affected by (a) monophasic and multiphasic preparations (i.e., examine dosage and hormone variability), (b) different OC formulations (i.e., examine the relative contribution of estradiol and progestin or different types of each), and (c) active vs. nonactive pill days (i.e., whether the effects are due to a general factor in OC use such as ovulation suppression or due to day-to-day changes in hormones). A second way to examine hormonal causal factors might involve examining whether polymorphisms on specific hormonal genes (e.g., estrogen or progesterone genes) are associated with individual difference in emotional recall, perception, and evaluation.

It is also important that future research address whether the observed recall effects are the result of OCs altering encoding, consolidation, retrieval, or all three with respect to memory. Understanding the mechanism(s) by which OCs alter recall of emotional stimuli at all levels (e.g., molecular/hormonal, neuroanatomical, circuitry/functional) will be an important next step in extending this replicated finding. It may be that OC users, nonusers, and men have differing brain area activation patterns during the processing of emotional stimuli, which may then affect subsequent participant perception (affective valence and intensity ratings) and recall of emotional stimuli. Studies involving fMRI imaging of brain regions activated when viewing, rating, and recalling emotional stimuli in OC users, nonusers, and men would be an interesting direction for future research. More specifically, further studies in the area could include measures of lateralized amygdala function between sexes to examine amygdala-related memory processes in the recall and evaluation of emotional stimuli. Past research has found that activity in the right amygdala in males, and the left amygdala in females, relates to significantly

enhanced memory for emotional events (Cahill et al., 2001; 2004). Furthermore, OC users have showed significantly decreased bilateral amygdala reactivity in response to negatively valenced, emotionally arousing stimuli compared with nonusers (Petersen & Cahill, 2015). It would be interesting to see if OC use influences amygdala-related memory processes and hemispheric lateralization in response to emotional stimuli as well. Perhaps OC users would show more activity on the right side (more like men) while nonusers would show more activity on the left side (more like women). This would be especially interesting to look at given our memory findings, which suggest a defeminization or masculinization of emotional memory in OC users. However, it is noteworthy that people with Urbach-Wiethe disease (who exhibit bilateral calcification of the amygdala and loss of amygdala functioning) still demonstrate good memory for most emotional information (Anderson & Phelps, 2002; Wiest et al., 2006). Although there is reliable evidence that amygdala functioning is correlated with cognitive and emotional behvaiour (Beissner et al., 2013; Quadt et al., 2022), other processes may be involved as the amygdala does not appear essential for emotional memory (i.e., neither necessary for nor uniquely associated with emotional behaviour) given the area of research with Urbach-Wiethe patients. It may be that OCs are affecting another brain area of interest that future research can explore as it is established that emotional experience and behaviour reflect the interaction of multiple neural areas and not just one area (e.g., Barrett, 2017; LeDoux, 2012). In particular, the ventral insula, posterior cingulate cortex, and vmPFC may be of interest given that these structures are widely found to be correlated with emotional experience (e.g., Brinkmann et al., 2017).

In terms of additional directions for future research on emotional memory, it would be interesting to explore whether the continuous measures of gender (e.g., voice pitch) would show memory effects similar to sex effects (e.g., lower recall of negative stimuli in more masculine

and less feminine individuals). Lastly, specific types of OCs such as triphasic, extended cycle, or androgenic versus anti-androgenic pills should be investigated for their effects on cognitive and emotional processing to improve external validity. Further, direct hormone measurement would be helpful in determining if reductions/changes in the endogenous hormones of OC users play a role in the effect.

Given our finding that OC users were more likely to evaluate negative stimuli as more negative than nonusers, it is important that future research examines positive, negative, and neutral stimuli separately as it may be the case that any sex-related or OC-related evaluation biases do not affect all stimuli in the same way. Furthermore, a tendency to evaluate stimuli more in line with the expected valence category could hide or obscure effects across categories of stimuli (e.g., significant memory findings for positive and negative objects or valence findings for negative facial expressions when looking at the categories separately). Thus, examining stimuli as a function of valence category may allow researchers to see patterns within categories and potentially reveal hidden differences.

Interestingly, we found that voice pitch was a better predictor of biological sex than the social gender variables (i.e., self-report on the BEM Sex Role Inventory). More specifically, voice pitch explained 57% of the variance in sex while the social variables only explained 10.7% of the variance. This is the first study to examine whether gender relates to valence and affective intensity ratings. Furthermore, it appears to be the first study to use voice pitch as a more biological continuous measure related to gender and sex. Overall, there appears to be value in continuing to use voice pitch as a continuous and objective measure of a sex/gender factor in future research.

Conclusion

In conclusion, our results replicate our previous finding of altered emotional memory with OC use (Person & Oinonen, 2020) and provide evidence that OC use is associated with altered valence perception and affective intensity evaluation of stimuli. The results suggest that OC use may be associated with (a) a defeminization of emotional memory processes, olfactory valence perception, and word valence perception; and (b) a feminization of the valence perception of negative stimuli and of affective intensity. Our findings underline the importance of considering OC use when looking at sex differences in emotion and cognition. Furthermore, there appears to be value in examining the continuum of gender, in addition to sex, when investigating affective intensity. Overall, our findings may contribute to a better understanding of the role of ovarian hormones, and possibly OC use, in emotional disorders that differentially effect women. This area of research is an important contribution towards providing true informed consent for women electing to take OCs.

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Appendix A

Research Ethics Board Approval Letter

Lakehead UNIVERSITY

Research Ethics Board
t: (807) 343-8283
research@lakeheadu.ca

June 22, 2018

Principal Investigator: Dr. Kirsten Oinonen
Student Investigator: Brandi Person
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, ON P7B 5E1

Dear Dr. Oinonen and Ms. Person:

Re: Romeo File No: 1466524
Granting Agency: N/A
Agency Reference #: N/A

On behalf of the Research Ethics Board, I am pleased to grant ethical approval to your research project titled, "The Emotional Perception Project".

Ethics approval is valid until June 22, 2019. Please submit a Request for Renewal to the Office of Research Services via the Romeo Research Portal by May 22, 2019 if your research involving human participants will continue for longer than one year. A Final Report must be submitted promptly upon completion of the project. Access the Romeo Research Portal by logging into myInfo at:

https://erpwp.lakeheadu.ca/

During the course of the study, any modifications to the protocol or forms must not be initiated without prior written approval from the REB. You must promptly notify the REB of any adverse events that may occur.

Best wishes for a successful research project.

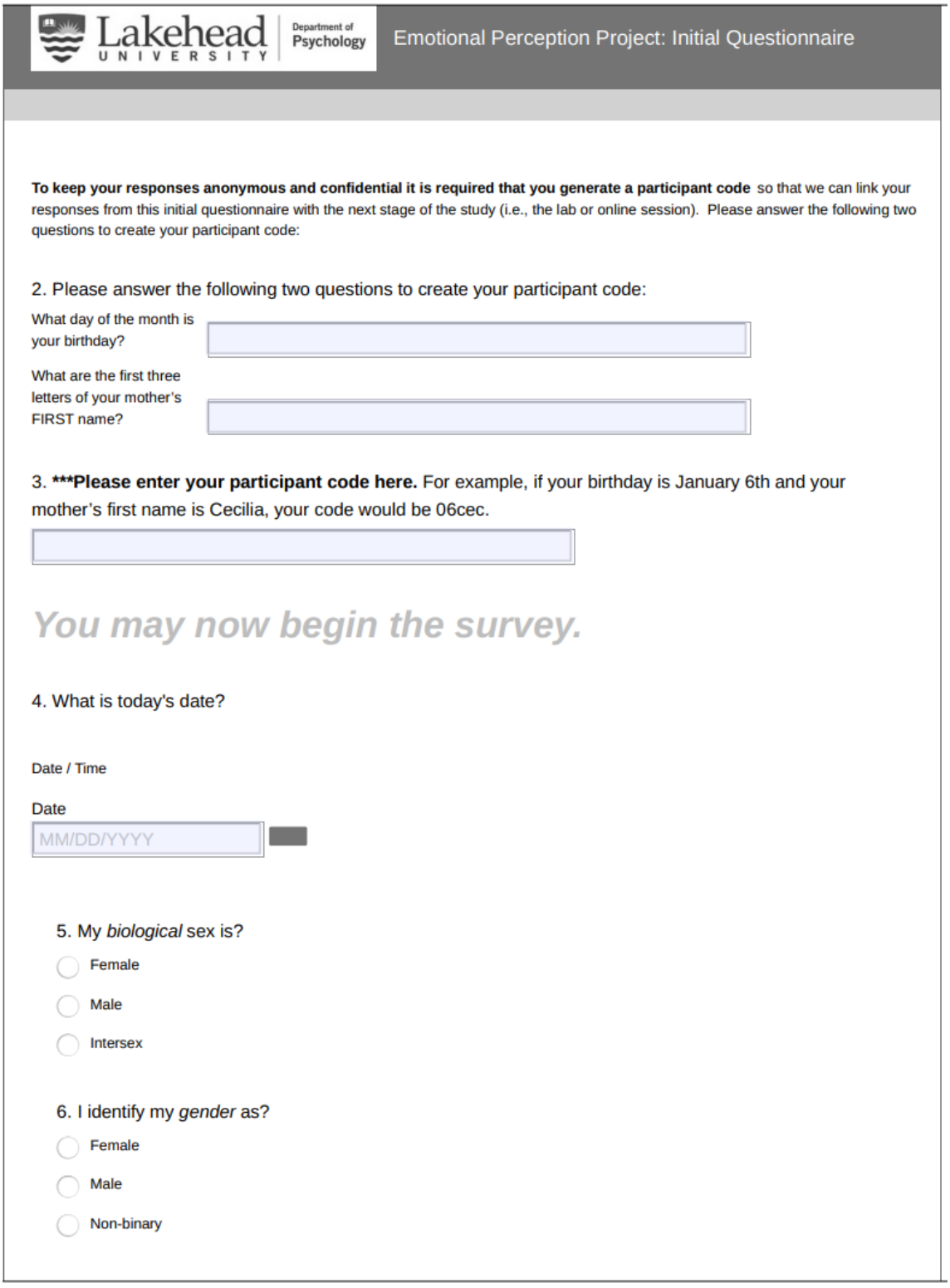
Sincerely,

Dr. Kristin Burnett
A/Chair, Research Ethics Board

/scw

Appendix B

Initial Questionnaire



Lakehead UNIVERSITY | Department of Psychology

Emotional Perception Project: Initial Questionnaire

To keep your responses anonymous and confidential it is required that you generate a participant code so that we can link your responses from this initial questionnaire with the next stage of the study (i.e., the lab or online session). Please answer the following two questions to create your participant code:

2. Please answer the following two questions to create your participant code:

What day of the month is your birthday?

What are the first three letters of your mother's FIRST name?

3. ***Please enter your participant code here.** For example, if your birthday is January 6th and your mother's first name is Cecilia, your code would be 06cec.

You may now begin the survey.

4. What is today's date?

Date / Time

Date

MM/DD/YYYY

5. My *biological* sex is?

- Female
- Male
- Intersex

6. I identify my *gender* as?

- Female
- Male
- Non-binary

7. If you identified your biological sex as *female*, are you currently taking any type of hormonal contraceptive? (e.g., an oral contraceptive or "the pill", Depo Provera, hormonal patch, NuvaRing)

- ◯ Yes
- ◯ No

8. What is your age?

9. What is your height in feet and inches? For example, if you are 5 feet and 4 inches, write 5'4".

10. What is your current weight in pounds?

11. Which race/ethnicity best describes you? (Please choose only one.)

- ◯ American Indian or Alaskan Native
- ◯ Asian / Pacific Islander
- ◯ Black or African American
- ◯ Hispanic
- ◯ White / Caucasian
- ◯ Multiple ethnicity / Other (please specify)

12. Are you currently taking any medications?

- ◯ Yes
- ◯ No

If YES, what medications are you taking? (please list)

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

14. Are you *currently* diagnosed with or being treated for a mood-related disorder (e.g., depression, bipolar disorder, manic depression)?

- ◯ Yes
- ◯ No

15. Have you *ever been* diagnosed or treated for a mood related disorder (e.g., depression, bipolar disorder, manic depression)?

- ◯ Yes
- ◯ No

16. Do you smoke cigarettes?

- ◯ Yes
- ◯ No

If YES, how many cigarettes on average do you smoke each day?

17. How often do you normally consume alcohol?

- ◯ Never
- ◯ Once or twice a month
- ◯ Once or twice a week
- ◯ Three to four times a week
- ◯ Almost every day
- ◯ Every day

18. What is the average or typical number of drinks you have when/if you drink?

19. Based on your sex, how often do you typically drink the following?
Women - four or more drinks on one occasion (generally within two hours)
Men - five or more drinks on one occasion (generally within two hours)

- ◯ Never
- ◯ Once or twice a month
- ◯ Once or twice a week
- ◯ Three to four times a week
- ◯ Almost every day
- ◯ Every day

20. How many days per week do you typically use mind-altering substances such as drugs or alcohol for recreational purposes (not including caffeine or nicotine)?

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7

21. How often do you consume caffeine (e.g., coffee, tea, colas, chocolate)?

- ◯ Never
- ◯ Once or twice a month
- ◯ Once or twice a week
- ◯ Three to four times a week
- ◯ Almost every day
- ◯ Every day

22. Do you have any problems with your vision?

- ○ Yes
- ○ No

23. If YES to the previous question, check all that apply.

- ☐ Eye glasses or contacts
- ☐ Eye disease
- ☐ Eye surgery
- ☐ Eye injury

Other (please specify)

24. Have you ever suffered a brain injury or other medical condition that had a significant effect on your memory?

- ○ Yes
- ○ No

25. Have you ever been diagnosed with a memory problem?

- ○ Yes
- ○ No

26. Have you ever been diagnosed with an attention problem? For example, Attention deficit and hyperactivity disorder (ADHD).

- ○ Yes
- ○ No

27. How does your memory for visual information (e.g., images, pictures, objects)compare to other people of your same age and sex?

Very poor	Below average	Slightly below average	Average	Slightly above average	Above average	Excellent
☆	☆	☆	☆	☆	☆	☆

28. How does your memory for verbal information (e.g., things you hear or read) compare to other people of your same age and sex?

Very poor	Below average	Slightly below average	Average	Slightly above average	Above average	Excellent
☆	☆	☆	☆	☆	☆	☆

29. How does your memory for emotional information or experiences (e.g., emotional things that happen to you or others) compare to other people of your same age and sex?

Very poor	Below average	Slightly below average	Average	Slightly above average	Above average	Excellent
☆	☆	☆	☆	☆	☆	☆

30. Compared to the average person, how emotionally involved do you get when watching or hearing about an emotional story or event?

Much less involved	Slightly less involved	Average level of involvement	Slightly more involved	Much more involved
☆	☆	☆	☆	☆

31. Please check the highest education level you have completed:

- ○ Less than a high school diploma
- ○ Graduated high school or high school equivalent
- ○ Current college or university undergraduate student
- ○ Graduated college or university
- ○ Current graduate or doctoral student
- ○ Completed graduate school

32. What best describes your current educational status?

- ○ Not in school
- ○ In college
- ○ First year university
- ○ Second year university
- ○ Third year university
- ○ Fourth year (+) university
- ○ Graduate student

33. What is your current grade point average? (e.g., 55%, 72%). If unsure, or currently not in school, what was your past/most recent grade point average?

34. During an average week, how many hours of sleep do you get each night?

35. How many minutes of moderate to intense exercise do you normally get each week?

36. Toronto Empathy Questionnaire (TEQ). Removed due to copyright reasons. The citation is provided below:

Spreng, R. N., McKinnon, M. C., Mar, R. A., & Levine, B. (2009). The Toronto empathy questionnaire: Scale development and initial validation of a factor-analytic solution to multiple empathy measures. *Journal of Personality Assessment, 91*(1), 62–71. doi:10.1080/00223890802484381

37. Toronto Alexithymia Scale (TAS-22). Removed due to copyright reasons. The citation is provided below:

Bagby, R.M., Parker, J.D., & Taylor, G.J. (1994a). The twenty-item Toronto Alexithymia Scale—I. Item selection and cross-validation of the factor structure. *Journal of Psychosomatic Research, 38*(1), 23-32. doi:10.1016/0022-3999(94)900005-1

38. Perth Emotional Reactivity Scale (PERS). Removed due to copyright reasons. The citation is provided below:

Becerra, R., Preece, D., Campitelli, G., & Scott-Pillow, G. (2017). The assessment of emotional reactivity across negative and positive emotions: Development and validation of the perth emotional reactivity scale (PERS). *Assessment*, *26*(5), 867-879. doi:10.1177/1073191117694455

39. Reduced Emotional Intensity Scale (EIS-R). Removed due to copyright reasons. The citation is provided below:

Bachorowski, J.A., & Braaten, E.B. (1994). Emotional intensity: Measurement and theoretical implications. *Personality and Individual Differences, 17*(2), 191-199. doi:10.1016/0191-8869(94)90025-6

40. Emotion Regulation Questionnaire (ERQ). Removed due to copyright reasons. The citation is provided below:

Gross, J.J., & John, O.P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*, 348-362. doi:10.1037/0022-3514.85.2.348

41. Affect Intensity Measure – Short Form (AIM). Removed due to copyright reasons. The citation is provided below:

Larsen, R. J. (1984). *Affect Intensity Measure* [Database record]. APA PsycTests. doi:10.1037/t06142-000

42. Symptom Checklist 90 Revised – Depression Scale (SCL-90-R). Removed due to copyright reasons. The citation is provided below:

Derogatis, L.R. (1994). *SCL-90-R: Symptom checklist-90-R: Administration, scoring and procedures manua*l. National Computer Systems, Inc.: Minneapolis, MN.

43. Bem Sex Role Inventory – Short Form (BSRI). Removed due to copyright reasons. The citation is provided below:

Bem, S.L. (1981). *Bem sex-role inventory: Professional manual*. Palo Alto, CA: Consulting Psychologists Press.

44. Personal Attributes Questionnaire (PAQ). Removed due to copyright reasons. The citation is provided below:

Spence, J.T., & Helmreich, R.L. (1978). *Masculinity and femininity*. Austin: University of Texas Press.

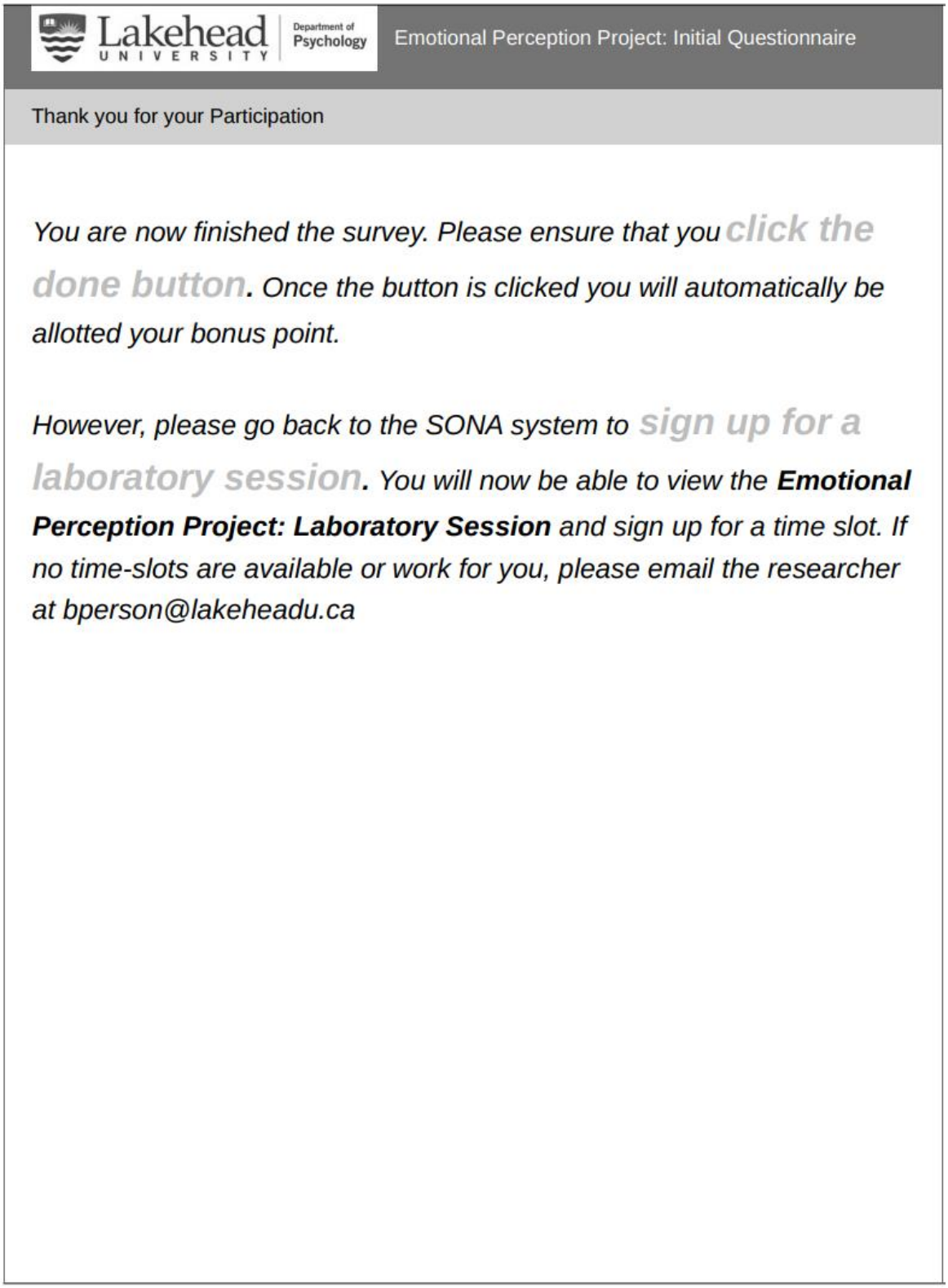
45. BIS/BAS Scale. Removed due to copyright reasons. The citation is provided below:

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective

responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology*, 67, 319-333. doi:10.1037/0022-3514.67.2.319

46. Social Desirability Scale-17 (SDS-17). Removed due to copyright reasons. The citation is provided below:

Stober, J. (1999). The social desirability scale-17 (SDS-17): Development and first results of reliability and validity. *Diagnostica, 45,* 173-177.


Lakehead UNIVERSITY
Department of Psychology
Emotional Perception Project: Initial Questionnaire
Thank you for your Participation
You are now finished the survey. Please ensure that you click the done button. Once the button is clicked you will automatically be allotted your bonus point.
However, please go back to the SONA system to sign up for a laboratory session. You will now be able to view the Emotional Perception Project: Laboratory Session and sign up for a time slot. If no time-slots are available or work for you, please email the researcher at bperson@lakeheadu.ca

Appendix C

Additional Measures from the Initial Questionnaire

Affect Intensity Measure (AIM) Short Form. The AIM is designed to measure the characteristic strength or weakness with which one experiences emotion (Larsen, 1984). The short form is a 20-item questionnaire that measures emotional reactions to typical life events rated on a six-point Likert scale ranging from 1 (*never*) to 6 (*almost always*). Mean AIM scores differ significantly between men and women, with women on average obtaining higher overall mean scores than men (Bagozzi & Moore, 2011; Goldsmith & Walters, 1989). The AIM was selected as scores reflect how strongly or weakly participants tend to experience emotions in their everyday lives. In the present study, the AIM demonstrated good reliability (Cronbach's alpha reliability coefficient = .83).

Reduced Emotional Intensity Scale (EIS-R). The EIS-R (Bachorowski & Braaten, 1994) is a measure of emotional intensity that is unconfounded by the frequencies with which positive and negative affect are experienced, which is a common criticism of the AIM. It is a 17-item questionnaire that taps both positive (EIS-R-POS; 9 items) and negative (EIS-R-NEG; 8 items) emotional intensity (i.e., a two-dimensional perspective). Individuals rate their responses on a five-point Likert scale by choosing the answer that best describes how they usually feel in certain situations (e.g., I have accomplished something valuable, I feel…). The wording of response options varies slightly depending on the question but generally ranges from having little effect to an extreme effect, for example, ranging from 1 (*it has little effect on me*) to 5 (*so satisfied it's as if my entire life was worthwhile*). The EIS-R has a high degree of internal consistency (Cronbach's alpha = .90) and high test-retest reliability (r = .83) according to Bachorowski and Braaten (1994). Women have been found to score significantly higher on the

full scale EIS than men, however, descriptive statistics and correlations with other measures indicate that the scale operates in a similar manner for men and women (Bachorowski & Braaten, 1994).

Emotion Regulation Questionnaire (ERQ). The ERQ is a measure of an individual's tendency to regulate their emotions (Gross & John, 2003) in two ways: (1) cognitive reappraisal and (2) expressive suppression. The questionnaire asks how an individual controls (i.e., regulates and manages) their emotions with regards to emotional experience (i.e., what you feel like inside) and emotional expression (i.e., how you show your emotions through talk, gestures, and behaviour). The ERQ is a 10-item self-report measure and items are rated on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The ERQ has moderate test-retest reliability across three months (r = .69) for both scales. Regarding internal consistency, Gross and John (2003) reported that alpha reliabilities for the cognitive reappraisal and emotional expression subscales are .79 and .73, respectively. Recently, the ERQ has demonstrated similar internal consistency values (Enebrink et al., 2013).

Perth Emotional Reactivity Scale. The Perth Emotional Reactivity Scale (PERS) is a 30-item self-report measure of emotional reactivity (Becerra et al., 2017). The PERS measures the typical ease of activation, intensity, and duration of one's emotional responses. Each statement is rated according to how much the statement applies or does not apply to oneself on a typical day using a five-point Likert scale ranging from 1 (*very unlike me*) to 5 (*very like me*). The PERS was chosen as our measure of emotional reactivity/affective style as it makes the important distinction between negative and positive emotions and assesses them separately. Confirmatory and exploratory factor analyses support the capacity of the PERS to measure separate positive and negative reactivity factors, and to distinguish between the activation,

intensity, and duration of emotional reactivity (Becerra et al., 2017). Two scale scores (General Negative Reactivity and General Positive Reactivity; 15 items each) and six subscale scores (Negative Activation, Negative Intensity, Negative Duration, Positive Activation, Positive Intensity, Positive Duration; 5 items each) can be derived. The PERS has shown concurrent validity and good to excellent internal reliability in an adult community sample (Becerra et al., 2017).

Toronto Empathy Questionnaire (TEQ). The TEQ is a brief 16-item self-report measure of empathy (Spreng et al., 2009). The questionnaire captures the underlying consensus of other current measures of empathy that represent empathy as a primarily emotional process (i.e., accurate affective insight into the feeling state of another). Participants rate how frequently they feel or act in the manner described using a five-point Likert scale ranging from 0 (*never*) to 4 (*always*). According to Spreng and colleagues (2009), the TEQ demonstrates strong convergent validity (e.g., with other self-report measures of empathy) and divergent validity (e.g., with a measure of Autism symptomology). The questionnaire also demonstrates good internal consistency (Cronbach's α = .85 to .87) and high test-retest reliability (r = .81; Spreng et al., 2009).

Toronto Alexithymia Scale (TAS-20). The TAS-20 was included to measure each participant's ability to express and identify with emotional events (Bagby et al., 1994a). This 20-item instrument is commonly used to measure alexithymia, the extent to which people: (a) have trouble identifying and describing emotions, (b) minimize emotional experiences, and (c) focus attention externally. It is comprised of three subscales: difficulty describing feelings, difficulty identifying feelings, and externally oriented thinking. The TAS-20 is a self-report measure and items are rated on a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly*

agree). Reliability data indicates good internal consistency (Cronbach's alpha = .81) and test-retest reliability (r = .77). In addition, the TAS-20 demonstrates adequate levels of construct, criterion, and concurrent validity and these have been well established in diverse samples of adults (Bagby et al., 1994a; Bagby, et al., 1994b; Parker et al., 2003; Taylor et al., 2003).

Symptom Checklist 90 Revised (SCL-90-R) – Depression Subscale. The SCL-90-R (Derogatis, 1994) measures current psychological problems and symptoms of psychopathology using a 5-point Likert scale of distress ranging from 0 (*not at all*) to 4 (*extremely*). Only the 13-item Depression subscale was utilized for the purposes of the present study and the item "*Thoughts of ending your life*" was removed for ethical reasons. The internal consistency of this subscale has been estimated at .90 (Derogatis, 1994). Participants rated their experience of these symptoms in the past seven days. The SCL-90-R depression subscale was used to assess for depression and was chosen for its brevity and accuracy.

BIS/BAS scale. The BIS/BAS Scale is a 20-item self-report questionnaire that measures the relative strength of participant's approach (BAS) and avoidance (BIS) motivations (Carver & White, 1994). Participants rate their agreement to statements using a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The questionnaire consists of a BIS scale that measures concern over the possibility of bad occurrences and sensitivity to such events (i.e., an avoidance or behavioural inhibition motivation) and a BAS scale that consists of three subscales that measure Fun Seeking, Reward Responsiveness, and Drive (i.e., approach or appetitive motivation). The internal consistency and test-retest reliability of the BIS/BAS scales range from .66 to .76 (Sutton & Davidson, 1997). In addition, the BIS scale is relatively independent of the BAS subscales. For example, the BIS scale has a correlation of -.12 with the BAS Drive subscale, .28 with the BAS Reward Responsiveness subscale, and -.08 with the BAS Fun

Seeking subscale (Carver & White, 1994). This measure was included in the questionnaire for exploratory purposes, as approach and avoidance motivation may be related to an individual's perception and rating of emotional stimuli.

Appendix D

Valence and Intensity Measures

Negative Scale

Please rate the extent to which you perceive the stimulus as negative using the following scale:

Not at all Negative		Slightly Negative		Moderately Negative		Very Negative		Extremely Negative	
0	1	2	3	4	5	6	7	8	9	10

Positive Scale

Please rate the extent to which you perceive the stimulus as positive using the following scale:

Not at all Positive		Slightly Positive		Moderately Positive		Very Positive		Extremely Positive	
0	1	2	3	4	5	6	7	8	9	10

Valence

Please directly categorize the stimulus as positive, negative, or neutral by choosing one of the response options below (i.e., your overall evaluation).

a. Positive
b. Neutral
c. Negative

Appendix E

Stimuli Lists

Stimuli from the Emotional Spatial Memory Task

Negative Objects	Positive Objects	Neutral Objects
Bat	Flower	Twist Tie
Rat	Cake	Button
Handcuffs	Present	Thread
Tombstone	Winking Face	Clothespin
Knife	Peace Sign	Paper Clip
Spider	Heart	Elastic
Gun	Rainbow	Pen Cap
Overdue Notice	Smiling Face	Bobby Pin
Needle	Bow	Toothpick
Skull	Birthday Candle	Key

Note: Stimuli came from Person & Oinonen (2020).

Stimuli from the Emotional Picture Task

Negative Images	Positive Images	Neutral Images
Sad Children	Vacation	Mug
Suicide/Gun	Fireworks	Spoon
Hospital	Smiling Baby	Lamp
Attack	Money	Bowl
Car Accident	Puppies	Bridge
Solider/Gun	Happy Couple	Lightbulb
Drug Addict	Baby Seal	Key Ring
Black Eye	Smiling Bride	Basket
War Scene	Happy Family	Towel
Baby Crying	Seaside	Cabinet

Note: Stimuli came for the International Affective Picture System (IAPS).

Stimuli from the Emotional Word List

Negative Words	Positive Words	PMS Words
Solemn	Joyful	Temper
Spiteful	Fondness	Outburst
Glum	Amused	Rage
Remorse	Passion	Tearful
Horror	Cheery	Clumsy
Dismay	Admire	Greedy
Morose	Fond	Nausea
Grief	Bliss	Cramp
Homesick	Cheerful	Helpless
Ashamed	Gleeful	Muddied
Dreary	Kindly	Hunger
Resentful	Satisfied	Miserable
Regret	Joyous	Gloomy
Contempt	Consoled	Overwhelmed
Embarrassed	Warmhearted	Withdraw

Note: Stimuli came from Perry and colleagues (2014).

Stimuli from the Emotional Auditory Task

Negative Sounds	Positive Sounds	Neutral Sounds
Child Abuse	Rock & Roll	Walking/Footsteps
Baby Crying	Women Laughing	Spray Paint
Man Yelling	Baby Giggling	Faucet Dripping
Man & Woman Fighting	Beethoven	Breathing
Female Scream	Wedding Bells	Night/Crickets
Break & Enter	Casino Win	Wind Blowing
Woman Sobbing	Harp	Train
Bicycle Crash	Applause	Lawnmower
Car Accident	Boy Laughing	Typewriter
Vomiting	Crowd Cheering	Fan

Note: Audio clips came from Freesound, available to users at https://freesound.org

Appendix F

Image Number and Mean Standardized Ratings of the International Affective Picture System (IAPS) Images.

Positive Images	Neutral Images	Negative Images
Image 1710: 8.34	Image 7547: 5.21	Image 2703: 1.91
Image 1440: 8.19	Image 7004: 5.04	Image 2205: 1.95
Image 2040: 8.17	Image 7002: 4.97	Image 6313: 1.98
Image 5210: 8.03	Image 7010: 4.94	Image 9910: 2.06
Image 8501: 7.91	Image 7009: 4.93	Image 6212: 2.19
Image 5910: 7.80	Image 7059: 4.93	Image 2345: 2.26
Image 2550: 7.77	Image 7055: 4.90	Image 2710: 2.52
Image 2360: 7.70	Image 7006: 4.88	Image 6570: 2.54
Image 2209: 7.64	Image 7175: 4.87	Image 2683: 2.62
Image 1340: 7.13	Image 7705: 4.77	Image 2457: 3.20

Note: Ratings can range from 1 (negative) to 10 (positive). The ratings are published in the IAPS database. For the current study, 10 positive images (M = 7.86 ; SD = 0.35), 10 neutral images (M = 4.94; SD = 0.10) and 10 negative images (M = 2.32; SD = 0.40) were chosen.

Appendix G

Laboratory questionnaire

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Emotional Perception Project: Session Questionnaire

Session Questionnaire

To keep your responses anonymous and confidential it is required that you enter the participant code you generated in the initial questionnaire so that we can link your responses to this stage of the study (i.e., the lab session).

2. If you have forgotten your code, simply answer the following two questions again to re-create your participant code:

What day of the month is your birthday? (e.g., 06)

What are the first three letters of your mother's FIRST name? (e.g., cec for Cecilia)

For example, if your birthday is January 6th and your mother's first name is Cecilia, your code would be 06cec.

3. ***Please enter your participant code here:**

You may now begin the survey.

4. Have you consumed any alcohol in the past 24 hours?

Yes No

If YES, please indicate the number of standard alcoholic drinks you consumed in the past 24 hours (1 standard drink is equivalent to a 12 ounces of 5% alcoholic beer, a 1.5 ounce serving of 40% hard liquor, or a 5 ounce glass of wine with 12% alcohol):

5. Have you consumed any caffeine (e.g., coffee, tea, pop) prior to coming to the lab today?

Yes No

If YES, please indicate the number of standard servings (1 standard serving is equivalent to 10 fluid ounces or a small coffee/tea at Tim Hortons):

6. Do you use tobacco or nicotine products? (e.g., cigarettes, chew, vaporizers).

Yes

No

7. If YES to the previous question, please rate your **current level of nicotine withdrawal symptoms** you are experiencing right now by circling the best answer.

None at all	Mild	Moderate	Severe	Extremely severe
☆	☆	☆	☆	☆

8. Have you consumed any recreational drugs or alcohol (not including tobacco or caffeine) in the past 24 hours?

- ○ Yes
- ○ No

9. Have you taken any medication to alleviate symptoms of pain in the past 2 hours? (e.g., Tylenol, Advil, Midol, morphine).

- ○ Yes
- ○ No

10. Please rate your current level of fatigue by checking the best answer.

None at all	Mild	Moderate	Severe	Extremely severe
☆	☆	☆	☆	☆

11. How many hours of sleep did you get last night?

12. Please rate your current level of stress by checking the best answer.

None at all	Mild	Moderate	Severe	Extremely severe
☆	☆	☆	☆	☆

13. Please rate your current level of hunger by checking the best answer.

Not at all	Mild	Moderate	Very	Extremely
☆	☆	☆	☆	☆

14. Please rate your current level of interest by checking the best answer.

Not at all	Mild	Moderate	Very	Extremely
☆	☆	☆	☆	☆

15. During the lab session how bored did you feel?

Not at all	Mild	Moderate	Very	Extremely
★	★	★	★	★

16. During the lab session, how well did you attend to or pay attention to the tasks you were asked to complete?

Not at all	Somewhat	Moderately	Very	Extremely
★	★	★	★	★

17. Positive and Negative Affect Scale (PANAS). Removed due to copyright reasons. The citation is provided below:

Watson, D., Clark, L.A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063-1070. doi:10.1037/0022-3514.54.6.1063

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Emotional Perception Project: Session Questionnaire

Qualifier

18. There are some questions asked only of women or only of men (based on *biological* sex). Which questions would you prefer to answer? Those for:

- ○ Men
- ○ Women

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Emotional Perception Project: Session Questionnaire

Women Only

THE FOLLOWING QUESTIONS ARE FOR FEMALES ONLY:

19. Are you currently taking any type of hormonal contraceptive? (e.g., oral contraceptives, the Pill, Depo Provera, hormonal patch, Implanon implant, NuvaRing).

- ○ Yes
- ○ No

20. If YES to the previous question, please indicate what type of hormonal contraceptive you are currently taking:

- ○ Alesse
- ○ Brevicon 0.5/35
- ○ Brevicon 1/35
- ○ Cyclen
- ○ Demulen 30
- ○ Demulen 50
- ○ Loestrin 1.5/30
- ○ Marvelon
- ○ MinEstrin 1/20
- ○ Min-Ovral
- ○ Norinyl
- ○ Norlestin 1/50
- ○ Ortho 1/35
- ○ Ortho 0.5/35
- ○ Ortho 7/7/7
- ○ Ortho 10/11
- ○ Ortho-Cept
- ○ Ortho-Novum 1/50
- ○ Ovral
- ○ Synphasic
- ○ Tri-Cyclen
- ○ Triphasil
- ○ Triquilar
- ○ Depo-Provera (Injected)
- ○ Lunelle (Injected)
- ○ Ortho-Evra (Patch)
- ○ NuvaRing

Other (please specify)

21. Are you currently menstruating?

- ○ Yes
- ○ No

22. Using the calendars below, please indicate 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 indicate the **day that you believe your next period will start**.

First day of your last menstrual cycle:

The day you believe your next period will start:

23. How confident are you that the response provided above was the first day of your last period?

0% 25% 50% 75% 100%

24. How confident are you that the response provided above is the day that you will next get your period?

0% 25% 50% 75% 100%

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Emotional Perception Project: Session Questionnaire

Oral Contraceptive Side Effects

25. **Please fill out the following questionnaire if you have ever used oral contraceptives in the past.** Some women who use oral contraceptives (birth control pills) experience side effects. Side effects are changes in physical, emotional, and sexual functioning that can be either *positive* or *negative*. We would like to learn about any changes that you have experienced due to oral contraceptives.

Please read the following list of side effects and choose either YES or NO to indicate whether you have experienced a change in the item as a result of using oral contraceptives. If you noticed any of these changes in yourself, only choose YES if your experience is due to oral contraceptive use and reflects a change from when you did not use oral contraceptives.

If you choose YES, please indicate the amount and direction of change as compared to when you did not use oral contraceptives:

	Yes, large decrease	Yes, moderate decrease	Yes, mild decrease	No change	Yes, mild increase	Yes, moderate increase	Yes, large increase
Amount of menstrual bleeding (period)	○	○	○	○	○	○	○
Weight	○	○	○	○	○	○	○
Tiredness/fatigue	○	○	○	○	○	○	○
Appetite	○	○	○	○	○	○	○
Problems concentrating	○	○	○	○	○	○	○
Short-tempered	○	○	○	○	○	○	○
Irritability	○	○	○	○	○	○	○
Depression	○	○	○	○	○	○	○
Mood instability	○	○	○	○	○	○	○
Feeling unsociable	○	○	○	○	○	○	○
Enjoyment of sex	○	○	○	○	○	○	○
Ability to become sexually aroused	○	○	○	○	○	○	○
Desire to masturbate	○	○	○	○	○	○	○
Sexual thoughts	○	○	○	○	○	○	○
Bloating/swelling	○	○	○	○	○	○	○
Headaches	○	○	○	○	○	○	○
Vaginal dryness	○	○	○	○	○	○	○

	Yes, large decrease	Yes, moderate decrease	Yes, mild decrease	No change	Yes, mild increase	Yes, moderate increase	Yes, large increase
Disrupted sleep	○	○	○	○	○	○	○
Hot flashes/cold sweats	○	○	○	○	○	○	○
Sadness	○	○	○	○	○	○	○
Agressive feelings	○	○	○	○	○	○	○
Desire for sex with others	○	○	○	○	○	○	○

26. I believe that oral contraceptives affected my mood and emotions:

Very negatively	Slightly negatively	In no way at all	Slightly positively	Very positively
☆	☆	☆	☆	☆

27. I believe that oral contraceptives affected my physical health:

Very negatively	Slightly negatively	In no way at all	Slightly positively	Very positively
☆	☆	☆	☆	☆

28. I believe that oral contraceptives have affected my sexual functioning (i.e., arousal, sex drive):

Very negatively	Slightly negatively	In no way at all	Slightly positively	Very positively
☆	☆	☆	☆	☆

29. Menstrual Distress Questionnaire (MDQ). Removed due to copyright reasons. The citation is provided below:

Moos, R.H. (1968). The development of a menstrual distress questionnaire. *Psychosomatic Medicine*, *30*(6), 853-867. doi:10.1097/00006842-196811000-00006

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Emotional Perception Project: Session Questionnaire

Pregnancy Symptoms

THE FOLLOWING QUESTIONS ARE ONLY FOR FEMALES WHO HAVE EVER BEEN PREGNANT:

30. If you have ever been pregnant, please fill out the following questionnaire If you have had more than one child, and had different experiences during each pregnancy, please consider your **OVERALL** experience with pregnancy in general. Pregnancy is associated with many physical, emotional, and sexual changes that can be positive or negative. Please read the following list of experiences and indicate the extent and direction of the change you experienced. **If you did not experience the symptom, or if there was no change please circle 4 (no noticeable change).**

	Large decrease	Moderate decrease	Mild decrease	No noticeable change	Mild increase	Moderate increase	Large increase
Fatigue	○	○	○	○	○	○	○
Frequency of urination	○	○	○	○	○	○	○
Nausea	○	○	○	○	○	○	○
Vomiting	○	○	○	○	○	○	○
Heartburn	○	○	○	○	○	○	○
Indigestion	○	○	○	○	○	○	○
Flatulence	○	○	○	○	○	○	○
Bloating	○	○	○	○	○	○	○
Food aversions	○	○	○	○	○	○	○
Food cravings	○	○	○	○	○	○	○
Food intake	○	○	○	○	○	○	○
Tender/painful breasts	○	○	○	○	○	○	○
Irrationality	○	○	○	○	○	○	○
Frustration	○	○	○	○	○	○	○
Depression	○	○	○	○	○	○	○
Headaches	○	○	○	○	○	○	○
Constipation	○	○	○	○	○	○	○
Feeling faint/dizzy	○	○	○	○	○	○	○
Appetite change	○	○	○	○	○	○	○

	Large decrease	Moderate decrease	Mild decrease	No noticeable change	Mild increase	Moderate increase	Large increase
Nasal congestion	○	○	○	○	○	○	○
Swelling of ankles/feet	○	○	○	○	○	○	○
Varicose viens	○	○	○	○	○	○	○
Hemorrhoids	○	○	○	○	○	○	○
Concentration problems	○	○	○	○	○	○	○
Leg cramping	○	○	○	○	○	○	○
Abdominal achiness	○	○	○	○	○	○	○
Backache	○	○	○	○	○	○	○
Change in cervical mucous	○	○	○	○	○	○	○
Clumsiness	○	○	○	○	○	○	○
Diarrhea	○	○	○	○	○	○	○
Forgetfulness	○	○	○	○	○	○	○
Bleeding gums	○	○	○	○	○	○	○
Change in energy	○	○	○	○	○	○	○
Change in sensitivity of smell	○	○	○	○	○	○	○
Insomnia	○	○	○	○	○	○	○
Pelvic discomfort/pressure	○	○	○	○	○	○	○
Restless leg syndrome	○	○	○	○	○	○	○
Shortness of breath	○	○	○	○	○	○	○
Tingling hands	○	○	○	○	○	○	○
Urinary incontinence	○	○	○	○	○	○	○
Vaginal dryness	○	○	○	○	○	○	○
Hot flashes	○	○	○	○	○	○	○
Change in sexual desire	○	○	○	○	○	○	○
Acne/pimples	○	○	○	○	○	○	○
Discolouration of skin	○	○	○	○	○	○	○

31. Did you develop any significant medical conditions or illnesses while you were pregnant?

Yes No

If yes, please specify:

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Emotional Perception Project: Session Questionnaire

Pregnancy

32. If you have previously given birth, do you think that you experienced the "postpartum blues" at all after giving birth (i.e., up to 6 months after the birth of your child)? That is, did you feel anxious for no reason, unhappy, sad, teary, worried, unable to enjoy life, or perhaps had thoughts of harming yourself?

- ◯ Not at all
- ◯ Somewhat
- ◯ Definitely, yes

33. When answering the above pregnancy questions, where you thinking about a pregnancy or pregnancies that were:

- ◯ All planned
- ◯ All unplanned
- ◯ Planned and unplanned

34. When answering the above pregnancy questions, where you thinking about a pregnancy or pregnancies that were:

- ◯ All wanted/desired
- ◯ All unwanted/undesired
- ◯ Both wanted and unwanted

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Emotional Perception Project: Session Questionnaire

Menopause

THE FOLLOWING QUESTIONS ARE ONLY FOR FEMALES WHO BELIEVE THEY HAVE STARTED TO GO THROUGH, OR HAVE GONE THROUGH, MENOPAUSE:

35. At what age did your menopausal transition begin? (i.e., variable menstrual cycle length, at least 7 days different than normal).

36. The following scale outlines different stages of the menopausal transition. Please circle the number that best corresponds where you **currently** fall on this continuum.

- ○ Early menopause (variable menstrual cycle length - at least 7 days different than normal)
- ○ Late menopause (at least 2 skipped menstrual periods in a row)
- ○ Early post-menopause (at least one year since your last menstrual period)
- ○ Post-menopause (1 to 4 years since your last menstrual period)
- ○ Late post-menopause (over 4 years since your last menstrual cycle)

37. If you are currently postmenopausal (i.e., 12 months without a menstrual period), approximately how long did your menopausal transition last?

Years

Months

38. 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 ovary was removed
- ○ Yes, both were removed

39. Menopause-Specific Quality of Life Questionnaire (MENQOL). Removed due to copyright reasons. The citation is provided below:

Hilditch, J.R., Lewis, J., Peter, A., van Maris, B., Ross, A., Franssen, E., … & Dunn, E. (1996). A menopause-specific quality of life questionnaire: Development and psychometric properties. *Maturitas, 24*, 161–175. doi:10.1016/0378-5122(96)01038-9

Appendix H

Additional Measures from the Laboratory Questionnaire

OC side effects questionnaire (OCQ). The OCQ measures the severity of adverse physical, emotional, and sexual effects of oral contraceptives (Oinonen & Bird, 2012). The short form of the original questionnaire was used in the present study and retains all three subscales of the original version: physical, emotional/cognitive, and sexual/libido. The internal consistency of the side effects scales are: 0.70 (physical), 0.90 (emotional), and 0.89 (sexual; Stone, 2010). Participants were asked to rate whether they experienced each side effect while taking oral contraceptives. Women who were currently using OCs were asked to fill out this questionnaire as well as any women who have used OCs in the past. Items were rated on a 7-point scale ranging from -3 (*Yes, large decrease*) to 3 (*Yes, large increase*). If there was no change experienced, the participant was asked to respond with 0 (*No change*). This measure was included in the questionnaire for exploratory purposes.

Menstrual distress questionnaire (MDQ). The MDQ assesses the severity of premenstrual symptoms across seven domains: pain, concentration, behavioural change, autonomic reactions, water retention, negative affect, and arousal (Moos, 1991). Participants were asked to rate the severity of menstrual symptoms across the seven domains. It is a 46-item self-report questionnaire that can be used in the assessment and treatment of premenstrual and menstrual symptoms. The MDQ identifies the type (e.g., physical symptoms, mood, behaviour, and arousal) and intensity of symptoms women experience in certain phases of the menstrual cycle. This questionnaire was used to measure the occurrence and severity of premenstrual and menstrual symptoms in reproductive -aged participants. This measure was included in the questionnaire for exploratory purposes.

Pregnancy experiences questionnaire (PEQ). The PEQ measures physical and emotional symptoms experienced during pregnancy (Stone et al., 2013). It was only completed by woman who reported a history of pregnancy. The questionnaire consisted of 48 items, with an additional open-ended question asking about any medical illness or complications that may have arisen during pregnancy. The PEQ consists of two subscales: physical symptoms and emotional symptoms. The internal consistency of the physical subscale is .92 while the internal consistency of the emotional subscale is .91 (Stone, 2010). Participants rated each item on a 7-point scale ranging from -3 (*large decrease in the symptom*) to 3 (*large increase in the symptom*). Those who did not experience a change in symptom were asked to endorse 0 (*No noticeable change*). This measure was included in the questionnaire for exploratory purposes.

Menopause-specific quality of life questionnaire (MENQOL). This questionnaire measures various symptoms experienced during menopause in four symptom domains: physical, vasomotor, psychosocial, and sexual (Hilditch et al., 1996). The MENQOL is based on women's experience and is a 30-item questionnaire that shows high face validity and confirmed content validity (Hilditch et al., 1996). Test-retest reliability estimates are as follows: physical domain (r = .81), psychosocial domain (r = .79), sexual domain (r = .70), vasomotor domain (r = .37), and the quality of life question (r = .55). Discriminative construct validity shows correlation coefficients of .69 for the physical domain, .66 and .40 for the vasomotor domain, .65 and -.71 for the psychosocial domain, .48 and .38 for the sexual domain, and .57 for the quality of life question (Hilditch et al., 1996). This measure was included in the questionnaire for exploratory purposes to measure menopausal symptoms and hormonal sensitivity for participants who were no longer of reproductive age.

Appendix I

Class-Wide Email Announcement

The Emotional Perception Project

You are invited to participate in a psychology study looking at individual differences in how emotional stimuli are perceived. More specifically, the study is looking at how sex, gender, mood, and hormones (e.g., hormonal medications, the menstrual cycle) affect perception of various emotional stimuli (e.g., objects, situations). We are seeking both female and male participants to complete a 40-minute initial questionnaire and either a lab or online session that will be approximately an hour in duration. If you wish to complete the initial questionnaire using a hard copy, please contact the researchers at bperson@lakeheadu.ca. If you would like to complete the initial questionnaire online, please click on the link listed below.

Students enrolled in Introductory Psychology or other select Psychology courses (where bonus points are permitted) will receive 1 bonus point for completing the initial questionnaire and either 1 bonus point for completing the online session or 1.5 bonus points for completing the lab session (for up to 2.5 bonus points).

This study has been reviewed and approved by the Lakehead University Research Ethics Board, (807) 343-8283.

Please follow the link below to participate in the online initial questionnaire:

https://www.surveymonkey.com/

If you have any questions regarding this study, please email the researchers (contact information below).

Thank you, your time and participation is greatly appreciated. Sincerely,

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Appendix J

Recruitment Poster

HHAB Lab

Health Hormones Behaviour

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SEEKING PARTICIPANTS TO TAKE PART IN THE **EMOTIONAL PERCEPTION PROJECT.**

Participate in either:

STUDY 1: Initial online questionnaire lasting approximately 40 minutes and **one online session** lasting approximately 60 minutes (2 bonus points).
or
STUDY 2: Initial online questionnaire lasting approximately 40 minutes followed by **one laboratory session** lasting approximately 60 minutes (2.5 bonus points).

This project is investigating individual differences in how emotional stimuli are perceived with respect to hormonally relevant factors and will involve completing a variety of interesting cognitive tasks and short questionnaires.

Be **ENTERED IN A DRAW TO WIN ONE OF TWO $50 VISA GIFT CARDS** for completing either study in its entirety.

For more information or to participate in either study, please contact the principal investigator, Brandi Person (Department of Psychology), at bperson@lakeheadu.ca or visit: <insert link>

Appendix K

Online Recruitment and Site Advertisement

The Emotional Perception Project

Researchers in the Department of Psychology at Lakehead University are conducting a study investigating individual differences in how emotional stimuli are perceived with respect to hormonally relevant factors. We are looking for men and women who are 18 years of age or older, to complete a initial questionnaire and either a lab or online session. The initial questionnaire will take 40 minutes and can be completed using the link below. The lab and online sessions will take approximately an hour each and involve completing a variety of interesting emotional and cognitive tasks and short questionnaires in the Health Hormones and Behaviour Laboratory in the department of Psychology at Lakehead University. All responses will be kept anonymous and confidential. You will be entered into a draw for one of two $50 VISA gift cards for completing the study in its entirety.

This study has been approved by Lakehead University's Research Ethics Board, (807) 343-8283.

For full details and/or to participate please email bperson@lakeheadu.ca, phone (807) 343-8096, or click the link below to participate: https://www.surveymonkey.com

Appendix L

Personal Email Announcements to Non-Lakehead Student Individuals

The Emotional Perception Project

You are invited to participate in a psychology study being conducted at Lakehead University looking at individual differences in how emotional stimuli are perceived. The study will examine the effects of hormonally relevant factors. We are seeking both female and male participants to complete a 40-minute online initial questionnaire (see link below). Anyone who is 18 years or older can participate.

Following completion of the initial questionnaire, participants can either schedule a lab session or proceed directly to an online session that will take approximately an hour to complete. The lab sessions will involve participating in several interesting cognitive tasks and completing short questionnaires. You will be entered into a draw for one of two $50 VISA gift cards for completing the study in its entirety.

This study has been reviewed and approved by Lakehead University Research Ethics Board, (807) 343-8283.

Please follow the link below to participate in the online initial questionnaire:

https://www.surveymonkey.com

If you have any questions regarding this study, please email the researchers (see contact information below).

Thank you, your time and participation is greatly appreciated. Sincerely,

Brandi Person, H.B.A., M.A.
PhD Student, Department of Psychology
Lakehead University, 955 Oliver Road, Thunder Bay, Ontario P7B 5E1
email: bperson@lakeheadu.ca

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor, Department of Psychology
Lakehead University, 955 Oliver Road, Thunder Bay, Ontario P7B 5E1
email: koinonen@lakeheadu.ca

Appendix M

Letter to Participants

The Emotional Perception Project

Dear Potential Participant,

This study is being conducted by Brandi Person and Dr. Kirsten Oinonen from the Health Hormones and Behaviour Laboratory in the department of Psychology at Lakehead University. The main purpose of this study is to examine individual difference factors involved in the perception of emotional stimuli with respect to hormonally relevant factors. The data will be used in Brandi Persons' PhD Dissertation on this topic as well as to examine additional research questions in the laboratory. Participation in the study involves completing a initial questionnaire followed by either a lab or online session. The sessions will take approximately an hour to complete. The initial questionnaire can be completed online (but participants may have the option to complete a hard copy version if they wish). Both sessions involve answering personal questions about your health, mood, and behavior as well as completing several cognitive tasks. There are no obvious risks involved in participating in this study other than the fact that some participants may feel uncomfortable answering some personal questions or may experience minor positive or negative changes in their mood that would normally occur on a daily basis. Please note that you are not required to answer all questions and can skip any question that makes you uncomfortable. This study is open to Lakehead University students who are 16 years or older as well as members of the general public who are 18 years or older.

Lakehead University Psychology students may receive up to 2.5 bonus points for participation (1 bonus point for the initial questionnaire and either 1 bonus point for the online session or 1.5 bonus points for the lab session). Participants who complete the study in its entirety will be entered into a draw for one of two $50 VISA gift cards. Your participation in this study is completely voluntary and you have the right to withdraw from or refuse to participate in any part of the study, at any time without explanation or penalty. All records of your participation will be kept confidential, and reports of the study will not reveal your identity. A participant code will be created for you during the initial questionnaire to link your responses from the initial questionnaire to either the lab or online session. Thus, all your responses will be anonymous. While a name, email address, or student number is required to confirm your completed participation if you are a student in the Lakehead University Psychology Research Pool and you wish to receive bonus points, this information will be collected separately and cannot be linked

to your responses. There is no obligation to provide an email address or any other identifying information. However, the email of female participants will be requested to complete a 2-minute follow-up questionnaire at a later date. Email addresses will be stored separate from any data provided. Once the study is complete, no one, including the researchers, will be able to connect any information gathered to a specific individual. Again, all identifying information will be separate from the data and will be deleted once bonus points have been recorded and the study is complete. Participants will be anonymous in any publications or presentations of research findings.

University regulations state that all data must be stored for a minimum of five years; data will be kept in a secure location by Dr. Oinonen and will remain confidential and anonymous. If you have any questions or concerns regarding the study, please contact Brandi Person or Dr. Oinonen. This study has been approved by the Lakehead University Ethics Board (807-343-8283 or research@lakeheadu.ca) and they can also be contacted if you have any questions related to the ethics of the research and would like to speak to someone outside of the research team. Upon completion of the study, interested participants are welcome to contact one of the researchers to request a summary of the results.

Thank you very much for your time. We very much appreciate your contribution to our research.

Brandi Person, H.B.A., M.A.
PhD Student, Department of Psychology
Lakehead University, 955 Oliver Road, Thunder Bay, Ontario P7B 5E1
email: bperson@lakeheadu.ca

Dr. Kirsten Oinonen Ph.D., C. Psych.
Associate Professor, Department of Psychology
Lakehead University 955 Oliver Road Thunder Bay, Ontario P7B 5E1
email: koinonen@lakeheadu.ca (807) 343-8096

Appendix N

Consent Form A

I have read and understood the cover letter for the Emotional Perception Project conducted by Brandi Person and Dr. Oinonen in the Health Hormones and Behaviour Laboratory in the Department of Psychology at Lakehead University. I agree to participate in this research and understand the following:

1. I am being invited to participate so that I may contribute to the understanding of how hormonal factors influence perception and evaluation.

2. I am a volunteer, can withdraw at any time from this study, and may choose not to answer any question.

3. This study will involve completing an initial questionnaire online (approximately 40 minutes) and then my commitment to either a lab session scheduled at my convenience or an immediate online session that will take approximately an hour to complete.

4. There are no known serious risks involved in participating in this study. Benefits include (a) learning about research processes, (b) a first-hand experience with experimental processes, (c) knowledge that you are contributing to important research questions, and (d) the receipt of bonus points if enrolled in eligible Psychology courses at Lakehead University and (c) the chance to win one of two $50 VISA gift cards.

5. I will remain anonymous in any publications or presentations of research findings. All data will remain anonymous and confidential and will only be accessed by researchers in the lab who have been trained in research ethics. At the end of the study, the data I have provided will be associated with a participant number, and not my name, e-mail address, or any other identifying information.

6. The data will be securely stored for at least 5 years by Dr. Oinonen at Lakehead University as per ethics guidelines.

7. If I am a Lakehead University Psychology student eligible for bonus points, I will receive up to 2.5 bonus points (if applicable) for participation (1 bonus point for the initial questionnaire and either 1 bonus point for the online session or 1.5 bonus points for the lab session).

8. If I am a Lakehead University Psychology student eligible for bonus points, my name, email

address, or student ID number is required (in a separate window at the end of the study) and will not be linked with my responses. This information will not be used for any other reason.

9. I will be entered into a draw for one of two $50 VISA gift cards if I complete the study in its entirety.

10. Upon completion of my participation, I will receive a more detailed written explanation about the rationale underlying this study.

11. I may contact the researchers if I would like to receive a summary of the findings.

By checking the box below, I agree to all of the above.

Appendix O

Debriefing Form A

Thank you for completing the Initial Questionnaire for the Emotional Perception Project. You will receive 1 bonus point for your participation if you are in the Psychology Research Pool and have provided the relevant information. You can now participate in the next stage of the study by participating in either the lab or online session. If applicable, Lakehead University Psychology Research Pool participants can receive an additional bonus point for the completion of the online session or 1.5 bonus points for completing the lab session. In addition, participants who complete the study in its entirety will be entered into a draw for one of two $50 VISA gift cards.

Please be assured that any identifying information will remain confidential and will not be connected to the initial or laboratory questionnaire s. Once we have connected your data together via a participant code there will be no way to identify your responses and they will remain completely anonymous. Please keep a copy of this for your records. If you have any questions or concerns regarding this study, please contact Brandi Person or Dr. Kirsten Oinonen. You may also contact Lakehead University Research Ethics Board, which has approved this study, at (807) 343-8283.

Thank you very much for your time. We very much appreciate your contribution to our research.

Sincerely,

Brandi Person, H.B.A., M.A.
PhD Student, Department of Psychology
Lakehead University, 955 Oliver Road, Thunder Bay, Ontario P7B 5E1
email: bperson@lakeheadu.ca

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor, Department of Psychology
Lakehead University, 955 Oliver Road, Thunder Bay, Ontario P7B 5E1
email: koinonen@lakeheadu.ca

Appendix P

Consent Form B

I have previously read and understood the cover letter for the Emotional Perception Project conducted by Brandi Person and Dr. Oinonen in the Health Hormones and Behaviour Laboratory (HHAB lab) Department of Psychology at Lakehead University. I agree to participate in this research and understand the following:

1. I am now participating in the next stage of the study. This stage involves the completion of a variety of cognitive tasks and questionnaires in the HHAB lab in the Department of Psychology at Lakehead University or online (approximately an hour).

2. I will be asked to respond to questions of a personal nature that include, but are not limited to, the following: personal health, mood, behaviour, and the menstrual cycle (for women).

3. I am a volunteer, can withdraw at any time from this study, and may choose not to complete any part or question in the study.

4. There are no known serious risks involved in participating in this study. Benefits include a) learning about research processes, (b) a first-hand experience with experimental processes, (c) knowledge that you are contributing to important research questions and (d) the receipt of bonus points if enrolled in eligible Psychology courses at Lakehead University and (c) the chance to win one of two $50 VISA gift cards.

5. I will remain anonymous in any publications or presentations of research findings. All data will remain confidential and will only be accessed by the researchers, who have been trained in research ethics. At the end of the study, the data I have provided will be associated with a participant number, not my name, e-mail address, or any other identifying information.

6. The data will be securely stored for at least 5 years by Dr. Oinonen at Lakehead University as per ethics guidelines.

7. If I am a Lakehead University Psychology student eligible for bonus points, I will receive up to 2.5 bonus points (if applicable) for participation (1 bonus point for the initial questionnaire and either 1 bonus point for the online session or 1.5 bonus points for the lab session).

8. If I am a Lakehead University Psychology student eligible for bonus points, my name, email address, or student ID number is required (in a separate window at the end of the study) and will

not be linked with any of my responses. This information will not be used for any other reason.

9. I will be entered into a draw for one of two $50 VISA gift cards if I complete the study in its entirety.

10. Upon completion of my participation, I will receive a more detailed written explanation about the rationale underlying this study.

11. I may contact the researchers if I would like to receive a summary of the findings at the end of the study.

I have read and understood the above information and agree to participate in the Emotional Perception Study:

Yes

No

Appendix Q

Debriefing Form B

Thank you for participating in the Emotional Perception Project. The data you provided will be used to complete a PhD Dissertation by Brandi Person under the supervision of Dr. Kirsten Oinonen. It will also be used to examine other exploratory research questions within the Health Hormones and Behaviour Laboratory. For the dissertation, the data will specifically be used to investigate differences in the perception and evaluation of emotional stimuli and memory for emotional stimuli between men and women, within women (between oral contraceptive users versus nonusers) and across different hormonal groups of women. We are particularly interested in contributing to the understanding of factors that influence one's perception of, and memory for, emotional information. Additional exploratory research questions will also be examined. Given that this study involves examining certain aspects of memory, it was essential that you, as a participant, not be fully aware of this at the onset of the study. This was done in order to ensure that the findings were not influenced in any way by participants rehearsing or engaging in strategies to enhance memory in the session.

Given that this study involves some aspects of which participants are not fully informed of at the start, it is very important that you not discuss your experiences with other students. If participants have prior knowledge of the fact that we are also examining memory it may influence their results, and the data we collect would not be reliable. Please feel free to discuss with the researchers any thoughts or feelings you have about the study right away.

Please be assured that any identifying information, including an email address or student ID number if provided, will not be connected to the information you have provided and there will be no way to identify your responses. All your responses will remain completely anonymous and confidential. If you would like to receive a summary of the results of the study, please email one of the researchers and, upon completion of the study, a summary of the results will be emailed to you. This research project was approved by the Lakehead University Research Ethics Board, (807) 343-8283.

Psychology students at Lakehead University who have completed the entire study will receive up to 2.5 bonus points (if applicable). All volunteers will be entered into a draw for one of two $50 VISA gift cards upon the completion of the study in its entirety.

Sometimes people can feel upset when thinking about their mood or viewing emotional material. If you feel as though you would like to talk to a mental health practitioner for any reason, please

consider the resources listed below:

- Lakehead University Student Health and Counselling Centre: (807) 343-8361
- Thunder Bay Counselling Centre: (807) 684-1880
- Catholic Family Development Centre: (807) 345-7323
- Thunder Bay Crisis Response Program (24 hours): (807) 346-8282
- Emergency services are available at the Thunder Bay Health Sciences Centre
- If you are not residing in Thunder Bay, please visit the following site to find a mental resource in your region: http://www.ementalhealth.ca/index.php?m=selectRegion

Thank you very much for your time. We very much appreciate your contribution to our research.
Sincerely,

Brandi Person, H.B.A., M.A.
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email: bperson@lakeheadu.ca

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Appendix R

Convergent Validity for Measures of Valence & Intensity

Pearson Correlations Between the Explicit and Implicit Valence Ratings

Task	Correlation	Significance Level
Facial Task	$r = .571$	$p < .001$
Image Task	$r = .746$	$p < .001$
Word List	$r = .825$	$p < .001$
Auditory Task	$r = .788$	$p < .001$
Olfactory Task	$r = .897$	$p < .001$

Note: $n = 105$.

Pearson Correlations Between Mean Intensity and Highest Intensity Ratings

Task	Correlation	Significance Level
Facial Task	$r = .950$	$p < .001$
Image Task	$r = .954$	$p < .001$
Word List	$r = .907$	$p < .001$
Auditory Task	$r = .949$	$p < .001$
Olfactory Task	$r = .927$	$p < .001$

Note: $n = 105$.

Appendix S

Mean Intensity Scores by Valence Category

Mean Intensity Scores for Positive, Negative, and Neutral Stimuli: Unadjusted Means and SDs

Valence Category	Mean Intensity Scores (SDs)	
Negative Stimuli		
Auditory Task	7.94 (1.27)	4.14 (0.62)
Facial Task	5.56 (1.50)	6.26 (1.69)
Picture Task	8.47 (1.09)	4.37 (0.50)
Word List	5.87 (1.32)	3.45 (0.81)
Positive Stimuli		
Auditory Task	7.63 (1.20)	4.12 (0.63)
Facial Task	7.71 (1.06)	4.01 (0.54)
Picture Task	7.95 (1.09)	4.17 (0.56)
Word List	7.17 (1.21)	3.87 (0.68)
Neutral Stimuli		
Auditory Task	n/a	3.26 (1.27)
Facial Task	n/a	2.33 (1.59)
Picture Task	n/a	1.77 (1.86)

Note: The means in the first column were calculated using only the corresponding rating scales (i.e., the negative rating scale for negative stimuli; the positive rating scale for positive stimuli). The means in the second column were calculated with both the positive and negative rating scales (as they were in the main analyses).