# The Effects of Sex, Menstrual Cycle Phase, and Hormonal Contraceptives on Inhibitory Control

Nicole Keir, MA

Department of Psychology

Lakehead University

Submitted in partial fulfillment of a Doctor of Philosphy (PhD) degree in Clinical Psychology

Dissertation

November 3, 2022

Supervisor: Dr. K. Oinonen

Second Reader: Dr. G. Hayman

Internal Reader: Dr. D. Mazmanian

External Reader: Dr. E. Hampson

**Abstract**

Inhibitory control is a major aspect of executive functioning, and ovarian hormones (e.g., progesterone and estrogen) have been found to affect processes related to inhibitory control. This was the first study to examine the effects of sex, menstrual cycle phase (follicular, luteal), and oral contraceptives (OC) (users, nonusers) on four different types of inhibition (response inhibition, deferred gratification, reversal learning, and emotional reactivity) across two studies. The first study examined self-reported inhibitory control in 372 participants at two time points two-weeks apart. The second study ($N$ = 162) compared groups on several laboratory tasks of inhibitory control that were given after three mood primes (sad, happy, fear). Group differences (sex, cycle phase, OC use) were examined. Women showed: (a) higher negative emotional reactivity than men across self-report and laboratory measures, including relatively higher accuracy with negative than positive self-associations when sad; (b) more errors of commission than men on a GoNogo task after sad and fear mood induction; and (c) more problems with self-reported perseverative thinking than men. No sex differences were found for self-report measures of response inhibition; or any measures of deferred gratification. Regarding cycle phase effects, follicular phase women had more errors of commission than luteal phase women after fear mood induction, and this follicular phase effect explained the sex difference. Cycle effects were not found for reversal learning, emotional reactivity, or self-report measures of response inhibition. Also, no cycle effects were found for deferred gratification. There was no evidence that OC users and non-users differed on any of the four types of inhibitory control either on self-report or lab measures, suggesting no effects of OCs. Findings are discussed in terms of understanding the role of endogenous and exogenous hormones in inhibitory control.

**Acknowledgments**

I would like to first and foremost thank my supervisor, Dr. Kirsten Oinonen, for her support and guidance. Her expertise, patience, and diligence were necessary for the completion of this project. I am proud of what we accomplished together. I would also like to thank my esteemed committee members Dr. Hayman, Dr. Mazmanian, and Dr. Hampson for their comments and suggestions.

Further, I would like to thank and acknowledge my remarkable colleagues that have been instrumental in my growth as a clinician, researcher, and human: Elaine Toombs, Hillary Jones, Karin Almuhtadi, Katelyn Gomes, and Stephanie Campbell.

Finally, I would also like to thank my parents, Katherine and Bill, and my fiancé, Joel Stevens, for always believing in me and cheering me on.

**Table of Contents**


Abstract 2
Acknowledgements 3
Table of Contents 4
List of Tables 6
List of Figures 8
List of Appendices 9
Introduction 10
What is Inhibitory Control? 11
The Menstrual Cycle and Oral Contraceptives 17
Hormones and Inhibitory Control 20
Prepulse Inhibition 26
Fear Extinction 30
Behavioural Inhibition 34
Response Inhibition 35
Deferred Gratification 45
Reversal Learning 58
Cognitive Inhibition 75
Emotional Reactivity 75
Conclusion 116
Current Studies 119
Methods 123
Study 1 Participants 123
Study 2 Participants 127
Measures Study 1 127
Time 1 Questionnaire 127
Time 2 Questionnaire 136
Follow-Up Questionnaire 136
Measures Study 2 137
Procedure Study 1 146
Procedure Study 2 149
Cycle Phase Counting 151
Results 152
Reliability of ICS-48 152
Validity of ICS-48 and Laboratory Measures 154
Validity of Mood Induction 155
Validity of EIAT Task 160
Data Screening 163
Statistical Considerations 163
Covariates and Group Equivalency 164
Main Analyses 166
Sex Differences in Inhibitory Control 167
Cycle Phase Effects on Inhibitory Control 185
Oral Contraceptive Effects on Inhibitory Control 197
Discussion 205

Summary of the Results 205
Sex Differences in Inhibitory Control 207
Cycle Phase Effects on Inhibitory Control 223
Oral Contraceptive Effects on Inhibitory Control 231
Limitations 235
Strengths 237
Summary and Conclusion 240
References 242
Appendices 275

**List of Tables**

Table 1. Age, Sex, and Hormonal Demographic Information: Means (*SD*s), and Frequencies (%) for Participants in Studies 1 and 2 125

Table 2. Ethnicity and Education information: Means (*SD*s), and Frequencies (%) for Participants in Studies 1 and 2 126

Table 3. Internal Consistency (Cronbach's Alpha) and Test-Retest Reliability (r) of the Inhibitory Control Scale 48-hours (ICS-48) Scales 153

Table 4. Convergent (and Divergent) Validity for Response Inhibition Measures: Pearson Correlations 156

Table 5. Convergent (and Divergent) Validity for Deferred Gratification Measures: Pearson Correlations 157

Table 6. Convergent and Divergent Validity for Reversal Learning Measures: Pearson Correlations 158

Table 7. Convergent and Divergent Validity for Emotional Reactivity Measures: Pearson Correlations 159

Table 8. Mood Induction Manipulation Checks: Descriptive Data and Paired Sample t-Tests Examining Change in Positive and Negative Affect Schedule (PANAS) Positive Affect (PA) and Negative Affect (NA) scores after the Three Mood Inductions 161

Table 9. Emotional Implicit Association Task (EIAT) Validity: Descriptive Data and Paired Sample t-Tests Examining Change in the EIAT Accuracy (Acc) and Speed (RT) of Negative Emotional Associations after the Three Mood Inductions 162

Table 10. Sex Differences: Means (*SD*s), and MANOVA/ANOVA Results for Self-Report (Study 1) and Laboratory Measures (Study 2) of Inhibitory Control 168

Table 11. Sex Differences: Untransformed Means (*SD*s) and One-Way ANOVAs for Errors of Commission (EOC) at Baseline and After Each Mood Prime 170

Table 12. Sex Differences: Untransformed Means (*SD*s) and Univariate ANOVA Results for Self-Report Trait Measures of Reversal Learning 175

Table 13. Sex Differences: Means (*SD*s) and Follow-Up Univariate ANOVA Results on State and Trait Measures of Emotional Reactivity for Study 1 177

Table 14. Sex Differences: Means (*SD*s) and Follow-Up Univariate ANOVA Results for PANAS NA at Baseline and After the Sad and Fear Mood Prime 179

Table 15. Sex Differences: Untransformed Means (*SD*s) and Follow-Up Univariate ANOVA Results for Emotional Implicit Association Task (EIAT), Speed and Accuracy of Negative Emotional Associations at Baseline and After Each Mood Prime 182

Table 16. Cycle Phase Effects: Means (*SD*s), and MANOVA/ANOVA Results for Self-Report (Study 1, Time 1) and Laboratory Measures (Study 2) of Inhibitory Control 186

Table 17. Menstrual Cycle Effects: Means (*SD*s), Global Repeated Measures MANOVA, and Follow-up ANOVAs on Self-Report (Study 1) Measures of Inhibitory Control as a Function of Time (1, 2) and Cycle Phase Testing Order [Follicular-Luteal (FL), Luteal-Follicular (LF)] 188

Table 18. Untransformed Means (*SD*) and Follow-Up Univariate ANOVA Results for Errors of Commission (EOC) at Baseline and After Each Mood Prime for Naturally Cycling Women in the Follicular and Luteal Phase 189

Table 19. Untransformed Means (*SD*s) for the Positive and Negative Emotion Questions from the Inhibitory Control 48-hours (ICS-48) Emotional Reactivity Scale as a Function of Cycle Phase (Follicular vs. Luteal) at Time 1 and Cycle Phase Order [Follicular-Luteal (FL), Luteal-Follicular (LF)] across Time 1 and Time 2 194

Table 20. Untransformed Means (*SD*s) for PANAS NA, and EIAT Speed and Accuracy of Negative Emotional Association Scores at Baseline and After Each Mood Prime as a Function of Cycle Phase Group (Follicular or Luteal) 196

Table 21. Oral Contraceptive Effects: Means (*SD*s), and MANOVA/ANOVA Results for Self-Report (Study 1) and Laboratory Measures (Study 2) of Inhibitory Control 198

Table 22. Oral Contraceptive (OC) Effects: Means (*SD*s) and Follow-Up Univariate ANOVA Results on Positive, Negative, and Trait-Like Measures of Emotional Reactivity (Study 1) 200

Table 23. Oral Contraceptive Effects: Means (*SD*s) and Follow-Up Univariate ANOVA Results for PANAS NA at Baseline and After the Sad and Fear Mood Primes 202

Table 24. Oral Contraceptive Effects: Untransformed Means (*SD*s) for EIAT Speed and Accuracy of Negative Emotional Associations at Baseline and After Each Mood Prime 203

## List of Figures

Figure 1. Example of a Trial on the Emotional Implicit Association Task (EIAT) 141

Figure 2. Procedure for Study 1 and Study 2 148

Figure 3. Sex Differences: Errors of Comission At Baseline and After Each Mood Prime With No Covariate 171

Figure 4. Sex Differences: Errors of Comission At Baseline and After Each Mood Prime with Baseline as a Covariate 172

Figure 5. Sex Differences: PANAS NA Score at Baseline and After Negative Mood Induction 180

Figure 6. Sex Differences: Relative Accuracy of Negative Emotional Associations at Baseline and After Three Mood Inductions 184

Figure 7. Cycle Phase Effect: Errors of Commission at Baseline and After Mood Inductions 191

## List of Appendices

Appendix A. Research Ethics Board (REB) Approval Letter 275

Appendix B. Time 1 Questionnaire 276

Appendix C. Additional Time 1 Questionnaires 324

Appendix D. Time 2 Questionnaire 329

Appendix E. The Positive and Negative Affect Schedule 348

Appendix F. Recruitment Materials: Email Invitations 349

Appendix G. Recruitment Materials: Posters 355

Appendix H. Letter to Participants 357

Appendix I. Consent Form for All Participants 363

Appendix J. Debriefing Forms 365

Appendix K. Bivariate Correlations Between Study 1 and Study 2 Variables 370

Appendix L. Covariate Analyses for Study 1 372

Appendix M. Covariate Analyses for Study 2 376

Appendix N. Group Equivalency Analyses 380

## Hormones and Inhibition: The Effects of Sex, Menstrual Cycle Phase, and Hormonal Contraceptives on Inhibitory Control

Previous research has examined how endogenous and exogenous hormones affect mood (Sanders et al., 2001; see review in Oinonen & Mazmanian, 2002) and cognitive performance (see reviews in Kimura, 1996; Torres et al., 2006). For example, there is evidence that a subgroup of women experience negative mood side effects from oral contraceptives (OCs) (e.g., sadness, increased tearfulness; Gingnell et al., 2013a) and some naturally cycling women experience increased negative affect during the week preceding menstruation (e.g., increased irritability; Rapkin, 2003). Further, many studies have found small sex differences in cognitive performance (see review in Miller & Halpern, 2014) and sex differences in inhibitory control (see review in Weafer & de Wit, 2014). However, little research has been conducted on the effects of hormones on inhibitory control. Examining the effects of hormones on inhibition is important because there is evidence that steroid hormones may have a direct role in altering the GABAergic processes in the Central Nervous System (CNS) (Majewska, 1986; Siegel et al., 1999). Indeed, Gamma-aminobutyric acid (GABA) plays a key role in inhibition, and is related to behaviours such as emotional control (e.g., anxiety, depression), cognitive functioning, sleep, and sexual behaviours (Rapkin et al., 2006). Therefore, sex, cycle phase, or use of exogenous hormones such as OCs may affect inhibitory control and overall well-being through effects on GABA. This hormone-GABA-inhibition connection may be an underlying mechanism in the link between hormones and both mood and cognition.

The following literature review presents studies that have examined sex, cycle phase, and oral contraceptive effects on inhibitory control. However, first, definitions for inhibitory control are provided, and the evidence linking hormones and inhibition are reviewed.

**What is Inhibitory Control?**

The term inhibitory control can refer to a wide range of behaviours and reactions and can generally be defined as the ability to suppress pre-potent responses (Bari & Robbins, 2013). The proposed studies aim to examine the role of sex, cycle phase, and OC use on inhibitory control by tapping into several different inhibitory processes. Measuring these inhibitory processes, in turn allows for the study of disinhibition or impulsivity which demonstrates the behavioural and functional consequences of the failure to withhold a response (Bari & Robbins, 2013). Indeed, failure to inhibit responses is related to difficulty with prefrontal cortex functioning and has been associated with criminal behaviour, substance use, and certain clinical diagnoses such as binge eating disorder (Schag et al., 2013), attention-deficit hyperactivity disorder (ADHD), mania, Post-Traumatic Stress Disorder (PTSD), intermittent explosive disorder as well as many neurological conditions (e.g., dementia) (Cross et al., 2011).

In their extensive review on the behavioural and neural basis of response control, Bari and Robbins (2013) differentiated between two broad categories of inhibition: behavioural and cognitive. Behavioural inhibition is further comprised of specific behavioural responses: response inhibition, deferred gratification, and reversal learning. Cognitive inhibition, on the other hand, is comprised of memories, thoughts, perceptions and emotions. The definitions for each type of inhibition provided Bari and Robbins (2013) will be explored and expanded upon.

The first type of inhibition under the behavioural umbrella is response inhibition and its opposite, impulsive action. Response inhibition is the overriding of a planned or already initiated

action and consists of action postponing (waiting), action restraint or withholding (no-go), and action cancellation (stopping) (Bari & Robbins, 2013). In the laboratory, response inhibition is often measured using a GoNogo or Stop-Signal task (SST). In these paradigms, an action must be postponed until a "go" signal appears (waiting), withheld when an unexpected "no-go" signal is presented, or stopped when a "stop-signal" appears after the beginning of a response. Response inhibition is therefore more simple, observable, and measurable compared to other types of inhibition such as cognitive inhibition. Consequently, response inhibition is the most widely studied type of inhibitory control.

Research examining the brain areas and neurocorrelates associated with response inhibition reveal a complex circuit that involves the inferior frontal cortex (IFC) and pre-supplementary motor area (SMA). Further, neuropharamacological studies indicate an important role of prefrontal noradrenergic neurotransmission in inhibiting an already initiated response. Further, dopamine is associated with motor readiness for both inhibiting and activating a response, and serotonin (5-HT) is associated with waiting behaviour. In a clinical setting, deficits in response inhibition are related to ADHD, drug and alcohol abuse, obsessive compulsive disorder (OCD), and schizophrenia (Bari & Robbins, 2013).

Deferred gratification and its opposite, impulsive choice, is a motivational and affectively charged process that is comprised of delay discounting, probability discounting, and effort discounting (Bari & Robbins, 2013). Paradigms measuring impulsive choice measure the urge to obtain immediate reward that should be inhibited to obtain larger rewards after a certain amount of time or effort. This type of inhibition is typically assessed using decision-making paradigms where the participant chooses between actions that are more rewarding in the long run (i.e., postponing gratification) and actions that result in immediate, smaller reward (e.g., the Iowa

Gambling Task). Deficits in delay discounting are associated with compulsivity, perseveration, drug addiction, obesity, and compulsive gambling (Bari & Robbins, 2013).

Research examining the brain areas and neurocorrelates associated with deferred gratification has found three important brain networks related to this type of inhibitory control: A ventral cortico-striatal network including medial orbital frontal cortex (OFC) and ventral striatum (determines reward value), a lateral prefrontal cingulate network including lateral OFC, cingulate cortex, dorsolateral and ventrolateral pre-frontal cortex (PFC; related to conflict detection and behavioural inhibition), and a medial temporal-hippocampus network (associated with the prospective evaluation of future outcomes) (Bari & Robbins, 2013).

Reversal learning is operationally defined as the ability to inhibit a response previously rewarded but now punished or no longer rewarded (Bari & Robbins, 2013; Izquierdo et al., 2017). It is comprised of discrimination reversal, and rule or strategy reversal. In these reversal learning procedures, the subject is usually faced with choosing between two distinct responses only one of which is correct, thus leading to a reward or reinforcement. Once this association has been established, the contingencies are reversed, without warning, and the participant must amend behaviour accordingly. Thus, reversal learning also measures cognitive flexibility, perseveration, and compulsive responding as well as the ability to inhibit responding to previously rewarded stimuli. Deficits in reversal learning have been associated with drug abuse and criminal conduct (Bari & Robbins, 2013).

A common reversal learning task is the Wisconsin Card Sorting Test (WCST). However, Bari and Robbins (2013) reported that reversal learning tasks tend to be learned easily by most participants, which can lead to ceiling effects. Therefore, some research in reversal learning examines reward and punishment sensitivity, and spurious feedback designs such as those used

in probabilistic reversal learning (PRL) paradigms (i.e., feedback that is not contingent to the accuracy of the response). These paradigms are less likely to have a ceiling effect because of the need to incorporate reinforcement history over several trials, and to regulate responding to reinforcement. Another common reversal learning task identified by Bari and Robbins (2013) is the use of extinction trials. In extinction trials, respondents inhibit their response to a classically conditioned cue after it is no longer reinforced. This perseveration in responding or failure to learn extinction is related to reversal learning. However, because extinction trials involve automatic responses to a classically conditioned stimulus rather then the ability to learn specific stimulus-outcome associations, they tap into different motivational and inhibitory processes than is measured by more typical reversal learning tasks.

Regarding the brain areas and neurocorrelates related to reversal learning in humans, neuroimaging studies have shown increased activity in the OFC, the medial prefrontal cortex (mPFC), and the dorsal and ventral regions of the striatum in human brains during reversal tasks (Izquierdo et al., 2017). Also, deficits in reversal learning have been associated with lesions in these same areas in both humans and non-human primates (Bari & Robbins, 2013; Izquierdo et al., 2017).

Beyond behavioural inhibition, Bari and Robbins (2013) identified cognitive inhibition as one of the major areas in the study of inhibitory control. Rather than the inhibition of manifest behaviour, cognitive inhibition is the stopping or overriding of a mental process, in whole or in part, with or without intention (MacLeod, 2007). Thus, cognitive inhibition strictly refers to mental processes. However, mental processes can be difficult to measure compared to observable behaviours and are instead comprised of memories, thoughts, perceptions, and emotions. Additionally, cognitive and behavioural inhibition inevitably share overlapping brain networks

and both require the attentional processing of attending to a particular stimulus while inhibiting reactions or attention to other irrelevant stimuli. MacLeod (2007) recommended that authors create their own definition of cognitive inhibition due to its broad and overlapping processes.

Of interest in this present study, is the emotional aspect of cognitive inhibition. The opposite of emotional inhibition, emotional reactivity, can be defined as reactions to emotional events or stimuli. These reactions can be measured via self-reported emotions (labelling or identifying the emotion); ratings of valence and intensity of emotion; self-reported or measured physiological reactions subsequent to emotional stimuli such as heart rate, skin conductance response (SCR), and blood pressure; and measures of response times to emotional stimuli. Conversely, emotional inhibition can be conceptualized as an aspect of emotion regulation. Emotion regulation is the conscious or nonconscious control of an affective response (Sheppes et al., 2014). Indeed, emotional reactivity may be adaptive in some situations (e.g., when in danger and needing to signal for help or when expressing or showing love or gratitude towards someone) whereas regulating an emotional response may be adaptive in another situation (e.g., during an argument). Thus, restraining affective impulses in certain circumstances is indicative of healthy adaptation. Emotion regulation is often measured via self-report questionnaires in humans. However, emotion regulation can also be inferred through observing behaviour after an emotional event.

The emotional aspect of cognitive inhibition is of particular importance because hormones, including endogenous hormones that fluctuate across the menstrual cycle, and exogenous hormones delivered through OCs have both been associated with emotional changes, and emotionally-driven behaviours (Oinonen & Mazmanian, 2002; Sanders et al., 2001). However, previous research examining whether hormones affect mood has not examined this

issue from the perspective of cognitive inhibition (i.e., do hormones affect the automatic ability or tendency to inhibit emotions?). Instead, the majority of research has focused on the changes in mood level or mood symptoms as opposed to any changes in inhibitory control that may underlie the mood change (e.g., Oinonen & Mazmanian, 2002; Rapkin, 2003).

The methodological approaches to measuring the various types of inhibitory control discussed do not measure pure forms of inhibition per se. Instead, the methods most often used in laboratories are proxy measures of inhibition. However, Bari and Robbins (2013) explain that this lack of specificity is not necessarily detrimental to the heuristic and scientific value of these behavioural tasks. Indeed, these tasks have ecological validity. Inhibition, as it manifests in everyday life, involves a multitude of interrelated processes such as the monitoring of behaviour, sustained attention, conflict detection, and more. These occur before the inhibition of the planned (or ongoing) response (Bari & Robbins, 2013). Therefore, researchers can contribute to the literature on inhibitory control by continuing to use proxy measures of inhibition that have been established in research on inhibition.

Consistent with the subtypes of inhibitory control defined by Barri and Robbins (2013) were the findings from a cross-species translational study conducted by Broos et al. (2012). They tested 30 rats and 101 humans across various measures of inhibition and impulsivity. Correlations between performance on the different tasks were presented and a principal component analysis was performed. Three independent factors emerged from their analysis: impulsive action (response inhibition) and impulsive choice (deferred gratification) in both humans and rats, and self-reported impulsivity in humans. This further solidifies supports the need for research to investigate multiple forms of inhibitory control and to examine both self-report and lab/objective measures.

Other types of inhibition beyond those mentioned in either the Barri and Robbins (2013) or Broos et al. (2012) reviews are the more automatic or implicit types of inhibition such as those found in prepulse inhibition (PPI) or fear extinction trials. PPI is a more direct measure of inhibitory control compared to the processes described above under behavioural and cognitive inhibition. PPI measures the nervous systems' ability to adapt or react to stimuli and it ultimately measures an individual's sensorimotor gating and ability to filter out unnecessary information (Braff et al., 2001). Similarly, fear extinction measures classically-conditioned learning and the nervous system's ability to inhibit a fear response to a conditioned stimulus when that behaviour is no longer reinforced. Thus, fear extinction requires the ability to filter out information that is no longer necessary and to inhibit an unnecessary fear response.

This ability to filter out unnecessary information can impact both behavioural and cognitive inhibition, and has been related to clinical disorders such as OCD, PTSD, Bipolar Disorder, Schizophrenia, and more (Braff et al., 2001; Glover et al., 2012; 2013). Further, it has been suggested that a reduction in PPI and impaired fear extinction may be due to an impairment in the top down processes related to the inhibition of reflexes (Hazlett et al., 1998; Linnman et al., 2011). Moreover, performance on PPI and extinction trials has been shown to differ as a function of cycle phase and with OC use (e.g., Borgstrom et al., 2008; Jovanovic et al., 2004; Graham & Milad, 2014; Kask et al., 2008; Lebron-Milad & Milad, 2012; Lonsdorf et al., 2015; Swerdlow et al., 1997). However, before examining the literature on PPI and extinction, there is a need to review the connection between hormones and inhibitory control.

**The Menstrual Cycle and Oral Contraceptives**

Of relevance to the current study are the sex hormones, estrogen (e.g., estradiol), progesterone (e.g., progestin), and androgens. These hormones are known as sex steroids

(Micevych & Sinchak, 2008) and are primarily released by the gonads (ovaries or testes) or the adrenal glands (Hawkins & Matzuk, 2008). The brain synthesizes and converts these circulating steroids into neuroactive steroids such as estradiol (from circulating estrogen) and allopregnanolone (from circulating progesterone) (Micevych & Sinchak, 2008). These neurosteroids are made in the brain and modulate intracellular signaling pathways, channels, and transcription, much like neurotransmitters (Reddy, 2010; Rupprecht, 2003). Thus, like neurotransmitters, neurosteroids can significantly effect behaviour, emotion, and cognition.

A woman's menstrual cycle can be broken down into several phases each marked by a particular fluctuation in hormones (see Hawkins & Matzuk, 2008). The cycle begins with the follicular phase (days 1 to 14 in a regular 28-day cycle) and the cycle ends with the luteal phase (days 15 to 28 in a regular 28-day cycle). Both the early follicular and late luteal phases represent low hormonal periods in the cycle, while the late follicular (including ovulation) and mid luteal phases represent high hormonal periods in the cycle. Specifically, the late follicular part of the cycle (days 11 to 13 in a regular 28-day cycle) is marked by peak estradiol, luteinizing hormone (LH), and follicle stimulating hormone (FSH) levels, while the mid luteal phase (days 5 to 9 following the LH surge or days -5 to -9 using backward cycle day counts), is marked by peak progesterone, intermediate estradiol, and low LH and FSH levels (Hawkins & Matzuk, 2008).

It is important to recognize, however, that cycle phases differ between naturally cycling women and those taking OCs. Indeed, OCs typically work on the brain by inhibiting ovulation, suppressing LH and FSH, and reducing overall neurosteroid levels compared to pre-OC use levels and compared to naturally cycling women (Follesa et al., 2002; van Heusdan, & Fauser, 1999; Zimmerman et al., 2014). Thus, women taking OCs do not typically ovulate, have lower hormone levels, and show less cyclicity in their hormones.

OCs are typically composed of a combination of ethinyl estradiol (EE) and a derivative of progesterone (Kurshan & Epperson, 2006). Most levels of EE in OCs remain at a steady low dose of between 30 to 35 μg but can range from between 20 and 50 μg (Batur et al., 2003). Unlike EE, however, the type and dose of progestins vary from brand to brand. Based on their progestin derivatives, OCs can be categorized into three generations. Both second and third generations contain progestins with androgenic properties whereas new generation OCs contain progestins with anti-androgenic properties (Batur et al., 2003; Wharton et al., 2008). Thus, different brands of OCs may have opposite effects on the brain depending on their progestin derivative.

To examine the effects of hormones in a controlled experimental manner, many studies have used animal subjects, such as rats, to investigate the effects of gonadal hormones on behaviour. Although female rats do not have similar menstrual cycles to women, researchers are still able to investigate the effects of cycle phase using rat models. The rat estrous cycle is a four-day cycle that consists of four phases: (a) proestrous (estrogen peaking at the beginning, LH and FSH peaking in the middle, and progesterone peaking at the end of the 12 to 14-hour phase), (b) estrous (also known as the sexually receptive phase; marked by low progesterone and slightly higher estrogen), (c) metestrous (low hormones), and (d) diestrous (slightly increasing estrogen) (Marcondes et al., 2002).

Certainly, men and women, male and female rats, as well as naturally cycling women and women on OCs differ in their levels and types of endogenous and exogenous sex hormones. It is these differences in estrogens, progestins, and androgens that many researchers speculate to be the driving force behind some differences in emotion, behaviour, and cognition between (a) men and women, (b) women using versus not using OCs, and (c) cycle phases in naturally cycling

women. One of the processes that sex hormones have been found to affect in both humans and animals is inhibition.

## Hormones and Inhibitory Control

Given that estrogen and progesterone appear to have differential effects on inhibitory control (Inghilleri et al., 2004; Rasmusson et al. 2006; van Broekhoven et al., 2007), and because these are the most predominate hormones that fluctuate across the menstrual cycle (Hawkins & Matzuk, 2008), these ovarian hormones are a particular focus of this study.

### *GABA and Progesterone*

Recent research has suggested that neurosteroids, such as those that fluctuate across the menstrual cycle or those contained in OCs, are potent modulators of the major inhibitory system in the CNS of mammal, the GABAergic system (Majewska, 1986; Siegel et al., 1999). Gamma-aminobutyric acid (GABA) is a widely distributed chemical messenger that reduces the activity of the neurons to which it binds (Majewska et al., 1986). Thus, binding neurosteroids such as progestin metabolites attach to the GABAA receptor and cause an influx of negatively charged chloride ions which further enhances neuronal inhibition (Majewska et al., 1986; Rupprecht, 2003; Siegel et al., 1999). For example, Allopregnanolone (a progestin metabolite) is known to have anxiolytic, anticonvulsant and neuroendocrine effects similar to benzodiazepines and barbiturates (Biggio & Purdy, 2001; Carver & Reddy, 2013; Rapkin et al., 2006). Thus, the metabolite of progesterone, allopregnanolone, inhibits or slows down excitatory effects within the CNS.

A study conducted by van Broekhoven et al., (2007) demonstrated the anti-anxiety and sedative effects of combined allopregnanolone and pregnanolone (ALLO) administration. Nine men and women were administered increasing intravenous doses of ALLO in a double-blind

manner. For women, ALLO decreased saccadic eye velocity (an indicator of sedation), and increased subjective ratings of sedation and contentedness in a fashion relative to dosing of ALLO. Men reacted slightly differently than women in that they showed less of a decrease in saccadic eye velocity and a decrease in subjective ratings of contentedness. This study demonstrated that an increase in ALLO led to physiological and self-reported sedation, especially in women. Furthermore, the finding that men experience lower contentment with higher ALLO levels suggests the possibility that more masculine or androgenized women may show the same effect.

While increased ALLO is related to inhibition of the CNS, decreased levels of ALLO may be related to decreased inhibitory processes. Rasmusson et al. (2006) measured levels of ALLO, dehydroepiandrosterone (DHEA, a negative modulator of GABAA receptor function), and progesterone in women with and without PTSD. There were no group differences in progesterone or DHEA levels. However, the PTSD group had 39% lower ALLO levels compared to the healthy group. Moreover, a low ALLO high DHEA ratio was correlated with higher re-experiencing symptoms and higher depression scores. The authors concluded that low cerebral spinal fluid ALLO levels might contribute to an imbalance in inhibitory versus excitatory neurotransmissions and thus, disrupt sensory-motor gating. Further, the authors indicated that this ALLO:DHEA ratio could contribute directly to hyperactivity in the amygdala and to an enhancement in fear conditioning and resistance to extinction of fearful conditioned responses, thus maintaining PTSD symptoms (Rasmusson et al., 2006).

The van Broekhoven et al. (2007) and Rasmusson et al. (2006) studies provide evidence that a decrease in certain neurosteroids leads to a disruption in neural inhibition. Interestingly, one common treatment known to reduce neurosteroids is OCs. OCs reduce the overall

neurosteroid levels to similar or lower than what is naturally present during the follicular phase of the menstrual cycle (Follesa et al., 2002; Zimmerman et al., 2014). Therefore, it follows that OC use could ostensibly lead to lower levels of progesterone and its metabolites (Follesa et al., 2002), thus resulting in lowered neuronal inhibition. Indeed, a study conducted by Follesa et al. (2002) revealed that treatment with OCs led to reduced concentrations of pregnanolone, progesterone, and ALLO in the cerebral cortex and plasma in rats as well as in the plasma levels of humans. OC use was also associated with increased anxiety-related behaviour in rats. These results are congruent with the Rasmusson et al. (2006) study that also linked lower levels of progestin metabolites with anxiety-like symptoms in individuals with PTSD. Indeed, anxiety-like behaviours such as hypervigilance (often associated with PTSD) and increased anxious behaviour (in rats) may reflect a lack of neuronal inhibition.

Unlike progesterone and its metabolites, which affect neuronal inhibition, estrogen is known to lead to neuronal excitability (Rapkin et al., 2006). A study conducted by Huang and Woolley (2012) recorded GABAA receptor-mediated postsynaptic currents after application of estrogen in cells of the hippocampus of rats. They found that estrogen rapidly suppressed inhibitory synaptic transmission in the hippocampus, and suppressed GABA release in female, but not male, rats. Therefore, Huang and Woolley's (2012) results indicate that estrogen is related to neural excitation in a sex-specific manner.

Taken together, these studies provide evidence that sex steroids are metabolized into neuroactive steroids that act on the inhibitory processes in the CNS. That is, while progesterone and progesterone metabolites both increase $GABA_A$ inhibition through different mechanisms, a reduction in each of these hormones leads to disinhibition or decreased GABAergic inhibition. While the behavioural symptoms of decreased GABAergic transmission might involve anxiety,

irritability, reduced contentedness, insomnia, mood instability (Plante et al., 2012; Rasmusson et al., 2006), research has yet to establish a clear link between levels of neuroactive steroids, $GABA_A$ receptor metabolites, and observable behaviour in humans. More research is required to determine the practical relevance of the link between hormones and neuronal inhibition outside of the laboratory.

***Hormones and Cortical Excitability***

Beyond research related to the GABAergic system, other studies have highlighted the link between hormones and inhibition by examining the effects of neurosteroids on cortical and transcallosal inhibition. One of the first studies that demonstrated direct evidence of changes in cortical excitability across the menstrual cycle is a study conducted by Smith et al. (1999). They tested 13 healthy women during their follicular and luteal phases using paired transcranial magnetic stimulation (TMS). They found TMS produced more cortical inhibition during the luteal phase (high progesterone phase) compared to the follicular phase (low progesterone phase). The authors also indicated that the level of inhibition found was similar to the level of cortical inhibition after administration of benzodiazepine drugs. These results are consistent with the Rapkin et al. (2006), Rupprecht (2003), and van Broekhoven et al. (2007) studies that implicated progesterone in inhibitory behaviours.

Another study also found that ovarian hormones influence cortical excitability, and provided further evidence that estradiol is related to neural excitation. Inghilleri et al. (2004) examined repetitive TMS on 8 women on days 1 and 14 of their menstrual cycles, and 8 age-matched men with a 14-day interval. They found that repetitive TMS induced facilitation of the cortical excitability on day 14 but not on day 1 in women. Cortical excitability remained stable on both days of testing for men. They concluded that the higher levels of estrogen on day 14

compared to day 1 could be responsible for the change in cortical excitability, specifically because estradiol acts on the motor cortex by promoting synaptic potentiation and decreasing GABAergic inhibition. These results are consistent with Huang and Woolley's (2012) study that indicated that estrogen was related to neural excitation. In addition to neural excitation, estrogen has also been associated with increasing levels of dopamine in the brain, both of which can have effects on inhibitory control.

***Estrogen's Effect on Dopamine***

It has been established that estrogen modulates dopamine function by enhancing dopamine release (Colzato & Hommel, 2014; Weafer & de Wit, 2014). Dopamine release is relevant to inhibitory control because dopamine drives many higher order cognitive processes including learning, reward, working memory, impulsive action, and inhibition (Cardinal et al., 2001; Dalley et al., 2007; del Campo et al., 2011; Diergaarde, et al., 2008). Therefore, dopamine may be the mechanism by which estrogen modulates impulsivity.

Accordingly, in their review, Colzato and Hommel (2014) reported that the effect of dopamine on cognitive performance is likely an "inverted U" where the best performance is related to medium levels of dopamine. Because high estrogen is associated with high dopamine turnover rates, Colzato and Hommel (2014) contend that those with low levels of dopamine would experience the highest cognitive benefit in the high estrogen phase of the menstrual cycle (the late follicular phase). Conversely, those with an already optimal baseline level of dopamine would experience decreased cognitive benefit in the late follicular phase. Thus, low baseline levels of dopamine, which are already associated with poor cognitive performance may be improved by high levels of estrogen, while high baseline levels of dopamine commonly related to good cognitive performance may be reduced by estrogen.

### *Metabolic Resources*

Along with evidence for estrogen modulating inhibitory control via dopamine, Gailliot et al. (2010) proposed a theory explaining the relationship between hormones and inhibition. In their paper, Gailliot et al. (2010) focused on higher level mechanisms associated with hormones and inhibitory control. They proposed that the increased metabolic demands during the luteal phase leave little metabolic resources for self-control. Indeed, Gailliot et al. (2010) explain that the basal metabolic rate is the highest in the late luteal phase and premenstrual syndrome (PMS), and its associated symptoms, occur during the most metabolically expensive phase of the menstrual cycle. Further, these same metabolic resources may be necessary for self-control. They define self-control as the capacity to alter one's thoughts, emotions, urges and impulses and to override habitual behaviours or incipient responses. Galliot et al. (2010) reviewed previous research examining evidence for impaired self-control during the luteal phase and found that the pre-menstrual phase was associated with impaired emotional control; increased stress; impaired attentional control; increased intake of alcohol, nicotine, caffeine and controlled drugs; altered food preferences; increased aggression; increased interpersonal problems; impaired work performance; and increased criminal acts. Ultimately, the authors propose that the metabolic effects of PMS do not necessarily intensify impulses, rather they weaken self-control and this may manifest as PMS.

The theory from the Gailliot et al. (2010) paper appeared contrary to evidence that progesterone, which peaks in the luteal phase, increases inhibition, sedative and anti-anxiety effects. Galliot et al. (2010) however do not differentiate between early-, mid- and late-luteal cycle phases, all of which have varying levels of progesterone. Therefore, it may be that the

symptoms of lowered self-control are more apparent during the late-luteal phase which corresponds with a decline in progesterone levels and, theoretically, lowered inhibitory control

While the focus of the current project is on the influence of hormones on observable and measurable behaviours reflecting inhibitory control, it is important to consider the role of hormones in more implicit forms of inhibition given that similar mechanisms may exist. Thus, prior to discussing research on the effortful forms of inhibition (i.e., behavioural and cognitive inhibition), the effects of hormones on two types of automatic inhibition, prepulse inhibition (PPI) and fear extinction, will be reviewed.

**Prepulse Inhibition**

PPI is a measure of sensorimotor gating in which the response to a startling stimulus (such as a strong puff of air or loud tone) is decreased when a weaker prestimulus (such as a weak puff of air or quiet tone) precedes it closely in time. This reduction of the amplitude of startle (often measured by eye-blink response in humans) reflects the ability of the nervous system to adapt to a stronger stimulus when a weaker stimulus is presented first. Thus, higher PPI indicates an ability to inhibit based on the prepulse, while lower PPI indicates decreased ability to inhibit the startle response.

With respect to sex differences in PPI, animal and human research has consistently indicated that male rats and men have increased PPI compared to female rats and women (Aasen et al., 2005; Kumari et al., 2003; Lehman et al., 1999; Swerdlow et al., 1993; 1999). However, this sex difference may depend on menopausal status, sexual orientation, and certain clinical diagnoses. For instance, a study conducted by Kumari et al. (2008) found that while pre-menopausal women demonstrated reduced PPI compared to age-matched men, there were no differences in PPI in post-menopausal women compared to age-matched men. However, within-

gender comparisons revealed that older men showed a decrease in PPI compared to younger men, and pre-menopausal women showed no difference in PPI compared to post-menopausal women. Kumari et al. (2008) proposed that younger men may have the advantage in PPI because of the influence of male sex hormones (i.e., higher testosterone). Nevertheless, Kumari et al. (2008) found no relationship between levels of salivary hormones and PPI. Thus, a direct relationship between testosterone levels and PPI performance cannot be established from these results. Additionally, Kumari et al. (2008) did not take into account the cycle phase of the pre-menopausal women in their study. Indeed, a later study conducted by Bannbers et al. (2010) found that pre-menopausal women in their late luteal phase had reduced PPI compared to post-menopausal women. Therefore, it is likely that performance on PPI is affected by not only sex, but also by cycle phase, and menopausal status.

Further, a study by Rahman et al. (2003) found that sex differences in PPI may also be affected by sexual orientation. They examined PPI in 59 heterosexual and homosexual men and women and found that heterosexual women had lower PPI compared to both heterosexual men and homosexual women. Further, neither homosexual women nor homosexual men differed from heterosexual men in PPI. To explain the masculinized response of homosexual women, Rahman et al. (2003) speculated that higher prenatal androgen exposure in homosexual versus heterosexual women may alter the neural system responsible for sensorimotor gating. This explanation of androgen exposure affecting PPI performance in homosexual women is also congruent with Kumari et al.'s (2008) theory of the advantage of testosterone on PPI performance.

However, among certain populations, men (but not women) demonstrate reduced PPI. For example, Kumari et al. (2004), found that women with schizophrenia displayed increased

PPI compared to men with schizophrenia. These results are also consistent with PPI research using animal models of schizophrenia. Indeed, Gogos and van den Buuse (2003; 2007; 2015) and Gogos et al. (2010; 2012) demonstrated a protective effect of estrogen on PPI disruptions in animal models of schizophrenia. Additionally, one study conducted by Gogos, van den Buuse, and Rossell (2009) found that amongst individuals diagnosed with bipolar disorder, men had reduced PPI compared to women. Therefore, estrogen may have a protective effect against the PPI disruptions in bipolar disorder as well as schizophrenia.

To further examine the effect of gonadal hormones on PPI, several researchers have examined PPI across the estrous or menstrual cycle in female rats and women. In rats, one study found a reduction in PPI when both estrogen and progesterone peak (the proestrous phase) compared to when progesterone is low and estrogen is moderate (estrous) and when estrogen and progesterone are both low (diestrous) (Koch, 1998). Another study found that PPI increased in female rats during progesterone withdrawal (i.e., after removal of a progesterone implant) compared to control females (Gulinello et al., 2003). Thus, high hormones (i.e., high estrogen and progesterone) may decrease PPI while low hormones, or specifically withdrawal from progesterone, may improve PPI. Results from research on PPI and the menstrual cycle in women parallel these findings. This also fits with the theory from Galliot et al. (2010) which contends that, due to increased metabolic demands, inhibition is lowered in the late luteal phase when progesterone is declining.

Human research has consistently indicated that PPI is reduced when hormones are high (i.e., the luteal phase) and increased when hormones are lower (i.e., the early follicular phase). For instance, women in the luteal phase have demonstrated reduced PPI compared to women in the follicular phase (Jovanovic et al., 2004; Swerdlow et al., 1997). More specifically, Swerdlow

et al. (1997) found that PPI was reduced during phases in the cycle that had peak estrogen levels such as the mid- to late-follicular phase (days 10-15) and the mid-luteal phase (days 21-15), and PPI was highest during low hormonal levels such as the early follicular phase (days 1-9). Further, women displayed significantly lower PPI compared to men during the luteal but not the follicular phase and no sex differences were found during the early follicular phase (days 1-9) (Swerdlow et al., 1997). Studies conducted by Abel et al. (1998) and Jovanovic et al. (2004) also found no sex differences in PPI between men and women during women's follicular phase (e.g., days 1-4, and days 4-11, respectively). Therefore, lower PPI during the luteal phase, rather than the follicular phase, may explain the consistent findings of lower PPI in women compared to men.

In addition to considering cycle phase, it is useful to consider PPI with respect to symptoms or disorders related to the cycle phase. For example, among women diagnosed with premenstrual dysphoric disorder (PMDD), one study conducted by Kask et al. (2008) found that women with PMDD had significantly lower PPI compared to healthy controls during the late luteal (1-7 days prior to the onset of menstruation), but not the late follicular phase (days 6-12). Kask and colleagues (2008) concluded that women with PMDD demonstrated a relative failure in sensory motor gating systems and an inability to alleviate responses to negative stimuli (i.e., prepulse and pulse). However, this difficulty with sensorimotor gating among women with PMDD occurs only during the luteal phase, suggesting that women with PMDD have a particular sensitivity to the ovarian hormones present in this phase.

In addition to research on sex and cycle phase, three studies have attempted to examine the effect of OC use on PPI. However, the three studies rendered inconsistent findings. For instance, Holloway et al. (2011) found that women taking OCs demonstrated reduced PPI

compared to naturally cycling women while Gogos (2013) found that OC was not associated with performance on a PPI task. Additionally, a study conducted by Borgstrom et al. (2008) found that the effect of OC use on PPI may depend on current negative mood side effects, or the hormonal compound of the OC. Indeed, Borgstrom et al. (2008) found that OC users with no negative mood side effects had increased PPI compared to OC users with negative mood side effects (Borgstrom et al., 2008). Moreover, within the group of OC users with no negative mood side effects, those who were taking an OC with estrogenic properties demonstrated increased PPI compared to those who were taking an OC with progestagenic properties. Type of OC did not affect PPI within the group of OC users with current negative mood side effects. Also, no differences in PPI were found between previous OC users with or without negative mood side effects from OCs. However, Borgstrom et al. (2008) did not report on differences in PPI between OC users versus nonusers. Evidently, additional research including within-subjects designs is needed to examine the effects of OCs on PPI, and other tasks of inhibition.

**Fear Extinction**

Fear extinction is a decline in a fear response following nonreinforced exposure to feared conditioned stimulus (Myers, Resseler, & Davis, 2006). Fear extinction trials typically follow a similar protocol. First, the conditioning or fear acquisition phase occurs wherein a conditioned stimulus (e.g., a green light) is continuously paired with an unconditioned stimulus (e.g., an electric shock). Eventually, the subject learns that the conditioned stimulus will be followed by an aversive unconditioned stimulus and they will exhibit a fear response (e.g., freezing behaviour in rats). In the second phase, often called the extinction learning phase, the conditioned stimulus (e.g., green light) is presented without the aversive stimulus. Eventually, the subject learns that the conditioned stimulus is no longer threatening and the fear response dissipates. In the third

phase called extinction recall, which typically occurs 24 hours after extinction learning, the conditioned stimulus is again presented to the subject and their fear response is measured. If the subject elicits a fear response, it is evident that the subject did not retain the extinction learning, and they are exhibiting an exaggerated or inappropriate fear response. Because the extinction recall portion of the fear extinction protocol taps into an automatic process of inhibiting a fear response when it is no longer adaptive, it is the focus of the following research review.

In a review conducted by Lebron-Milad and Milad (2012) on sex differences in fear extinction, they reported that very few studies have examined sex differences in extinction learning and recall. Further, they reported that without taking menstrual or estrous cycle into account, most studies do not yield sex differences in human or animal studies. However, research across the estrous and menstrual cycle consistently indicates that estradiol facilitates fear extinction in rats (Lebron-Milad & Milad, 2012; Milad et al., 2009), healthy women (Lebron-Milad & Milad, 2012) and women diagnosed with PTSD (Glover et al., 2012; 2013). For instance, one study reviewed by Lebron-Milad and Milad (2012) found that blocking estrogen receptors in naturally cycling female rats increased freezing behaviour during recall (Milad et al., 2009). Additionally, a later study conducted by Graham and Milad (2014) found that preventing the aromatization of androgens into estradiol impairs extinction in male rats. Therefore, estradiol may facilitate extinction learning in both males and females.

Additionally, studies on humans have found that women with high estrogen typically exhibit enhanced extinction recall (i.e., less fear) compared to women with low estrogen levels (Lebron-Milad & Milad, 2012). Increased estrogen levels have also been associated with ventromedial prefrontal cortex, hippocampal and amygdala activation during extinction recall which indicates that estrogen is indeed involved in the neural processes related to extinction

(Lebron-Milad & Milad, 2012). Further, estradiol has a protective effect against the disruption of fear extinction learning in women diagnosed with PTSD. In two studies, Glover et al. (2012) and Glover et al. (2013) found that women with PTSD demonstrated a deficit in fear inhibition (i.e.., increased levels of fear-potentiated startle during extinction) compared to women without PTSD. However, when the groups of women were divided based on serum estradiol levels, women diagnosed with PTSD with higher levels of endogenous estradiol demonstrated reduced levels of fear-potentiated startle during extinction compared to women with PTSD with lower levels of endogenous estradiol (Glover et al., 2012, 2013).

Regarding the role of progesterone on fear extinction, results have been inconclusive. Progesterone has been found to facilitate fear extinction learning in female rats (Milad et al., 2009), impair fear extinction learning in female rats (Graham & Daher, 2016), or have no relationship with extinction in women (Lebron-Milad & Milad, 2012). However, given that neurosteroid levels, including estradiol, are lower in women that take OCs (Follesa et al., 2002; Zimmerman et al., 2014), one may predict that OC use is related to decreased fear inhibition.

Indeed, research has indicated that OC use is associated with impaired extinction and that this impairment in extinction is likely due to its role in reducing estradiol (Graham & Milad, 2013; Hwang et al., 2015; Lonsdorf et al., 2015; Zsido, 2014). For example, one paper by Graham and Milad (2013) included data on fear extinction in rodents as well as women. In their rat studies, naturally cycling rats were treated with levonorgestrel or placebo daily for four days prior to and throughout the conditioning and extinction training. Rats treated with levonorgestrel demonstrated significantly more freezing behaviour during extinction recall, and this effect increased as the dose of levonorgestrel increased. Among the rats treated with placebo, those in the proestrous phase (high hormone phase) demonstrated the least amount of freezing compared

to all other groups. Rats in the metestrus (low hormone) phase, however, demonstrated similar freezing behaviour to rats treated with high dose levonorgestrel. To examine if the extinction impairments induced by hormonal contraceptive use could be repaired, Graham and Milad (2013) treated a separate group of rats with levonorgestrel and either one of two estrogen-receptor agonists (an ERβ agonist or an ERα agonist), or placebo 30 minutes prior to extinction recall. The rats treated with levonorgestrel and placebo demonstrated the highest amount of freezing compared to all other groups whereas rats treated with levonorgestrel and an estradiol agonist exhibited low freezing responses similar to the responses of placebo-treated rats. Thus, treatment with hormonal contraceptives reduces neurosteroids levels in rats, impairs extinction recall, and this impairment can be mitigated through treatment with estradiol agonists.

Human studies on OC use and fear extinction parallel these results. Women taking OCs demonstrated impaired fear extinction compared to women not taking OCs and men (Lonsdorf et al., 2015), compared to women not taking OCs with either high or low serum estradiol (Graham & Milad, 2013) and compared to women not taking OCs with high (but not low) serum estradiol and men (Hwang et al., 2015; Zsido et al., 2014). Evidently, research on extinction recall and hormonal contraceptives consistently indicates that OC use is associated with impaired fear extinction, while higher levels of estradiol are associated with enhanced fear extinction (Graham & Milad, 2013; Hwang et al., 2015; Lonsdorf et al., 2015; Zsido, 2014).

**PPI, Fear Extinction and Hormones: Conclusions**

Both the PPI and fear extinction studies indicate that inhibition of an unnecessary fear or startle response may be reduced depending on the cycle phase, or the level of gonadal hormones. The literature has consistently provided evidence that fear extinction in healthy women is reduced when estradiol levels are lower (Lebron-Milad & Milad, 2012; Milad et al., 2009), and

that PPI is impaired during the luteal phase (Gulinello et al. 2003; Jovanovic et al., 2004; Kask et al., 2008; Koch, 1998; Swerdlow et al., 1997). However, reduced PPI in the luteal phase may be related to elevated levels of both progesterone and estradiol (Koch, 1998), or due to decreasing progesterone levels that occur near the end of the luteal phase (i.e., progesterone withdrawal) (Gulinello et al., 2003). Nevertheless, estradiol has been found to improve performance on PPI tasks in individuals with schizophrenia, and bipolar disorder (Gogo et al., 2009; Kumari et al., 2004) and on fear extinction trials in individuals with PTSD (Glover et al., 2012; 2013). This finding of improved performance with estradiol among clinical populations may be due to the relationship between estradiol and dopamine. As previously discussed, Colzato and Hommel (2014) posited that the relationship between estradiol and dopamine has an inverted U effect and those with low levels of dopamine reap the highest cognitive benefit from estradiol. Indeed, altered dopamine levels have been found in individuals with schizophrenia (Cohen & Servan-Schreiber, 1992), and bipolar disorder (except during mania) (Berk et al. 2007). Therefore, these populations may benefit from estradiol due to its effects on dopamine. Nevertheless, more research is needed before this link is clearly established.

In addition to examining the effect of gonadal hormones on lower-order inhibition, it is of importance for the present studies to examine inhibition related to higher-order cognition (i.e., behavioural and cognitive inhibition).

**Behavioural Inhibition**

Behavioural inhibition, as described above, encompasses several other types of inhibition: Response inhibition, deferred gratification, and reversal learning (Bari & Robbins, 2013). The following sections review research on the effects of sex, menstrual cycle, and OC use on each type of behavioural inhibition.

### *Response Inhibition*

Response inhibition, or impulsive action, is the inhibition most widely studied as it encompasses the relatively straightforward process of overriding an already planned or initiated action (Bari & Robbins, 2013). However, few studies have examined how hormones may affect this type of inhibition. Typically, response inhibition is measured in the laboratory with GoNogo or Stop Signal Tasks (SSTs). A GoNogo task consists of a simple stimulus, such as a letter or a shape, that flashes on a computer screen for a short period of time (e.g., 40 milliseconds). Participants are asked to respond via button press to a certain stimulus (e.g., the letter "W") and to not respond to another stimulus (e.g., the letter "M"), or to respond to all stimuli unless one is presented twice in a row. Accuracy, errors of commission, errors of omission, and response times are collected. For a stop-signal task, participants are required to press a button in response to a certain symbol (e.g., a right arrow) and press a different button in response to a different symbol (e.g., a left arrow). However, participants are instructed to inhibit their response if an audio tone is presented at the same time as one of the symbols. Accuracy, response times, and stop-signal response times (SSRTs) are collected. SSRTs are calculated from the distribution of "Go" reaction times and the observed probability of responding on "Stop" trials. Longer SSRTs indicates slower inhibitory processes, thus, a latency to inhibit a prepotent response.

#### Sex Differences in Response Inhibition.

***Animal Studies.*** Two reviews of sex differences in impulsive action (i.e., response inhibition) in rodents (Grissom & Reyes, 2019; Weafer & de Wit, 2014) have been published. Taken together with a study examining sex differences in GoNogo and SST performance in monkeys (Lacreuse et al., 2016), there is evidence of inconsistent sex differences with a need for further research. These papers are reviewed below.

Grissom et al. (2019) reviewed rodent studies that measured response inhibition via a five-choice serial reaction time task. In this task, rats were placed in a box with 5 nose-poke apertures and trained via pellet dispensing to make a sustained nose poke in various illuminated apertures for variable durations. Overall, they found little evidence for a consistent sex difference in response inhibition in rats. Of the studies they reviewed, two found a higher rate of impulsive errors (i.e., lowered response inhibition) in female compared to male rats (Ciampoli et al., 2017; Grissom et al., 2015), yet three found that males had more impulsive action when the task increased in difficulty (e.g., shorter stimulus duration, variable stimulus intervals) (Anshu et al., 2017; Bayless et al., 2012; Jentsch & Taylor, 2003). Two other studies found that age and development of the rat was important. For example, younger male rats were more impulsive than younger female rats yet impulsive behaviour was increased in adult females relative to adult males (Burton et al., 2012; Lukkes et al., 2016). No studies found sex differences in response times.

Weafer and de Wit (2014) also reviewed sex differences in response inhibition in rodents and found mixed results. There were two studies not included in the above Grissom et al. (2019) review, one found no sex differences in response inhibition when food was a reward, but when cocaine was the reward, female rats were more impulsive than males (Anker et al., 2008). The other found no sex differences in mice based on task difficulty and instead found male mice were more impulsive than females after being exposed to a stressor (Papaleo et al., 2012). Weafer and de Wit (2014) concluded that the sex differences observed depended on the species (rat vs. mice), the reward (e.g., food vs. cocaine), and the task difficulty.

Interestingly, a further examination of the Jentsch and Taylor (2003) study (included in the reviews of both Grissom et al., 2019 and Weafer & de Wit, 2014) revealed that some aspects

of inhibitory performance are mediated by circulating sex hormones. For example, they compared intact and gonadectomized rats and found that gonadectomized females had more impulsive responses compared to intact females while gonadectomized males had fewer impulsive responses compared to intact males. However, intact male rats had significantly more impulsive responses compared to female rats, suggesting greater impulsivity in intact males. Thus, the absence of circulating hormones appeared to lead to more impulsivity in female rats and less impulsivity in males.

Beyond rodents, Lacreuse et al. (2016) examined response inhibition in 5 male and 8 female socially-housed baboons. Data from over a year of stop-signal and GoNogo trials was collected. Results indicated that males were slower than females on the "Go" trials and less efficient in inhibiting their responses on "Stop" trials. However, a speed-accuracy trade off occurred with overall better accuracy in males compared to females. Additionally, results revealed that females had faster response times after a successful "Go" trial compared to males, but both males and females showed a slowing of responses after unsuccessful trials. Unlike the rodent studies, Lacreuse et al. (2016) found sex differences in response times in baboons. However, Lacreuse et al. (2016) had a very small sample size, thus, their results may be due to individual rather than group differences. More research needs to be conducted to draw conclusions regarding sex differences in response inhibition.

***Human Studies.*** In human studies of response inhibition, both task performance and its neurophysiological correlates are often measured. Neurophysiological responses such as N2 (a negative wave peak) and P3 (a positive wave peak) are measured via electroencephalography (EEG) during tasks of response inhibition (e.g., GoNogo tasks and SSTs). N2 is related to processes involved in stimulus evaluation or categorization with larger N2 amplitudes during

detection of conflict (i.e., detection of features that deviate from the context; Chen et al., 2008). P3 is related to response decisions and P3 amplitudes increase with the amount of cognitive resources recruited for response inhibition (Donkers & van Boxtel, 2004). Both N2 and P3 are used as an index of inhibition. However, many studies on response inhibition fail to find consistent sex differences in both task performance and neurophysiological responses. For example, Weafer and de Wit (2014) conducted a review of response inhibition in animals (cited above) and humans. They reviewed 13 human studies and found that on the GoNogo task and Continuous Performance Tasks (CPT), men displayed less inhibitory control, while on the SSTs, women displayed less inhibitory control (i.e., required more time to inhibit).

Studies not included in the Weafer and de Wit (2014) review also indicated inconsistent findings regarding sex differences in response inhibition. For instance, Yuan, He, Qinling, Chen, and Li (2008) examined 15 men and 15 women on a GoNogo task that required a key press to a "standard" stimulus and a different key press to a "deviant" stimulus. Compared to men, women had shorter response times to the deviant stimuli, larger deviant-related amplitudes and shorter latencies across the P2, N2, and P3. These results suggest that women were faster at detecting the occurrence of deviant stimuli, and they directed more attentional resources to these deviant features (Yuan, et al., 2008).

In contrast, Omura and Kusumoto (2015) found an opposite pattern of N2 amplitudes. In their GoNogo task men ($n$ = 13) demonstrated a larger N2 amplitude during the "Nogo" trials compared to women ($n$ = 11). However, there were no sex differences in overall performance on the task. They concluded that men require more neural activation than women to achieve similar performance. Ramos-Loyo et al. (2016) came to a similar conclusion based on their study. They had 15 men and 15 women complete a GoNogo task with emotionally neutral, unpleasant, and

pleasant backgrounds. There were overall no sex differences in accuracy across all contexts, and no sex differences in ERPs during the emotionally neutral context. However, during the emotional contexts, men showed a correlation between inhibition accuracy and higher N2 and lower P3 amplitudes. They concluded that men need to recruit areas related to attention and conflict monitoring more than women, especially during emotionally unpleasant contexts.

Beyond overall neural activation, Thakkar et al. (2014) found sex differences in sensitivity to trial history during an SST. No sex differences were found in overall performance on this task. However, it was found that women ($n$ = 346) sped up more following correct "Go" responses and slowed down more following errors compared to men ($n$ = 285). Consistent with these results, Lacreuse et al. (2016) found that female baboons sped up more following successful inhibitory responses and Jentsch and Taylor (2003) found that female rats decreased their response times following errors. However, Lacreuse and colleagues (2016) found no sex differences in the slowing of responses after incorrect responses, thus making it difficult to draw a general conclusion from these results.

This review of research on sex differences in response inhibition has demonstrated that while women may be more neurally efficient at response inhibition, there is lack of consistent evidence for sex differences in response inhibition. Therefore, it is likely that sex has little impact on response inhibition outside the laboratory. Nevertheless, grouping all women together in one category could potentially mask the differences in response inhibition that may be affected by fluctuations in sex hormones across the menstrual cycle. Thus, it is prudent to examine how cycle phase is associated with performance on tasks of response inhibition.

**Gonadal Hormones, the Menstrual Cycle, and Response Inhibition.**

***Rat Studies.*** No studies have examined response inhibition using animal models of the menstrual cycle. However, one study conducted by Swalve et al. (2016) examined response inhibition in male and female rats after administration of progesterone. Thus, this study could provide insight into how progesterone (which fluctuates across the menstrual cycle) may affect response inhibition.

In the study by Swalve et al. (2016), lever press was reinforced with a sucrose pellet during the "Go" trial and lack of lever press was reinforced with a sucrose pellet during the "Nogo" trial. After GoNogo behaviour was established, rats received either 0.5mg/kg of progesterone, or saline 30 minutes prior to testing. In the testing portion, rats were randomly assigned to an active lever that produced a food pellet when pressed, or an inactive lever that had no consequence when pressed. Progesterone significantly decreased impulsive action in both male and female rats without decreasing variable interval responding for food. Therefore, progesterone successfully decreased motor impulsivity without affecting motivation for food. These results indicate that response inhibition increases during periods of high progesterone. However, this study did not examine how estrogen may affect response inhibition. Thus, conclusions regarding estrogen's specific role in inhibition cannot be determined from this study.

***Human Studies.*** At least six human studies have found menstrual cycle effects on response inhibition. Consistent with the results from the rodent study by Swalve et al. (2016), Milivojevic et al. (2016) also found that progesterone was associated with higher response inhibition. In the Milivojevic et al. (2016) study, 46 treatment seeking cocaine-dependent men and women participated in a Stroop task. The Stroop task requires the inhibition of a pre-potent response (i.e., name the colour of the ink the word is printed in and inhibit the urge to read the

word). Participants were administered micronized progesterone or placebo for 7 days and were tested during days 5 to 7. Women received their first dose of progesterone during their early follicular phase (days 1 to 9). They found no sex differences in performance, however, those in the progesterone group had improved performance on the Stroop task compared to the placebo group. These results provide evidence that progesterone may be involved in enhancing inhibitory control. However, the Milivojevic et al. (2016) study examined a specific subgroup of individuals (i.e., cocaine-dependent adults). Therefore, it is unknown if these results could be generalized to the average adult population. Also, women were tested during days 6 to 16 (mid- to late-follicular phase) of their menstrual cycle yet Milivojevic et al. (2016) did not indicate whether fluctuating levels of endogenous estrogen played a role in inhibitory control in women.

Similarly, Hatta and Nagaya (2009) also examined response inhibition during relatively high levels of both progesterone and estrogen. In their study, 30 women completed a Stroop task twice during their menstrual cycle: once in the mid-luteal phase (days 21-22) and once in the early-follicular phase (days 2-3). They found that when women were in their mid-luteal phase (high estrogen, high progesterone) they demonstrated better response inhibition compared to when they were in the early follicular phase (low estrogen, low progesterone). These results are consistent with Milivojevic et al. (2016) results in that increased progesterone was found to be related to increased inhibitory control. However, Hatta and Nagaya (2009) did not examine women during their late follicular phase (high estrogen, low progesterone) or late luteal phase (low estrogen, high progesterone). Thus, this study like the Milivojevic et al. (2016) study, was not able to examine the potential differential effects of estrogen and progesterone on inhibition. It is possible that, in these studies, the full inhibitory effects of progesterone were masked by peaking levels of estrogen.

Indeed, estrogen has also been associated with decreased inhibitory control. For instance, Colzato et al. (2010) examined performance on a SST in 16 women during three phases of their menstrual cycle (menstrual, late follicular, and luteal) and 16 men using a within-subjects design. Women in their late follicular phase (days 9 to 12) demonstrated greater impulsive action (longer SSRTs) compared to their luteal (days 17 to 27) or menstrual phase (days 1 or 2). Moreover, women in their late follicular phase, but not in their luteal or menstrual phase, showed greater impulsive action on the SST compared to men. Additionally, greater impulsive action was correlated with higher levels of salivary estradiol and no correlation was found with performance on the SST and progesterone levels. This study suggests an inverse relationship between decreased response inhibition and estradiol and that response inhibition may be lowest when estradiol is high and progesterone is low (i.e., the late follicular phase).

Consistent with the findings from the Colzato et al., (2010) and Milivojevic et al. (2016) studies, Griskova-Bulanova et al. (2016) also found evidence that inhibition may decrease with higher estrogen (i.e., the follicular phase), and increase with higher progesterone (i.e., the luteal phase). Griskova-Bulanova et al. (2016) examined electrophysiological responses to a GoNogo task in 34 women. Participants were randomly assigned to testing during their early follicular, late follicular, or luteal phase. However, participants were not grouped by their cycle phase, but by their concentrations of sex hormones. Results revealed that higher levels of salivary estradiol were correlated with P3 latency prolongation on the “Go” trials while higher levels of salivary progesterone contributed to P3 latency shortening on “NoGo” trials. Further, higher estradiol was associated with more negative frontal N2 amplitudes. Griskova-Bulanova et al. (2016) explained that progesterone is related to P3 lengthening and increased response inhibition, while estradiol is related to P3 latency shortening, decreased N2 amplitudes, and decreased inhibition in women.

Nevertheless, they did not measure performance (e.g., response times, or accuracy) on the GoNogo task as a function of hormone levels. Therefore, it is not known how N2 and P3 latency and amplitudes were associated with actual performance on the task in this study.

Despite evidence that progesterone is related to increased inhibition (Griskova-Bulanova et al., 2016; Hatta & Nagaya, 2009; Milivojevic et al., 2016; Swalve et al., 2016), the opposite may be true for women who have PMDD. Indeed, Bannbers et al. (2012) examined differences in brain function and performance on a GoNogo task between 18 naturally cycling women with PMDD and 14 naturally cycling healthy controls during their mid-follicular phase (days 6-12) or their late luteal phase (days 8-13). Participants underwent an MRI while completing the GoNogo task. Results revealed no difference in performance on the GoNogo task between groups of women across the menstrual cycle. However, women with PMDD displayed decreased activity during response inhibition compared to controls in several brain areas related to inhibitory control. Specifically, women with PMDD displayed decreased left insula activity (related to increased inhibitory control) during the follicular phase and increased left insula activity (related to decreased inhibitory control) during the luteal phase. Healthy controls did not display this differential response in the left insula. Thus, women with PMDD demonstrated brain activations patterns indicative of decreased inhibitory control when levels of progesterone were higher (i.e., during the luteal phase).

In another study by Roberts et al. (2008), it was found that, under certain conditions, estradiol and not progesterone contributed to increased response inhibition. Roberts et al. (2008) examined brain activations of 15 women via MRI during a GoNogo task that used attractive male and female faces as stimuli. Women were tested during either their late follicular (days 10 to 14) or mid-luteal (days 21 to 24) phase. While no overall performance differences were found,

women in their follicular phase had superior inhibitory brain function (reduced inferior frontal gyrus activity) and heightened detection of inhibitory failures (enhanced anterior cingulate cortex activity) when the stimuli were male faces. Thus, when conception was most likely, attractive male stimuli increased women's typical inhibitory response. The authors suggested that women's cognitive control mechanisms are more attuned to potential sexual mates during the follicular phase.

The literature regarding response inhibition across the menstrual cycle is slightly more consistent than the literature regarding sex differences in response inhibition. The studies in this section indicated that response inhibition increases when progesterone levels are high (Griskova-Bulanova et al., 2016; Swalve et al., 2016) or when both progesterone and estrogen levels are high (Hatta & Nagaya, 2009; Milivojevic et al., 2016). However, this pattern may be reversed in certain populations of women, such as women with PMDD (where progesterone is related to decreased inhibition; Bannbers et al., 2012) or when women are viewing attractive male faces (where women with high estradiol and low progesterone demonstrate increased inhibitory brain function; Roberts et al., 2008). The following section will further examine hormones and response inhibition by reviewing the literature on OCs and response inhibition.

**OCs and Response Inhibition.**

***Animal Studies.*** There are no published animal studies that examine the effect of OC use (or a similar non-oral hormone formulation) on response inhibition.

***Human Studies.*** There appears to be only one published study that examines the effect of OC use on response inhibition (Gingnell et al., 2016). In this randomized double-blind placebo-controlled study, 34 women using OCs or placebo participated in a GoNogo task while undergoing an fMRI. Gingnell et al. (2016) found no differences between women using OCs and

placebo users in number of correct inhibition responses. However, women on OCs significantly improved their performance between baseline and treatment assessments (i.e., faster inhibition learning) compared to women on placebo. Further, OC users displayed decreased activity in the right middle frontal gyrus in comparison with placebo users, indicating that OC use may increase efficiency in response inhibition.

However, in contrast to Gingnell et al. (2016), unpublished data from our laboratory indicates that OC use may be related to poorer performance on a task of response inhibition (Keir & Oinonen, 2016a; 2016b). In this study, 51 women using OCs, 43 women not using OCs, and 35 men underwent three different mood inductions (sad, happy, and fear) and completed a GoNogo task after each induction. Results revealed that after the happy mood induction, women (both OC users and nonusers), and OC users only had more errors of commission (i.e., reduced response inhibition) compared to men. Additional analyses were conducted where OC users were grouped based on current mood side effects. After sad mood induction, OC users with current negative mood side effects ($n$ = 15) had fewer errors of commission compared to OC users with no negative mood side effects ($n$ = 37). No other group differences were found after any other mood induction. Evidently, performance on a task of response inhibition may be affected by both mood induction and current mood side effects. These findings require replication but suggest the possibility that OCs may affect response inhibition. More research is required to further investigate the relationship between OC use and response inhibition.

***Deferred Gratification***

The next type of behavioural inhibition that will be examined is deferred gratification. Deferred gratification and its opposite, impulsive choice, are typically assessed using discounting tasks. In these tasks, subjects chose between smaller rewards delivered immediately or larger

rewards delivered later. Discounting of the delayed reward in favour of the immediate reward is indicative of a lack of inhibitory control.

**Sex Differences in Deferred Gratification.**

***Rat Studies.*** Three articles were found that compared male and female laboratory animals on measures of deferred gratification. However, the three papers resulted in somewhat inconsistent findings. Female rats were found to make more impulsive choices (delay times not reported) compared to male rats (Weafer & de Wit, 2014), male rats were found to make more impulsive choices (at 15 and 30 second delays) compared to female rats (Bayless et al., 2013), and no sex difference in impulsive choice (at 0 to 40 second delays) was found in the third study (Eubig et al., 2014). Only after exposure to estrogen or androgens during critical periods of development did impulsive choice increase in female rats compared to female controls (Bayless et al., 2013) and only after being treated with a dopamine agonist did female rats demonstrated greater impulsive choice compared to male rats (Eubig et al., 2014). Thus, it appears that estradiol and dopamine may serve to increase impulsive choice.

Bayless et al. (2013) explained that gonadal hormones that act during critical periods of development create permanent organizational changes to the brain. In their experiment, both androgens and estrogens presented during a critical neonatal period in female and male rats increased impulsive choice behaviour. Thus, although androgens and estrogens may have made differential organizational changes in the brain (a factor not investigated in their study), these changes resulted in the same phenotypic behaviour (i.e., increased impulsive choice). Additionally, because Eubig et al. (2014) found that female rats demonstrated less preference for larger rewards (i.e., more choice impulsivity) than male rats after a dopamine agonist (D-Amphetamine) administration and no sex differences in choice after administration of a

dopamine antagonist (cis-flupenthixol), they concluded that dopamine plays an important role in sex differences in deferred gratification. Nevertheless, previous research has indicated that estradiol increases female rats' preference for smaller food amounts (Butera, 2010). Therefore, these results may be confounded by the effect of estradiol on the reinforcing value of food or appetite.

***Human Studies.*** At least three reviews and one meta-analysis have been published examining sex differences in deferred gratification. Weafer and de Wit's (2014) review of seven studies yielded mix results. Overall, they found women were generally shown to have greater impulsive choice (i.e., higher delay discounting) than men. However, in one study, men discounted more steeply than women when they were told that they would be entered into a lottery and could potentially win based on their choices (Kirby & Marakovic, 1996). This study of sex differences in impulsive choice indicated that women show greater impulsive choice for hypothetical rewards, while men may show greater impulsive choice for actual rewards. However, other studies have found that there may be other motivational components related to deferred gratification beyond impulsive choice.

Most recently, Grissom et al. (2019) reviewed 21 studies that examined sex differences on various deferred gratification tasks (e.g., Iowa gambling task, delay discounting task, multi-armed bandit task). They concluded that there are very little sex differences in decision making, however, when differences were observed it was typically because women tended to avoid frequent losses compared to men. Similar conclusions were made by Cross et al. (2011) in their meta-analysis. They analyzed 741 effect sizes from 277 studies on sex differences in impulsivity and found that men showed punishment hyposensitivity, higher sensation seeking, and

moderately higher deficits in effortful control on questionnaire measures, and higher behavioural risk taking on laboratory tasks of risk (e.g., Balloon Analogue Risk Task).

Cross et al.'s (2011) meta-analysis showed no overall sex differences in reward sensitivity, suggesting that men and women respond equally positively to rewards. However, sex differences in reward sensitivity were found but depended on the measure used. For example, items on the Behavioural Activation Scale (BAS) tend to focus on emotional responses to positive events and scores on this measure demonstrate higher reward sensitivity among women. On the other hand, items on the Generalized Reward and Punishment Expectancy Scales (GRAPES), tend to focus on rewards related to money or status and scores on this measure demonstrate higher reward sensitivity for men. Regarding punishment sensitivity, results were consistent across measures and found a large effect size indicating that women were more punishment sensitive compared to men (Cross et al., 2011). Specifically, the sex differences in risk taking were driven by the finding that women were more prone to avoid risky situations and not that men were more likely to seek out risky situations. Further, women tended to report greater anticipation of negative consequences and had higher ratings of severity of those anticipated consequences.

Another review, conducted by van den Bos et al. (2013), specifically examined sex differences in decision making on the Iowa Gambling Task (IGT), the Risky Gains Task (RGT). and the Cambridge Gambling Task (CGT). They also found no sex differences in overall performance on the tasks and instead, sex differences appeared in the types of decisions that men and women made and their overall progression in the task. For example, on the IGT men make choices that have more losses but are inherent to a long-term winning strategy. Similarly, sex differences on the RGT and CGT appeared in response patterns of decisions, especially in terms

of responses to loss and risk framing. On the RGT, participants chose between a safe option of winning 20 points or two risky options of winning 40 or 80 points. While there was no overall sex difference in risk-taking behaviour, women were more likely to choose the safe option after a loss compared to men. Additionally, women's decisions were more likely to depend on a previous win or loss and they were more likely to be risk-aversive following a loss compared to men. Similarly, in the CGT, sex differences were found in relation to risk adjustment. On the CGT, men were less risk-aversive and more risk-prone on this task compared to women. However, women become more risk-prone compared to men when the task was framed to focus on the loss rather than the gain (van den Bos et al., 2013).

Taken together, the studies indicate that sex differences in impulsive choice are centered around motivational (or affective) rather than effortful or executive forms of behavioural control. Thus, it is important to consider potential affective and motivational factors influencing impulsive action when examining sex differences in behavioural or cognitive inhibition.

Not included in the reviews discussed above is a study conducted by Mei et al. (2017). This study examined impulsive choice (i.e., deferred gratification) via a delay discounting task and a probability discounting task on university students in China. All participants (30 men and 30 women) completed two conditions. In the first condition, participants performed the tasks as normal; in the second condition, participants were required to simultaneously undergo a working memory task which required participants to remember the position of a given number in a string of numbers. Men were found to make the most impulsive choices under the working memory load condition when the reward was the highest. For women, the working memory condition did not significantly change their discounting pattern. For the probability discounting task, there were no sex differences were found regarding risky and choice all participants became more risk

aversive as the reward amount increased regardless of sex or working memory load. Ultimately, these results indicate that there are generally no sex differences in delay discounting or probability discounting. However, men's inhibitory control may be more sensitive to changes in their working memory compared to women.

Similar to the animal studies, the research on humans examining sex differences in deferred gratification has yielded mixed results. Some studies indicate that men show overall less deferred gratification (i.e., more impulsive choice) than women (see review in Weafer & de Wit, 2014). However, more generally, studies found no sex differences in delay discounting tasks and instead demonstrated that men and women employ different strategies to complete the tasks (Cross et al., 2011; Grissom et al., 2019). For instance, women demonstrated greater impulsive choice for hypothetical rewards, while men may show greater impulsive choice for actual rewards (Weafer & de Wit, 2014), men demonstrated greater impulsive choice when the amount is high and they are simultaneously engaging their working memory (Mei et al., 2017) and men and women have different decision making strategies that may reflect a decreased sensitivity to punishment and loss (Grissom et al., 2019; ven den Bos et al., 2013). Indeed, one of the reasons for a lack of sex differences in deferred gratification may be because many studies fail to consider women's fluctuating endogenous hormones. That is, decision making and impulsive choice may differ amongst women depending on their phase in the menstrual cycle. Further, this variability within women may wash out any sex differences. The following sections will explore deferred gratification across the menstrual cycle in animals and humans.

**Gonadal Hormones, the Menstrual Cycle, and Deferred Gratification.**

***Animal Studies.*** Only two studies examined the relationship between gonadal hormones and deferred gratification in animals. The first study, conducted by Caroll et al. (2013),

investigated deferred gratification in seven female *rhesus* monkeys that were undergoing withdrawal from phencyclidine (PCP). They note that withdrawal from PCP has been shown to increase impulsive choice for food on delay discounting tasks for both male and female *rhesus* monkeys and this effect was stronger in males than females. Thus, they hypothesized that the increased impulsive behaviour for food during withdrawal from PCP may have a hormonal component. In their within-subjects design, 7 adult female *rhesus* monkeys completed a delayed gratification for saccharine task during PCP withdrawal in their mid-follicular (days 7-11) and late luteal (days 24 - 28) phase. During withdrawal, monkeys in both phases demonstrated impulsive choice (mean adjusted delay) for saccharine yet impulsive choice was greater during the luteal compared to the follicular phase.

The second study, conducted by Smethells et al. (2015), investigated deferred gratification in rats for IV cocaine or saccharine after administration of placebo, progesterone, or atomoxetine (ATO). ATO is a pharmaceutical agent that has been demonstrated to reduce impulsive choice for cocaine in rats. Regardless of treatment, both male and female rats tended to discount the larger reward with a delay (at 7.5, 15, 30, 60 second delays) in favour of the smaller, immediate food pellet. Thus, there were no sex differences in delay discounting for sucrose pellets. However, for cocaine infusions, sex differences in delayed discounting appeared as a function of treatment. Female rats treated with progesterone or progesterone and ATO showed more preference for larger cocaine reward after a delay (i.e., increased deferred gratification). Conversely, male rats showed more preference for larger cocaine reward after a delay only after treatment with ATO. Smethells et al. (2015) explained that progesterone significantly reduced delay discounting in female rats likely because it blunts the reinforcement

enhancement effect of estrogen and estrogen has long been established to enhance the reinforcement effect of cocaine (Roberts et al., 1989).

Nevertheless, Smethells at al. (2015) found no sex differences with respect to impulsive choice for sucrose pellets. Thus, it cannot be concluded from this study that progesterone decreases impulsive choice for female rats for stimuli other than cocaine. Moreover, results from Caroll et al. (2013) indicated that progesterone increased impulsive choice for saccharine. However, the Caroll et al. (2013) and Smethells et al. (2015) studies differed in their subjects (female *rhesus* monkeys versus male and female rats), delay discounting task (impulsive choice for saccharine after PCP withdrawal versus impulsive choice for IV cocaine or sucrose), and hormone variable (menstrual phases versus treatment with hormones regardless of estrous phase). Thus, due to the vast differences between these studies it is difficult to draw conclusions from their results. Evidently, more experiments need to be conducted to examine how hormones differentially affect impulsive choice.

***Human Studies.*** The review conducted by van den Bos et al. (2013) discussed earlier also examined menstrual cycle effects on impulsive choice. Some studies have found that women in the follicular phase are more sensitive to rewards compared to women in the luteal phase (van den Bos et al., 2013). Further, as discussed earlier, increased ovarian metabolic demand during the luteal phase could be diverting energy away from and thus impairing certain self-control processes (Gailliot et al., 2010). Some studies suggest that PMS is related to difficulty controlling emotions, attention, fine-motor movements as well as increased intake of alcohol, drugs, nicotine, caffeine and food (Gailliot et al., 2010). However, in van den Bos et al.'s (2013) review of sex differences on delay discounting tasks, they found that cycle phase did not alter performance on the IGT, a popular measure of impulsive choice. Further, there is evidence that

sex differences appear on the IGT prior to puberty indicating that sex differences exist on the task irrespective of cycle phase (van den Bos, Homber, & de Visser, 2013).

In contrast to the findings from van den Bos et al. (2013), three studies (Diekhoff, 2015; Kaighobadi & Stevens, 2013; Smith et al., 2014) did find menstrual cycle effects on tasks measuring impulsive choice. The first study conducted by Kaighobadi and Stevens (2013) examined how women's impulsive choice across the menstrual cycle may differ depending on perceived availability of attractive men. They noted that viewing attractive men can put women in a "mating mindset" that may differentially affect their decision making and risk taking during their late-follicular phase (peak fertility) compared to their luteal phase. In their study, 28 naturally cycling women completed two laboratory sessions: one in their mid to late follicular phase (days -15 to -11 or days 9 to 13 for a regular 28-day cycle) and one in their mid- to late-luteal phase (days -13 to – 2 or days 15 to 26 for a regular 28-day cycle). Follicular phase was confirmed with luteinizing hormone (LH) predictor tests. The LH surge occurs 24 to 48 hours prior to ovulation and participants were tested either on the day of LH surge or during ovulation.

Women participated in an intertemporal choice and a risky choice task both before and after exposure to photographs of either attractive men or neutral stimuli (e.g., a landscape). The intertemporal task was a delay discounting task where the women chose between a smaller more immediate monetary award and a larger delayed monetary award. The risky choice task was a probability discounting task where the women chose between varying amounts of money with varying probability of receipt (e.g., 1/10 chance of $17 or 5/10 chance of $10). Kaighobadi and Stevens (2013) found no main effect of menstrual cycle phase on intertemporal choices based on baseline scores. However, after comparing baseline and post-exposure scores, they found that the women that viewed attractive men were more likely to choose the larger delayed rewards when

they were at peak fertility compared to when they were at low fertility. For the risky choice task, there was no main effect of cycle phase on risky choice. Neither image type (e.g., attractive men, neutral images) nor cycle phase affected the difference score from baseline. To explain the lack of effect on the probability discounting task, Kaighobadi and Stevens (2013) acknowledged that the options in the task may not have been risky enough as the differences between hypothetical reward amounts were minimal. Although no effects were demonstrated for probability discounting, these results still demonstrate that shifts in delay discounting occur across the menstrual cycle. Further, these results are congruent with the Roberts et al. (2008) study discussed in the response inhibition section which indicated that women showed increased inhibitory brain function when viewing attractive male faces during peak fertility.

The second menstrual cycle study predicted that impulsive choice would be associated with dopaminergic activity in the brain as a function of genetics [i.e., a certain polymorphism on the gene encoding the catechol-O-methyltransferase (COMT) enzyme] and circulating estradiol levels (Smith et al., 2014). Variations in genes that encode the COMT enzyme regulate the levels of dopamine in the frontal lobes of the brain (Männistö & Kaakkola, 1999). In the Smith et al. study, 34 naturally cycling women completed a delay discounting task, measures of trait impulsivity, and provided saliva samples for COMT genotyping and estradiol levels during both the menstrual phase (days 1 to 2) and the late-follicular phase (days 11 to 12). Women showed a decline in impulsive choice and more delay discounting during the late follicular phase compared to their menstrual phase. Additionally, 23 of the 34 women demonstrated an increase in estradiol from their menstrual phase to their late follicular phase, and this increase in estradiol was associated with a significant decrease in impulsive choice. Furthermore, the women that did not demonstrate an increase in estradiol from their menstrual phase to their follicular phase showed a

trend for increased impulsive choice in the follicular phase. Regarding trait impulsivity, they found that higher estradiol levels were also associated with decreased impulsive choice and lower impulsivity on the Behavioural Inhibition Scale's (BIS) non-planning scores. Finally, regarding COMT genotypes, those with the met/val ($n$ = 9) or val/val ($n$ = 15) genotype had less impulsive choice with greater estradiol levels yet those with the met/met COMT genotype ($n$ = 10) had more impulsive choice with greater estradiol levels. Average estradiol levels did not differ across any of the genotypes. Thus, Smith et al. (2014) posited that the estradiol rise during the follicular phase may modulate impulsive choice through its interactions with tonic frontal dopamine. The Smith et al. (2014) study was consistent with the Kaighobadi and Stevens (2013) results where women in the late-follicular (high estrogen) phase demonstrated decreased impulsive choice and increased deferred gratification.

The third study, conducted by Diekhoff (2015), also found decreased impulsive choice in the late follicular phase and provided indirect evidence for the relationship between estrogen and dopamine and impulsive choice. Diekhoff (2015) had 28 women participate in a "clock task" which required them to employ an optimal response time (i.e., either speeding up or slowing down) to maximize their overall reward. Diekhoff noted that this task may directly relate to the dopamine system as the dopamine system has been shown to help individuals learn from reward rather than punishment (Frank et al., 2004). The participants all completed the clock task twice, in the menstrual (days 1 to 3) and late follicular (days -17 to -15 or days 11 to 13 in a regular 28-day cycle) phases. Salivary estradiol and progesterone levels were measured as well as trait impulsivity via the BIS scale. Women in the menstrual phase acted more impulsively than women in the late-follicular phase. Additionally, in the menstrual phase, there was a positive correlation between higher estradiol levels and an enhanced ability to speed up for a higher

reward yet a negative correlation between higher estradiol and the ability to slow down or wait for a higher reward (i.e., less deferred gratification). Further, the correlation between an impulsive style of responding and higher estradiol levels in the menstrual phase was found to be strongest in women with low trait impulsivity. However, there were no significant differences in performance on the clock task during the late follicular phase as a function of estradiol levels or trait impulsivity. Diekhoff (2015) indicated that the relationship between estradiol and dopamine is likely non-linear and similar to an inverted U-function (also see review by Colzato & Hommel, 2014). Ultimately, these results indicate that the effect of estrogen on impulsive choice is unmasked by progesterone. However, more research is needed in order to clarify the relationship between dopamine, estradiol and impulsivity in women.

Beyond measures of impulsive choice on tasks of deferred gratification, some studies have examined the effects of menstrual cycle phase on other types of impulsive behaviour such as binge eating, or spending. For instance, a study conducted by Edler et al. (2007) examined menstrual cycle effects on binge eating in naturally cycling women (11 women with bulimia nervosa and 15 healthy controls). Hormone samples, binge eating behaviour, and mood ratings were collected for 35 consecutive days. Both between- and within-subjects analyses were conducted. Edler et al. (2007) found that mean estradiol and progesterone levels did not differ between women diagnosed with bulimia nervosa and healthy controls. However, in women diagnosed with bulimia-nervosa, increased binge eating was associated with a decrease in estradiol and increase in progesterone. Further, negative affect did not significantly differ across menstrual cycle phases for women diagnosed with bulimia nervosa. Therefore, changes in binge eating patterns were not associated with cycle-related changes in mood. Instead, across all participants, negative mood accounted for only 10% of the variance in binge frequency while

ovarian hormones accounted for 24% of the variance in binge frequency. Nevertheless, these results were only significant among women diagnosed with an eating disorder. Thus, the effect of menstrual phase on the impulsive action of binge eating may not be applicable to women without disordered eating.

In addition to binge eating, some research has also indicated that spending may change with cycle phase. Pine and Fletcher (2011) studied impulsive spending behaviours in women across the menstrual cycle. In their study, 322 naturally cycling women participated in an online survey that included a spending scale titled "15 items of Recent Spending and Saving Scale (RSSS)". They found that women's spending habits were most controlled during the follicular phase, less so mid-cycle, and the least controlled in their luteal phase. Therefore, spending was less controlled, more impulsive, and more excessive in the luteal phase, a time of higher progesterone levels.

Results from the Pine and Fletcher (2011) study are relatively consistent with the results from the Edler, (2007) study in that impulsivity was found during the lower estrogen phase (e.g., the luteal phase). However, Pine and Fletcher (2011) did not specify the cycle days they used to define the menstrual cycle phases. Also, in the Pine and Fletcher study, spending behaviour may not have been entirely based on impulse. For example, most of the women endorsed buying something on impulse, yet the item bought could have been a food item that related more to food cravings rather than impulsive spending per se. Indeed, deferred gratification involves many motivational components that work together with impulsivity to lead to an impulsive choice. Thus eating, and spending are more proximal measures of deferred gratification compared to the delay discounting tasks measured in the van den Bos (2013), Kaighobadi and Stevens (2013), Smith et al. (2014), and Diekhoff (2015) studies.

Overall, only one review study indicated that the menstrual cycle did not affect deferred gratification (i.e., van den Bos et al., 2013). Instead, of the remaining six studies, two indicated that deferred gratification was increased (i.e., impulsive choice has decreased) during the mid-to late-follicular or high estrogen phase of the menstrual cycle (Kaighobadi & Stevens, 2013; Smith et al., 2014), one study indicated that higher estradiol levels were related to decreased deferred gratification (Diekhoff, 2015) and two indicated the deferred gratification was decreased in women during the mid-to-late luteal phase (Elder et al., 2007; Pine & Fletcher, 2011). However, of the two studies that indicated that deferred gratification increased during the mid-to late-follicular phase, this occurred only after viewing photographs of attractive men (Kaighobadi & Stevens, 2013), or if they had a particular COMT genotype (Smith et al., 2014). Thus, although most of the studies reviewed indicate evidence for increased deferred gratification during the follicular phase and decreased deferred gratification during the luteal phase more evidence is needed before conclusions can be drawn regarding menstrual cycle effects for deferred gratification.

**OCs and Deferred Gratification.** No animal or human studies have been conducted to date examining deferred gratification and OCs (or similar non-oral hormonal formulations).

### *Reversal Learning*

As discussed above, reversal learning is operationally defined as the ability to inhibit a response previously rewarded but now punished or no longer rewarded (Bari & Robbins, 2013). Common reversal learning tasks are discrimination reversal or rule or strategy reversal tasks as these tap into cognitive flexibility and compulsive or perseverative responding. In a standard reversal learning paradigm, the participant is presented with the option of choosing between two distinct stimuli (e.g., choose the red square instead of yellow circle) only one of which is deemed

"correct". If the participant makes the correct choice, they are rewarded (e.g., rat receives a food pellet) or given feedback that the choice was correct. Once the subject has learned the stimulus-reward association (also called discrimination acquisition), the contingencies are reversed without warning. The subject is then required to amend their behaviour by trial and error and reverse their responding. If the subject continues to select the original choice despite receiving corrective feedback or no reward, the subject is thought to have perseverative responding, and a deficit in reversal learning.

**Sex Differences in Reversal Learning.**

***Animal Studies.*** A total of six studies were found that examined sex differences in reversal learning in rodents. No studies involving primates were found. These studies mostly revealed a slight male advantage with respect to performance on reversal learning tasks, however other studies found no sex differences or a male advantage only under certain circumstances. Indeed, a study by Mihalick et al. (2000) found that male mice outperformed female mice during an olfactory discrimination learning task. In this task, mice were required to choose the correctly scented sand to receive a food reward. After the mouse sufficiently learned the acquisition task, the correct choice was switched. The reversal learning task continued and scents were switched in a series of repeated trials. They found that males outperformed females on the acquisition and the learning tasks in that they made the correct choices faster and more consistently and they learned discrimination reversals quicker compared to the female mice. However, all mice made a similar number of perseveration errors (i.e., incorrectly choosing the previously reinforced odour) which indicates that the mice maintained the same level of inhibitory control. Thus, the females appeared to underperform compared to males, not because of a deficit in inhibition, but

because they used a different adaptive strategy wherein they sampled the available options with more frequency.

Similar to Mihalick et al. (2000), Bissonette et al. (2012) also found that female mice employed a different sampling strategy compared to males during a discrimination reversal task. Mice were placed in a chamber to explore two bowls with a combination of digging media (e.g., wood chips or gravel) and odours (e.g., various dried spices). In some trials, mice were required to learn to dig in the bowl associated with a certain scent and in other trials, mice were required to learn to dig in the bowl associated with a digging medium. Reversal learning was measured when the mouse was presented with the same set of cues as the previous task, but with the stimulus-reward reversed. Female mice had similar reversal learning ability compared to male rats yet they required significantly more time to form an attention set (i.e., to pay attention to only one perceptual aspect and ignore others). Indeed, female mice often sampled the odors and textures repeatedly from both bowls prior to making a final decision by digging into the medium. Conversely, the male mice typically ran directly to their bowl of choice, without investigating the other bowls. Bissonette et al. (2012) reported that the performance of the female mice in this study was similar to the performance of male mice lacking the D3 dopamine receptor in previous studies (see Glickstein, Desteno, Hof, & Schmauss, 2004). Thus, they speculated that female mice may have differential activation of dopamine in their frontal cortex. Alternatively, the authors posited that the female mice may have been more anxious, or had different motivation compared to the male mice.

Eddy et al. (2013) aimed to investigate how exercise may improve the cognitive functioning of intact or gonadectomized male and female rats. During testing, rats completed a cross-maze (four-armed maze). Each arm of the maze varied along two dimensions: brightness

and texture. If the rat chose the correct arm, it was rewarded with a food pellet. Once acquisition criteria was met, the stimulus dimension was shifted and rats previously rewarded for smooth-textured arms (regardless of colour) were now rewarded for choosing white coloured arms (regardless of texture). Castrated and intact male rats attained acquisition criteria quicker than both ovariectomized and intact female rats. During the reversal trials, castrated male rats outperformed ovariectomized female rats. However, no sex differences were found between male and female intact rats. When examining errors made across the tasks, they found that both intact and ovariectomized females demonstrated greater perseveration and made significantly fewer correct choices when the choice involved an arm that had previously been reinforced compared to both groups of males. Thus, there appears to be a sex difference in the strategy used to complete the task that favours male rats.

Interestingly, Goodwill et al. (2018) found that the slight male advantage in reversal learning tasks appears only under certain circumstances. In their study, early stress was induced in mice via limited bedding during critical developmental periods. Using a scent- and media-based reversal task [as described by Mihalick et al. (2000) above], mice learned to search for a reward based on scent or media cues which were then reversed. Early life stress did not impair cognitive function in males, and there were no sex differences in reversal learning amongst the non-stressed mice. However, females with early life stress took longer to make the reward associations and made more reversal errors compared to unstressed male and female controls. Further, early life stress in females, but not males, was associated with a reduction of certain interneuron markers that express parvalbumin (PV; an inhibitory neuron) in the OFC. A secondary experiment was conducted wherein they selectively inhibited OFC PV interneurons in control mice and similar deficits in reversal learning were observed. Thus, these interneurons,

which are decreased in density and expression by early life stress, may be the cause of some deficits in reversal learning in mice.

Another study also found a slight female advantage when using a punishment- rather than reward-based discrimination reversal task. Harte and Edwards (2010) had adolescent and adult male and female rats undergo a reversal learning task by reversing the location of an electric shock. In young adolescent mice, female rats outperformed male rats as they were found to spend greater amount of time avoiding the shock zone than males in both the acquisition and reversal learning trials. Thus, male rats received more shocks than female rats. However, no sex differences in learning were observed in adult rats. Previous research on animals and humans indicate that female animals and women are more punishment sensitive compared to male animals and men (Cross et al., 2010; van den Bos et al., 2013). Thus, female rats could have an advantage on this type of task due to increased punishment sensitivity and this slight advantage lead to adolescent females outperforming adolescent males and diminished sex differences in adults.

Finally, one study using bank voles found no sex differences in reversal learning and instead, found that performance was dependent on personality characteristics irrespective of sex. Mazza et al. (2018) examined the activity and boldness in 86 bank voles as well as their associative learning speed and flexibility via a reversal learning task. Activity and boldness was measured with an open field test (more activity in the open field indicated a more active vole) and a novel object test (quicker to explore and more time spent with the novel object indicated a more bold vole). Reversal learning was tested by pairing a food reward with a smell and then reversing the reward contingency by pairing the food reward with the previously unrewarded smell. Mazza et al., (2018) found that the more active and more bold voles were faster, yet more

inflexible in the learning task whereas the shyer and less active voles were slow yet flexible. A speed-accuracy trade off was also found with slower voles making more correct choices.

Animal research on reversal learning was slightly inconsistent with some finding a male advantage on reversal learning tasks (e.g., Bissonette et al., 2012; Eddy et al., 2013; Mihalick et al. 2000), yet other studies finding no sex differences (Harte & Edwards, 2010; Mazza et al., 2018*)* or a male advantage only when rats were exposed to early life stressors (Goodwill et al., 2018).

***Human Studies.*** Only four studies were found that examined sex differences in reversal learning in humans. One paper by Overman (2004) reviewed data from their laboratory on sex differences across the lifespan in cognitive tasks that rely on the orbital prefrontal cortex. They found consistent results that male children under the age of 36 months outperformed same-aged female children on tasks of reversal learning. However, they found no consistent evidence for sex differences on reversal learning tasks in adolescents or adults. Overman (2004) explained that one possible explanation for the lack of sex differences seen in older children and adults may be due to a ceiling effect. That is, most people make very few mistakes on the tasks. Indeed, a problem with the floor effect on tasks of reversal learning is corroborated by other researchers (e.g., Bari & Robbins, 2013). To adjust for this effect, some researchers increase the difficulty of the reversal learning task.

A study by Evans and Hampson (2015) reduced potential floor effects by using a probabilistic reversal learning task which is intended to be more challenging than traditional reversal learning tasks. In this task, 45 men and 48 women viewed a pair of common objects on a computer screen (e.g., fruit or a musical instrument) and selected one of the two objects by pressing a button. The participants were not told which choice was correct however they were

told that the correct object may change over the course of the task. If the participant made the correct choice they won 100 points and if they made the incorrect choice they lost 100 points. At some point during the sessions, the correct choice is reversed. Feedback was given in a probabilistic fashion so that in the first condition, 90% of the trials received correct feedback and 10% of the trials they received incorrect feedback. This ratio switched to 80 and 20% respectively for the second condition. Their results revealed no sex differences in the acquisition phase of the task indicating that men and women equally learned to pick the correct object prior to reversal. However, during the reversal stages of the task, males significantly outperformed women. Evans and Hampson (2015) posited that these results indicated that there may be a sex difference in inhibitory control, in attention given to or in the impact of reversal cues, or in learning based on reward and punishment. They also contended that more research on the effects of endogenous hormones on tasks of probabilistic learning should be conducted.

In congruence with Evans and Hampson (2015), Halari et al. (2005) also found a male advantage on reversal learning tasks. Halari et al. examined sex and individual differences in cognitive performance on several cognitive tasks, one of which included a component of reversal learning. Participants (42 women, 42 men). For the reversal learning task, participants were required to respond to obvious stimuli (i.e., detecting numbers increasing in numerical order) in some trials and to inhibit responses to obvious stimuli in favour of less obvious stimuli (i.e., detecting numbers in decreasing numerical order) in other trials. This task represents a task of reversal learning as participants were required to shift sets and selectively respond to and inhibit their response to certain stimuli. Additionally, because the reversal task required inhibition of an obvious response in favour of a less obvious response, it is likely to avoid the ceiling effect compared to other, simpler reversal learning tasks. Men demonstrated more accuracy on the

reversal learning task compared to women. However, no significant relationships were found between any of the hormones (testosterone, estradiol, progesterone, luteinizing hormone, follicle-stimulating hormone, and sex hormone binding globulin) and cognitive performance. They concluded that there were sex differences, yet gonadal hormones may have little effect on reversal learning.

The fourth and final study that examined sex differences in reversal learning in humans is a study conducted by Shields et al. (2016). They examined how cognitive flexibility is impaired in 20 men and 36 women after acute stress. Men and women were randomly assigned to the stress or the non-stressful control condition. The Trier Social Stress Test for Group was used to induce stress in the laboratory. Cognitive flexibility was measured using the Berg Card Sorting Test which is a version of the already established Wisconsin Card Sorting Task. Shields et al. (2016) found no overall main effect of sex in that both men and women committed the same number of perseverative errors on the card sorting test. Further, no difference in performance was found between women in the stress or the control condition. However, men in the stress condition committed significantly more perseverative errors than men in the control condition. Additional analyses also indicated no effect of menstrual cycle, and no relationship between levels of cortisol and performance on the task. These results indicate that acute stress may reduce men's, but not women's, cognitive flexibility irrespective of menstrual cycle or cortisol levels. These results also provide evidence that stressful or emotional experiences may play an important role in altering performance on reversal learning tasks in men. Nevertheless, no overall sex differences were found in the Sheilds et al. (2016) study making their results inconsistent with the Evans and Hampson (2015) and Halari et al. (2005) findings. However, all three studies used a different methodology to examine reversal learning. It is possible that the card sorting task

used by Shields et al. (2016) may be susceptible to ceiling effects much like the tasks discussed in the Overman (2004) review.

Although some studies reported no sex differences in reversal learning (Harte & Edwards, 2010; Overman, 2004; Shields et al., 2016) most studies examining sex differences in reversal learning revealed that male animals and men outperformed female animals and women (Bissonette et al., 2012; Eddy et al., 2013; Evans & Hampson, 2015; Halari et al., 2005; Mihalick et al. 2000). To explain the male advantage with respect to performance on reversal learning tasks, some researchers have noted the different strategies employed by the sexes. In mice studies for example, Mihalick et al. (2000) and Bissonette et al. (2012) noted that female mice tend to inspect their options more thoroughly and take overall more time to make their choice compared to male mice. Thus, there may be a sex difference in the adaptive strategy to complete the task. Alternatively, Bissonette et al. (2012) reported that female mice may have a differential activation of dopamine in their frontal cortex which is an area known to control the functions related to cognitive flexibility. Male and female mice may also differ in their motivation on the task, or levels of anxiety while competing the task (Bissonette et al. 2012). Further, there may be sex differences in the attention given to the reversal cues, or learning based on reward or punishment (Evans & Hampson, 2015). One suggestion from Broverman et al. (1968) indicated that men may be better than women at a specific type of inhibitory control called inhibitory perceptual restructuring. That is, men may have a greater ability to separate certain stimulus attributes from the context in which they are embedded and are thus better able to ignore previously relevant stimuli (Boverman et al., 1968). To further explore this type of inhibitory control, the following section will examine the effect of gonadal hormones on reversal learning.

**Gonadal Hormones, the Menstrual Cycle, and Reversal Learning.**

***Animal Studies.*** Eight studies were found that investigated the effect of gonadal hormones on reversal learning in monkeys or rodents. First, three studies on reversal learning in female monkeys will be discussed. The first two studies on female monkeys were conducted by Voytko (2000) and Kromrey et al. (2015) who both studied reversal learning in *cynmolgus monkeys* (*Macaca fascicularis*). The *cynomolgus* monkey has a nearly identical menstrual cycle to that of human women and has brain organization like humans (Kromrey et al., 2015) making them ideal study subjects in lieu of human participants.

In the study conducted by Voytko (2000), 13 monkeys were ovariectomized (surgical menopause) and tested on reversal learning at one week, one month and two months after surgery. After the testing at two months, the monkeys were implanted with either estrogen or placebo. They were then tested on reversal learning again at one week and monthly for five months. During the reversal learning testing, the monkeys were presented with an object on two screens. A liquid reward was provided when the monkey responded to one of the objects in the pair. Monkeys completed trials until acquisition was reached (90% correct on two consecutive blocks of 20 trials). The next day (24 hours later), monkeys completed the reversal trials where the reward contingency was opposite of that during the acquisition phase. Mean serum estradiol levels confirmed that the levels of estradiol in the monkeys with the estrogen implant were comparable to the levels during the follicular phase of the menstrual cycle. Results revealed that the monkey's ability to perform reversals of object discrimination significantly decreased from baseline two months after their ovariectomy and prior to the implant of estrogen. This decrease in reversal learning after ovariectomy indicates that some naturally cycling hormones may serve to protect the monkeys from deficits in reversal learning. However, after monkeys were

implanted with either estradiol or placebo, there were no group differences in performance on the task. Thus, estradiol alone had little effect on reversal learning compared to placebo in these monkeys. Nevertheless, it is possible that estradiol did not affect the performance of these monkeys because it was administered two months after ovariectomy. As per the critical period hypothesis, estradiol may need to be administered soon after ovariectomy in order to have a beneficial effect of cognitive performance (Maki, 2006).

To examine the effect of naturally cycling hormones on reversal learning, Kromrey et al., (2015) tested reversal learning in 14 female *cynomolgus* monkeys (Macaca fascicularis) across their menstrual cycle. In their study, the monkeys completed stimulus discrimination and reversal tasks. In the discrimination task, the monkeys responded to one of three shapes on a touchscreen and were rewarded with a food pellet after the correct choice was made. Once stimulus discrimination acquisition was met (18 correct responses out of the previous 20 trials), the contingencies were altered and stimulus discrimination reversal learning was measured. Maintenance of discrimination and reversal learning was tested once a week for 3 months. Blood serum samples were taken to confirm cycle phase and endogenous hormone levels. They found, that during the acquisition phase, higher progesterone levels were related to worse performance on the task as defined by increased number of trials to reach discrimination acquisition and increased number of errors. There was no significant correlation between progesterone and the reversal trials. Similarly, no significant associations between estradiol and task performance were found. However, there was a trend for increased estradiol to be associated with better performance (i.e., fewer trials to reach acquisition and fewer errors) on both the stimulus discrimination and reversal tasks. During the 3-month maintenance period, there was no relationship between gonadal hormones and performance on the tasks. Thus, these results

indicate an initial decrease in performance on stimulus discrimination with higher levels of progesterone and a nonsignificant trend for higher levels of estradiol to be related to better performance on a reversal learning task.

In the third and final study, Lacreuse et al. (2014) investigated cognitive performance as a function of estradiol in 12 female marmosets (*Callithrix jacchus*). The marmosets were trained to perform an object reversal task. In this task, the monkeys initially learned to respond to one object via touch screen and receive a reward. After acquisition criteria was met (90% correct over 2 consecutive sessions), response contingencies were reversed and reversal learning was measured. After the monkeys learned the tasks, they underwent ovariectomy and were implanted with capsules that contained estradiol or placebo. The monkeys were then re-tested. The number of errors made (including perseverative errors) and the number of trials to reach acquisition were significantly higher in the group that received estradiol implants compare to the control group. Thus, Lacreuse et al. (2014) found a direct relationship between estradiol and poor performance on reversal tasks.

Like the Voytko (200) and the Lacreuse et al. (2014) studies, Gibbs and colleagues (2011) examined the effect of estradiol on a reversal learning task after ovariectomy, but in female rats. In the Gibbs et al. (2011) study, female rats were ovariectomized and treated with galanthamine or placebo. Galanthamine is a cholinesterase inhibitor and is used to treat forms of memory impairment. Rats were then either treated with estradiol or vehicle so that there were four different groups of ovariectomized rats: Galanthamine with placebo, galanthamine with estradiol, placebo with estradiol, or control rats. For the reversal learning task, rats were trained to respond to either a light or a tone to receive a food reward. After seven days of testing, the stimulus contingency was reversed and the correct response (i.e., entering the food bowl area

after the correct stimulus presentation) was measured. Overall, the rats that received the treatments produced no significant effects on the number of correct or incorrect responses during the discrimination or reversal tasks. However, when the data was collapsed according to hormone status, the rats that received estradiol showed significantly more incorrect responses during the reversal task than rats that were not treated with estradiol. The finding that estradiol is related to worse performance on a reversal learning task is congruent with the results from the Lacreuse et al. (2014) study.

Also demonstrating decreased performance in reversal learning after estradiol injection, is a study conducted by Arad and Weiner (2012). Ovariectomized or sham-operated rats were tested on a task of discrimination reversal across three days. On day one, the rats were trained to complete a T-maze submerged under water. The ability to consistently choose the correct arm (defined as the correct choice on five consecutive trials) was indicative of discrimination learning. On day two, retention was measured and the rats were trained until they met the criteria from the previous day. Rats then began reversal training and the platform was switched to the opposing arm. After the second day of testing, the sham-operated and ovariectomized rats were treated with either placebo, low-dose estradiol, or high dose estradiol. The effect of estradiol on reversal learning performance was measured on day three. Prior to estradiol injection, ovariectomized rats required fewer trials to reach reversal criterion compared to sham operated rats. Additionally, no difference was found between these groups in the number of trials to reach discrimination. After estradiol or placebo treatment, the groups with the highest levels of estradiol performed the worst. Thus, high dose estradiol slowed the reversal speed in both ovariectomized and sham-operated rats.

Interestingly, although Arad and Weiner (2012) found that ovariectomized rats performed well on the reversal learning task, they reported that it may have been due to excessive attentional switching rather than superior learning. For instance, they noted that during the testing sessions, the ovariectomized rats rapidly switched their attention to the previously non-reinforced alternative as if they were learning about novel stimuli. This may indicate that the normal influence of experience on current behaviour is weakened in this ovariectomized group. However, treatment with estradiol reduced this rapid switching behaviour. They concluded that the abnormally rapid reversal learning was due to the reduction in estradiol levels. Further, because estradiol did not affect discrimination, the results indicated that estradiol specifically affected abnormally rapid switching. Thus, while their results suggesting that estradiol is related to impaired reversal learning are consistent with the Lacreuse et al. (2014) and Gibbs et al. (2011) studies, it is unclear if the ovariectomized groups in these studies were learning reversal or instead had a deficit in learning from past experiences caused by low estradiol. Nevertheless, this does not explain why sham-operated rats treated with estradiol required the most trials to reach criteria.

To investigate if estradiol can correct other response abnormalities on a reversal learning task, Almey et al. (2017) examined reversal learning in female rats that have undergone amphetamine-sensitization. Amphetamine-sensitization is often used as a rat-model of schizophrenia and is associated with several cognitive deficits (see Featherstone et al., 2007). In their study, ovariectomized female rats were treated with either low estradiol, high estradiol, or placebo. All rats were then administered 1 mg/kg of amphetamine daily for four consecutive days, they then had 7 days without amphetamine, and were finally presented with an amphetamine challenge (0.5mg/kg). Sensitization was considered to have developed if the rats'

responded to the challenge dose with comparable or higher levels of locomotor activity as the initial doses. Rats were then split into groups and half of them received haloperidol (an antipsychotic medication) and half received placebo. The testing followed a typical reversal discrimination task in that the rats initially learned to press a certain lever to receive a reward until acquisition criteria was met. Rats were then tested on reversal learning after the reward contingencies were switched. As expected, amphetamine-sensitized rats that received no estradiol and no haloperidol had the worst performance on the reversal learning task. Treatment with haloperidol alone (without estrogen) improved the rat's reversal learning, especially for the rats that received a higher dose of haloperidol, while treatment with estradiol alone did not affect perseveration or reversal learning in amphetamine-sensitized rats. However, a low dose of estradiol combined with high dose of haloperidol and a high dose of estradiol combined with a lower dose of haloperidol both helped to reduce perseverative responding and improve performance on the task of reversal learning in amphetamine-sensitized rats. Almey et al. (2017) concluded that estradiol facilitates the effects of haloperidol on reversal learning in a dose-dependent manner in a rat model of schizophrenia.

Another study conducted by Olvera-Hernandez et al. (2013) examined perseverative responding in male and female rats as an overall means to investigate sex differences in OCD in older populations. Rats were trained to perform in a T-maze with two goal arms characterized by distinctive visual cues. Prior to testing, rats were injected with either the serotonin agonist 8-OH-DPAT or saline. Also, a subgroup of rats injected with 8-OH-DPAT were also injected with the selective serotonin reuptake inhibitory (SSRI) fluoxetine. Acquisition and reversal learning were tested using a typical reversal learning protocol. Treatment with 8-OH-DPAT resulted in the expected perseverative behaviour compared to placebo in all groups. Female rats in persistent

diestrous (indicative of high estradiol) demonstrated significantly more repetitive choices after injection with 8-OH-DPAT compared to female rats with irregular cycles and male rats that received that same treatment. However, treatment with an SSRI (fluoxetine) significantly reduced number of perseverative choices in female rats with persistent diestrous whereas this effect was not seen in the other groups. Therefore, high levels of estradiol alone impaired reversal learning in rats treated with 8-OH-DPAT, while high levels of estradiol combined with an SSRI improved reversal learning in rats treated with 8-OH-DPAT. However, there were no significant differences in task performance between vehicle treated rats. That is, without a serotonin agonist or an SSRI, male rats, female rats in diestrous, and females rats with irregular estrous cycles had similar performance on the reversal learning task.

In the final study examining gonadal hormones on reversal learning, Workman et al. (2013) also found that gonadal hormones affect performance on a reversal task. However, these effects were contingent upon reproductive experience (e.g., parity/gravidity). In their study, female rats who had given birth zero times, once, or twice completed a set-shifting task and a response reversal learning task. In the set shifting task, rats were required to complete a visual-cue discrimination task and press a lever in response to a light cue on day one. On day two, rats were then required to switch their response strategy and ignore the light cue in order to receive a food reward. Rats also completed an additional reversal task and were trained to press a lever in one location on the first day, and to press the opposite lever to obtain a reward the next day. Results revealed that maternal history and estrous phase interacted to alter the frequency of specific error types. Of the rats in estrous, the rats with two previous pregnancies committed significantly more perseverative errors in the set shifting task compared with rats with no maternal history. Among rats with no previous maternal history, estrous reduced the number of

perseverative errors. This suggests that multiple reproductive experiences and high ovarian hormones may cause organizational changes in the brain that reduce the ability to disengage from a previously learned, but no longer relevant, strategy. For the response reversal task, there was a nonsignificant trend for estrous to decrease errors. Maternal history did not interact with estrous cycle on the reversal learning task. These results provide evidence for the importance of factoring in maternal history when examining the effects of gonadal hormones on cognitive performance.

Overall, results research on the effects of gonadal hormones on reversal learning are inconsistent. Two studies revealed no effect of gonadal hormones on reversal learning (Kromrey et al., 2015; Voytko, 2000). Three studies indicated that estradiol worsens reversal learning (Arad & Weiner, 2012; Gibbs et al., 2011; Lacreuse et al., 2014), however, Arad and Weiner (2012) explained that this effect may be due to the abnormally rapid reversal behaviour displayed in the comparison ovariectomized groups. Also, one study found worse performance on a task of cognitive flexibility only in rats in the high hormone phase with multiple pregnancies (Workman et al., 2013). Finally, in rat models of schizophrenia and OCD, estradiol was associated with improved reversal learning only if paired with haloperidol or an SSRI, respectively (Almey et al., 2017; Olvera-Hernandez et al., 2013).

***Human Studies.*** No studies were found that investigated the effect of gonadal hormones or the menstrual cycle on reversal learning in humans.

***Reversal learning and OCs.*** No studies were found that investigated the effect of oral contraceptive and reversal learning in animals or humans.

## Cognitive Inhibition

### *Emotional Reactivity*

The type of cognitive inhibition of interest for this project is emotional inhibition and, its opposite, emotional reactivity. Emotional reactivity refers to measurable or reportable reactions to emotional events or stimuli. As described above, these reactions can be measured via self-reported emotions (labelling or identifying the emotion), observed emotions such as crying or shouting, ratings of valence and intensity of the emotion, self-reported or measured physiological reactions subsequent to emotional stimuli such as heart rate, skin conductance response (SCR), blood pressure, and measures of response times to emotional stimuli. In simple terms, someone who demonstrates increased emotional reactivity can be thought of as having low emotional inhibition. To control an emotional response to an event, many individuals consciously or nonconsciously employ emotion regulation strategies. Some common strategies related to emotion regulation that have been established in the literature include: acceptance, problem-solving, suppression, reappraisal (changing the interpretation of an event to change one's feelings about it), rumination, and distraction (Nolen-Hoeksema, 2011). However, there is a dearth of research on how specific hormones may affect emotion regulation strategies. Therefore, the following literature review will mainly focus on studies that examine differences in emotional reactivity based on sex, menstrual or estrous cycle effects, and OC use.

One important factor to consider is that unlike response inhibition, deferred gratification, or reversal learning where inhibition is clearly the more adaptive response, an adaptive emotional response largely depends on the context and the motivation of the individual. For example, emotional inhibition may be adaptive in a professional setting whereas emotional reactivity may be adaptive when a person is in danger or requires the assistance of others. Similarly, an

individual may be motivated to inhibit their emotions to adhere to certain gender norms, or they may be motivated to express their emotions to establish an intimate relationship. Therefore, while higher emotional reactivity ultimately indicates lower emotional inhibition, it does not necessarily indicate a less adaptive response. A primary purpose of this project was to examine group differences in emotional reactions as well as group differences in the ability to engage in inhibitory control of those reactions when adaptive.

**Sex Differences in Emotional Reactivity.**

***Rodent Studies.*** Emotional reactivity in animals is measured via observable behaviours often linked to an anxiety or fear response such as a freezing response or a latency to explore a novel situation. To verify tests that tap into emotional reactivity in rats, Aguilar et al. (2002) conducted a factor analysis of data on 800 inbred *Roman* rats' performance on anxiety-related tasks. They found that variables from most of the tests loaded onto an emotional reactivity factor. The emotional reactivity factor reflected variables from the shuttlebox conditioning test (e.g., avoidance), classical fear conditioning tasks (e.g., freezing behaviours), the plus-maze test (e.g., entering the enclosed rather than the open arm), and the open field test (e.g., distance covered). Thus, tests that include novel or threatening stimuli are established measures of emotional reactivity in rats. Typically, studies on sex differences in rodents demonstrate that male rodents display more anxious behaviours than female rodents (e.g., Brand & Slob, 1988; Johnston & File, 1991). However, results regarding sex differences in emotional reactivity in rodents are variable and often depend on the genetic strain of the rodent (Armario et al., 1995; Ostaszewski & Pisula, 1994). The following brief overview will discuss some recent studies demonstrating the variability in sex differences in emotional reactivity in rodents.

Eight recent rodent studies examining sex differences in emotional reactivity revealed that results were largely dependent on rodent strain and type of test. One relatively consistent finding across three studies suggested that male rats may be more emotionally reactive than female rats on the elevated plus maze (Dominokos et al., 2017; Renard et al., 2005; Voikar et al., 2001). However for most other tasks, the results were inconsistent. For instance, in the open field task, female mice in the *129 strain* and *domesticus strain*, and female *Wistar-Kyoto* (*WKY*) rats displayed more emotional reactivity compared to male rats from the same strains (Renard et al., 2007; Voikar et al., 2001; Voslajerova Bimova, et al., 2016). Conversely, other studies found that male mice in the *FVB* strain and male *Lewis* rats were more emotionally reactive in the open field task compared to females from the same strain (Dominokos et al., 2017; Voikar et al., 2001). Additionally, one study found there were no sex differences among *WKY* rats on the open field test (in contrast to Renard et al., 2007), and no sex differences among *WKY* rats on the forced swim test, or the marble burying test (Burke et al., 2016).

Beyond measuring emotional reactivity via mazes and reactions to novel objects, a study conducted by Trainor et al. (2013) measured emotional reactivity in mice after experiencing social defeat by a dominant same-sex mouse. They found that social defeat induced social withdrawal in female, but not male, mice. This sex difference disappeared, however, when the same scenario was presented to mice raised on corncob bedding (which has known estrogenic properties). They concluded that steroid hormones activated by the corncob bedding may serve to influence development and masculinize the brain of female mice, leading to a blunted response to social defeat stress.

Interestingly, another study conducted by Wainwright et al. (2016) tested the hypothesis that testosterone may reduce emotional reactivity. In their study, male *Sprague-Dawley* rats

were castrated and were randomized into groups that received daily injections of either testosterone or placebo along with treatment with the antidepressant imipramine or vehicle. Rats were then assigned to undergo the Chronic Unpredictable Stress (CUS) test or no application of stressors. Testosterone effectively attenuated depressive behaviours and physiological stress-responses both independently and in conjunction with imipramine in rats that underwent CUS. Results from this study also found that testosterone treatment produced an antidepressant-like effect in the forced swim test (i.e., increased latency to immobility), decreased the latency to feed after the CUS condition, and testosterone enhanced the antidepressant-like effects of imipramine on sucrose preference (i.e., increased sucrose preference). However, only male rats were included in their study, thus it is difficult to determine if testosterone changes emotional reactivity in male rats when compared with female rats.

Evidently, research on the effects of hormones on emotional reactivity in rodents is inconsistent. Fortunately, research examining emotional reactivity in humans yields more consistent results.

***Human Studies.*** Unlike the rodent studies described above, sex differences in emotional reactivity in humans are more consistent with most finding that women are more emotionally reactive than men, particulary with respect to negative emotions.

In a comprehensive study conducted by Brebner (2003) results from 9,667 international self-report questionnaires about emotion were analyzed. Participants were required to report the frequency and intensity of eight emotions (anger, fear, guilt, sadness, affection contentment, joy, pride) in the past month. Women had a higher frequency of experiencing affection, anger, fear, joy, and sadness compared to men. Moreover, women rated negative emotions as more intense than men did. Men only scored higher on pride compared to women. This study contributes to

the evidence that women report experiencing emotions more frequently and intensely than men. However, because this study required men and women to self-report their emotions over the past month, and men and women may face different situations, it is difficult to determine from this study if there are sex differences when men and women experience the same emotional event, or when they view the same emotional stimuli.

To examine sex differences in emotional reactivity while experiencing the same event, Bradley et al. (2001) had 50 men and 45 women view emotional pictures from the International Affective Picture System (IAPS). Pictures were presented one at a time and participants rated their emotional reaction. Data on facial electromyography (EMG), heart rate, and skin conductance was collected while participants were viewing the photos. Additionally, acoustic startle response was measured after the random presentation of white noise bursts through headphones while viewing the pictures. They found that women had greater intensity of displeasure ratings, greater fear bradycardia (i.e., cardiac deceleration), greater change in skin conductance, and facial EMG activity for unpleasant stimuli regardless of the content (e.g., pollution, death). Data from the facial EMG also found that women frowned more than men when viewing unpleasant stimuli, and smiled more than men while viewing pleasant stimuli. Additionally, women rated neutral pictures as less pleasant compared to men while men rated pleasant pictures as slightly more pleasant and reacted with more skin conductance to pleasant pictures compared to women. Finally, women showed a greater startle reflex compared to men when viewing unpleasant stimuli relative to neutral or pleasant stimuli. Bradley et al. (2001) concluded that affective cues in pictures can activate the defensive motive system more intensely in women than in men, suggesting that women are generally more emotionally reactive when processing emotionally aversive stimuli.

Similarly, Bianchin and Angrilli (2012) examined sex differences in self-reported and psychophysiological reactions to emotional stimuli. Psychophysiological measures were facial EMG, an electrocardiogram (ECG) to measure changes in heart rate, acoustic startle response, and electroencaphalgram (EEG) to measure brain activation. To capture the startle response, participants (22 men and 21 women) had electrodes placed on their face and were told that they would occasionally hear noise in their headphones while viewing the photos. Self-reported data revealed that compared to men, women rated the unpleasant stimuli as more arousing than pleasant stimuli. No sex differences were found in SCR, or in EMG facial expressions. However, women showed greater overall heart rate deceleration, greater startle reflex, and greater EEG reactivity (increased P300 amplitude) while viewing unpleasant stimuli compared to men. Additionally, the EEG pattern was congruent with previous studies indicating that women show more left frontal activation in their brains while viewing unpleasant stimuli (e.g., left anterior cingulate, left amygdala activation, and left prefrontal cortex).

Wilhelm et al. (2017) also measured psychophysiological responses to emotional stimuli and found women had higher negative emotional reactivity compared to men. In their study, 22 men and 22 women watched emotional film clips that were either high or low in arousal and induced either positive emotions (via achievement-related and recreation-related films) or negative emotions (via threat-related and loss-related films). Three emotionally neutral clips were also played. Data was collected for facial muscular activity, cardiovascular activity (via electrocardiography), skin-conductance response, and respiratory rate. They found no clear sex differences for the positive or neutral films. However, for the negative-valence films, women were more emotionally reactive than men and this sex effect was the highest for the high-arousal threat-related films.

When women viewed threat-related (versus neutral) films, they demonstrated increased facial muscular activity including frowning, eye narrowing, increased body movement (indicating physical agitation), heart rate acceleration, increased finger temperature, increased skin conductance response, increased ventilation and respiratory variability, and other cardiac responses indicative of a "fight or flight" response (e.g., decreased preejection period, increased cardiac output) (Wilhelm et al., 2017). In contrast, men showed decreased body movement, heart rate deceleration, decreased finger temperature, and none of the increased cardiac output or preejection period that women had (Wilhelm et al., 2017). Wilhelm et al. (2017) explained their results using the defense cascade model which describes two stages of defensive activation (Lang et al., 1997). The first stage is an orienting response that facilitates the intake of sensory information and is marked by dual activation of the parasympathetic and the sympathetic nervous systems with the parasympathetic system dominating. Responses in this stage include reduced body movement, heart rate deceleration, and heightened electrodermal activity; all of which were responses demonstrated by the men in their study after the threat-related films. The second stage switches to a defensive response pattern as the threat intensity increase and is marked by predominately sympathetic nervous system activation in preparation for active defense (i.e., a "fight or flight" response). A defensive pattern is reflected by heightened body movement, heart rate acceleration, increased ventilation, and a decreased preejection period; all of which were responses demonstrated by the women in their study following threat-related films.

The defense cascade model also fits with the findings from Bradley et al. (2001) and Bianchin and Angrilli (2012) who both found changes in psychophysiological responses indicative of an activated defense system. These studies provide strong evidence for a sex

difference in emotional reactivity and specifically, highlight the need for more studies to examine reactivity to different types of negative emotional stimuli (e.g., sad, fear).

Beyond psychophysiological measures, Filkowski et al. (2017) conducted a meta-analysis on 56 studies that examined neural activation via fMRI while participants viewed emotional photographs or videos. They found sex differences in distinct brain regions. Compared to women, men had distinct activation in the medial prefrontal cortex, the anterior cingulate cortex, frontal pole, and mediodorsal nucleus of the thalamus. Compared to men, women had distinct activation in the bilateral amygdala, hippocampus, and regions of the dorsal midbrain (e.g., superior colliculus). This was the first study to indicate that the thalamus and brain stem regions may be sexually divergent with respect to emotional reactivity. They also reported that the sex differences in the brain activation patterns indicate that men may engage in volitional control processes when faced with emotional stimuli as evidenced by men recruiting more frontal regions. Thus, men may be exhibiting more effortful control over their emotional reactions. In contrast, women demonstrated enhanced subcortical sensitivity to emotional cues, consistent with patterns related to harm avoidance. Nevertheless, their analyses included participants' reactions to both negative and positive stimuli together. Therefore, the results may have been different if they were presented separately for unpleasant and pleasant stimuli. Indeed, most studies yield sex differences in response to negative rather than positive or neutral emotional stimuli (e.g., Bianchin & Angrilli, 2012; Bradley et al., 2001; Wilhelm et al., 2017).

A study by Gard and Kring (2007) had 58 men and 53 women view negative, neutral, or positive pictures from the IAPS and rate their emotional experience. Acoustic startle response and scores from the Behavioural Inhibition Scale (BIS) were also collected. Self-reports revealed that women rated negative stimuli as more negative and more emotionally arousing than men

did. No sex differences were found in self-reported reactions to positive or neutral photos. Women also scored higher on the BIS compared to men suggesting women show a greater sensitivity of the aversive motivational system. Regarding startle response, both men and women exhibited increased startle response during the presentation of negative stimuli. However, women continued to exhibit the startle response after the presentation of negative stimuli and during the recovery period, indicating that women were continuing to engage in the aversive motivational system even when negative stimuli were no longer present. They concluded that women displayed a more robust and prolonged responsivity to negative emotional stimuli.

Along with greater emotional reaction, Domes et al. (2010) found fMRI evidence that women may have greater difficulty regulating (i.e., decreasing) their emotional reactions to negative stimuli. In their study, 16 men and 17 women were asked to increase, decrease, or maintain their emotional reactions evoked by negative pictures while undergoing an fMRI. They found that women, compared to men, had enhanced activity in the amygdala in response to both negative and neutral pictures in the initial viewing phase (i.e., baseline). No sex differences were found in amygdala activity during the phase when participants were asked to decrease their emotional reaction. However, women recruited parts of the orbitofrontal cortex, the anterior cingulate, and the dorsolateral prefrontal cortex to a lesser extent than men when trying to decrease their emotional response. During the increased emotional phase, men recruited a network of areas known to be involved in emotion regulation (e.g., the bilateral inferior prefrontal cortex, the paracentral lobe, the supplementary area, and mid-temporally) to a greater extent than women. Also, men recruited areas related to the generation of emotional responses such as the amygdala, insula, and fusiform gyrus more so than women. These results suggest that men used cognitive strategies to enhance their emotions, as per instructed, more efficiently than

women. However, the authors suggested that a ceiling effect may have occurred considering women's initial response to the stimuli were stronger than men's, thus compromising the further enhancement of their emotional reaction. These results may suggest that women are more reactive to emotional stimuli and are less effective at regulating their emotional responses. Thus, women may have more difficulty with inhibitory control over their emotions compared to men.

A review conducted by Nolen-Hoeksema (2012) examined the role of gender-role socialization in sex differences in emotional regulation. Nolen-Hoeksema acknowledged previous research that indicates that women are often viewed as more emotional than men. Further, in part due to gender-role socialization, men and women engage in different emotion regulation strategies. For instance, women are found to engage in more passive and internally focused strategies such as rumination, while men are more likely to engage in suppression or avoidance. Overall, women report using more emotion regulation strategies compared to men including rumination, reappraisal, problem-solving, acceptance, distraction, and seeking social support. However, rumination has consistently been found to show the largest sex difference. Further, higher rumination scores have been found to be related to higher levels of depression. Indeed, Nolen-Hoeksema reported that rumination mediated the relationship between gender and depression. Thus, some of the predominate emotion regulation strategies used by women to regulate emotions can be linked to certain psychopathologies that are more often diagnosed in women. These sex differences in emotion regulation may in part explain why women may have more prolonged emotional responses as seen in the Gard and Kring (2007) study. Nolen-Hoeksema (2012) suggest that more research on nonconscious and implicit forms of emotion regulation needs to be conducted.

Contrary to the above review, a critical review by Wester et al. (2002) revealed that there is a lack of evidence suggesting sex differences in emotional reactivity. Their review broke down sex differences in emotions based on overt actions (observable behaviours), subjective experiences (description of one's feelings), and physiological responses (e.g., heart rate, breathing, fMRI, facial EMG) and found inconsistent evidence for sex differences in verbal communication and nonverbal expression of emotions. They reported that when sex differences did appear, they tended to be influenced by the context of the situation and sex-based emotional stereotypes. For example, many studies indicate that men report being more willing to express anger compared to women, yet other studies indicate that women are equally as likely as men to express anger depending on the situation. Moreover, one study reviewed noted that men indicated less willingness to express fear due to situational pressures to be masculine. Thus, even though there has been consistent evidence that women have increased ability to encode and decode nonverbal behaviour, show more expression in their faces and bodies and self-report higher negative affect compared to men, Wester et al. (2002) concluded that sex differences in emotionality are small, inconsistent, or limited to the influence of specific situational demands. Their paper highlights the need to consider context and gender norms when examining sex differences in emotional reactivity.

Indeed, a study conducted by Grossman and Wood (1993a) found that respondents' own expectations regarding sex differences in emotional reactivity were associated with self-reported emotional reactivity. Self-reported emotional reactions and facial EMG responses were collected across two studies. In the first study, 48 men and 37 women rated the frequency, intensity, and their expressiveness with respect to fear, joy, sadness, anger, and love over the past month. They also rated their stereotypical beliefs about how a typical man or woman may experience these

emotions. Results for this study revealed that compared to men, women reported more frequent and intense feelings, and more expressiveness of all emotions except anger. There were no sex differences in the frequency, intensity, or expressiveness of anger. Also, women's self-ratings of their own emotional expressiveness were positively correlated with their stereotyped beliefs about women's expressiveness. Additionally, men's self-rating of their own emotional expressiveness were negatively correlated with their stereotyped beliefs about women's expressiveness. Grossman and Wood (1993a) concluded that there was support for the social role theory of sex differences in emotions. However, it should also be noted that an individual's beliefs and stereotypes about emotional expression may be affected by their own personal experiences with emotions (e.g., self-insight). That is, a woman high in emotional expressiveness may perceive a greater sex difference in emotional expressiveness than women with low emotional expression. This could be a potential confound in this study.

In the second study conducted by Grossman and Wood (1993b) 61 men and 57 women viewed emotional photographs from the IAPS and self-reported reactions and facial EMG data were collected. In some conditions, participants were encouraged to heighten their emotional response by being told there was a positive correlation between emotional expressiveness and psychological adjustment. In another condition, participants were encouraged to decrease their emotional response by being told there was a negative correlation between emotional expressiveness and psychological adjustment. In the control condition participants were simply asked to rate the photos with no additional information. Results revealed that when no instructions were given, women gave more extreme ratings of negative and positive stimuli than men and no sex differences on ratings of neutral stimuli were obtained. However, when instructions were provided encouraging participants to increase or decrease their responses, no

sex differences were found in ratings. These results indicate that normative pressures on responding can affect sex differences in emotional reactivity and that sex differences in emotional reactivity may at least partly derive from normative pressures. Nevertheless, data from EMG revealed that women had greater facial muscle movement compared to men regardless of the instruction condition. Thus, women were more reactive with respect to facial expressions regardless of normative pressures. This study reveals the importance of considering socially desirable responses as well as both gender expectations and sex when examining sex differences in emotional reactivity.

Ultimately, many studies provide evidence that women are more emotionally reactive, and have different emotion regulation strategies compared to men. Of the eleven studies reviewed, seven studies indicated that women are more emotionally reactive compared to men to unpleasant stimuli (Bianchin & Angrilli, 2012; Bradley et al., 2001; Domes et al., 2010; Gard & Kring, 2007; Whilhelm et al. 2017), and to both pleasant and unpleasant stimuli (Brebner et al., 2003; Grossman & Wood, 1993). Further, three studies indicated that women may not be as effective at regulating their emotional responses compared to men. For instance, women continued experiencing negative emotions after emotion induction longer than men (Gard & Kring, 2007), fMRI data indicated that, compared to women, men engaged in more effortful control of their emotional reactions (Filkowski et al., 2017), and the emotion regulation strategy most commonly used by women (e.g., rumination) has been shown to enhance negative emotional experiences (Nolen-Hoesksema, 2012). However, some studies indicated that sex differences in emotional reactivity depend on context and social norms (Wester, 2002). For example, two studies found that when men and women were directly or indirectly prompted to reduce their emotional response, there were minimal sex differences in emotional reactivity

(Domes et al., 2010; Grossman & Wood, 1993). Moreover, one study indicated that in countries where women have higher status (e.g., Western countries), men feel powerless emotions less intensely (Fischer et al., 2004), and one study found that women are only more emotionally reactive than men if they hold their own stereotypical beliefs about how men and women react to emotional events (Grossman & Wood, 1993). Evidently, while research suggests that women may be more emotionally reactive than men, social norms, gender stereotypes, and context of emotional experience should all be taken into consideration when examining sex differences in emotion.

**Gonadal Hormones, the Menstrual Cycle, and Emotional Reactivity.**

***Rat Studies.*** Unlike the research on sex differences in emotional reactivity in animals previously reviewed, research on emotional reactivity across the estrous cycle in rats is relatively consistent. Indeed, most studies that examine emotional reactivity across the estrous cycle find decreased emotional reactivity during the proestrous phase. However, the proestrous phase is marked by both peaking estrogen at the beginning and peaking progesterone at the end of the 12- to 14-hour cycle as well as peaking LH in the middle (Marcondes et al., 2002). Therefore, it is difficult to determine which hormone is responsible for the observed behavioural changes. The studies discussed below review evidence for the role of estradiol, progesterone, and both estradiol and progesterone in emotional reactivity in rats.

The first two studies reviewed provide evidence that estradiol is related to decreased emotional reactivity. The first study, conducted by Marcondes et al. (2001), examined male rats, naturally cycling female rats, and ovariectomized rats on the elevated plus maze task. Additionally, one group of female rats in the diestrous phase were treated with estradiol to mimic the levels of estradiol during the proestrous phase. Overall, results revealed no sex differences in

performance on the maze. However, females in the proestrous phase and females in the diestrous phase that were treated with estradiol spent more time in the open arms than untreated females in the diestrous phase. Also, hormonal assays confirmed that levels of estradiol were highest in the proestrous phase compared to the other phases. No effect of progesterone levels was found. Thus, Marcondes et al. (2001) posited that the higher levels of estradiol were related to less anxious performance in the elevated plus maze.

The second study, conducted by Walf and Frye (2007), indicated that while estradiol is related to reduced anxiety and depression, the effects of estradiol may be limited depending on prenatal exposure to stress. In their study, pregnant female rats were randomly assigned to be submitted to the stressed or the non-stressed condition. In the stressed condition, pregnant rats were restrained for 45 minutes daily for 6 days. Female rats from the litters of both the stressed and non-stressed conditions were then used for the experiment. Some rats were ovariectomized and implanted with estradiol or placebo, while others remained intact and naturally cycling and were grouped into the estrous phase (defined by Walf and Frye as high estradiol) or the diestrous phase (defined by Walf and Frye as low estradiol). Rats participated in the open field, elevated plus maze, and the inhibitory avoidance tasks. In the inhibitory avoidance task, latency to enter a room where they had previously been shocked was measured. Rats in the estrous phase and ovariectomized rats that received estradiol demonstrated fewer anxious behaviours (e.g., more entries into the open field) on all tasks compared to diestrous rats and ovariectomized rats treated with placebo. Additionally, gestational stress reduced anxious behavior in the elevated plus maze among intact but not ovariectomized rats. The authors suggested that estradiol has anti-anxiety and cognitive-enhancing effects regardless of exposure to gestational stress. However, they did not measure progesterone which is present in varying degrees in the diestrus phase (Marcondes

et al., 2002). Thus, it is difficult to determine the effect of estradiol independent of progesterone in this study.

In contrast to Marcondes et al. (2001) and Walf and Frye (2007), a study by Severino et al. (2004) found that estradiol was not related to performance on tests of emotional reactivity. Severino et al. (2004) examined if the reduced stress-response that occurs in rats that were handled in the neonatal period is affected by gonadal hormones. Indeed, they found that rats handled in the neonatal period demonstrated decreased stress-responses later in adulthood. Furthermore, as adults, one group of adult rats underwent a stress condition (submitted to a jar filled with ether vapour) and another group of rats were tested in the elevated plus maze. All female rats were naturally cycling and tested during either their estrous or diestrous phase. Results revealed females in the diestrous phase that were handled neonatally showed reduced anxiety responses after stress induction and in the elevated plus maze compared to the other groups of females. However, plasma estradiol did not differ between the estrous and diestrous groups on the morning of testing. Therefore, estradiol did not appear to be responsible for the observed group differences. Progesterone was not measured, making it difficult to determine the effects of progesterone on emotional reactivity in their study.

Frye et al. (2000) examined the effects of progesterone on emotional reactivity in naturally cycling female rats and male rats. Female rats were randomly assigned to be tested in either the proestrous, estrous, or diestrous phase and underwent a battery of tests such as the open field test, elevated plus maze, and emergence test (latency of rat to emerge from cylinder was measured). Proestrous and estrous females entered more squares than males in the open field test; proestrous females had more entries in open arms and more time spent in open arms than estrous, diestrous, or male rats on the elevated plus maze; and proestrous females demonstrated a

shorter latency to emerge from the cylinder compared to estrous and diestrous females in the emergence test. Evidently, proestrous females demonstrated the least anxious behaviours compared to all other groups. Blood plasma levels also confirmed that the female rats in the proestrous group had higher levels of progesterone than all other groups suggesting a potential anxiolytic effect of endogenous progesterone. Unforuntately, Frye et al. (2000) did not measure endogenous estrogen, which is also known to increase during the proestrous phase (Marcondes et al., 2002). Thus, the anxiolytic effect observed during the proestrous phase in this study cannot necessarily be separated from estrogen.

Similar to the Frye et al. (2000) study, a study by Molina-Hernandez et al. (2013) also concluded that progesterone decreased emotional reactivity in rats. They set out to examine if the anxiolytic effects of the anticonvulsant drug topiramate was affected by estrus cycle phase in female rats. Naturally cycling rats were treated with topiramate, diazepam (a benzodiazepine), or placebo and submitted to an elevated plus maze. Female rats in the proestrous or the metestrus-diestrous phases were examined as they have previously shown to elicit the largest behavioural differences. Results revealed that control rats in the proestrous phase demonstrated more exploration of the open arms than control rats in the metestrus-diestrous phase. Treatment with diazepam or topiramate decrease the anxiety-like behaviours, however only the highest doses of diazepam or topiramate produced anxiolytic behaviours in the metestrus-diestrous phase rats. Molina-Hernandez et al. indicated that progesterone may be interacting with the anxiolytic treatments to exert an effect on GABAergic inhibitory neurons. However, their discussion did not include the potential role of estrogen in performance on the elevated plus maze or after injection with anticonvulsant medication, nor did they measure hormones to determine the relative progesterone and estrogen levels between phases.

The research discussed thus far has been limited in its exploration of the individual effects of progesterone and estradiol. Instead, it is plausible that emotional reactivity in rats is due to the combined effect of estradiol and progesterone. Indeed, the next four studies reviewed provide evidence for the concomitant effect of progesterone and estradiol on decreasing emotional reactivity in rodents.

One of the earlier studies examining gonadal hormones and emotional response in rats was conducted by Mora et al. (1996). They found that estradiol and progesterone differentially decreased emotional reactivity based on task-specific features. Intact and ovariectomized female rats completed the elevated plus maze under two illumination conditions: high illumination (more anxiety-provoking for rats) and low illumination (less anxiety provoking for rats). Intact rats were divided into groups based on their estrous phase, and ovariectomized rats were injected with estradiol or placebo, and progesterone or placebo, creating four groups: placebo, estradiol only, progesterone only, and estradiol plus progesterone. Estrous cycle phase interacted with illumination condition on the elevated plus maze. In the low illumination condition, female rats in the proestrous and estrous phases showed increased open-arm entries compared to female rats in the metestrous or diestrous phases. Similarly, in ovariectomized rats, the control group, the group that received estradiol, and the group that received estradiol plus progesterone all demonstrated increased entries into the open arms during the low illumination condition. However, in the high illumination condition, only ovariectomized rats that received progesterone demonstrated increased entries into the open arm indicating the least amount of anxiety of the progesterone group under this condition. Thus, estradiol or a combination of estradiol and progesterone decreased anxiety in a lower anxiety condition, whereas progesterone only decreased anxiety in a high anxiety condition.

Another study suggesting that both progesterone and estradiol lead to reduced emotional reactivity was conducted by Sayin et al. (2014). They examined the effect of estrus cycle on anxious behaviour after treatment with an anti-depressant (citalopram) or no treatment. Intact female rats received 10 injections over 10 days of citalopram or no injections. Rats were then classified to be in their proestrous or non-proestrous phase and tested on the elevated plus maze. Results indicated no differences between the citalopram or control group on behaviour in the maze. However, rats in the proestrous phase stayed significantly longer in the open arms and made more entries than the rats in the others phases of the cycle. The authors concluded that rats in the proestrous phase demonstrated less anxious behaviours due to both the increased estradiol and progesterone levels in this phase which both have anxiolytic effects. Nevertheless, this study did not include hormone level measures making it difficult to determine if fluctuating gonadal hormones were significantly different across phases.

Beyond the elevated plus maze task, Gouveia et al. (2008) examined performance on a forced-swim test in male rats and female rats across their estrous cycle. They found that female rats in the diestrous and proestrous phases had increased time to immobility compared to males and females in the metaestrous phase. Females in the diestrous phase had overall shorter immobility time compared to males and females in the metaestrous phase and females in the proestrous phase had overall shorter immobility time compared to males. Rats in the both the diestrous and proestrous phase demonstrated less despondent behaviour compared to the other groups of rats. They noted that in the diestrous phase, progesterone peaks with estradiol (Schwartz et al. 1969). Thus, the reduced depressive behaviours seen in rats in the diestrous and proestrous phase may have been a result of both estradiol and progesterone. The authors explain that estrogen modulated the firing activity of dorsal raphe nucleus 5-HT neurons in female rats

whereas progesterone effects are likely mediated by GABA, 5-HT1A and 5-HT2A receptors. However, elsewhere the diestrous phase is conceptualized as a low hormone phase (Marcondes et al., 2002) rather than a phase marked by high estradiol and progesterone. Moreover, Gouveia and colleagues did not collect hormone levels, thus rendering it impossible to verify the relative levels of hormones in the phases. Nevertheless, these results are consistent with results from the Sayin et al. (2014) and Mora et al. (1996) studies in that the proestrous phase (which is consistently marked by peaking levels of progesterone and estradiol) was associated with a decrease in emotional reactivity.

Finally, Mitra et al. (2016), provide evidence for the differential effect of estradiol and progesterone on decreased reactivity depending on genetic strain of mice. In their study, strains of mice known for more compulsive behaviour (BIG-strain), less compulsive behaviour (SMALL strain), and a randomly bred control strain were used. The BIG-strain mice were comprised of two different sub-strains BIG1 and BIG2. Mice were either ovariectomized or sham-operated and divided into groups and received estradiol, progesterone or placebo injections. Mice were then tested on compulsive behaviours (nest building, marble burying), and anxious behaviours (open field test, elevated plus maze). Ovariectomized BIG-strain mice showed increased compulsive-like behaviour and increased anxiety-like behaviour on the open field test and the elevated plus maze compared to BIG-strain sham-operated mice, and control mice. With respect to treatment with hormones, estradiol but not progesterone decreased compulsive-like behaviours in BIG-strain rats. Also, estradiol only decreased anxious behaviours for BIG1 strain during the open field task while progesterone only decreased anxious behaviours for both rat strains in the open field and elevated plus maze. These results indicate a strain-specific response to anxiety-like behaviour due to gonadal hormones. These results also indicate

that both estradiol and progesterone decrease anxious behaviours under certain circumstances. Additionally, the hormonal effects could also be specific to the rodent strain and not generalizable.

Overall, studies examining emotional reactivity in rodents across the estrous cycle provide evidence that gonadal hormones indeed play a role in reducing emotional reactivity. Of the six studies that included female rats in the proestrous phase, five of them revealed that the proestrous phase is related to decreased emotional reactivity (Frye et al., 2001; Gouveia et al., 2008; Marcondes et al., 2001; Molina-Hernandez et al., 2013; Sayin et al., 2014) and one revealed that the proestrous phase is related to decreased emotional activity only in the low illumination condition of the elevated plus maze (Mora et al. 1996). However, there was no consensus among the authors as to which hormones were related to the observed behaviour. Furthermore, the studies that did not include the proestrous phase found that estrogen was related to decrease in anxiety response (Walf & Frye, 2007), estradiol was not related to decrease in anxiety response (Severino et al., 2004), and both progesterone and estrogen are related to decreased anxiety response in certain mice strains (Mitra et al., 2016).

Two major limitations in the research reviewed in this area are that many of the researchers did not sample hormone levels and many did not specify the criteria for their selected estrous cycle phases. Thus, there were inconsistencies with respect to which hormones were apparently prominent in each phase, and lack of evidence to confirm hormone levels in the phases. Nevertheless, these studies provided evidence that fluctuating gonadal hormones affect emotional reactivity in rodents. The following section examines the effect of gonadal hormones on emotional reactivity in women.

***Human Studies.*** This section reviews 10 relevant studies that examine women's emotional reactivity across the menstrual cycle, most of which indicate that increased emotional reactivity occurs in the luteal phase. One study by Andreano and Cahill (2008) examined medial-temporal activity in 17 women across the menstrual cycle in response to negative stimuli. To investigate reactivity to emotional stimuli across the menstrual cycle, they had participants undergo fMRI while viewing negative or neutral pictures from the IAPS in their early follicular phase (low estrogen and low progesterone) and mid-luteal phase (medium estrogen, high progesterone) in a within-subjects design. Specifically, they aimed to examine the relationship between progesterone and HPA activity and amygdala responsiveness without the influence of estrogen. When the participants were in the mid-luteal phase, they demonstrated greater neural reactivity to negative stimuli compared to when they were in the early follicular phase. Additionally, the amygdala and hippocampus showed the largest neural response to negative stimuli compared to neutral photographs when women were in the mid-luteal phase. According to serum hormone samples the main difference between the early follicular phase and mid-luteal phase was the level of progesterone. Thus, the authors posited that the changes in the amygdala and hippocampus in reaction to negative stimuli are likely due to the changes in progesterone. However, there was no collection of self-report or behavioural data in this study. Therefore, it cannot be determined if these neural changes correspond to self-reported or observed emotional reactivity.

Another study examined both self-reported and observed emotional reactivity (Lusk et al., 2017). In their between-subjects design, 28 naturally cycling women in their early follicular phase (days 2 to 6), 29 naturally cycling women in their mid-luteal phase (days 18 to 24), and 27 men completed an emotion regulation scale, and a depression, anxiety, and stress scale. They

also participated in an emotion regulation task while EEG data were collected. Salivary estradiol and progesterone were also collected. In the emotion regulation task, participants were instructed to reappraise (i.e., consciously alter the meaning of an emotion to decrease its influence), maintain, or suppress (i.e., conceal or avoid) their reactions to unpleasant pictures from the IAPS. Women in the mid-luteal phase rated the negative pictures as significantly more arousing than women in the early follicular phase, and both groups of women rated the images as significantly more unpleasant and more arousing than did men. Data from the EEG indicated that N2 amplitude was greater in all groups when they were required to suppress their reactions compared to when they were required to reappraise their reactions. However, women in the mid-luteal phase had significantly greater P1 activity and N1 amplitude compared to men when asked to reappraise or suppress their reactions compared to when they were asked to maintain their reactions. Additionally, Lusk and colleagues found a relationship between increased progesterone levels and increased N2 amplitude following suppression instructions. The authors reported that the increased N1 and P1 amplitudes in mid-luteal women were indicative of an attentional bias to the negative stimuli. Moreover, the increased N2 amplitude during the suppression condition in mid-luteal women indicated that these women exhibited greater difficulty suppressing negative emotional stimuli relative to men. Indeed, women in the mid-luteal phase reported greater distress and effort during emotion suppression compared to men. They posited that these results are congruent with previous research that demonstrates men have an increased capacity to suppress negative emotional reactions compared to women. This study also extended previous findings and revealed that, not only are women in the mid-luteal phase more reactive, they also have increased difficulty inhibiting their reactions compared to other groups.

Also demonstrating increased emotional reactivity among women in the luteal phase is a study conducted by Childs et al. (2010). In their between subject's design, 23 women in their luteal, 29 women in their follicular phase (phase days not defined by the authors), and 28 men underwent the Trier Social Stress test (TSST) or a control condition. Heart rate, hormones samples, and self-reported measures of distress were collected. Women's cycle phases were confirmed with serum estradiol and progesterone tests. In the stress condition, women in the luteal phase had higher heart rate and lower blood pressure compared to men, but not compared to follicular women. Men, but not women, exhibited an increased cortisol response to the stress condition compared to the control condition. Additionally, women in the luteal phase showed increased ratings of anger and hostility compared to women in the follicular phase, and higher scores on depression, anxiety, and tension compared to both men and women in the follicular phase. Moreover, these negative affect ratings remained elevated 20 minutes after the stress test. Conversely the affect ratings for women in the follicular phase and men were no different from baseline 10 minutes after the task. These results indicate that women in the luteal phase had a significantly higher stress response and that this stress response continued for longer compared to both women in the follicular phase and men.

Similar to Childs et al. (2010), Chung et al. (2016) examined stress responses in women in the follicular and luteal phase. In their study, naturally cycling women underwent a stress paradigm while under fMRI after being treated with androstadienone (ANDR) or placebo. ANDR is a synthetic male hormone that Chung et al. (2016) expected would amplify social evaluative threat depending on menstrual cycle phase. Thus, women participated in the stress paradigm two times, approximately four weeks apart: once after treatment with ANDR and once after treatment with placebo. All participants experienced the same sequence of events during the

testing. First, the women were instructed to solve the arithmetic problems while undergoing fMRI with no time or evaluative pressure. In the pre-feedback phase, women were then instructed to solve arithmetic problems with variable time pressures and performance monitoring. In the post-feedback phase, women received negative feedback from a male investigator who discredited the participants' performance and asked them to improve. Self-reported ratings of stress, anxiety, and mood were also collected. Women ($n$ = 16) in the mid-luteal phase (days 20-25) treated with ANDR rated themselves as less competent and made more errors compared to women in the same phase that were on placebo. This effect was not seen in women ($n$ = 15) in their early follicular phase (days 2 to 7). Women in the mid-luteal phase showed increased hippocampal activity compared to women in the early follicular phase, especially after treatment with ANDR. Additionally, there was a significant negative correlation between subjective competence ratings and amygdala activation in the pre-feedback stress phase for women in the mid-luteal phase. They reported that women in the mid-luteal phase anticipated negative outcomes and had increased stress sensitivity compared to women in the follicular phase. Moreover, this increased stress sensitivity was enhanced by ANDR.

Albert et al. (2015) also examined stress response across the menstrual cycle by comparing 28 naturally cycling women tested in their early follicular (days 1 to 2) or ovulatory phase (days 12-14), two phases where progesterone is low. To induce stress, all women participated in the Montreal Imaging Stress Task (MIST) while under fMRI. In the MIST, participants are required to complete arithmetic tasks and are told they should achieve 80 to 90% accuracy for their data to be usable. However, the task adjusted based on their prior performance on a baseline math test to ensure difficult questions and lower performance. The control group also completed arithmetic questions with no request for accuracy or time limits. Albert et al.

(2015) found that women in the early follicular (low estradiol) phase had significantly less left hippocampal activity and higher distress scores than the women in the ovulatory phase (high estradiol) during the stress condition. The authors noted that lower hippocampal activity is associated with a stress response. Indeed, women with higher self-reported distress scores had significantly less activity in their bilateral hippocampus. They posited that low estradiol levels during the early follicular phase of the menstrual cycle may exaggerate the effect of psychosocial stress on brain activity. Thus, higher levels of estradiol may be protective against emotional reactivity.

Similarly, Ziomkiewicz et al. (2012) also found that found that high levels of estradiol were related to decreased emotional reactivity. In their study, 114 naturally cycling women completed a one-time self-report measure of their temperament and provided daily urine samples for their entire menstrual cycle for the analysis of estrogen and progesterone. Temperament was assessed using the Formal Characteristics of Behaviour-Temperament Inventory (FCB-TI) which measures briskness, perseveration, sensory sensitivity, emotional reactivity, activity, and endurance. Results revealed that women with higher levels of estrogen in all phases of their menstrual cycle also had low emotional reactivity scores, high endurance, high ability to process stimulation, and high activity scores. Conversely, women with overall higher emotional reactivity scores and a low ability to process stimulation had lower levels of estrogen in their luteal phase compared with women with lower emotional reactivity scores. Progesterone levels were not correlated with any of the temperament measurements. Interestingly, women with high ability to process stimulation had significantly higher levels of estrogen (up to twice as high) across the menstrual cycle compared to women with a low ability to process stimulation. Taken together, results indicate that higher levels of estrogen are related to lower emotional reactivity

and potentially a more resilient phenotype. However, there is a lack of consistent evidence across studies that estrogen is related to lower emotional reactivity.

Although the studies reviewed thus far have consistently indicated that women in the luteal phase have increased emotional reactivity compared to women in the follicular phase or men, these studies did not examine whether their participants experienced symptoms of pre-menstrual syndrome (i.e., PMS). Indeed, women that experience PMS or more severely, premenstrual dysphoric disorder (PMDD), report a multitude of negative emotional and physical symptoms that may further impact their emotional reactivity especially during the late luteal phase. To examine this, four relevant studies that examined emotional reactivity in women with PMS or PMDD were briefly reviewed.

A study by Hoyer et al. (2013) compared to women with and without PMS in their early follicular (days 11 to 15) and late luteal phases (defined as days 24 to 29). They found that women with PMS in their late luteal phase were slower on an emotional stroop task (i.e., took longer to identify a facial expression when it was paired with an incongruent emotion word) compared to women without PMS in the same phase. Also, women with PMS showed an increase in salivary cortisol levels and self-reported stress from their late follicular to their late luteal phase whereas this effect was not observed in women without PMS. Liu et al. (2017) also found similar results when comparing women with and without PMS in their late luteal phase (1 to 3 days before menstruation) and their early follicular phase (days 1 to 3 of menstruation). They found that, compared to women without PMS, women with PMS had lower positive and higher negative self-reported affect and higher alpha activity during an EEG stress evaluation test in both their early follicular and late-luteal phases. These effects remained even when cycle phase was used as a covariate. Because the menstrual phase was controlled for, Liu et al., (2017)

concluded that women with PMS had continued abnormality in their emotional state and stress reactivity regardless of cycle phase.

Regarding women with PMDD, Gingnell et al. (2012) compared women with PMDD and asymptomatic controls during their mid-follicular phase (days 6 to 12) and again during their late-luteal phase (8 to 13 days post ovulation as determined by a LH assay). They found that compared to asymptomatic controls, women with PMDD had higher self-reported negative affect scores in both phases but this effect was especially strong during their late-luteal phase. Also, during the follicular phase, women with PMDD had higher bilateral amygdala reactivity compared to controls during the emotion task (which involved looking at angry and fearful faces). In the Gingnell et al. (2013b) study, they examined women with and without PMDD in their mid-to-late follicular phase (6 to 12 days after day 1 of menstrual bleeding) and their mid-to-late luteal phase (8 to 13 days after post ovulation as determined by LH assay) during an emotional task. They found no group differences in neural responses to, or self-reported valence ratings of, the emotional stimuli. However, women with PMDD in their luteal phase were more neutrally reactive (i.e., had higher anterior mPFC and dlPFC reactivity) when anticipating the presentation of the emotional stimuli compared to the control group. They concluded that women with PMDD may be hypervigilant or anxiety sensitive, especially during their luteal phase. Overall the studies on PMS and PMDD provide additional evidence of variability in mood in the luteal phase.

Of the 10 studies reviewed, four studies found increased emotional reactivity during the luteal compared to the follicular phase (Andreano & Cahill, 2008; Childs et al., 2010; Chung et al., 2016; Lusk et al., 2017). Moreover, two of these four studies revealed that women in the luteal phase had more difficulty regulating their emotions (Childs et al., 2010) even after being

expressly instructed to do so (Lusk et al., 2017). Another study indicated that increased estradiol across the entire menstrual cycle is related to less emotional reactivity (Ziomkiewicz et al., 2012), and one study indicated that compared to the early follicular (low estrogen) phase, women were less emotionally reactive during the ovulatory (high estrogen) phase (Albert et al., 2015). Regarding women with PMS or PMDD, three studies indicated that women with PMS or PMDD had increased emotional reactivity compared to asymptomatic women in the luteal phase (Gingnell et al., 2012; 2013b; Hoyer et al., 2013) and one study indicated that women with PMS had increased emotional reactivity compared to asymptomatic women regardless of cycle phase (Liu et al., 2017). No studies found decreased emotional reactivity in the luteal phase. Despite the lack of evidence for direct relationships between either estrogen or progesterone and emotional reactivity, there was consistent evidence indicating increased emotional reactivity (measured via neural activation, physiological activation, or self-report) during the luteal phase in women, especially if women have PMS or PMDD.

**Oral Contraceptive Use and Emotional Reactivity.** Given that emotional reactivity tends to fluctuate across the menstrual cycle and is highest during the period of high progesterone and moderate estradiol, and OCs provide a consistent dose of hormones thus providing a relatively stable hormonal profile (especially monophasic OCs; Follesa et al., 2002; Montoya & Bos, 2017), it may be predicted that women on OCs would have less emotional reactivity compared to women not on OCs. However, some research suggests that testosterone may also be relevant given evidence that men may be less emotionally reactive compared to women due to the anti-depressant effects of testosterone (e.g., Wainwright et al., 2016). The potential anti-depressant effect of testosterone is particularly relevant considering that one of the primary hormonal effects of OCs is reduced testosterone levels (Zimmerman et al., 2014). Thus,

it may conversely be predicted that women on OCs are more emotionally reactive compared to women not taking OCs or men due to this testosterone reduction. Additionally, recent research has indicated that a certain subgroup of women experience negative mood side effects from OCs (Skovlund et al., 2016) while others experience positive or no mood side effects (Hamstra et al., 2017; Huber, Heskamp, & Schramm, 2008). The following section will review findings related to emotional reactivity and OCs in animal and human studies.

***Rat Studies.*** Only two studies have been published that examined emotional reactivity and OCs in animals. The first study, conducted by Follesa et al. (2002), examined neurosteroids, $GABA_A$ receptors, and behaviour in the elevated plus maze in female rats after receiving a combination of ethinyl estradiol (EE) and levonorgestrel (LNG). This EE-LNG combination is used as an animal model of OC use. Rats were ovariectomized or sham-operated and then given either a 0.03 mg EE and 0.125mg LNG combination or placebo subcutaneously daily for six weeks. They also examined neurosteroid levels in human women before and after three months of treatment with OCs. For sham-operated rats, the 6-week treatment with EE-LNG was associated with: (a) reduced concentrations of pregnenolone, progesterone, and allopregnanolone in plasma and the cerebral cortex compared to sham-operated placebo treated rats, and (b) increased $GABA_A$ receptor genes (i.e., $\gamma$2L and $\gamma$2S subunit mRNAs). In ovariectomized rats, EE-LNG treatment did not reduce the neurosteroids levels largely due to reduction in neurosteroids already caused by the ovariectomy. However, EE-LNG treatment did increase the amount of $GABA_A$ receptor genes in ovariectomized rats similar to sham-operated rats. Follesa et al. also found that, in women, treatment with OCs abolished the fluctuations of pregnanolone, progesterone and allopregnanolone across their menstrual cycle. These results confirm that treatment with hormonal contraceptives reduces neurosteroid levels in women and intact female

rats. In the elevated plus maze, the rats (sham-operated) treated with EE-LNG demonstrated increased anxiety-like behaviours compared to rats treated with placebo. Indeed, the proportion of total time spent in the open arms was reduced by 50% and the proportion of entries into the open arms was reduced by 45% compared to placebo-treated rats. The authors posited that the increased anxiety behaviour in rats treated with EE-LNG may be a result of decreased neurosteroids such as allopregnalone which has previously been indicated to be associated with mood and anxiety disorders. However, they did not examine emotional reactivity in women. Thus, it is unknown if the reduction of these neurosteroids is related to increased emotional reactivity in women.

The second study also indicated that hormonal contraceptives decrease neurosteroid levels, but also that $GABA_A$ receptor subunits are upregulated (Porcu et al., 2012). They extended the Follesa et al. (2002) findings and aimed to evaluate which component of the combined OC was most important for changes at the $GABA_A$ receptor and subsequent mood and anxiety effects. Porcu and colleagues tested adult female rats in the elevated plus maze after injecting them once daily for four weeks with either a combination of 0.03mg of EE and 0.125mg of LNG, EE alone, LNG alone, or placebo. Treatment with EE, LNG, or EE-LNG combination all resulted in reduced cerebrocortical, hippocampal, and plasma concentrations of pregnenolone, progesterone and allopregnanolone compared to placebo-treated rats. Further, treatment with LNG alone and combined EE-LNG significantly increased $GABA_A$ receptor subunits (i.e., $\gamma 2$) in the cerebral cortex and hippocampus. Both the LNG group and the combined EE-LNG group (but not the EE group) showed more anxiety-like behaviours in the in the maze compared to the control group. These results suggested that it is the progesterone component of OCs that act at the $GABA_A$ receptor and that affects anxiety-like behaviour in rats.

Moreover, since EE and LNG both reduce levels of neurosteroids, this further indicates that it is not simply a decrease in neurosteroid levels that influences changes at the $GABA_A$ receptor site, and is instead something specific about the progestin component in OCs.

Although only two studies have been conducted that examine the effects of OCs on emotional reactivity in rats, both the Follessa et al. (2002) and Porcu et al. (2012) studies provide consistent evidence that the combination EE-LNG and LNG alone both result in increased emotional reactivity in female rats. Nevertheless, as discussed below, research regarding OC use and emotional reactivity in humans is less consistent.

***Human Studies.*** Many reviews have indicated a range of mood side effects from OCs from an increase in positive affect, to mood stabilization, and even mood deteriorating effects (e.g., Oinonen & Mazmanian, 2002; Rapkin et al., 2006). When oral contraceptives are examined as a function of their progestin derivatives, however, there tends to be some consistency in the effects on mood. Indeed, some studies have indicated that the adverse effects on mood tend to be related to androgenic OCs that contain the 19-nortestosterone derivatives (e.g., specifically LNG) whereas positive affect is related to anti-androgenic OCs containing 17alpha-hydroxy-progesterone and 17alpha-spironolacone derivatives (Huber et al., 2008; Poromaa & Segebladh, 2012). For example, Huber et al. (2008) conducted four observational prospective studies on 50,000 healthy women in Germany using a 17alpha-hydroxy-progesterone derivative OC [chlormadinone acetate (CMA) 2mg and EE 0.03mg]. They found that more than 60% of the women (prior OC users and nonusers) who experienced depressive symptoms prior to switching to or starting CMA no longer reported depressive mood after 4 OC cycles and 90% of the women no longer reported depressive mood after 12 OC cycles. The authors concluded that OCs containing CMA promote emotional well-being, reduce mood swings, and improve depressive

mood in healthy women. However, these four studies did not include an empirically based measure for depressive mood and did not consider the fact that women who had worsening mood symptoms may have discontinued OC use before the 12th cycle (i.e., survivor effect). Nevertheless, this study contributes to the literature on OC use and affect and, importantly, highlights the potential for positive mood side effects with a 17alpha-hydroxy-progesterone derivative.

Another review on mood effects from OCs was conducted by Kurshan and Epperson (2006). They examined 13 studies on healthy women taking a variety of OCs. Of the 13 studies reviewed, 8 of them involved a 19-nortestosterone derivative (either DSG, LNG, and GSD) and 5 of the studies involved a 17alpha-spironolacone derivative (DRSP). Of the five studies that examined DRSP containing OCs, all five showed an improvement in PMS symptoms and/or in negative mood. However, results from the eight studies involving a 19-nortestosterone derivative were more variable. Some of those studies found negative mood change (e.g., one study showed negative mood change for 9% of participants, and one showed negative mood change for 26% of the participants) while others found positive mood changes (e.g., two studies showed an increase in quality of life scores, and two showed decreases in PMS symptom). While it is important to factor in the type of progesterone derivatives in OCs, results indicate that not all women respond to progesterone derivatives in the same way. Furthermore, despite Kurshan and Epperson (2006)'s consistent finding that DRSP-containing OCs were related to positive mood changes, one large national study conducted by Skovlund et al. (2016) found that mood changes associated with OC use regardless of the progesterone derivative.

Skovlund et al. (2016) investigated whether hormonal contraceptive use is associated with use of anti-depressants and diagnoses of depression in their Nationwide Danish Sex

Hormone Register Study which included all women living in Denmark. For this study, all women aged 15 to 34 were observed from January 2000 to December 2013 ($N$ = 1, 061, 997). All women with a diagnosis of depression or any other psychiatric diagnosis, or a history of antidepressant use before January 2000 were excluded. Results revealed that compared with nonusers, OC users had a higher rate of first use of antidepressants (combined OCs - 1.8-fold higher; progestin-only pills - 2.2-fold higher; and non-oral hormonal contraceptives - 3-fold higher). Incidence rate ratios (RRs) for first diagnosis of depression followed a similar pattern but were slightly lower. Additionally, if women began taking hormonal contraceptives in adolescence (between ages 15 to 19) their RRs for first use of antidepressant and first diagnosis of depression was higher than women who began hormonal contraceptives later in life. This study revealed that all types of hormonal contraceptive use (regardless of progesterone derivative) are associated with subsequent antidepressant use and a diagnosis of depression.

Conversely, a study conducted by Hamstra et al. (2017) found that women on OCs do not experience negative mood changes compared to naturally cycling women. In their prospective longitudinal study, 57 women using EE-LNG combination OCs (existing users) and 35 naturally cycling women completed questionnaires measuring affect at four time points over two consecutive months. Naturally cycling women completed the questionnaires during their early follicular (day 4), late follicular (day 13), mid-luteal (day 21), and late luteal (day 27) phases and OC users were tested at equivalent time points. All women also came into the laboratory to provide saliva samples for hormone levels and DNA sampling. OC users reported less affective lability, less rumination, and fewer negative cognitions associated with anger and risk avoidance compared to naturally cycling women. When cycle phase was considered, OC users also reported fewer mood swings in the luteal phase compared to naturally cycling women. No group

differences for interpersonal sensitivity, or positive and negative affect (PANAS) were found. The authors noted that the reduced mood and affect variability in OC users may reflect the mood stabilizing effects of OCs, or, alternatively, a blunting of emotional reactivity.

These Hamstra et al. (2017) findings are in apparent contrast to the Skovlund et al. (2016) study which revealed negative mood changes following OC use. However, Skovlund et al. followed women over a 14-year period whereas Hamstra et al. examine women over two months. It is likely that mood changes may appear after women are observed for many years and compared to their own baseline. Indeed, one limitation with the studies discussed thus far is that they make between-group comparisons of OC users and nonusers. However, the Hamstra et al. (2017) results may be subject to the survivor effect, whereas the Skovlund et al. (2016) included data for women who discontinued OCs in their study.

To mitigate the limitation of between-group analyses, Lisofsky et al. (2017) conducted a within-subjects design to examine the neural, affective, and cognitive changes in 56 women before and after using OCs. In their study, 28 women planning to use OCs and 28 healthy naturally cycling women not planning to use OCs (control group) participated in two experimental sessions. For OC users, the first session occurred prior to beginning OCs and the second session occurred during the inactive pill phase in their third pill cycle. For the control group, women were in their early follicular phase (days 1 to 10) and the sessions were scheduled approximately 3 months apart. During each session, participants completed a PANAS and several cognitive tasks (e.g., word-list recall, working memory, object location, and mental rotation tasks), as well as underwent an fMRI. They found no group differences in negative affect from the first to second session. However, positive affect significantly decreased from the first session to the second session in OC users, especially for younger aged OC users, while no

changes in positive affect were found in the control group. Additionally, younger women in the pill group also demonstrated an increase in negative affect from the first to second session. Regarding fMRI data, Lisofsky et al. (2017) found that the left amygdala/anterior parahippocampal gyrus (PHG) volume decreased in women using OCs compared to the control group. Additionally, positive affect was positively related to gray matter volume in the left amygdala/anterior PHG at the second session in both groups. This finding indicates that OC use is associated with decreased gray matter volume in healthy women after only three months and that this decreased gray matter is associated with decreased positive affect. There were no group differences appeared with respect to performance on the cognitive tasks. Previous pill use, progesterone derivative, and hormonal concentrations were not associated with changes in affect, grey matter, or task performance.

Thus far, while OC use has been shown to have differential effects on mood and affect, these changes alone are not necessarily indicative of emotional reactivity per se. Instead, other measures such as reactions to emotional stimuli are required to assess the effect of OCs on emotional reactivity. This section discusses one recent review and four additional studies.

In their comprehensive review, Montoya and Bos (2017) examined the evidence for an OC effect on the neural correlates related to emotional functioning. First, they reviewed evidence suggesting OC use alters the neural mechanisms for fear processing. One study found that OC users had impaired fear extinction recall that was mitigated with administration of estrogen, suggesting that estrogen suppression from OC use may explain altered fear processing in OC users (Graham & Milad, 2013). Other studies also found that, compared to nonusers, OC users had higher activation during fear extinction trials in brain networks associated with fear conditioning and extinction such as the amygdala, thalamus, anterior cingulate cortex (ACC),

and ventromedial prefrontal cortex, as well as a slower habituating skin response (Hwang et al., 2015; Merz et al., 2012a). Further, one study comparing the resting brain activity of OC users and nonusers found that OC users had decreased functional connectivity between brain regions central to emotion regulation (i.e., the ACC and the frontal nodes of the executive network) (Petersen et al., 2014). Put together, these studies suggest that OC users may be more emotionally reactive, particularly to fear stimuli. This could have important implications for future research and suggests the importance of including fear mood induction into research on OC use and emotional reactivity.

Second, Montoya and Bos (2017) reviewed mixed evidence from five studies examining the effect of OC use on neural correlates related to other types of emotional processing. Regarding stress research, three studies found that OC use is related to a blunted hypothalamus-pituitary-adrenal (HPA) stress response (Bouma et al., 2009; Merz et al., 2012b; Rohleder et al., 2003). Specifically, when OC users were administered cortisol during a stressful task, they had increased hippocampal activation while men and nonusers had decreased hippocampal activation after cortisol administration during the same task. Another study found that OC users had suppressed amygdala activation when viewing negative pictures compared to nonusers (Petersen & Cahill 2015; further described below) which may imply that OC users have altered processing of emotional information (Montoya & Bos, 2017). Also, another study found that OC users had increased activity in the fusiform gyri when viewing angry and neutral faces which suggests increased attention and processing of emotional information in faces amongst OC users (Mareckova et al., 2014). Montoya and Bos concluded that findings regarding neural activation and OC use were mixed and limited and suggest more research is needed with respect to OC use and emotional reactivity.

Due to its relevance, the Petersen and Cahill (2015) study reviewed by Montoya and Bos (2017) above was further explored here. In their study, 20 naturally cycling women were tested during their early follicular phase (days 2 to 6) and 25 naturally cycling women were tested in their mid-luteal (days 18-24) phase. OC users in this study were taking OCs with 3-weeks of active pills (i.e., pills with hormones) and 1 week of inactive pills (i.e., placebo pills). Twenty-two OC users were tested during the inactive pill phase (days 2 to 6 after starting the placebo pills) and 24 OC users were tested during the active pill phase (days 18 to 24 after starting the active hormone pills). Under fMRI, the participants viewed negative and neutral pictures from the IAPS. When OC users and nonusers' neural reactivity to negative pictures was compared, the naturally cycling women demonstrated higher right amygdala activation than OC users. Further, women in the follicular phase showed more right amygdala activation compared to active pill users while women in the luteal phase showed more left amygdala activation compared to active pill users. No differences in amygdala activation was found between active and inactive pill users. When follicular and luteal phases were compared, women in the follicular phase had significantly more reactivity in their right amygdala compared to women in luteal phase. The results stayed the same even after the groups were split based on high and low progesterone levels (to correct for potential errors in assigning cycle phase). Petersen and Cahill noted that the amygdala is sensitive to habituation and that within-subjects designs used by previous researchers may yield confounding results compared to their between-subjects design. Further, they reported that this is the first investigation to examine amygdala reactivity to emotional stimuli in OC users. More studies are needed to verify the Petersen and Cahill findings.

Interestingly, a study conducted by Jarva and Oinonen (2007), that also found reduced reactivity in OC users compared to nonusers. In their study, a sample of 40 OC users, 36

nonusers, and 31 men completed the (PANAS) before and after a series of procedures designed to induce positive affect, jealousy, social ostracism, and parental feelings. While no differences were found between groups at the level of jealousy, social ostracism, or parental feelings, OC users did display significantly less positive affect reactivity than non-users and men across all mood primes. Furthermore, women who had been taking OCs for less than 24-months displayed the highest blunting of positive affect reactivity.

Examining both self-report and psychophysiological responses to emotional stimuli was a study conducted by Armbruster et al. (2017). In their study, 37 naturally cycling women and 37 women taking OCs viewed negative, neutral, and positive photographs from the IAPS. Self-reported emotional reactions, facial EMG, and skin conductance response was measured, as well as acoustic startle response after delivery of white noise burst through headphones. Naturally cycling women were tested twice: once in their early follicular phase (days 1 to 7) and once in the late luteal phase (1 to 6 days prior to menstruation). OC users were tested once during the active pill phase. Results from facial EMG revealed no group differences except for OC users demonstrating increased mouth movements in response to both positive and negative stimuli compared to nonusers, especially women in the luteal phase. Regarding skin conductance response, OC users showed a significantly smaller response compared to naturally cycling women, especially women in the follicular phase. For the acoustic startle reflex, OC users experienced a decreased startle response compared to naturally cycling women. However, OC users rated their subjective startle response as more intense than naturally cycling women. This is interesting because it contrasts with the actual startle magnitude collected by EMG. Furthermore, OC users also reported a higher tendency to be startled in everyday life. Finally, there were no group differences in rating the images however, there was a nonsignificant trend for OC users to

rate negative pictures as more arousing compared to naturally cycling women. Overall, this study indicated that OC users showed a reduction in physiological responses to both emotional stimuli. However, based on self-reported data, OC users felt more aroused and experienced more negative affect than non-users. These results demonstrate the importance of collecting both implicit (e.g., physiological) and explicit (e.g., self-report) data when measuring emotional reactivity.

The final study that examined emotional reactivity in OC users differs from the three studies previously discussed as it specifically included women with negative mood side effects from OCs. In this study, conducted by Gingnell et al. (2013b), women with previous negative mood side effects from OCs were recruited and randomly assigned to be re-administered either a LNG-containing OC ($n$ = 15) or placebo ($n$ = 15). Mood ratings were measured, and after two months, participants completed an emotion recognition task while undergoing an MRI. They found that within two months, the women taking OCs were re-experiencing negative mood side effects while the women taking placebo did not experience a change in mood. Further, during the emotion recognition task, the women taking the OCs had quicker response times to identify the angry and fearful faces, lower reactivity in the left insula (typically associated with positive or salient emotional stimuli) (Jabbi et al., 2007; Takahashi et al., 2008), and lower reactivity in the inferior frontal gyri (associated with verbal language production, empathy, response inhibition, and emotional distraction) (Hampshire et al., 2010; Liakakis et al. 2011; Wang et al., 2008). These results indicate that OCs may cause some women to be more reactive to negative stimuli and have lower emotional distraction and lower response inhibition while viewing negative stimuli compared to naturally cycling women.

Overall, there is a lack of consistency in the findings with respect to mood change and emotional reactivity in women taking OCs. Of the five studies that examined mood effects from OCs, two indicated that OC use was related to negative mood changes especially if OC use was started at a younger age (Skovlund et al., 2016) or only if OC users were younger (Lisofsky et al., 2017), two studies indicated that OC use was related to increased positive mood changes, but only if they were using OCs with a 17alpha-spironolacone progesterone derivative (Huber et al., 2008; Kurshan & Epperson, 2006), and one study indicated that OC was associated with less mood change (either positive or negative) compared to naturally cycling women across the menstrual cycle (Hamstra et al., 2017). Additionally, of the studies that examined OC effects on reactions to emotional stimuli, the Montoya and Bos (2017) review found fairly consistent evidence that OC use alters neural correlates related to fear response, yet mixed results regarding the effect of OC use on neural correlates related to other emotional response (e.g., stress, examining negative emotional faces). Two studies indicated that OC users demonstrated decreased emotional response via decreased amygdala reactivity in response to negative emotional stimuli (Petersen & Cahill, 2015) and decreased self-reported positive affect after various mood inductions (Jarva & Oinonen, 2007). Further, one study indicated that OCs users displayed reduced physiological reactions to positive and negative stimuli, but increased self-reported reactivity to negative stimuli compared to naturally cycling women (Armbuster et al., 2017). Finally, one study indicated that women on OCs with current negative mood side effects had increased negative reactivity compared to nonusers (Gingnell et al., 2013b). Evidently, the effects of OC use on mood changes and emotional reactivity are not clear from these studies. Further, there has been no study that has investigated the effects of OC use on inhibiting emotional reactions in situations where it may be adaptive.

**Conclusion**

The literature review on response inhibition yielded relatively consistent results with respect to gonadal hormones. Both animal and human studies indicated that response inhibition improved when progesterone levels are high (Griskova-Bulanova et al., 2016; Swalve et al., 2016) or when both progesterone and estrogen levels are high (e.g., Colzato et al., 2010; Milivojevic et al., 2016), and decreased when estrogen levels are high (Colzato et al., 2010; Milivojevic et al., 2016). However, there were inconsistent results regarding sex differences in response inhibition in both animal and human studies. Further, only three studies examined the effect of OC use on response inhibition and they yielded inconsistent findings (Gingnell et al., 2016; Keir & Oinonen, 2016a; 2016b). No study to date has investigated the effect of sex, menstrual cycle phase, or OC use on response inhibition using multiple measures of response inhibition.

The literature review on sex differences in deferred gratification revealed little to no sex differences in performance on tasks of delayed gratification (e.g., Cross et al., 2011; Grissom et al., 2019). Instead, sex differences were observed in the various strategies employed by men and women, with women showing increased loss aversion compared to men (e.g., Grissom et al., 2019; ven den Bos et al., 2013). Regarding deferred gratification and the menstrual cycle, studies suggest that, in laboratory tasks of deferred gratification, deferred gratification is either improved during the mid-to-late-follicular phase (Kaighobadi & Stevens, 2013; Smith et al., 2014) or decreased with higher levels of estradiol (Diekhoff, 2015). Outside of the laboratory, deferred gratification measured via self-reported spending, or eating behaviours has been shown to decrease during the mid-to-late luteal phase (Elder et al., 2007; Pine & Fletcher, 2011). No study to date has measured deferred gratification across the menstrual cycle using multiple methods

(e.g., laboratory task, and self-reported behaviours in daily "real world" activities). Further, no study has examined the effects of OC use on deferred gratification.

The literature consistently indicates a male advantage with respect to performance on reversal learning tasks both in animal and human laboratory studies (Bissonette et al., 2012; Eddy et al., 2013; Evans & Hampson, 2015; Halari et al., 2005; Mihalick et al. 2000). However, because typical reversal learning tasks are quite simple, researchers are required to make more difficult tasks for humans by changing the contingency of feedback (Evans & Hampson, 2015). Thus, it is important for future research to employ this strategy to better tap into sex differences in reversal learning. Many studies have examined the effects of gonadal hormones on reversal learning in animals, however the results yielded inconsistent and contradictory results. Further, no studies have examined performance on reversal learning tasks in women across the menstrual cycle or in women taking OCs. Moreover, no study has examined how reversal learning may differ as a function of sex or other hormonally relevant groups outside of laboratory tasks (i.e., via self-report measures).

The review of research on emotional reactivity yielded interesting results regarding sex, gonadal hormones, and OC use. It is evident that women are generally more reactive to emotional stimuli compared to men (e.g., Bianchin & Angrilli, 2012; Bradley et al., 2001; Brebner, 2003; Wilhelm et al., 2017). Moreover, women may be less able to regulate their emotional reactions compared to men (e.g., Filkowski et al., 2017; Nolen-Hoeksema, 2012). Additionally, women were found to have increased emotional reactivity, and more difficulty with emotion regulation in the mid-luteal phase compared to the follicular phase (e.g., Chung et al., 2016; Lusk et al., 2017). Further, women with PMS or PMDD were found to have increased emotional reactivity during the luteal phase compared to asymptomatic women in the same phase

(Gingnell et al., 2012; 2013b; Hoyer et al., 2013). However, the literature review on OC use and emotional reactivity yielded mixed results. Only two animal studies were conducted and both indicated that hormonal contraceptive use was associated with increased emotional reactivity (i.e., anxiety-related behaviours in an elevated plus maze task). In humans, OC use was associated with both negative and positive mood changes (e.g., Lisofsky et al., 2017; Hamstra et al., 2017; Skovlund et al., 2016) with more positive mood change related to anti-androgenic hormone derivatives in OCs (e.g., Huber et al., 2008). Regarding the effects on neural correlates related to emotional reactivity, the results have been inconsistent. OC use has been associated with increased neural activation indicative of increased fear reactivity (Montoya & Bos, 2017), and increased self-reported negative emotional reactivity despite evidence of lower physiological activation (Armbruster et al., 2017). Also, OC use has been associated with a blunting of affect reactivity (Hamstra et al., 2017; Jarva & Oinonen, 2007; Petersen & Cahill, 2015). Given these inconsistencies, more research needs to be conducted to examine how OC use may affect emotional inhibition.

Ultimately, it is evident that sex, menstrual cycle, and OCs may affect different types of inhibition to varying degrees. However, very little research has been conducted on hormones and inhibition, especially with respect to OC use. This dearth of research in unfortunate considering that inhibitory control is important for overall functioning and well-being for both men and women. Indeed, examining the effect of hormones on inhibition could provide insight into how endogenous and exogenous hormones affect executive functioning. Further, examining the effect of hormones on inhibition can provide insight into how certain clinical disorders may manifest differently in men and women (e.g., anxiety, depression, PTSD, ADHD, or substance use disorders).

## Current Studies

The purpose of these studies was to examine the effects of sex, cycle phase, and OC use on four distinct types of inhibition across two separate studies. In the first study, participants completed a series of online self-report questionnaires measuring response inhibition, deferred gratification, reversal learning and emotional reactivity twice, two weeks apart. This repeated administration allowed for a within-subjects design to also capture individual variability across the menstrual cycle. Self-report measures were chosen for this study because they tap into self-perceived difficulties on everyday tasks and scenarios related to inhibitory control that cannot necessarily be captured with laboratory testing. Participants were asked to evaluate their inhibitory control based on their behaviours over the past two months, as well as over the past 48 hours. This 48-hour timeline was intended to capture recent behaviour and attitudes specific to the hormonal milieu at particular menstrual phases and to maximize the sensitivity of the questionnaires to capture variability or changes in inhibition over time.

In the second study, participants completed laboratory measures of inhibition both before and after mood induction. This design provided a direct measure of group differences in inhibitory control after experiencing the same emotional events. In this study, participants completed a GoNogo task to measure response inhibition, a delay discounting task to measure deferred gratification, a probabilistic reversal learning task to measure reversal learning, and self-report affect measures and an emotional implicit association task (EIAT) after mood induction videos to measure both explicit and implicit emotional reactivity.

Taken together, these are the first studies to examine the effects of sex, cycle phase, and hormonal contraceptive use on four different types of inhibitory control: response inhibition, deferred gratification, reversal learning, and emotional reactivity. This is also the first study to

examine how hormones affect inhibition within different mood contexts using mood induction paradigms, and to examine several types of inhibition using both objective lab tests and subjective self-report measures. Organized by group (men vs. women; follicular phase vs. luteal phase; OC users vs. nonusers vs. men) the analyses for this project began with a global examination of group differences for each type of inhibitory control for the self-report (Study 1) and the laboratory measures (Study 2). There were also six specific hypotheses and one exploratory analysis based on previous findings.

**Hypothesis 1: Sex Differences in Response Inhibition: Women will make more Errors of Commission (EOC) on the GoNogo Task Compared to Men After the Happy Mood Induction**

This hypothesis is based on previous research indicating that response inhibition appears to vary as a function of progesterone and estrogen levels, with higher levels of estrogen related to lower response inhibition (Colzato et al., 2010; Griskova-Bulanova et al., 2016; Hatta & Nagaya, 2009; Milivojevic et al., 2016; Swalve et al., 2016). Also, previous research on the GoNogo task indicated that it is generally more difficult to inhibit a "Go" response after positive mood induction (Albert et al., 2010; Keir & Oinonen, 2016a; 2016b) and past studies suggest that women are more emotionally reactive than men (Bianchin & Angrilli, 2012; Bradley et al., 2001; Brebner, 2003; Domes et al., 2010; Gard & Kring, 2007; Grossman & Wood, 1993). Thus, it is predicted that women will have more difficulty with response inhibition than men after happy mood induction.

**Hypothesis 2: Sex Differences in Reversal Learning: Women Will Show Deficits in Reversal Learning Compared to Men**

This hypothesis was an attempt to replicate findings from Evans and Hampson (2015). Moreover, previous research in both animal and human studies has demonstrated a male advantage on tasks of reversal learning (Bissonette et al., 2012; Eddy et al., 2013; Goodwill et al., 2018; Halari et al., 2005; Mihalick et al. 2000). Sex differences in laboratory measures of reversal learning (the Probabilistic Reversal Learning task) and self-report measures of reversal learning were both explored. This is the first study to examine reversal learning outside of the laboratory.

**Hypothesis 3: Sex Differences in Emotional Reactivity: Women will be More Emotionally Reactive than Men**

This hypothesis is based on the literature indicating that women are more emotionally reactive than men, especially with respect to negative emotions (Bianchin & Angrilli, 2012; Bradley et al., 2001; Brebner, 2003; Domes et al., 2010; Gard & Kring, 2007; Grossman & Wood, 1993; Wilhelm et al., 2017). Additionally, based on studies examining neural activation patterns, men may exhibit more effortful control over their emotions while women appear to have more difficulty overriding their negative emotional reactions (Filkowski et al., 2017; Gard & Kring, 2007; Nolen-Hoeksema, 2012). Sex differences in emotional reactivity are expected in both explicit (self-report) measures of emotions and implicit measures of emotions such as the Emotional Implicit Association Task (EIAT). Additionally, both state-based (e.g., ICS-48 emotional reactivity subscale) and trait-based (e.g., PERS) measures of emotional reactivity were examined.

**Hypothesis 4: Menstrual Cycle Effects on Response Inhibition: Women in the Follicular Phase Will Demonstrate More Problems with Response Inhibition Compared to the Luteal Phase**

This hypothesis is based on the literature indicating response inhibition improved in animals and women when progesterone levels were high (Griskova-Bulanova et al., 2016; Swalve et al., 2016) or when both progesterone and estrogen levels were high (Colzato et al., 2010; Hatta & Nagaya, 2009; Milivojevic et al., 2016), and decreased when only estrogen levels were high (Colzato et al., 2010; Milivojevic et al., 2016). Both self-report (e.g., ICS-48 Response Inhibition subscale) and laboratory measures (e.g., the Go Nogo task) of response inhibition were examined.

**Hypothesis 5: Menstrual Cycle Effects on Deferred Gratification: Naturally Cycling Women in the Luteal Phase Will Exhibit More Problems with Deferred Gratification Compared to the Follicular Phase**

This hypothesis is based on the previous literature which indicated increased deferred gratification during the mid-to-late-follicular phase (Kaighobadi & Stevens, 2013; Smith et al., 2014) and decreased deferred gratification during the mid-to-late luteal phase with respect to self-reported spending, or eating (Elder et al., 2007; Pine & Fletcher, 2011).

**Hypothesis 6: Menstrual Cycle Effects on Emotional Reactivity: Naturally cycling women in the luteal phase will demonstrate more emotional reactivity compared to the follicular phase**

This hypothesis is based on pervious literature that indicated women in the mid-luteal phase were more emotionally reactive compared to women in the follicular phase (Andreano & Cahill, 2008; Childs et al., 2010; Chung et al., 2016; Lusk et al., 2017). Menstrual cycle effects

on emotional reactivity were explored via self-report measures as well as via a laboratory based EIAT task measuring implicit emotional reactivity.

**Oral Contraceptive Effects on Emotional Reactivity: Differences in Emotional Reactivity Between OC users, Nonusers, and Men Were Explored**

There have been inconsistent results with respect to mood changes and emotional reactivity based on OC use. For example, two studies indicated that OC use was related to negative mood change (Lisofsky et al., 2017; Skovlund et al., 2016), whereas others found OC use was related to positive mood changes (Huber et al., 2008; Kurshan & Epperson, 2006). Thus, while it is expected that naturally cycling women, OC users, and men will differ in their self-reported affect and in their performance on the EIAT, past research does not point to a clear directional hypothesis.

## Method

### Study 1 Participants

#### *Time 1 Questionnaire*

A total of 560 participants initiated the Time 1 Questionnaire, 487 completed it, and 372 met study inclusion criteria [mean age = 21.13 *SD* = 4.46; 76 men, 296 women (111 OC users, 110 nonusers: 54 in follicular phase, 54 in luteal phase)]. Final sample demographic information can be found in Tables 1 and 2. The participants were recruited from Psychology and other university classes at Lakehead University in Thunder Bay, Canada as well as from the local community and the internet community to participate in a study on “individual differences in hormones, emotions, and reactivity”. University students were 16 years or older and members of the public were 18 years or older. University students were recruited directly through classroom visits, or indirectly through email, an online psychology study and bonus point management system, and

posters. From the larger local and national community, participants were recruited using posters or online forums such as Reddit. No exclusionary criteria were used at the recruitment phase of the study.

To reduce the effects of potential confounding variables and ensure only individuals of reproductive age were sampled, nine exclusion criteria were used to select participants for the main analyses: (1) peri- or post-menopausal ($n$ = 10), (2) taking any hormonal contraceptive for less than 2 months ($n$ = 7) or discontinued any hormones less than 2 months prior ($n$ = 1), (3) pregnant or lactating ($n$ = 3), (4) over the age of 39 ($n$ = 20), (5) positive for a history of head injury with sustained behavioural changes ($n$ = 42), (6) taking any mood-altering medication ($n$ = 85), (7) taking any medication for attention ($n$ = 18), (8) taking any antipsychotic medications or lithium ($n$ = 3), or (9) drinking more than one alcoholic drink on the day of the questionnaire ($n$ = 4). Additionally, two post-hoc exclusion criteria were added to exclude participants with certain response biases: (a) > 13 on the Negative Impression Management (NIM) scale (Morey & Quigley, 2002) indicating exaggeration of negative experiences ($n$ = 22), and (b) >23 on the Positive Impression Management (PIM) scale (Peebles & Moore, 1998) indicating exaggeration of positive qualities ($n$ = 17) (see Methods section below). It should be noted that some participants met multiple exclusion criteria (e.g., taking a mood medication and over the age of 39).

***Time 2 Questionnaire***

While 200 participants from the Time 1 sample completed the Time 2 Questionnaire, 192 remained after applying the additional exclusion criteria (for demographic information see Tables 1 and 2). Exclusion criteria included: (a) ingesting more than one alcoholic drink on the day of the Follow-up questionnaire ($n$ = 3), and (b) stopping/starting hormonal contraceptives

**Table 1**

*Age, Sex, and Hormonal Demographic Information: Means (SDs), and Frequencies (%) for Participants in Studies 1 and 2*

| Demographic Variable | Study 1 | | Study 2 |
|---|---|---|---|
| | Time 1 ($N$ = 372) | Time $2_x$ ($N$ = 192) | ($N$ = 126) |
| | Means (*SD*) | | |
| Age | 21.13 (4.46) | 20.99 (4.44) | 20.75 (4.01) |
| | Frequency (%) | | |
| Sex | | | |
| Male | 76 (20.4) | 43 (22.4) | 31 (24.6) |
| Female | 296 (79.6) | 149 (77.6) | 95 (75.4) |
| HC Use[a] | | | |
| OC users | 111 (44.9) | 64 (44.76) | 35 (38.9) |
| Non-oral HC users | 26 (10.5) | 12 (8.39) | 11 (12.2) |
| Nonusers | 110 (44.5) | 67 (46.9) | 44 (48.9) |
| Never users | 69 (63.7) | 39 (58.2) | 28 (63.6) |
| Previous Users | 41 (37.3) | 28 (41.8) | 16 (36.4) |
| Cycle Phase[b, c] | | Time $1_x$ Time $2_x$ | |
| Follicular Total | 54 (49.1) | 31(49.3) 26(43.3) | 26(59.1) |
| Early follicular | 21 (38.9) | 12(38.7) 10(38.5) | 11(42.3) |
| Mid follicular | 20 (37.0) | 14(45.2) 10(38.5) | 8(30.8) |
| Late follicular | 13 (24.1) | 5(16.1) 6(20.7) | 7(26.9) |
| Luteal Total | 54 (49.1) | 28(50.8) 34(56.7) | 18(40.9) |
| Early Luteal | 16 (29.6) | 9(32.1) 12(35.3) | 5(27.8) |
| Mid luteal | 12 (22.2) | 10(35.7) 7(20.6) | 6(33.3) |
| Late luteal | 26 (48.2) | 9(32.1) 15(44.1) | 7(38.9) |

Note. All participant numbers reflect number of participants after exclusion criteria was applied. For Study 1, the $_x$ includes all participants that completed both Time 1 and 2 questionnaires. Their data were used in repeated-measures analyses. Non-oral HC user refers to women taking a non-oral hormonal contraceptive. Nonusers refers to naturally cycling women taking no hormonal contraceptives. [a] Hormonal contraceptive information could not be determined for: 49 participants at Time 1, 7 participants at Time $2_x$ (Time 2), and 5 participants in Study 2 (due to participants not completing questionnaire or providing inconsistent information). [b] The *N*s reported for the cycle phases include only naturally cycling women (i.e., women not taking any hormonal contraceptives). [c] Menstrual cycle could not be determined for: 2 participants at Time 1, 8 participants Time 1 (Time $2_x$) and 7 participants at Time 2 (Time $2_x$).

**Table 2**

*Ethnicity and Education information: Frequencies (%) for Participants in Studies 1 and 2*

| Demographic Variable | Study 1 | | Study 2 |
|---|---|---|---|
| | Time 1 ($N$ = 372) | Time $2_x$ ($N$ = 192) | ($N$ = 126) |
| Ethnicity (check all that apply) | | | |
| White or Euro-Canadian | 285 (76.6) | 148 (77.1) | 80 (63.5) |
| Chinese | 11 (3.0) | 5 (2.6) | 2 (1.6) |
| South Asian (e.g., east Indian, Pakistani) | 26 (7.0) | 16 (8.3) | 21 (16.7) |
| Black, Afro-Caribbean or African-Canadian | 24 (6.5) | 6 (3.1) | 9 (7.1) |
| Filipino | 6 (1.6) | 2 (1.0) | 2 (1.6) |
| First Nations, Metis, or Inuk | 17 (4.6) | 14 (7.3) | 9 (7.1) |
| Latin American | 4 (1.1) | 2 (1.0) | 1 (0.8) |
| Arab | 4 (1.1) | 2 (1.0) | 2 (1.6) |
| Southeast Asian (Vietnamese, Thai, etc.) | 5 (1.3) | 3 (1.6) | 1 (0.8) |
| West Asian (Iranian, Afghan etc.) | 1 (0.3) | 1 (0.5) | 1 (0.8) |
| Korean | 0 (0) | 0 (0) | 0 (0.0) |
| Other | 10 (2.7) | 4 (2.1) | 5 (4.0) |
| Highest Education | | | |
| Completed High School | 82 (22.0) | 45 (23.4) | 37 (29.4) |
| Some College | 10 (2.7) | 5 (2.6) | 1 (0.8) |
| Completed College | 31 (8.3) | 13 (6.8) | 9 (7.1) |
| Some University | 217 (58.3) | 112 (58.3) | 67 (53.2) |
| Completed University | 15 (4.0) | 8 (4.2) | 5 (4.0) |
| Some Graduate Studies | 5 (1.3) | 1 (0.5) | 1 (0.8) |
| Completed a Graduate Degree | 7 (1.9) | 4 (2.1) | 1 (0.8) |

Note. Participants were instructed to "check all that apply" for their ethnicity. Thus, the percentages do not add up to 100% as some participants checked more than one ethnicity to describe themselves.

between Time 1 and Time 2 ($n$ =5). Lakehead University students received one bonus point towards a Psychology course mark for participation in each phase of the study (Time 1 and 2). This project received approval from Lakehead University's Research Ethics Board (REB) (see Appendix A for REB approval Letter).

**Study 2 Participants**

A total of 164 volunteers participated in the laboratory session. After exclusion criteria were applied, 126 participants (mean age = 20.75 $SD$ = 4.01) remained (for demographic variables after exclusion criteria see Tables 1 and 2). The same recruitment strategies and materials for Study 1 were used in this study with the exception that those recruited for Study 2 were asked to come into the laboratory. Students received 2 bonus points towards a psychology course mark for their participation in this study. No exclusionary criteria were used at recruitment and the same exclusion criteria for Study 1 were also used for Study 2. All participants in Study 2 also completed the Time 1 questionnaire in Study 1 and were invited to complete the Study 1 Time 2 questionnaire. Thus, all participants in Study 2 contributed questionnaire data to Study 1.

**Measures Study 1**

***Time 1 Questionnaire***

The Time 1 Questionnaire can be found in Appendix B and includes all the measures noted below (see Appendix B).

**Demographics.** The demographics portion of the Time 1 Questionnaire collected information on age, sex, ethnicity, menstrual cycle information (e.g., most recent and next predicted menstrual period), current health information, and psychiatric diagnoses. Additional

questions asked about recent caffeine and alcohol consumption, hours of sleep, and history of head injuries.

**Behaviour Rating Inventory of Executive Functioning-Adult Version (BRIEF-A).** The BRIEF-A is a self-report measure designed to capture executive functioning and self-regulation in one's everyday environment. It is comprised of 75 items with nine, non-overlapping clinical scales which make up two indices. The first index is called the Behavioural Regulation Index and is made up of the inhibit, emotional control, self-monitor, and shift scales. The second index is called the Metacognition Index and is made up of the plan/organize, initiate, task monitor, working memory, and organization of materials scales. The BRIEF-A has demonstrated evidence of reliability, validity, and clinical utility as an ecologically sensitive measure of executive functioning in individuals with a wide range of conditions (Roth et al., 2012).

For this study, items from four BRIEF-A individual scales, inhibit, shift, self-monitor, and emotional control scales, were used to represent response inhibition (inhibit), reversal learning (shift, self-monitoring), and emotional reactivity (emotional control), respectively. Participants were asked to evaluate their general behaviour with respect to the past two months with the following response options: 0 (never), 1 (sometimes), 2 (often), or 3 (always). For the individual scales, scores can range from 0 to 24 for the Inhibit scale, 0 to 30 for the Emotional Control scale, and 0 to 18 for the Self-Monitor and Shift scales. Higher scores on each scale represent more problems with the relevant behaviours. Internal consistency analysis of the BRIEF-A in the current study revealed a Cronbach's alpha of .92 ($N = 504$). For the individual scales, the Cronbach's alphas were: .734 (Inhibit), .809 (Shift), .808 (Self-monitoring), and .913 (Emotional control).

**Inhibitory Control Questions from the Effortful Control Subscale of the Adult Temperament Questionnaire (ATQ).** The ATQ was developed by Evans and Rothbart (2007) and includes 177 items tapping into effortful control, negative affect, extraversion, and orienting sensitivity. The effortful control subscale contains items about inhibitory control, activation control, and attentional control. For this project, only the 11 inhibitory control questions from the Effortful Control subscale were used as a measure of response inhibition (e.g., *If I want to, it is usually easy for me to keep a secret*). Participants indicate how much they believe each statement applies to themselves over the past two months on a scale from 1 (*extremely true*) to 7 (*extremely untrue*). Total scores can range from 11 to 77, with higher scores indicative of less inhibitory control (i.e., more problems with inhibitory control). Based on testing of 258 undergraduate students, the Inhibitory Control scale had an internal consistency of .65 (Evans & Rotherbart, 2007). The Cronbach's alpha for the ATQ Inhibitory control scale in the current study was .60 ($N$ = 535).

**Deferred Gratification Inventory (DGI).** The DGI, developed by Hoerger et al. (2011), contains 35 items that measure five domains of deferred gratification: food, physical pleasures, social interactions, money, and achievements (e.g., *I am able to control my physical desires*). Participants were asked to indicate how much they agree with each item on a scale of 1 (*strongly disagree*) to 6 (*strongly agree*), based on their behaviour over the past two months. Total possible scores range from 35 to 210, with higher scores indicating higher deferred gratification (i.e., fewer problems with inhibitory control in this area). In four studies conducted on large samples of adults, Hoerger et al. (2011) found evidence of construct validity in that the DGI correlated with a variety of other measures of self-control, and it met the conventional standards

for internal consistency ($\alpha > .90$) and test-retest reliability ($r = .90$). The Cronbach's alpha for the DGI in the current study was .904 ($N = 484$).

**Recent Spending and Saving Scale (RSSS).** The RSSS was developed by Pine and Fletcher (2011) and adapted from the inappropriate money behaviours questionnaire (Furnham & Okamura, 1999). The RSSS has 15 items aimed to measure spending behaviour (e.g., *In the last 7 days I have spent $25 or more than I needed to*). Participants evaluated their behaviour over the past two months and items were scored from 1 (*Strongly disagree*) to 6 (*Strongly agree*) with total scores ranging from 15 to 90. Higher scores indicate less control over spending. In a study using 443 adults, the RSSS yielded a good Cronbach's alpha (.89) (Pine & Fletcher, 2011). The Cronbach's alpha of the RSSS using the current sample was .88 ($N = 516$).

**Income Questions.** The income questions were four questions developed by the researchers to examine the degree to which individuals feel comfortable with their financial status and can afford life necessities. Questions (e.g., I am comfortable financially, I can afford the basic necessities such as food, rent) were rated on a scale from 1(*Strongly disagree*) to 6 (*Strongly agree*). Scores from this scale were used as a covariate to reduce potential confounds in analyses examining spending behaviour and behaviour related to choosing hypothetical monetary awards.

**Perseverative Thinking Questionnaire (PTQ).** The PTQ, developed by Ehring et al. (2011) is a 15-item scale that measures repetitive negative thinking (e.g., *I get stuck on certain issues and can't move on*). Items are rated from 0 (*never*) to 4 (*almost always*) and total scores can range from 0 to 60 with higher scores indicting higher repetitive negative thinking. Internal consistency was found to be excellent (.95), test re-test reliability was satisfactory (.65), and the PTQ was found to have substantial convergent validity based on its correlations with other

measures (Ehring et al., 2011; Lindstrom, 2010). For the purposes of this project, the PTQ was used as a self-report measure of reversal learning in daily life outside of the laboratory and participants rated items based on the past two months. Cronbach's alpha of the PTQ with the current sample was .96 ($N$ = 518).

**The Perth Emotional Reactivity Scale (PERS).** The PERS, created by Becerra and Campitelli (2013) is a 30-item measure that examines the activation, intensity, and duration of negative and positive emotional responses (e.g., I get frustrated easily, I feel positive emotions very intensely). Each item is rated from 1 (very unlike me) to 5 (very like me) and total scores can range from 15 to 75 for positive reactivity and 15 to 75 for negative reactivity. Higher scores indicate more reactivity. Here participants rated items based on the past two months. The PERS was found to have excellent internal reliability for both the negative (.94) and positive (.93) scales and convergent validity with several other scales measuring emotional reactivity (Becerra et al., 2017). Cronbach's alpha of the PERS in the current study was .86 ($n$ = 484).

**Major Life Altering Event Question.** This question asked participants to indicate if there has been a major life altering event in the past two months that has strongly affected their mood (e.g., death of parental figure, parental divorce, physical or sexual assault). Participants were asked to select "Yes" or "No" and then to specify the nature of the event. This question was used as a potential covariate to reduce the potential confound of a major life stressor on measures of emotional reactivity.

**The Behavioral Inhibition System (BIS) and Behavioural Activation System (BAS) Scales.** These measures were created by Carver and White (1994) on the theoretical basis that there are two general motivational systems that underlie behaviour: an approach system (BAS), and an avoidance system (BIS). The measure includes 20 items which respondents are asked to

rate on a scale ranging from 1 (very false for me) to 4 (very true for me). The seven BIS questions represent an avoidance or behavioural inhibition motivational-approach (e.g., Criticism or scolding hurts me quite a bit). The 13 BAS questions, on the other hand, represent appetitive motives or the tendency to move toward something. The BAS questions are subdivided into three different subscales: fun-seeking (4 items; e.g., I'm always willing to try something new if I think it will be fun), drive (4 items; e.g., I go out of my way to get things I want), and reward responsiveness (5 items; e.g., When I'm doing well at something I love to keep at it) subscales. High BIS scores are indicative of high avoidance (i.e., high inhibition), and high BAS scores are indicative of high approach (i.e., low inhibition). The three BAS subscales emerged empirically through validity testing and factor analyses. The BIS scale is highly correlated with measures of related constructs such as neuroticism (Elliot & Thrash, 2002). Both the internal consistency and test-retest reliability of the BIS/BAS scales range from .66 to .76 (Sutton & Davidson, 1997). Additionally, the BIS scale is relatively independent of the BAS subscales with correlations of -.12 with the Drive subscale, .28 with the Reward Responsiveness subscale, and -.08 with the Fun Seeking subscale (Carver & White, 1994). Reliability analysis on the current sample study when asked to evaluate their attitudes and behaviour over the past two months revealed Cronbach's alphas of .77 for the BIS ($N = 501$), and .84 for the BAS ($N = 489$).

**Barratt Impulsiveness Scale (BIS-11).** The BIS-11, created by Patton et al. (1995), is a 30-item scale constructed to measure the personality and behavioural construct of impulsiveness (e.g., I do things without thinking). Items are rated from 1 (*Rarely/Never*) to 4 (*Almost Always/Always*). Total scores can range from 30 to 120 with higher scores indicating more impulsivity. The BIS-11 was shown to have good internal consistency (.82) (Patton et al., 1995).

For the current sample when responding based on the past two months, the Cronbach's alpha was .84 ($N$ = 460).

**The Inhibitory Control Scale 48-hours (ICS-48).** This scale consists of 102 items from the BRIEF-A (22), the DGI (18), the RSSS (8), the PTQ (15), the PERS (18), the DERS (5), the BIS-11 (11), and the inhibitory control questions from the Effortful Control Subscale of the ATQ (5). These measures were described above. Items were selected to create four ICS-48 scales representing each of the four types of inhibitory control: Response Inhibition scale (24 items), Deferred Gratification (26 items), Reversal Learning (24 items), and Emotional Reactivity (28 items). Participants evaluated each item with respect to the past 48 hours using the following scale: 1 (*extremely untrue*) to 6 (*extremely true*). This 48-hour timeline was a novel way to use these questionnaires and allowed for an examination of state, or cycle phase effects, as opposed to trait. Thus, as part of the analyses for this study, the validity and reliability of the ICS-48 was assessed (see Results Section). Higher scores indicate less inhibitory control in the respective area. Higher scores on the ICS-48 Response Inhibition, Deferred Gratification, and Reversal Learning scales denote more problems with the respective type of inhibitory control. Higher scores on the ICS-48 Emotional Reactivity scale denotes greater emotional reactivity. The term "problems" is not used for this latter scale as some items capture emotional reactivity that is not necessarily problematic (e.g., "I have felt emotions very intensely"). To examine the difference in emotional reactivity for positive and negative emotions, two subscales were created: ICS-48 Emotional Reactivity: Positive emotions and ICS-48 Emotional Reactivity: Negative emotions. Items on the positive emotions subscale related to difficulty inhibiting positive emotional reactions (e.g., I have been reactive or expressive with positive emotions, I have gone from neutral to positive very quickly) and items on the negative emotions subscale related to difficulty

inhibiting negative emotional reactions (e.g., I have been emotionally upset easily, it has been hard to recover from frustration).

The Cronbach's alpha for the total scale was .96 for Time 1 ($N = 479$) and .97 for Time 2 ($N = 284$) and the test-retest reliability for the total scale was $r(247) = .77$. See Table 3 for internal consistency and test-re-test reliability for each scale.

**Additional Inhibitory Control "More Than Usual" Questions.** There were 13 additional questions created for the purposes of this study designed to measure whether participants consider their recent behaviours (over the past 48 hours) in the areas of response inhibition, deferred gratification, reversal learning, and emotional reactivity to be typical for themselves. For these items, participants rated the items on a scale from 1 (less than usual) to 5 (more than usual) (e.g., *I have been impulsive or uninhibited in a way that may have been negative*). This wording of "more/less than usual" was included to maximize sensitivity of the measure. These items were used to examine validity of the ICS-48 scales.

**Negative Impression Management (NIM)/Positive Impression Management scales (PIM).** These scales are included in the Personality Assessment Inventory (PAI) (Morey, 1991) to examine response validity. The NIM items are intended to detect respondents who are likely to present themselves in an exaggeratedly negative way while the PIM scale items are intended to detect respondents who are likely to present themselves in an exaggeratedly positive way (Morey, 2007). Both scales have been widely used and have highly established reliability and validity. The NIM Cronbach alphas have ranged from .63 to 74, with a test-retest reliability of .71 to .80 (Morey, 2007). Similarly, PIM Cronbach alphas range from .71 to 77, and test-retest reliability has ranged from .75 to .81. Both NIM and PIM scales accurately detected respondents that were told to malinger their responses either in a negative or positive manner from those who

were told to respond honestly with an 88.6% identification rate for the NIM and a 95.5% correct identification rate for the PIM. Furthermore, both scales correlate highly with other established measures that are intended to measure similar constructs. For example, the correlation between the NIM and the Minnesota Multi Phasic Personality Inventory F-scale ranges from .70 to .75. (Morey, 2007). For this current study, the Cronbach's alphas were .88 for NIM ($N = 483$), and .78 for PIM ($N = 472$). High scores on the NIM (total score > 13) and PIM (total score > 23) were used as post-hoc exclusion criteria to rule out participants with response biases that coincide with "faking bad" or "faking good" (e.g., Morey & Quigley, 2002; Peebles & Moore, 1998; see Participants section).

**Reproductive, Hormonal Contraceptive Use, and Menstrual Cycle History.** Women were asked to indicate their reproductive history (e.g., how many children have you given birth to?), their OC use history (e.g., Have you ever taken oral contraceptives? (yes/no)), and menstrual cycle history (e.g., at what age did you get your first period?). Questions regarding their most recent menstrual period and their predicted next menstrual period were also included and used to determine the menstrual phase of the participants at the time of participation (see Procedures section for how cycle phase was calculated for this study). Most of these items have been developed and used within our lab in past studies (e.g., Oinonen, 2009). Many of these measures were included to determine OC groups, and as possible covariates.

The remaining measures assessed gender, sociosexuality, reproductive history, and hormone-related symptoms (e.g., PMS, OC side effects) and were not used in the main analyses of this study. Instead, this data was collected for a separate project (Keir & Oinonen, 2022). The following questionnaires were included: BEM Sex Role Inventory (BSRI), 20 feminine and 20 masculine items (Bem, 1974); Open Sex Role Inventory (OSRI), 20 feminine and 20 masculine

items (Malloy, 2010); Multidimensional Sociosexuality Inventory (MDSOI), 25 items (Jackson & Kirkpatrick, 2007); DSM-5-Based Screening Measure of Premenstrual Symptoms, 33 items, (Richards & Oinonen, 2021); PCOS Questionnaire, 5 items (Pederson et al., 2007); Physical Symptoms from OCs Questionnaire, 26 items (Oinonen 2009); Emotional Symptoms from OCs Questionnaire, 26 items (Oinonen 2009). See Appendix C for a full description of these additional questionnaires.

***Time 2 Questionnaire***

The Time 2 Questionnaire (see Appendix D) was completed by participants approximately two-weeks after completing the Time 1 Questionnaire (see Procedure). This questionnaire allowed confirmation of some demographic information (e.g., age), and inquired about any changes to hormonal contraceptive use, or medication in the past two weeks. It included questions confirming current OC or other hormonal contraceptive use, and cycle phase (e.g., date of last menstrual period and predicted first day of next menstrual period). The questionnaire also included the ICS-48 Scale and the DSM-5-Based Screening Measure of Premenstrual Symptoms (Richards & Oinonen, 2021), both described above.

***Follow-up Questionnaire***

The follow-up Questionnaire was completed by female participants who completed the Time 2 questionnaire to collect information on their menstrual cycle. This final questionnaire consisted of two questions related to the woman's most recent menstrual period and was used to determine the backwards cycle count (Jochle, 1973).

## Measures Study 2

### *Laboratory Measures*

**The Positive and Negative Affect Schedule (PANAS).** The PANAS was developed by Watson et al. (1988) and consists of two scales: positive affect (PA) and negative affect (NA) (see Appendix E). High positive affect reflects a state of high energy, full concentration, and pleasurable engagement; whereas low PA is characterized by low energy and lack of interest or excitement. High NA reflects subjective distress and unpleasant mood states such as anger, contempt, and disgust while low NA indicates a lack of distress, fear, or irritability. The PA PANAS items include attentive, interested, alert, excited, enthusiastic, inspired, proud, determined, strong, and active, while the PANAS scale for NA includes the items distressed, upset, guilty, scared, hostile, irritable, ashamed, nervous, jittery, and afraid. Participants rate each adjective on a five-point response scale ranging from 1 (very slightly or not at all) to 5 (extremely). Participants were asked to indicate how they felt "at the moment" they were completing the surveys. The PANAS scales have been shown to be largely uncorrelated with one another and to have alpha reliabilities ranging from .84 to .90 for PA and from .84 to .87 for NA (Watson et al., 1988). For this sample, the Cronbach's alphas were .89 and .86 for the PA and NA scales, respectively. The PANAS scales have been found to be high in convergent and discriminant validity (Watson et al., 1988). For the current study, this scale was used to gather information about participants' affect both before and after each mood induction to examine emotional reactivity. Also, a PANAS NA change score was created to capture emotional reactivity across the laboratory session. To create this score, the NA score at baseline was first subtracted from the NA score after sad mood induction. The NA score after the happy induction

was then subtracted from NA score after the fear induction. The mean of those two difference scores was used as the NA change score. Validity of this scale is discussed in the results section.

**Mood Induction Stimuli.** The mood induction stimuli consisted of three separate emotional videos. The videos were a compilation of different emotional videos and slideshows of emotional pictures that were chosen based on their ability to elicit sadness, happiness, and fear. The videos and stimuli were identified using popular search engines such as Google and YouTube using general search terms such as "saddest videos", "happiest videos" and "scariest videos" and more specific search terms such as: "people laughing", "people crying", and "haunted houses". The pictures for the slideshow were chosen for this study from the International Affective Picture System (IAPS) (Lang et al., 2005) based on their scores of arousal and valence. The videos and pictures were edited using iMovie on a Macintosh computer. The stimuli within each emotion induction transitioned into one another resulting a 5-minute video and slideshow compilation for each emotion induction.

Mood congruent music was also chosen to play during each of the three mood induction videos. Music chosen was based on Google and YouTube searches for sad, happy, and fear-inducing music. Less popular music was selected to decrease the likelihood that participants had previously heard the songs and had existing associations or experience with them. The music was played on loop during the emotional videos and continued playing throughout the first two inhibitory control tasks. There is evidence of validity for these mood inductions as they elicited the expected emotional reactions in a previous study in the Health Hormones and Behaviour Laboratory (Keir & Oinonen, 2016b). Evidence of validity for the mood inductions in the present study is also presented in the results section.

**Emotional Implicit Association Task (EIAT).** The Implicit Association Test (IAT) was created by Greenwald et al. (1998) to measure the strength of automatic associations. One of the key features of the IAT is that it is purported to measure unconscious and implicit associations without the influence of self-presentation or social desirability (Greenwald et al., 2003). An Emotional IAT (EIAT) was created as a measure of emotional reactivity as it measures whether individuals implicitly associate themselves with positive or negative emotions. The EIAT was adapted from both the Anxiety Implicit Association task and the Depression Implicit Association Task used for Project Implicit Mental Health at Harvard University (Retrieved from https://implicit.harvard.edu/implicit/takeatest.html ). Because this task is novel and relies on assumptions about associations, it was used in this study as a supplemental/exploratory measure of emotional reactivity.

An example of an EIAT item appears in Figure 1 (see Figure 1). On the EIAT, participants were instructed to classify words into categories using the "e" and "i" computer keys as fast as they could while making as few mistakes as possible. The categories were "Me" (which included words such as "me", "self", "I", and "my"), "Not me" (which included words such as "they", "them", "other", and "not me"), "Positive" (which included words such as "happy", "joyful", "content", "cheerful", "calm", "relaxed", "serene", and "tranquil"), and "Negative" (which included words such as "sad", "miserable", "depressed", "gloomy", "panicked", "scared", "anxious", "frightened"). Words appeared one at a time in the middle of the screen, and participants were to classify each word into one of four categories. For example, if the word "gloomy" appeared in the middle of the screen, the participant would classify that word in the "Negative" category, and if the word "they" appeared in the middle of the screen, the participant would classify that words into the "Not me" category.

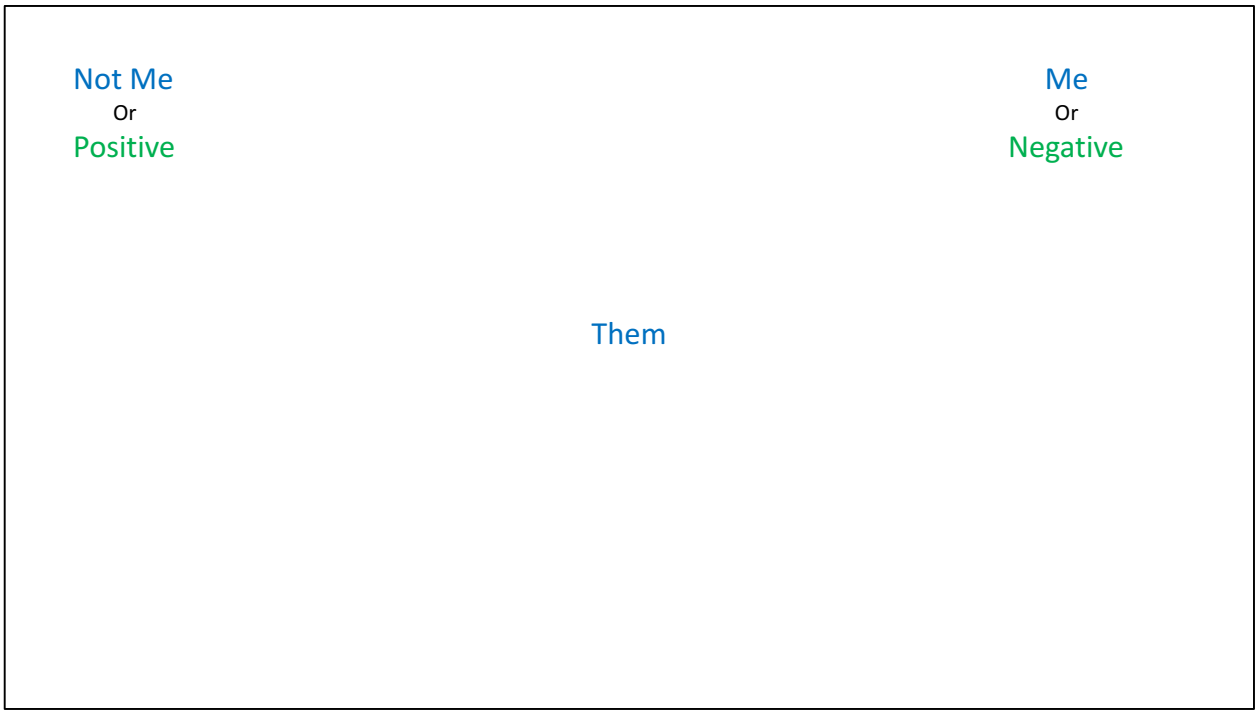
Participants were told which categories the words belonged to and practiced correctly categorizing target words. One of “Me” or “Not me” was displayed on the right-hand side of the screen and the other was on the left-side. Similarly, one of “Positive” or “Negative” was on the right side and the other was on the left-hand side of the screen. A target word appeared in the bottom-center of the screen (e.g., “gloomy” or “they”) and the participant was told to press the “i” key if the target word corresponds to the category on the right, or the “e” key if the target category responds to the word on the left. After the practice, the trial began.

The categories were counterbalanced so that the categories “Not Me or Positive”, “Not Me or Negative”, “Me or Positive”, and “Me or Negative” appeared on the right and left side for an equal number of trials. Participants were asked to always use the right hand to press the “i” key and the left hand to press the “e” key. If the participant correctly categorized the word, another word for the participant to categorize appeared. If the participant incorrectly categorized the word, a red “X” appeared in the bottom right corner of the screen, and the participant had to correctly categorize the word to move on to the next word. Each block required the participant to categorize 20 words and each participant completed eight blocks (160 trials). Two blocks had the target categories “Me and Positive”, two blocks have the target categories “Me and Negative”, two blocks had the target categories “Not Me and Positive”, and two blocks had the target categories “Not Me and Negative”. The target categories switched after every block so that participants did not have the same target categories two blocks in a row.

The EIAT was scored in two ways, based on response times and accuracy. The quicker a respondent correctly categorizes a word and the more correct categorizations they make, the more strongly that respondent is thought to have made an association between the word and the category. More specifically, because the target categories were always either “Me” or “Not me”

**Figure 1**

*Example of a Trial on the Emotional Implicit Association Task (EIAT)*




Note. This figure demonstrates a trial on the EIAT. The target word "Them" appears in the middle of the screen. This target word belongs in the category of "Not me" which is on the left side. Thus, the correct response would be "e" (key on left side of keyboard). If the target word belonged to the "Positive" category (e.g., "Happy"), the correct answer would also be "e". If the target word belonged to the "Me" category (e.g., "Self") or the "Negative" category (e.g., "Gloomy"), the correct answer would be "i" (key on right side of keyboard). More correct responses and faster response time when categorizing negative emotion words when the "Negative" and "Me" categories are paired, is indicative of stronger associations between negative emotion words and the self.

paired with “Positive” or “Negative” emotion words, the faster a respondent correctly associates negative emotional words to the “me and negative” category, the more strongly they associate negative emotions with themselves. Because the EIAT is used to assess implicit associations between certain emotions and the self, it is often used to determine if individuals implicitly associate themselves with negative or positive emotions. In this study, it was used as a measure of emotional reactivity because it was completed after three mood induction (sad, happy, or positive). Thus, it would be expected that those with higher negative emotional reactivity would self-associate with negative emotions after the negative mood inductions. This was a novel way to use the EIAT as it has never been used as a measure of emotional reactivity after a mood induction. Also, hormonal effects on performance on this task have not been explored in previous studies. For this sample, the mean RT was $M = 0.79$ ms ($SD = 0.16$) and the mean correct score was $M = 13.76$ (86% correct) ($SD = 1.61$). Also for this sample ($N = 162$), the Cronbach’s alpha for the total correct score was 0.90.

Consistent with previous IAT research (Greenwald et al., 1998; Greenwald et al., 2003), difference scores for response times and correct scores were created. A speed of negative emotional association score was calculated by subtracting the mean RT when correctly associating positive words with the self (when the self and positive categories were paired) from the mean RT when correctly associating negative words with the self (when the self and negative categories were paired) [ [i.e., self.neg RT – self.pos RT]. Lower difference scores indicate quicker self-associations with negative emotion words relative to positive emotion words and suggest higher negative emotional reactivity. Examining these scores across the different mood primes further evaluates negative emotional reactivity. Similarly, an accuracy of negative emotional association score was calculated by subtracting the total correct score when

associating positive words from the total correct score when associating negative words with the self [i.e., self.neg correct – self.pos correct]. Higher difference scores indicate more correct self-associations with negative emotion words relative to positive emotion words and suggests higher negative emotional reactivity. For this sample, the mean accuracy of negative emotional association was $M$ = -0.32 ($SD$ = 2.42) and the mean speed of negative emotional association was $M$ = 0.31 ms ($SD$ = 0.27).

**GoNogo Task.** The GoNogo task for this study was adapted from the task used by Albert et al. (2010) as a measure of response inhibition. On this task, two capital letters, either an "*M*" or a "*W*" were displayed for 200ms in yellow Ariel font to stand out clearly from the black background. The participants were asked to press the space bar as quickly as possible when they saw the letter "*M*" appear and to withhold pressing the space button whenever they saw the letter "*W*" appear. Outcome measures included response times and accuracy [i.e., errors of commission (i.e., responding to an item that required non-response) and errors of omission (i.e., not responding to an item that required a response)]. However, only errors of commission (EOC) were examined in this study. Albert et al. (2010) concluded that it may be more difficult for individuals to inhibit a pre-potent response during positive mood contexts. Also, previous research conducted in our lab has found that: (a) OC users make more errors of commission compared to men on a GoNogo task after positive mood induction and (b) OC users with current negative mood side effects made less errors of commission compared to OC users with no negative mood side effects on a GoNogo task after sad mood induction (Keir & Oinonen, 2016a). Thus, performance on this task may differ as a function of emotion induction type (positive or negative). Error of commission scores could range from 0 to 44 with higher errors of commission indicating lower response inhibition. For this sample, the overall mean correct score

was 27.72 (*SD* = 8.54) (63% correct). Also for this sample, Cronbach's alpha for the total correct score (i.e., not the response times) was 0.91.

**Probabilistic Reversal Learning (PRL) Task.** The PRL task is modeled after the task used in Evans and Hampson (2015). Participants viewed three pairs of common neutral objects (e.g., an apple and a banana, a tea cup and a sock, a maple tree and a telephone) on a white background one at a time. They were then asked to choose one of the objects in each pair by pressing the "I" key for the object on the right or the "E" key for the object on the left. Participants were given feedback after each response by gaining 100 points if the selection was correct or losing 100 points if the selection was incorrect. Participants were not provided any information about which object to select and were required to use the feedback (correct, or incorrect) to make their next selection. Objects were shown for 2300ms, feedback was shown for 900ms, and a fixation cross in between stimuli presentations appeared for 300ms as per Evans and Hampson (2016). After 20 trials, the reinforcement contingencies switched on two of the three pairs so that the other item in the pair was reinforced more frequently.

To increase the difficulty level and avoid a ceiling effect, feedback was given in a probabilistic fashion so that on the first condition 90% of the feedback given was correct and 10% of the feedback given was incorrect. For the next condition, the reinforcement contingency changed to 80% correct and 20% incorrect. The participants' total points were tallied and displayed at the top right of the screen throughout the task. Participants were not told which item in the pair was correct and instead were told to learn through trial and error. However, they were told that the correct object may change over the course of the task. A measure of accuracy was calculated with a separate accuracy score for the acquisition (the first 20 trials) and reversal

learning phases. For each of the two reversing pairs, acquisition accuracy was the number correct in the 10 trials immediately before reversal and reversal accuracy was the number correct in the 10 trials immediately after the reversal. Reversal and acquisition accuracy represents the number of correct selections regardless of the feedback given. Scores ranged from 0 to 20 and higher scores indicate better reversal learning. For the purposes of this study, a 'problems with reversal learning score' was also calculated by subtracting each participant's reversal learning accuracy score by the total possible score (20). This created a score where higher scores represented poorer performance on the task (i.e., more problems with reversal learning). Creating this score allowed ease of interpretation and comparison relative to the other laboratory scores wherein higher scores represent more problems with the respective type of inhibitory control.

Due to a coding error on this task, the 80:20 contingency was not used in the analysis and only data from the 90:10 contingency was used. The overall mean for acquisition accuracy in this sample was 17.11 (*SD* = 2.90) (86% correct) and the overall mean for reversal accuracy was 11.89 (*SD* = 3.57) (59% correct). Also for this sample, Cronbach's alpha was 0.70 for all trials, .73 for the acquisition trials, and .55 for the reversal trials (*N* = 162).

**Delay Discounting Task.** This measure of deferred gratification was created by Mitchell et al. (2005). Participants were instructed to select between two options that involve a sum of money and a delay of hypothetical receipt. For example, participants chose between $5 today, or $20 in one month. On the trials labelled "WANT" participants chose which option they would want for themselves. On the trials labelled "DON'T WANT" participants chose which option they would not want for themselves. On the trials labelled "SOONER" the participants chose which sum would be delivered sooner and on the trials labelled "LARGER" the participants

chose which sum is larger. The SOONER and LARGER trials were used as control trials to ensure the participants were paying attention and understood the task instructions. One half of the trials were the "WANT" trials, and the other trials (DON'T WANT, SOONER, and LARGER) were evenly distributed amongst the remaining half of the trials.

On every trial, there were two options and the delayed option was one of six dollar amounts ($1, $2, $5, $10, $20, $100) at one of five future delays (one week, two weeks, one month, three months, or six months). The immediate options were a lesser (i.e., discounted) amount that would be hypothetically received "today". The discounted amount was randomly assigned to be 70, 85, 90, or 95% of the delayed amount. Mitchell et al. (2005) chose these discount amounts based on pilot studies which indicated that this range results in individuals having to think over their decision as this discount range is considered a difficult decision for most. Participants used the "I" key to select the option on the right and the "E" key to select the option on the left. The delayed and immediate choices appeared on the left and right side in randomized order. To score this task, the impulsive choice was given 1 point. Scores ranged from 0 to 44 with higher scores indicating less deferred gratification (i.e., more impulsive choice). In this sample, the mean score was 21.16 (*SD* = 11.91) (48.09% of answers were the impulsive choice). Also for this sample, Cronbach's alpha for all items was 0.95.

**Software used for Presentation of Stimuli.** PsychoPy Psychology Software Python version 1.8 was used to create and present the EIAT, the GoNogo task, the Probabilistic Reversal Learning Task, the Delay Discounting Task as well as the PANAS. PsychoPy was also used to present the mood inductions and play the mood induction music.

**Procedure: Study 1**

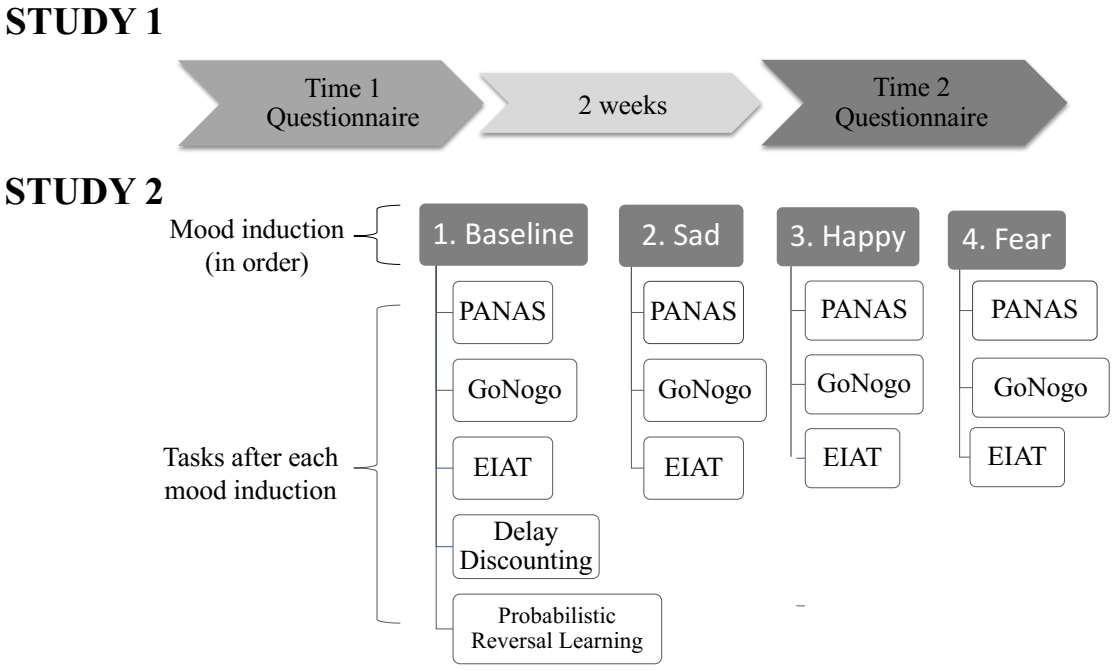
Following recruitment (see Appendix F for recruitment emails and Appendix G for Recruitment posters), participants were directed to a secure website within surveymonkey.com where they were provided with the Letter to Participants A (see Appendix H) that included a brief synopsis of the study and the details of what participation would entail and a Consent Form (See Appendix I) that explained the risks and benefits of participation. Participants were then directed to complete the online Time 1 Questionnaire (Appendix B). The entire questionnaire took approximately 40 to 60 minutes to complete. Participants were then provided with the Debriefing Form (see Appendix J) and told that they would be contacted via email in two weeks to complete the Time 2 Questionnaire (Appendix D). See Figure 2 for a flow chart of the procedure for Study 1 and 2.

Participants were emailed in the morning (between 8am to 10am) 13 days after their participation in the Time 1 questionnaire and asked to complete the Time 2 questionnaire within 48 hours. They were also given another email reminder on the morning of the 14$^{th}$ and 15$^{th}$ day, thus providing the participants with a 48-hour window and three reminders to complete the Time 2 questionnaire. If a participant did not complete the Time 2 questionnaire within the 48-hour time frame, they were contacted again one month later (i.e., 43 days after the completion of the Time 1 questionnaire) and invited to complete the Time 2 questionnaire again within 48-hours. These participants also received three reminders. The two-week timeline between the Time 1 and Time 2 questionnaires was chosen to ensure that women were captured in two different phases of their menstrual cycle.

Prior to beginning the Time 2 questionnaire, participants were provided with the Letter to Participants B (see Appendix H) which included a brief synopsis of the study and what participation would entail. The Time 2 questionnaire was also completed online and took

**Figure 2**

*Procedure for Study 1 and Study 2*




Note. For Study 1, participants completed the Time 1 questionnaire which collected data on self-reported inhibitory control over the past two months and the past 48-hours. After two weeks, participants completed the Time 2 questionnaire which primarily focused on self-reported inhibitory control in the past 48-hours. For Study 2, participants completed several laboratory tasks measuring inhibitory control at baseline (i.e., no mood induction) and after three mood inductions (sad, happy, fear) in the order displayed above. Study 2 participants also completed the Time 1 questionnaire on the same day. Many participated in both Study 1 and 2.

approximately 20 to 35 minutes. Upon completion, participants were informed via the Debriefing Form (see Appendix J) of the main purpose of the study and they were provided with resources to contact support for emotional or mental health should they wish/need to do so.

All responses to the questionnaires were anonymous. To ensure anonymity, a six-character coding system was used to link the Time 1 questionnaire data to the Time 2 questionnaire data using answers to personal questions. For example, participants were asked "what is the first initial of your middle name?". This generated a code specific to each individual without linking data to identifying information. To be contacted for the Time 2 questionnaire, participants were asked to provide their email address and this information was stored separately from their data. Also, participants in a psychology course were directed to a separate link and asked to provide their name, student number, course code, and email address to collect bonus points for their participation, if applicable.

**Procedure: Study 2**

After signing up for an appointment time via SONA (for participants eligible for bonus points) or via email correspondence (for participants not eligible for bonus points), participants came into the laboratory. They were then directed by the researcher to a private distraction-reduced room with a computer. After reading the Letter to Participants (See Appendix H) and the Consent form (see Appendix I), participants began the laboratory tasks.

First, the participants completed a PANAS (Appendix E) to collect baseline affect scores prior to mood inductions. They then completed the GoNogo task, the EIAT, the Delay Discounting task, and the Probabilistic Reversal Learning Task. Participants then underwent the first mood induction which was always the sad mood induction video paired with mood congruent music. Immediately after the mood induction, participants completed the PANAS, and

then the GoNogo task and the EIAT. Participants then underwent the second mood induction, which was always the happy mood induction, followed by the PANAS, the GoNogo task, and the EIAT. Finally, the third mood induction (i.e., fear) was administered followed by the PANAS, the GoNogo task and the EIAT. Before each task, participants were provided with brief instructions on how to complete the task and were required to indicate that they understood the instructions before continuing.

The order of negative-positive-negative mood inductions (i.e., sad, happy, fear) was chosen to increase the likelihood of seeing greater mood variability from one induction to the next and to prevent the participant from having to view two negative inductions in a row. After all the laboratory mood inductions and tasks, participants viewed a brief comedic video. The video was made up of clips of animals playing with other animals or engaging in playful behaviour. The purpose of this video was to ensure mood from the fear condition dissipated and to end the laboratory session on a positive, rather than negative mood induction.

After the laboratory tasks were complete, the participant directed to complete the Time 1 questionnaire (Appendix B). Upon completing the session, participants were given Debriefing Form (Appendix J) that informed participants that they were also invited to complete the Time 2 questionnaire (Appendix D) in two weeks. [Note: data from Time 1 and Time 2 questionnaires was used for Study 1.]

A follow-up email was sent out to all female participants following their participation in the Time 2 portion of the study to confirm the start date of their next period based on the estimate they provided. They were emailed once per week for four weeks to obtain this information. This confirmation allowed for a more accurate method of determining cycle phase during each session.

**Cycle Phase Counting**

To determine menstrual cycle days and phases, both the backward and forward counting method was employed for this study. The backward counting method controls for variability in menstrual cycle length (Wilcox et al., 2000). Since most of the variation in cycle length occurs due to variation in the follicular phase, the reverse count can be more accurate for the latter half of the cycle up to ovulation (Blake et al., 2016; Jochle, 1973; Penton-Voak et al.., 1999). In the backward counting method, the number of days between the date of the questionnaire completion and the woman's first day of her next menstrual cycle is calculated. For example, if the participant completed the initial questionnaire on January 1, 2019 and on the follow-up questionnaire reported that the first day of her most recent menstrual period was January 10, 2019, her cycle day on the day of the initial questionnaire would be -9 (i.e., the mid-luteal phase). Day -1 is the day before the first day of menstruation. Female participants also rated their confidence that their estimate of their last menstrual period was accurate. When more appropriate, the forward count method was used to calculate cycle phase. For example, a forward count was used for women who were currently menstruating and indicated the number of days they had menstruated for. Thus, if they indicated they had been menstruating for 3 days on the date of the initial questionnaire they were determined to be on cycle day 3 (i.e., early follicular phase). The forward count method was typically used for the first half of the cycle (i.e., up until day 13 for a 28-day cycle), if no information was provided to allow for a backwards count, or if the confidence level was low for the backwards count date (i.e., less than 50% confident) and high for the forward count date (i.e., 80% confident or higher).

After female participants completed the Time 1 and 2 Questionnaires, they were contacted by email at one-week intervals for four weeks after the final session and instructed to

follow a link to indicate the first day of their most recent menstruation. The information in this Follow-up questionnaire was used to determine the backwards count and cycle phases for Time 1 and Time 2.

Naturally cycling women were categorized into one of six cycle phases: Early follicular, mid-follicular, late-follicular, early luteal, mid luteal, late luteal. Table 1 displays the sample size for each cycle phase. Due to low sample size in many of the phases, naturally cycling women were instead categorized into two broader phases: follicular or luteal phase. These phases capture women in the early, mid, or late stages of the respective phase. Thus, some hypotheses related to portions of the follicular or luteal phase had to be examined with the overall follicular or luteal phase.

## Results

### Reliability of ICS-48

Because the ICS-48 is a novel scale, the reliability and validity of the scales were examined. Internal consistency was examined via Cronbach's alpha for each of the four subscales for Time 1 and Time 2. Each subscale yielded high internal consistency (range of .81 to .97) (see Table 3).

Test-retest reliability over a mean of 16.67 days ($SD$ = 45.7) days was examined via bivariate correlations between the scale scores for Time 1 and Time 2 for each of the four scales (see Table 3). A scale is often considered to have *good* test-retest reliability if the Pearson correlation coefficient is above .7 and the $p$-value is less than .05 (Vilagut, 2014). However, given that the current study is examining variability in test scores over time, the measures were specifically constructed to capture variability over this period. Thus, excellent test-retest

**Table 3**

*Internal Consistency (Cronbach's Alpha) and Test-Retest Reliability (r) of the Inhibitory Control Scale 48-hours (ICS-48) Scales*

| ICS-48 Scale | Cronbach Alpha (α) | | Test-Retest Reliability | |
|---|---|---|---|---|
| | Time 1 ($N$ = 479) | Time 2 ($N$ = 284) | $r$ | $p$ ($N$ = 247) |
| Response Inhibition | .90 | .91 | .72 | <.001 |
| Deferred Gratification | .81 | .84 | .53 | <.001 |
| Reversal Learning | .97 | .97 | .66 | <.001 |
| Emotional Reactivity | .90 | .90 | .68 | <.001 |
| Negative emotions | .96 | .95 | .70 | <.001 |
| Positive emotions | .94 | .85 | .56 | <.001 |
| Total ICS-48 score | .96 | .97 | .77 | <.001 |

Note. 14-day test-retest reliability ($M$ = 16.67 days, $SD$ = 45.7).

reliability above .80 is not necessarily expected on these measures, but one in the range of .40 to .80 seems ideal. For the ICS-48 Scales in this study, the correlations ranged from .53 to .77.

**Validity of ICS-48 and Laboratory Measures**

To examine the validity of the subscales of the ICS-48 and the laboratory measures of inhibitory control, bivariate correlations were run to examine correlations between the ICS-48 scales and the laboratory measures of inhibitory control and both similar (convergent validity) and dissimilar (divergent validity) measures (see Tables 4 to 7 for correlations for self-report and lab measures of the four types of inhibitory control). Consistent with past research suggesting typically low concordance between performance-based and self-report measures of executive functioning (Short et al., 2016), there was a small effect size significant correlation between lab and self-report measures for only one of the four inhibitory control factors, response inhibition. However, medium to large effect size correlations were often found between self-report measures of inhibitory control. See Appendix K to see bivariate correlations between all self-report and laboratory measures.

The ICS-48 Response Inhibition scale and Errors of Commission on the GoNogo Laboratory task (laboratory measure of response inhibition), both demonstrated convergent validity through significant positive correlations with other self-report measures of inhibition and impulsivity (e.g., BRIEF-A inhibitory control score, Barratt Impulsivity total score). Effect sizes were large for the ICS-48 Response Inhibition scale and small for the Errors of Commission scores. The self-report and lab measures had a small effect size correlation with each other (see Table 4).

The ICS-48 Deferred Gratification subscale demonstrated convergent validity through significant positive correlations (often of large effect size) with other self-report measures of

deferred gratification (e.g., DGI, RSSS). The laboratory measure of deferred gratification (Impulsive Choice score) did not correlate with any of the self-report measures of deferred gratification (see Table 5).

The ICS-48 Reversal Learning scale demonstrated convergent validity through significant positive correlations with other self-report measures of reversal learning and perseverative thinking (e.g., PTQ, BRIEF-A Shift scale), yet it was not significantly correlated with the laboratory measure of reversal learning (see Table 6). The laboratory measure of reversal learning did not correlate with any of the self-report measures of reversal learning.

The ICS-48 Emotional Reactivity scale demonstrated convergent validity through significant large effect size positive correlations with other self-report measures of emotional reactivity (e.g., BRIEF-A Emotional Control subscale, PERS). However, it did not demonstrate significant correlations with the laboratory emotional reactivity task, the EIAT (see Table 7). Although the EIAT measures did not correlate with the ICS-48 Emotional Reactivity scale, the EIAT accuracy of negative emotional associations score was positively correlated with other self-report measures of emotional reactivity (e.g., PANAS NA, BRIEF-A Emotional Control subscale). The EIAT speed of negative emotional associations score also demonstrated convergent validity through small effect size correlation with the accuracy of negative emotional association score and with an item measuring the extent to which one regrets emotional reactions (see Table 7).

**Validity of Mood Induction**

To investigate the validity of the mood inductions, two sets of paired sample *t*-tests were conducted to examine changes in PANAS PA and PANAS NA scores after each induction (i.e., comparisons with baseline and with affect after the previous mood induction). As indicated in

**Table 4**

*Convergent (and Divergent) Validity for Response Inhibition Measures: Pearson Correlations*

| | ICS-48 Response Inhibition (Self-Report) | | | Errors of Commission (Laboratory) | | |
|---|---|---|---|---|---|---|
| | *N* | *r* | *p* | *N* | *r* | *p* |
| ICS-48 Response Inhibition Scale | 479 | 1 | | 157 | .275** | .001 |
| BRIEF-A Inhibitory Control Scale | 469 | .614*** | <.001 | 157 | .205* | .010 |
| BRIEF-A Self-Control Scale | 472 | .542*** | <.001 | 155 | .175* | .029 |
| Adult Temperament Questionnaire Items[a]: | 479 | .586*** | <.001 | 162 | .151[t] | .055 |
| Uninhibited in negative way | 479 | .346*** | <.001 | 161 | -.039 | .626 |
| Uninhibited in positive way | 476 | .100* | .029 | 161 | .064 | .418 |
| Said something regretful | 478 | .340*** | <.001 | 160 | .086 | .279 |
| Baratt Impulsivity Scale | 429 | .618*** | <.001 | 139 | .210* | .013 |
| Behaviour Inhibition Scale (divergent) | 464 | .019 | .688 | 154 | .137[t] | .090 |

Note. Errors of Commission based on a GoNogo task. Except for the BIS, high scores on each measure reflect lower inhibitory control (i.e., more problems with response inhibition). For the BIS, higher scores indicate higher inhibition. [a] refers to items from the Response Inhibition "more than usual" Scale. [t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table 5**

*Convergent (and Divergent) Validity for Deferred Gratification Measures: Pearson Correlations*

| | ICS-48 Deferred Gratification (Self-Report) | | | Impulsive Choice (Laboratory) | | |
|---|---|---|---|---|---|---|
| | *N* | *r* | *p* | *N* | *r* | *p* |
| ICS-48 Deferred Gratification Scale | 478 | 1 | | 153 | .030 | .713 |
| Deferred Gratification Inventory | 431 | -.693*** | <.001 | 146 | -.043 | .607 |
| Recent Spending and Saving Scale | 460 | .570*** | <.001 | 149 | .076 | .355 |
| BAS Total | 455 | .052 | .269 | 153 | .103 | .207 |
| Baratt Impulsivity Scale | 429 | .547*** | <.001 | 140 | .107 | .207 |
| Items[a]: | | | | | | |
| Could not resist temptation | 475 | .258*** | <.001 | 162 | -.071 | .368 |
| Could not resist enjoyment despite negative long term consequences | 475 | .304*** | <.001 | 161 | -.028 | .161 |
| Could not resist enjoyment despite positive outcome if resisted | 474 | .235*** | <.001 | 160 | -.066 | .407 |
| Behaviour Inhibition Scale (BIS) total (divergent) | 463 | .108* | .020 | 155 | -.064 | .431 |

Note. Except for the BIS and DGI, high scores on each measure are indicative of lower inhibitory control (i.e., more problems with deferred gratification). For the DGI, higher scores indicate more inhibition (i.e., more deferred gratification) and for the BIS, higher scores indicate more inhibition. [a] refers to items from the Response Inhibition "more than usual" Scale. [t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table 6**

*Convergent and Divergent Validity for Reversal Learning Measures: Pearson Correlations*

| | ICS-48 Reversal Learning (Self-Report) | | | Problems with Reversal Learning (Laboratory) | | |
|---|---|---|---|---|---|---|
| | *N* | *r* | *p* | *N* | *r* | *p* |
| ICS-48 Reversal Learning Scale | 477 | 1 | | 153 | -.027 | .739 |
| BRIEF-A Shift Scale | 472 | .491*** | <.001 | 162 | .002 | .976 |
| Perseverative Thinking Questionnaire | 464 | .773*** | <.001 | 154 | -.070 | .390 |
| Baratt Impulsivity Scale | 427 | .414*** | <.001 | 141 | -.124 | .143 |
| Items[a]: | | | | | | |
| Had difficulty being flexible when problem solving | 476 | .401*** | <.001 | 163 | .077 | .327 |
| Had difficulty dealing with changes | 476 | .473*** | <.001 | 162 | .107 | .174 |
| Became frustrated when trying to change my behaviour or learn new things | 475 | .407*** | <.001 | 163 | -.023 | .773 |
| Behaviour Activation Scale (BAS) total (divergent) | 452 | -.104* | .027 | 154 | -.054 | .505 |

Note. High scores on each measure is indicative of lower inhibitory control (i.e., more problems with response inhibition). [a] refers to items from the Response Inhibition "more than usual" Scale. [t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table 7**

*Convergent and Divergent Validity for Emotional Reactivity Measures: Pearson Correlations*

| | ICS-48 Emotional Reactivity (Study 2) | | | EIAT accuracy of neg. emotional associations (Study 2) | | | EIAT speed of neg. emotional associations (Study 2) | | |
|---|---|---|---|---|---|---|---|---|---|
| | *N* | *r* | *p* | *N* | *r* | *p* | *N* | *r* | *p* |
| ICS-48 Emotional Reactivity Scale | 474 | 1 | | 153 | .126 | .120 | 152 | .011 | .891 |
| PANAS NA | 153 | .361*** | <.001 | 163 | .163* | .037 | 162 | .091 | .248 |
| EIAT accuracy of neg emotional associations | 153 | .126 | .120 | 163 | 1 | | 162 | -.247** | .002 |
| EIAT speed of neg emotional associations | 152 | .011 | .891 | 162 | -.247** | .002 | 162 | 1 | |
| BRIEF-A Emotional Control Scale | 456 | .626*** | <.001 | 157 | .140[t] | .080 | 156 | .061 | .448 |
| Perth Emotional Reactivity Scale Negative Scale | 456 | .639*** | <.001 | 150 | .053 | .521 | 149 | .035 | .668 |
| Items[a]: | | | | | | | | | |
| Been reactive neg emotions | 473 | .348*** | <.001 | 161 | .079 | .322 | 160 | -.070 | .382 |
| Been reactive pos emotions | 473 | .127** | .006 | 160 | .216** | .006 | 159 | -.020 | .803 |
| Been reactive and regretted it | 470 | .342*** | <.001 | 160 | .199* | .012 | 159 | -.165* | .038 |
| PANAS PA | 153 | -.085 | .295 | 163 | -.017 | .826 | 162 | .091 | .248 |
| PERS Positive Scale | 448 | .022 | .641 | 153 | .035 | .666 | 152 | .092 | .258 |
| Behaviour Activation Scale (Divergent) | 450 | .036 | .452 | 153 | .043 | .602 | 152 | <.001 | .996 |

Note. EIAT = the Emotional Implicit Association Task. EIAT speed scores = self.neg RT – self.pos RT. EIAT accuracy scores = self.neg correct – self.pos correct. For EIAT speed of neg emotional associations, lower scores indicate more reactivity. For the other measures, high scores indicate lower inhibitory control (i.e., more emotional reactivity). PANAS NA = Negative Affect score on the Positive and Negative Affect Schedule (PANAS) and PANAS PA = Positive Affect score on the PANAS (Watson et al., 1988). Only the PANAS and EIAT baseline scores were reported in this table (not scores after mood primes). [a] refers to items from the Response Inhibition "more than usual" Scale. [t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

Table 8, there was strong evidence for the validity of the three mood inductions. PA and NA scores showed significant changes ($p < .001$) in the expected direction following the three mood inductions. The only exception was the examination of PA following the happy mood induction compared with baseline. This likely reflects the fact that there were lingering effects of the sad mood induction, which explains why PA did not exceed baseline levels.

**Validity of EIAT Task**

To investigate the validity of the EIAT, two sets of paired sample *t*-tests were conducted with the speed of negative emotional association score and accuracy of negative emotional association score as the comparative variables after each induction (i.e., comparisons with baseline and with the previous mood induction). The first set of paired sample *t*-tests compared the accuracy and speed scores after each emotion induction to the accuracy and speed scores at baseline. The second set of paired sampled *t*-tests compared accuracy and speed scores after the happy and fear mood induction to accuracy and speed scores of the previous mood induction.

As indicated in Table 9, the accuracy of negative emotional association score after the happy condition were significantly lower (indicating more positive emotional reactivity) when compared to the accuracy scores at baseline and to the accuracy scores after the sad mood induction. Also, means were in the expected direction with higher accuracy scores (indicating more negative emotional reactivity) after the sad and fear mood induction compared to after the happy mood induction. For the speed of negative emotional association score, all speed scores after the sad, happy, or fear mood inductions were significantly lower (indicating more negative emotional reactivity) compared to speed scores at baseline. However, only speed scores after the fear mood induction were in the expected direction (i.e., lower) when compared to speed scores after the happy mood induction.

**Table 8**

*Mood Induction Manipulation Checks: Descriptive Data and Paired Sample t-Tests Examining Change in Positive and Negative Affect Schedule (PANAS) Positive Affect (PA) and Negative Affect (NA) scores after the Three Mood Inductions*

| Pairs | M (*SD*) | | *t* | df | *p* |
|---|---|---|---|---|---|
| Baseline Comparisons | | | | | |
| Baseline PA – Sad PA | 2.93 (0.73) | 2.14 (0.76) | -17.20*** | 162 | <.001 |
| Baseline PA –Happy PA | | 2.84 (0.87) | 1.95[t] | 162 | .053 |
| Baseline PA – Fear PA | | 1.99 (0.82) | 16.97*** | 162 | <.001 |
| Baseline NA – Sad NA | 1.49 (0.49) | 1.91 (0.64) | -8.74*** | 162 | <.001 |
| Baseline NA – Happy NA | | 1.18 (0.35) | 10.27*** | 162 | <.001 |
| Baseline NA – Happy NA | | 2.21 (0.77) | -11.70*** | 162 | <.001 |
| Previous Mood Induction Comparisons | | | | | |
| Sad PA – Happy PA | 2.14 (0.76) | 2.84 (0.87) | -12.35*** | 163 | <.001 |
| Happy PA – Fear PA | 2.84 (0.87) | 1.99 (0.82) | 13.27*** | 163 | <.001 |
| Sad NA – Happy NA | 1.92 (0.65) | 1.18 (0.35) | 16.14*** | 163 | <.001 |
| Happy NA – Fear NA | 1.18 (0.35) | 2.21 (0.77) | -17.00*** | 163 | <.001 |

Note. Baseline comparison *t*-tests compared PANAS NA and PA scores after each emotion induction to the PANAS NA and PA scores at baseline. The Previous Mood Induction t-tests compared PANAS NA and PA after the happy and fear mood induction to the PA and NA scores of the previous mood induction. Thus, NA and PA scores after the happy induction were compared to NA and PA scores after the sad induction, and NA and PA scores after the fear induction were compared to NA and PA scores after the happy induction. [t] = trend ($p < .10$), *$p <$ .05. **$p < .01$. *** $p < .001$

**Table 9**

*Emotional Implicit Association Task (EIAT) Validity: Descriptive Data and Paired Sample t-Tests Examining Change in the EIAT Accuracy (Acc) and Speed of Negative Emotional Associations After the Three Mood Inductions*

| Pairs | M (*SD*) | | *t* | df | *p* |
|---|---|---|---|---|---|
| Baseline Comparisons | | | | | |
| Baseline Acc – Sad Acc | -0.47 (2.50) | -0.23 (2.05) | -0.97 | 162 | .333 |
| Baseline Acc –Happy Acc | | -1.07 (2.09) | 2.43* | 162 | .016 |
| Baseline Acc – Fear Acc | | -0.77 (2.00) | 1.13 | 162 | .261 |
| Baseline speed – Sad speed | 0.33 (0.48) | 0.10 (0.15) | 5.87*** | 161 | <.001 |
| Baseline speed – Happy speed | | 0.08 (0.13) | 6.30*** | 161 | <.001 |
| Baseline speed – Fear speed | | 0.05 (0.17) | 6.64*** | 161 | <.001 |
| Previous Mood Induction Comparisons | | | | | |
| Sad Acc – Happy Acc | -0.23 (2.04) | -1.07 (2.08) | 3.51** | 163 | .001 |
| Happy Acc – Fear Acc | | -0.76 (2.00) | -1.33 | 163 | .186 |
| Sad speed – Happy speed | 0.10 (0.15) | 0.08 (0.13) | 1.63 | 163 | .105 |
| Happy speed – Fear speed | | 0.05 (0.17) | 1.78[t] | 163 | .077 |

Note. Higher Accuracy of Negative Emotional Associations (Acc) indicate more negative emotional reactivity, while lower Accuracy of Negative Emotional Associations (Acc) indicate more positive emotional reactivity. Lower Speed of Negative Emotional Associations indicate more negative emotional reactivity, while higher Speed of Negative Emotional Associations indicate more positive emotional reactivity. Baseline Comparison t-tests compared the scores after each emotion induction to the scores baseline. The Previous Mood Induction t-tests compared the scores after the happy and fear mood induction to the scores of the previous mood induction.

[t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Data Screening**

Prior to analyses, all variables were inspected for data entry accuracy, outliers, normality, linearity, and homoscedasticity. Data for each scale and task were also inspected for missing data. When dealing with missing data, a conservative approach was employed, and when variables were missing 5% of data or less (Cohen & Cohen, 1983; Tabachnick & Fidell, 2001; Roth & Switzer, 1995), missing data points were replaced with the overall sample mean for that item (i.e., the sample mean substitution method; Tabachnick & Fidell, 2001). There were 102 cases that were missing $\leq$ 5% data on at least one variable.

Normality and outliers were screened separately for groups (e.g., OC users, nonusers, and men). Outliers were identified based on *z*-score values of $\geq |3.29|$ (Tabachnick & Fidell, 2001). Given that the outliers appeared to represent accurate extreme data points, various techniques to address outliers (e.g., transformations, Winsorizing) were employed where appropriate (Field, 2018). This was done to satisfy any concerns about statistical assumptions as well as maximizing available data (see specific hypotheses below for a description of the method used to address outliers). Normality was determined through visual inspection of histograms, and examination of the Shapiro-Wilk test of normality ($p < .05$; Yap & Sim, 2011). Skewness and kurtosis values that differed significantly from zero were also considered non-normal (Tabachnick & Fidell, 2001).

**Statistical Considerations**

For all the main analyses, and examinations of group equivalency, a significance level of $p < .05$ was used. A trend was defined as $.05 \leq p < .10$. Pillai's criterion was used to evaluate multivariate significance. All between-group comparisons were analyzed using multivariate analyses of variance (MANOVAs) with follow-up univariate analyses of variance (ANOVAs).

All within-subjects comparisons were analyzed using repeated measures ANOVAs with follow-up univariate ANOVAS to examine any interactions. The Bonferroni adjustment was used for follow-up pairwise comparisons. All means reported are untransformed unadjusted means, unless otherwise indicated.

**Covariates and Group Equivalency**

To identify any covariates requiring inclusion in the main analyses, correlations, *t*-tests and ANOVAs were run to examine the relationship between the outcome variables in Study 1 and Study 2 and the following possible covariates: age, history of head injury (yes/no), a recent major or life altering event (yes/no), alcohol consumption in the past 24 hours (number of drinks), hours of sleep, and amount of physical exercise (minutes/week). Also, univariate ANOVAs and *t*-tests were run to examine group differences in these same variables. Covariates were used in the main analyses if they demonstrated both a relationship with the outcome variable and if there was evidence that the independent variables (i.e., groups) differed on the covariate.

Results from the covariate analyses (correlations, t-tests, ANOVAs) are displayed in Appendix L for Study 1 and Appendix M for Study 2. For Study 1, higher ICS-48 Response Inhibition scores (i.e., more problems with response inhibition) were associated with fewer hours of sleep at Time 1, $r(310) = -.153$, $p = .007$, but not at Time 2 (see Appendix L.1). The ICS-48 Deferred Gratification scale (i.e., problems with deferred gratification) was positively correlated with number of alcoholic drinks consumed in the past 24-hours, $r(313) = .114$, $p = .043$, at Time 1, but not at Time 2 (see Appendix L.2). Also, for ICS-48 Deferred Gratification scores at Time 2 (but not Time 1), an exercise effect was found, $F(4, 185) = 3.14$, $p = .016$, where those who did not exercise in the last 24-hours (0 minutes) had higher deferred gratification scores (i.e., more

problems with deferred gratification) compared to those who exercised 16-30 minutes ($p$ = .023), and those who exercised 46 minutes or more ($p$ = .002). Also, those who exercised 46 minutes or more had lower scores (i.e., less problems with deferred gratification) compared to those who exercised for 31-45 minutes ($p$ = .021). Finally, people with a history of a head injury reported more problems with deferred gratification compared to those with no history of a head injury, $t(286) = 1.973$, $p$ = .049. For ICS-48 Reversal Learning scores, individuals with a recent life altering event had higher reversal learning scores (i.e., more problems with reversal learning) than those who did not, $t(306) = 2.31$, $p$ =.021 (see Appendix L.3). Finally, ICS-48 emotional reactivity scores at Time 1 were negatively correlated with age, $r(308) = -.150$, $p$ =.008 (see Appendix L.4). Overall, in Study 1 there was some evidence that lower age, experience of a recent life altering event, a history of a head injury, less sleep, more alcoholic drinks in the past 24-hours, and lower levels of exercise in the past 24-hours were associated with more problems with some types of self-reported inhibitory control. These findings provide some further evidence of validity for these self-report inhibitory control scales.

For Study 2, the same potential covariates were examined by looking at their relationships with each outcome variable (correlations, t-tests, ANOVAs). There were no significant correlations or effects found between the outcome variables and any of the possible covariates (see Appendix M.1 to M.4).

With respect to group equivalency, there were three different between-group comparisons (independent variables) on which to examine equivalency: (1) men vs. women; (2) naturally cycling women in their follicular phase vs. naturally cycling women in their luteal phase; and (3) OC users, nonusers, and men. Group equivalency was examined for the same six variables identified above. Univariate ANOVAs and chi-square analyses examined group equivalency on

the continuous and categorical variables, respectively. There were no group differences within any of the three sets of groups for: age, history of head injury, recent major life event, physical exercise, alcohol consumption in the past 24 hours, and hours of sleep in the past 24 hours (see Appendix N.1 to N.3). Thus, no covariates were used in any of the main analyses.

**Main Analyses**

To examine the effects of sex, cycle phase, and hormonal contraceptive use on the overall construct of inhibitory control, three multivariate ANOVAs (MANOVAs) were conducted for Study 1 and Study 2 with group (men vs. women; follicular phase vs. luteal phase; or OC users vs. naturally cycling women vs. men) as the independent variable (IV) and scores on the four different types of inhibitory control (response inhibition, deferred gratification, reversal learning, emotional reactivity) as the dependent variables (DVs). For Study 1, scores on the four ICS-48 subscales were used as the DVs, unless otherwise specified. To examine cycle phase effects, repeated-measures ANOVAs were also conducted with Study 1 data for the four types of inhibitory control, with testing order group (follicular-luteal, luteal-follicular) as the between-subjects variable and time (1, 2) as the within-subjects variables. A group X time interaction indicates a cycle phase effect. For Study 2, scores on the laboratory measures of inhibitory control were used as DVs. Repeated-measures ANOVAs were also used for Study 2 Response Inhibition and Emotional Reactivity test scores with group as the between-subjects variable and the mood primes (sad, happy, fear) within the laboratory session as the within-subjects variables.

For clarity of interpretation and to allow direct comparison of any group differences in self-report (Study 1) and performance-based laboratory (Study 2) measures of inhibitory control, results for both studies will be presented together. The overall MANOVAs and follow-up

univariate ANOVAs will be presented first, followed by a summary of the results as they relate to specific hypotheses.

### *Sex Differences in Inhibitory Control*

**Global Examination of Sex Effects on Inhibitory Control.** The outcome variables for men and women in Studies 1 and 2 were screened for normality. Total scores on the self-report ICS-48 Deferred Gratification scale were non-normal and had one outlier. The Deferred Gratification variable reached normality with a square root transformation and the transformed variable was used in the analyses. All other self-report variables were normally distributed for men and women. For the laboratory variables to meet assumptions of normality, square root transformations were applied to errors of commission (EOC) and reversal learning scores.

Results from the MANOVA and follow-up univariate ANOVAs for Study 1 are presented in the top half of Table 10 (see Table 10). Visual inspection of the means indicates lower self-reported inhibitory control (i.e., higher scores) for women than men for all four variables. The overall MANOVA showed a sex difference for inhibitory control ($p = .005$), but follow-up univariate analyses only demonstrated a significant sex effect for emotional reactivity ($p < .001$), suggesting that women reported more emotional reactivity than men. No sex differences were found for scores on the Response Inhibition, Deferred Gratification, or Reversal Learning ICS-48 scales.

Results from the MANOVA examining sex differences in inhibitory control for Study 2 are presented in the bottom half of Table 10 (see Table 10). Visual inspection of the means indicates higher scores for women (i.e., less inhibitory control) for two of the four types of inhibitory control: response inhibition and emotional reactivity. However, there was no overall group effect for the MANOVA and, consistent with Study 1, the univariate ANOVAs only

**Table 10**

*Sex Differences in Self-Report (Study 1) and Laboratory Measures (Study 2) of Inhibitory Control: Means (SDs), and MANOVA/ANOVA Results*

| | M (*SD*) | | df | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|
| | Men | Women | | | | |
| **Study 1 MANOVA** | | | | | | |
| ICS-48 Scales | (*n* = 57) | (*n* = 238) | 4, 290 | 3.85** | .005 | .050 |
| Univariate ANOVAs | | | | | | |
| Response inhibition | 73.78 (18.60) | 76.43 (20.12) | 1, 293 | 0.83 | .363 | .003 |
| Deferred gratification | 88.39 (16.15) | 90.17 (19.41) | 1, 293 | 0.32 | .570 | .001 |
| Reversal learning | 78.91 (25.40) | 86.15 (30.51) | 1, 293 | 2.75 | .099 | .009 |
| Emotional reactivity | 103.78 (23.65) | 117.93 (26.58) | 1, 293 | 13.57*** | <.001 | .044 |
| **Study 2 MANOVA** | | | | | | |
| Laboratory Tasks | (*n* = 30) | (*n* = 94) | 4, 119 | 1.92 | .111 | .061 |
| Univariate ANOVAs | | | | | | |
| Response inhibition (EOC) | 13.47 (8.04) | 15.50 (8.88) | 1, 123 | 1.42 | .235 | .012 |
| Deferred gratification (impulsive choice) | 22.13 (12.30) | 20.70 (11.86) | 1, 123 | 0.33 | .570 | .003 |
| Reversal learning (PRL) | 8.03 (1.97) | 7.84 (3.75) | 1, 123 | 0.52 | .471 | .004 |
| Emotional reactivity (PANAS NA change score) | 0.46 (0.46) | 0.77 (0.62) | 1, 122 | 6.21* | .014 | .048 |

Note. Untransformed means are reported for all variables. Higher scores refer to less inhibitory control or greater emotional reactivity. EOC = Errors of Commission. PRL = probabilistic reversal learning task. PANAS NA = Negative Affect score on the Positive and Negative Affect Schedule (Watson et al., 1988). The change score is the mean change in NA scores after the two negative mood primes (i.e., the mean of: NA after baseline subtracted from NA after sad induction, and NA after happy induction subtracted from NA after fear induction). $^{t}$ = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

showed a sex difference for emotional reactivity ($p$ = .014), with women reporting greater mean negative affect reactivity across the three mood primes in the lab.

***Hypothesis 1: Sex Differences in Response Inhibition: Women Will Make More Errors of Commission (EOC) on the GoNogo Task Compared to Men After the Happy Mood Induction.*** The above global analysis (see Table 10) indicated no sex differences in scores on the self-report ICS-48 Response Inhibition scale (Study 1) or in total EOC on the GoNogo task (i.e., the overall sum of EOC after baseline, and the sad, happy, and fear mood inductions) (Study 2). However, to examine sex differences in EOC after each mood prime across the laboratory session, a repeated-measures ANOVA was conducted with sex as the between-subjects variable and mood prime (baseline, sad, happy, and fear) as the within-subjects variable. To adjust for normality issues, square root transformed variables were used in the analyses. Visual inspection of the means revealed that women had more EOC after each mood prime (see means/*SD*s in Table 11). The overall model demonstrated no sex effect, $F(1, 122) = 1.40$, $p = .239$, $\eta^2 = .01$, but a sex by mood prime interaction effect, $F(3, 120) = 3.13$, $p = .028$, $\eta^2 = .073$ (see Figures 3 and 4), suggesting men and women differed in their EOC across the mood prime conditions. Follow-up one-way ANOVAs were conducted with sex as the IV and the EOC scores as the DV. This was done for each of the four conditions (baseline and after each mood prime). The ANOVAs were run with and without baseline EOC as a covariate (see Table 11; Figure 3 depicts the data without baseline as a covariate; Figure 4 depicts the data with baseline as a covariate). There was a sex difference after the sad mood induction, as women made more EOC than men ($p$ = .007 with baseline as covariate). There was also an effect after the fear mood induction ($p$ = .030 with baseline as covariate). As indicated in Table 11, the sex differences in EOC after the sad and fear mood inductions were stronger when baseline EOC was used as a covariate. This

**Table 11**

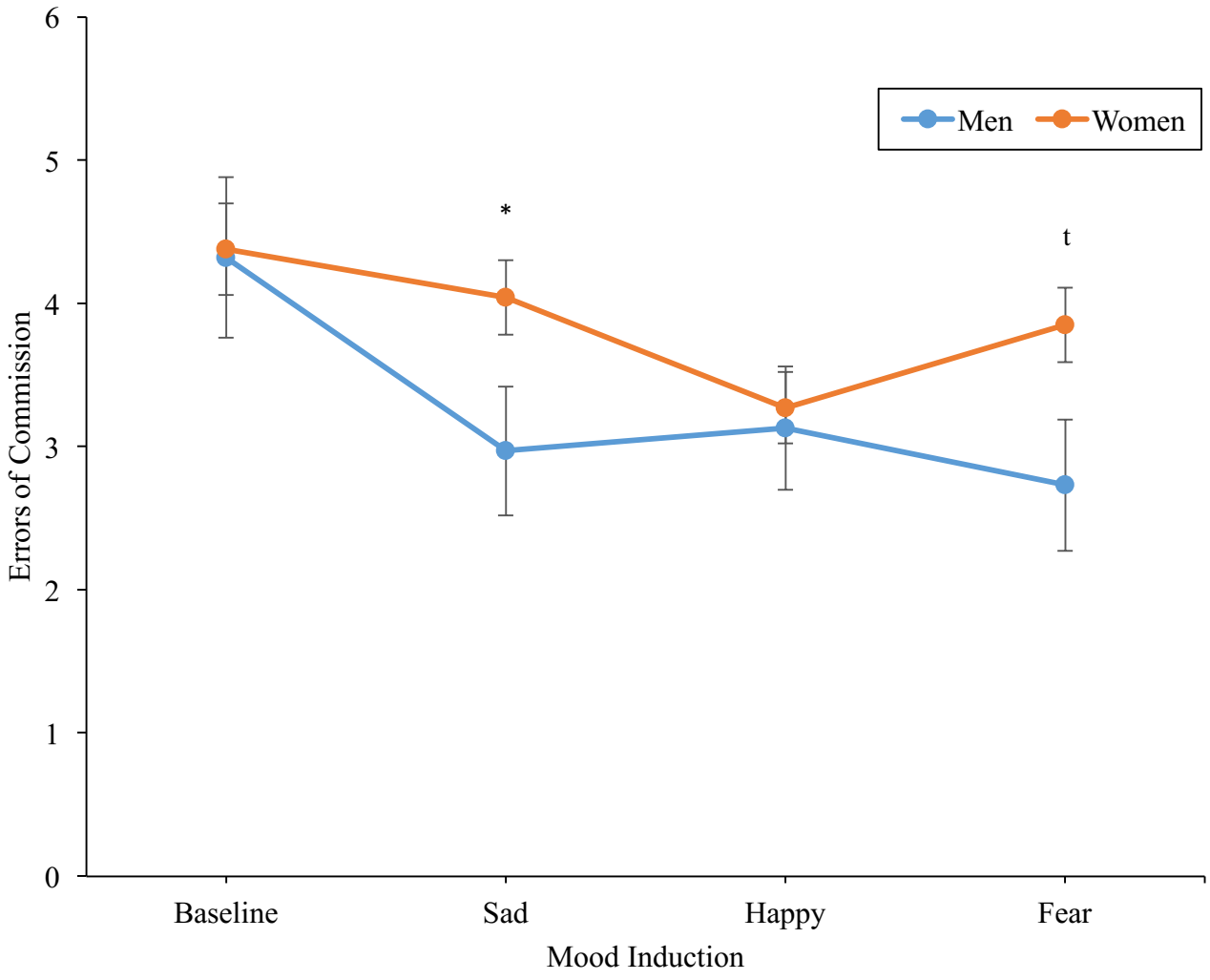
*Sex Differences in Errors of Commission (EOC) at Baseline and After Each Mood Prime: Untransformed Means (SDs) and One-Way ANOVA*

| Mood Prime | Covariate | Men ($n$ = 30) | Women ($n$ = 94) | df | $F$ | $p$ | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Baseline | No | 4.32 (2.87) | 4.38 (3.20) | 1, 124 | 0.10 | .921 | < .001 |
| Sad | No | 2.97 (2.44) | 4.04 (2.53) | 1, 125 | 5.17* | .025 | .040 |
| | Yes[a] | 2.99 (0.39) | 4.04 (0.22) | 1, 124 | 7.63** | .007 | .059 |
| Happy | No | 3.13 (2.33) | 3.27 (2.45) | 1, 125 | 0.01 | .914 | <.000 |
| | Yes[a] | 3.15 (0.36) | 3.25 (0.21) | 1, 124 | <0.00 | .987 | <.000 |
| Fear | No | 2.73 (2.00) | 3.85 (2.64) | 1, 124 | 3.87[t] | .051 | .030 |
| | Yes[a] | 2.73 (0.40) | 3.81 (0.22) | 1, 123 | 4.82* | .030 | .038 |

Note. Higher scores (higher errors of commission) reflect more problems with response inhibition (i.e., less inhibitory control in this area). [a]Baseline was used as the covariate. For the analyses with baseline as a covariate ([a]), means are reported with their respective standard error in parentheses. [t] = trend ($p$ < .10), *$p$ < .05. **$p$ < .01. *** $p$ < .001

**Figure 3**

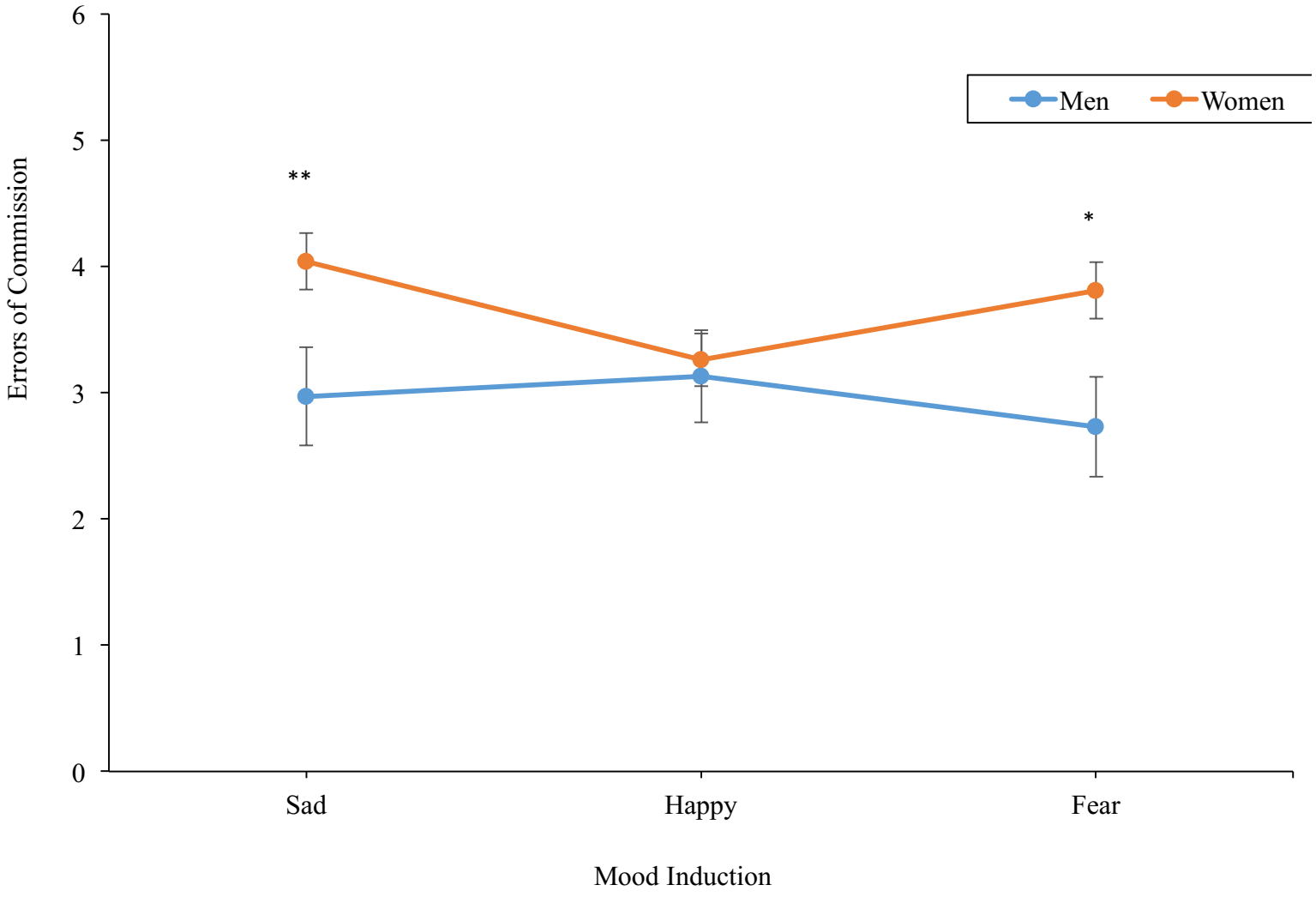
*Sex Differences: Errors of Commission At Baseline and After Each Mood Prime with No Covariate*




Note. This figure shows men and women's errors of commission on a GoNogo task at baseline and after three mood inductions (without a covariate). Women had more errors of commission than men after the sad mood induction ($p = .025$) and a trend towards more errors of commission than men after the fear mood induction ($p = .051$). The error bars represent the standard error for each data point. Untransformed means are reported for all variables. *$p < .05$, ᵗ$p < .10$

**Figure 4**

*Sex Differences: Errors of Commission After Each Mood Prime with Baseline as a Covariate*




Note. This figure shows men and women's errors of commission on a GoNogo task at baseline and after three mood inductions (with Baseline errors of commission as a covariate). Women had more errors of commission than men after the sad mood induction ($p = .007$) and after the fear mood induction ($p = .030$). The error bars represent the standard error for each data point. Untransformed means are reported for all variables. *$p < .05$, **$p < .01$ $^{t}p < .10$

analysis took into account baseline sex differences in EOC. None of the analyses provided any support for Hypothesis 1 as there was no sex difference after the happy mood induction.

***Hypothesis 2: Sex Differences in Reversal Learning: Women Will Show Deficits in Reversal Learning Compared to Men.*** The above univariate ANOVAs (see Table 10) indicated no sex differences in scores on the self-report ICS-48 Reversal Learning subscale (Study 1) or in the Reversal Learning laboratory task (Study 2). To further explore sex differences on the laboratory probabilistic reversal learning task, the analysis was re-run to replicate the analysis conducted by Evans and Hampson (2015). In their analysis, a repeated measures ANOVA was conducted with sex as the between-subjects factor, and phase of the task (acquisition accuracy, reversal accuracy) as the within-subjects factors (see the measures section for definition of reversal and acquisition accuracy). An interaction between sex and phase of the task would indicate a sex difference on the task. However, Evans and Hampson (2015) included only naturally cycling women (OC users were excluded) and only those participants that achieved a correct score of 70% or higher on the acquisition phase. With the present data, such analyses were conducted using these same exclusion criteria. No main effect of sex, $F(1, 66) = 0.691$, $p = .409$, $\eta^2 = .010$, or a sex X phase interaction, $F(1, 66) = 0.336$, $p = .564$, $\eta^2 = .005$, were found.

Additionally, given that the ICS-48 subscale only measured reversal learning in the past 48-hours (i.e., a more state-like measure), potential sex differences in reversal learning were further explored with self-report measures that captured reversal learning difficulties over the past two-months (i.e., more "trait-like" measures). A MANOVA was conducted with group (men, women) as the IV and scores on two trait-like measures of reversal learning (the Shift subscale on the BRIEF-A scale, and the Perseverative Thinking Questionnaire) as the DVs. To

meet assumptions of normality, a log transformation of the BRIEF-A subscale was used. Visual inspection of the means revealed that women had higher scores than men on both measures, indicating more difficulties (see Table 12 for means and *SD*s). The overall model indicated a sex effect, $F(2, 304) = 3.34$, $p = .037$ $\eta^2 = .022$. Follow-up univariate ANOVAs (see Table 12) showed that women reported more reversal learning problems (i.e., higher scores) than men on the Perseverative Thinking Questionnaire, and a trend towards higher scores on the BRIEF-A Shift subscale. These analyses demonstrated partial support for the hypothesis, with sex differences being observed for self-reported trait, but not state, measures of reversal learning (i.e., more difficulties reported by women).

***Hypothesis 3: Sex Differences in Emotional Reactivity: Women will be More Emotionally Reactive than Men.*** As reported above in the univariate ANOVAs examining sex differences in inhibitory control (see Table 10), there were sex differences in both the self-report and laboratory measures of emotional reactivity. Women reported higher emotional reactivity compared to men when an emotional reactivity score was used that included both positive and negative emotional reactivity.

For self-report measures (Study 1), emotional reactivity was further explored. To examine whether similar sex differences exist for positive and negative emotional reactivity items on the ICS-48, two ICS-48 Emotional Reactivity subscales were created: positive and negative emotional reactivity. Potential sex differences in emotional reactivity were also explored with measures that captured emotional reactivity in the past two-months (i.e., more "trait-like" measures), including the emotional control subscale on the BRIEF-A scale and the Perth Emotional Reactivity Scale (PERS). All variables met assumptions of normality. Visual

**Table 12**

*Sex Differences in Self-Report Trait Measures of Reversal Learning: Untransformed Means (SDs) and Univariate ANOVA*

| Reversal Learning Measure | Mean (*SD*) Men (*n* = 55) | Women (*n* = 252) | df | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|
| Shift subscale of BRIEF-A scale | 10.05 (2.93) | 10.40 (2.68) | 1, 306 | 3.05[t] | .082 | .010 |
| Perseverative Thinking Questionnaire | 42.11 (11.12) | 46.86 (12.73) | 1, 306 | 6.51* | .011 | .021 |

Note. Higher scores denote more problems with reversal learning (i.e., less inhibitory control in this area).

[t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

inspection of the means indicated that women reported higher scores (i.e., more reactivity) on all measures (see Table 13). A MANOVA with the above four scales as the DVs and sex (men, women) as the IV found an overall effect of sex, $F(4, 265) = 7.98$, $p < .001$, $\eta^2 = .107$. Follow-up univariate ANOVAs (see Table 13) revealed that women had higher scores (i.e., more reactivity) than men for all measures of emotional reactivity, except for positive emotional reactivity. Results based on the self-report data support the hypothesis that women are more emotionally reactive with respect to negative emotions.

To explore the possible effect of socially desirable responding on sex differences in emotional reactivity, the analyses above were also run with positive impression management (PIM) score as a covariate. No change in sex effects on emotional reactivity were found in any of the analyses when PIM was used as a covariate.

For the laboratory measures (Study 2), emotional reactivity was further explored using: PANAS NA scores after each mood prime, EIAT Negative Emotional Reactivity scores, and EIAT Negative Emotional Reactivity response times (RTs). For PANAS NA and EIAT Negative Emotional Reactivity scores, higher scores indicate more emotional reactivity. For Negative Emotional Reactivity RTs, lower (i.e., faster) response times indicate more emotional reactivity. See Tables 14 and 15 for means and *SD*s for each of the emotional reactivity variables for Study 2.

*PANAS NA Scores.* Emotional reactivity was examined with PANAS NA scores at baseline and after each mood prime. With respect to normality, PANAS NA scores after happy mood induction were not normally distributed across groups despite attempting several transformations. Given the normality issues and the fact that there were no expected sex differences in NA after positive mood induction, NA after the happy mood induction was not

**Table 13**

*Sex Differences in State and Trait Measures of Emotional Reactivity for Study 1: Means (SDs) and Follow-Up Univariate ANOVA*

| Emotional Reactivity Measure | Mean (*SD*) Men (*n* = 50) | Women (*n* = 220) | df | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|
| ICS-48 Emotional reactivity: Positive emotions | 35.97 (8.77) | 38.95 (10.14) | 1, 269 | 2.40 | .123 | .009 |
| ICS-48 Emotional Reactivity: Negative emotions | 57.27 (22.96) | 68.95 (27.29) | 1, 269 | 9.35** | .002 | .034 |
| Emotional Control subscale of BRIEF-A scale | 14.38 (4.40) | 17.54 (4.90) | 1, 269 | 23.73*** | <.001 | .081 |
| Perth Emotional Reactivity scale | 85.71 (13.17) | 93.60 (12.61) | 1, 269 | 20.72*** | <.001 | .072 |

Note. Higher scores denote greater emotional reactivity (i.e., less inhibitory control).

$^{t}$ = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

included in the analyses. NA scores in the baseline, fear, and sad conditions achieved normality after log transformations.

To examine changes in NA across the negative mood primes, a repeated measures ANOVA was conducted with sex (men, women) as the between subjects' variable and PANAS NA scores after baseline, sad, and fear mood inductions as the within subjects' variables. Visual inspection of the means indicated that women reported higher scores (i.e., more reactivity) after the sad and fear mood inductions (but not baseline) compared to men (see Table 14).

The repeated measures ANOVA revealed a sex by mood prime interaction effect, $F(3, 122) = 4.61$, $p = .012$, $\eta^2 = .070$. There was no main effect of sex, $F(1, 123) = 2.71$, $p = .102$, $\eta^2 = .022$. Given the significant interaction, three follow-up one-way ANOVAs were conducted with sex as the IV and PANAS NA scores in three conditions (baseline, fear, and sad) as the DV. These ANOVAS were run with and without baseline NA as a covariate (see Table 14). The ANOVAs revealed a sex effect with women having higher PANAS NA scores than men after the fear mood induction (both with and without baseline as a covariate), yet not after the sad mood induction or at baseline (see Figure 5). Figure 5 illustrates the reactivity of women's negative mood (versus men's) over time and with the fear mood prime.

*EIAT Speed of Negative Emotional Associations.* The speed of negative emotional associations score was calculated by subtracting the mean RT when correctly associating positive words with the self from the mean RT when correctly associating negative words with the self. Lower difference scores are meant to represent a quicker self-association to negative emotion words (relative to positive emotion words) and suggest higher negative emotional reactivity. The variables reached normality after Log transformations. Visual inspection of the means suggested

**Table 14**

*Sex Differences in PANAS Negative Affect (NA) at Baseline and After the Sad and Fear Mood Prime: Means (SDs) and Follow-Up Univariate ANOVAs*

| **PANAS NA Scores** | Men ($n$ = 31) | Women ($n$ = 94) | Covariate | df | $F$ | $p$ | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Baseline | 1.47 (0.41) | 1.47 (0.51) | N | 1, 124 | 0.06 | .802 | .001 |
| Sad | 1.79 (0.56) | 1.93 (0.69) | N | 1, 125 | 0.71 | .401 | .006 |
| | 1.79 (0.11) | 1.91 (0.06) | Y[a] | 1, 124 | 0.81 | .371 | .007 |
| Fear | 1.79 (0.63) | 2.27 (0.80) | N | 1, 125 | 9.07** | .003 | .068 |
| | 1.79 (0.13) | 2.26 (0.08) | Y[a] | 1, 124 | 9.71** | .002 | .074 |

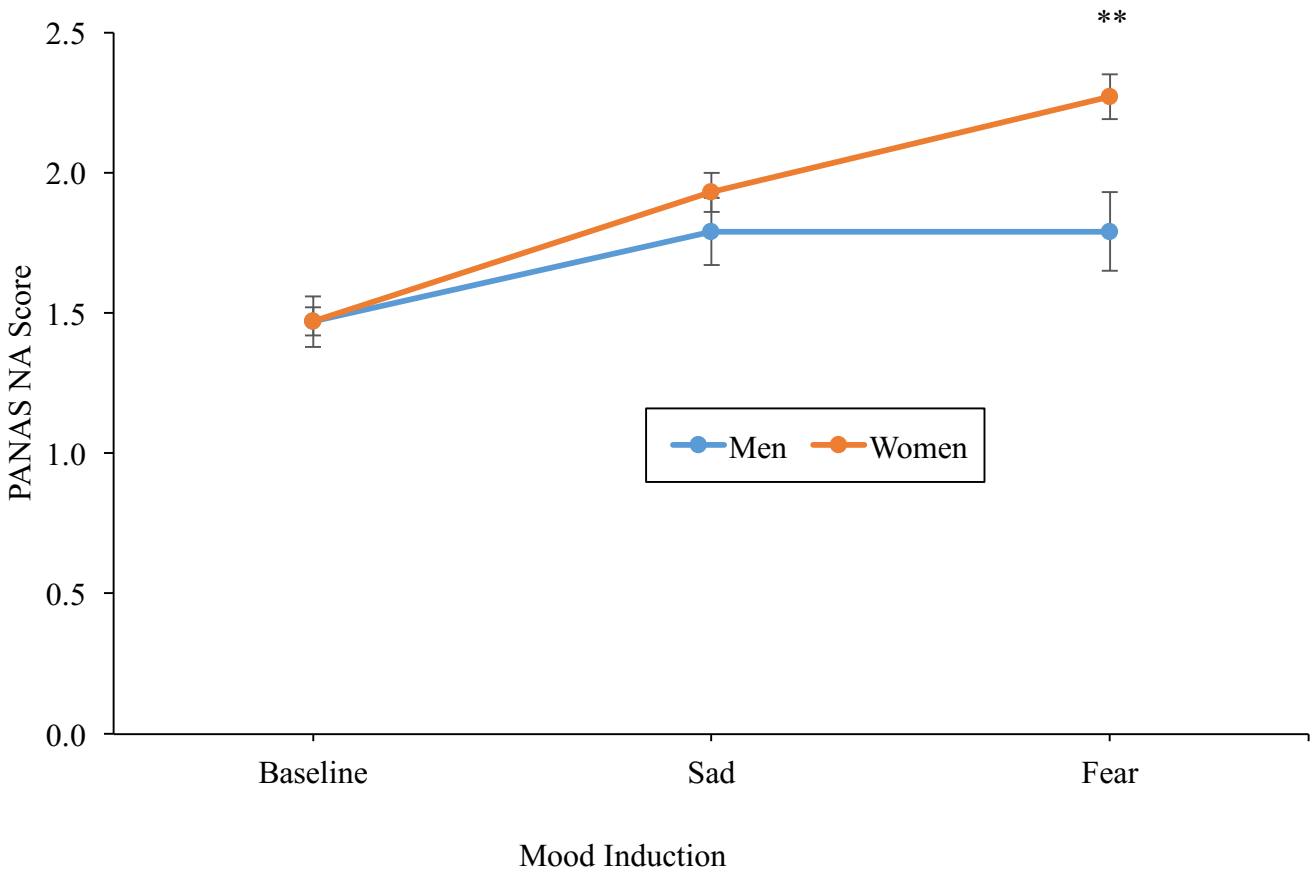
Note. PANAS NA = Negative Affect score from the Positive and Negative Affect Schedule. Higher scores imply greater emotional reactivity (i.e., less inhibitory control in this area).

[a]baseline scores were used as the covariate. For the analyses with baseline as a covariate ([a]), means are reported with their respective standard error in parentheses.

[t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Figure 5**

*Sex Differences: PANAS NA Score at Baseline and After Negative Mood Induction*




Note. This figure shows men's and women's Negative Affect (NA) scores on the Positive and Negative Affect Schedule (PANAS) at baseline, and after two mood inductions. Women had higher NA than men after the fear mood induction ($p = .003$). The error bars represent the standard error for each data point.

*$p < .05$

that women had faster speed of negative emotional associations (i.e., more reactivity) at baseline and after the happy mood induction, but not after the sad or fear mood inductions (see Table 15).

To examine changes in speed of negative emotional associations across mood primes and group, a repeated measures ANOVA was conducted with sex as the between subjects' variable and speed scores after baseline and the sad, happy, and fear mood induction as the within subjects' variables. There was no group effect, $F(1, 122) = 1.16$, $p = .284$, $\eta^2 = .009$; or group by mood prime interaction effect found, $F(3, 120) = 2.11$, $p = .102$, $\eta^2 = .050$. However, due to the weak trend ($p = .102$) and evidence for sex differences in emotional reactivity above, four follow-up univariate ANOVAs were conducted for each of the four conditions (at baseline and after each mood prime). The ANOVAs were run with and without baseline speed score as a covariate (see Table 15). There was a sex effect with men demonstrating relatively faster speed scores (i.e., more negative emotional self-association) than women after the sad mood induction when baseline was a covariate ($p = .02$), and a trend towards a sex difference when baseline was not used as a covariate ($p = .053$). No sex differences were found at baseline or after the happy or fear mood induction.

*EIAT Accuracy of Negative Emotional Associations.* The accuracy of negative emotional association score was calculated by subtracting the total correct score when associating positive words with the self from the total correct score when associating negative words with the self. Higher scores indicate a stronger self-association to negative emotion words (relative to positive emotion words) and suggests higher negative emotional reactivity. Given that all means were negative, participants tended to be slightly more accurate when self-associating positive words. Scores were normally distributed across men and women. Visual inspection of the means indicated that women had higher scores than men (relatively more accurate at self-associating

**Table 15**

*Sex Differences in Relative Speed and Accuracy of Negative Emotional Associations at Baseline and After Each Mood Prime on the Emotional Implicit Association Task (EIAT): Untransformed Means (SDs) and Follow-Up Univariate ANOVA*

| | Men ($n$ = 31) | Women ($n$ = 94) | Covariate | *df* | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Speed | | | | | | | |
| Baseline | 0.37 (0.37) | 0.30 (0.23) | N | 1, 123 | 1.69 | .196 | .014 |
| Sad | 0.06 (0.18) | 0.12 (0.14) | N | 1, 125 | 3.81[t] | .053 | .030 |
| | 0.06 (0.03) | 0.12 (0.02) | Y[a] | 1, 123 | 5.57* | .020 | .044 |
| Happy | 0.10 (0.17) | 0.07 (0.13) | N | 1, 125 | 0.94 | .335 | .007 |
| | 0.10 (0.03) | 0.07 (0.05) | Y[a] | 1, 123 | 0.97 | .327 | .008 |
| Fear | 0.05 (0.10) | 0.05 (0.11) | N | 1, 125 | 0.02 | .891 | <.001 |
| | 0.05 (0.02) | 0.05 (0.01) | Y[a] | 1, 123 | 0.02 | .898 | <.001 |
| Accuracy | | | | | | | |
| Baseline | -0.29 (2.13) | -0.34 (2.52) | N | 1, 124 | 0.01 | .921 | <.001 |
| Sad | -1.13 (1.89) | -0.05 (2.05) | N | 1, 125 | 6.74* | .011 | .052 |
| | -1.13 (0.36) | -0.05 (0.21) | Y[a] | 1, 124 | 6.64* | .011 | .052 |
| Happy | -0.81 (2.01) | -1.01 (1.91) | N | 1, 125 | 0.26 | .609 | .002 |
| | -0.81 (0.35) | -1.01 (0.20) | Y[a] | 1, 124 | 0.26 | .610 | .002 |
| Fear | -1.10 (2.12) | -0.69 (1.78) | N | 1, 125 | 1.20 | .276 | .010 |
| | -1.09 (0.03) | -0.69 (0.19) | Y[a] | 1, 124 | 1.08 | .302 | .009 |

Note. EIAT speed scores = self.neg RT – self.pos RT. EIAT accuracy scores = self.neg correct – self.pos correct. For speed of negative emotional association score, lower scores imply more emotional reactivity (i.e., making faster associations between negative emotional words and the self). For accuracy of negative emotional association score, higher (less negative) scores imply more emotional reactivity (i.e., making more correct associations between negative emotion words and the self). For the analyses with baseline as a covariate ([a]), means are reported with their respective standard error in parentheses.

[t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

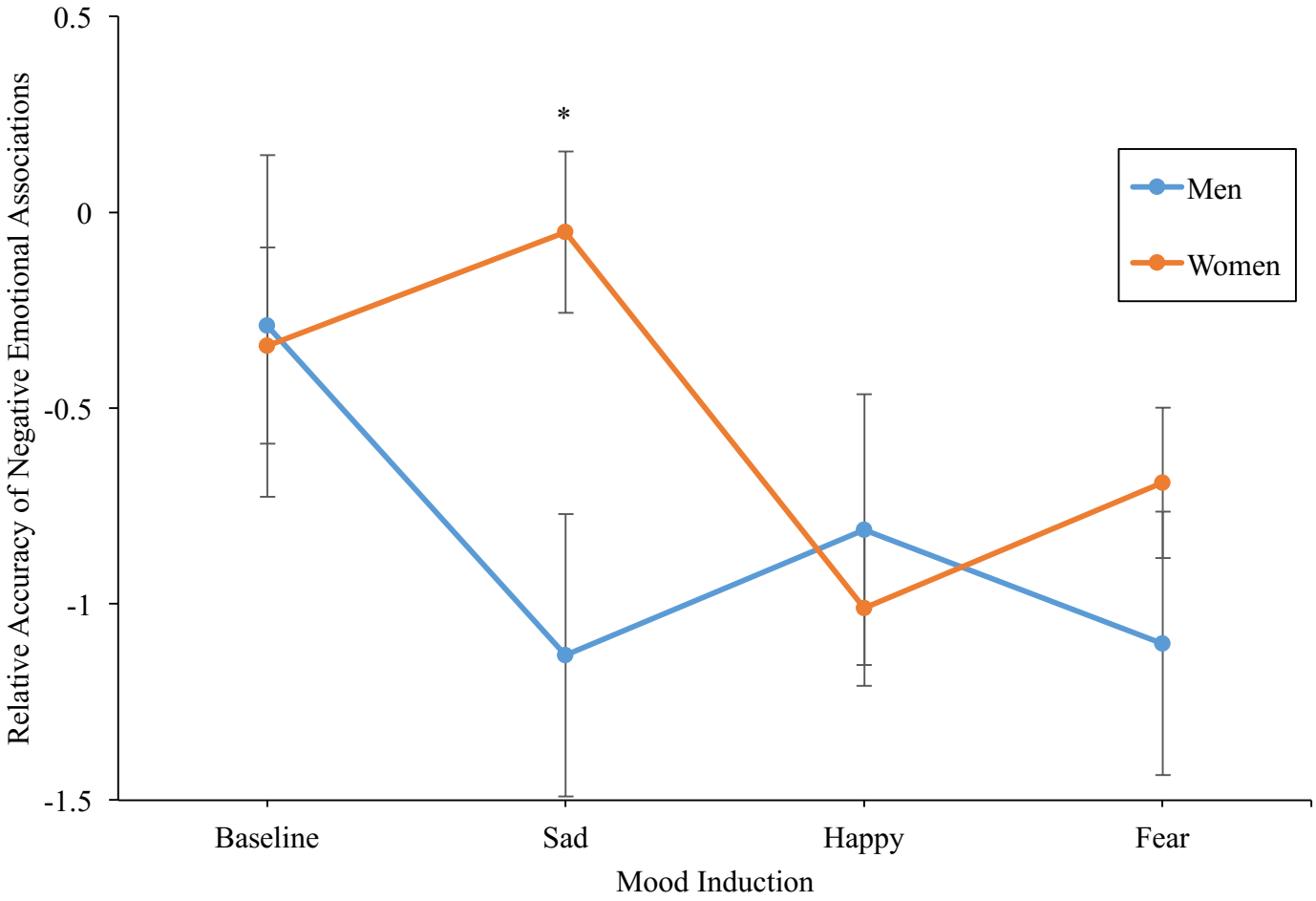
negative words) after the sad and fear mood primes but not after the happy mood prime or at baseline (see bottom of Table 15).

To examine sex differences in the accuracy of negative emotional associations score across mood primes for each group, a repeated measures ANOVA was conducted with sex as the between subjects' variable and accuracy of negative emotional association after baseline and the sad, happy, and fear mood induction as the within subjects' variables. There was no sex effect, $F(1, 123) = 0.15$, $p = .150$ $\eta^2 = .017$; or sex by prime effect found, $F(3, 121) = 1.77$, $p = .158$ $\eta^2 = .042$. However, due to a weak trend for the speed of negative emotional association above and evidence for sex differences in speed (RTs) after the sad mood induction, follow-up ANOVAs were conducted for each of the four conditions. The ANOVAs were run with and without baseline as a covariate. Results of the ANOVAs revealed a sex effect for the sad mood induction with women demonstrating higher accuracy scores than men both with and without baseline as a covariate (both $p = .011$) (see Figure 6). No sex differences were found at baseline or after the happy or fear mood inductions.

There was support for sex differences in emotional reactivity in the laboratory based on women demonstrating more emotional reactivity compared to men on the NA scores after the fear mood induction, and relatively more accurate negative (relative to positive) emotional self-associations after the sad mood induction. However, men demonstrated relatively more negative emotional reactivity (compared to positive reactivity) than women in one analysis, as they had a faster speed of negative (relative to positive) emotional associations after the sad mood induction, suggesting a faster association between negative emotion words and the self after sad mood induction.

**Figure 6**

*Sex Differences: Relative Accuracy of Negative Emotional Self-Associations at Baseline and After Three Mood Inductions*




Note. This figure shows men and women's relative accuracy of negative emotional association scores from the EIAT (Emotional Implicit Association Task) at baseline and after three mood inductions. EIAT speed scores = self.neg RT – self.pos RT. EIAT accuracy scores = self.neg correct – self.pos correct. Women had relatively higher accuracy scores or more accurate negative versus positive self-associations (i.e., more emotional reactivity) compared to men after the sad mood induction ($p = .011$). Higher or more positive scores reflect greater emotional reactivity for negative mood primes, but lower emotional reactivity for positive mood primes. The error bars represent the standard error for each data point. *$p < .05$.

### *Cycle Phase Effects on Inhibitory Control*

**Global Examination of Cycle Phase Effects on Inhibitory Control.** Data for naturally cycling women in the luteal and follicular cycle phases in Studies 1 and Study 2 were screened for normality. Total scores on the self-report ICS-48 Deferred Gratification subscale had one outlier. The Deferred Gratification variable reached normality after winsorizing the outlier. All other self-report variables were normally distributed. For the laboratory variables to meet assumptions of normality, the only adjustment was a square root transformation for the reversal learning scores. Given the strengths and limitations of each analysis, two sets of analyses were conducted: (a) between-subjects analyses on time 1 data, and (b) repeated measures analyses on time 1 and 2 data (across two weeks).

***Between Subjects Analyses.*** Results from the between-subjects MANOVA and follow-up univariate ANOVAs for Study 1 are presented in the top half of Table 16. Visual inspection of the means indicated that women in the follicular phase had slightly higher means on all four types of inhibitory control than those in the luteal phase. However, the overall MANOVA did not show a phase effect, ($p$ = .430), and follow-up univariate analyses revealed no phase effects for any of the self-report ICS-48 subscales of inhibitory control. Results from the between-subjects MANOVA examining menstrual phase effects in inhibitory control for Study 2 are presented in the bottom half of Table 16. Visual inspection of the means indicated that women in the follicular phase also had slightly higher means than women in the luteal phase for all variables except deferred gratification. There was no overall phase effect for the MANOVA, and follow-up univariate ANOVAs showed no phase effects for any of the laboratory measures of inhibitory control.

**Table 16**

*Menstrual Cycle Phase Effects for Self-Report (Study 1, Time 1) and Laboratory Measures (Study 2) of Inhibitory Control: Means (SDs), and MANOVA/ANOVA Results*

| | M(*SD*) | | df | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|
| | Follicular | Luteal | | | | |
| | | | **STUDY 1 MANOVA** | | | |
| ICS-48 Scales | (*n* = 49) | (*n* = 52) | 4, 96 | 0.97 | .430 | .039 |
| | | | Univariate ANOVAs | | | |
| Response inhibition | 76.22 (18.12) | 72.82 (19.61) | 1, 99 | 0.82 | .368 | .008 |
| Deferred gratification | 90.56 (15.90) | 83.50 (22.89) | 1, 99 | 3.21[t] | .076 | .031 |
| | 90.05 (16.21)[a] | 83.18 (23.13)[a] | 1, 99[a] | 2.90[a,t] | .092[a] | .028[a] |
| Reversal learning | 89.03 (26.08) | 82.67 (33.96) | 1, 99 | 1.10 | .297 | .011 |
| Emotional reactivity | 119.07 (25.38) | 118.20 (30.90) | 1, 99 | 0.02 | .878 | <.000 |
| | | | **Study 2 MANOVA** | | | |
| Laboratory Tasks | (*n* = 26) | (*n* = 18) | 4, 39 | 1.09 | .374 | .101 |
| | | | Univariate ANOVAs | | | |
| Response inhibition (EOC) | 16.92 (8.22) | 14.33 (9.82) | 1, 42 | 0.90 | .348 | .021 |
| Deferred gratification (Impulsive choice) | 20.85 (12.88) | 25.56 (10.42) | 1, 42 | 1.65 | .206 | .038 |
| | 19.75 (12.75)[a] | 26.06 (10.51)[a] | 1, 41[a] | 2.95[a] | .094[a, t] | .072[a] |
| Reversal learning (PRL) | 7.65 (3.01) | 6.50 (4.05) | 1, 42 | 1.79 | .188 | .041 |
| Emotional Reactivity (PANAS NA change score) | 0.75 (0.62) | 0.58 (0.65) | 1, 42 | 0.78 | .383 | .018 |

Note. Untransformed means are reported for all variables. Higher scores refer to less inhibitory control or greater emotional reactivity. EOC = Errors of Commission. PRL = probabilistic reversal learning task. PANAS NA = Negative Affect scores on the Positive and Negative Affect Schedule (Watson et al., 1988). The change score is the mean change in NA scores after the two negative mood primes. (i.e., the mean of: NA after baseline subtracted from NA after sad induction, and NA after happy induction subtracted from NA after fear induction).

[a] Deferred gratification scores when income was used as a covariate. [t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

***Repeated Measures Analyses.*** Repeated-measures ANOVAs were also conducted to compare scores on self-report measures of inhibitory control in the same women in different phases of their menstrual cycle. For the global repeated-measures analysis, time (scores on each of the ICS-48 subscales for Time 1 and Time 2) was the within-subjects variable and testing order group (follicular-luteal, luteal-follicular) was the between-subjects variable. A group X time interaction indicates a phase effect. There were four DVs: response inhibition, deferred gratification, reversal learning, and emotional reactivity. The global repeated measures MANOVA did not find a phase effect (i.e., no group by time interaction; see Table 17). Further, none of the univariate follow-ups revealed a phase effect either (see Table 17).

***Hypothesis 4: Menstrual Cycle Effects on Response Inhibition: Naturally cycling women in the follicular phase will demonstrate more problems with response inhibition compared to the luteal phase.*** The above repeated measures ANOVA for Study 1 revealed no group by time effect (phase effect) for response inhibition (see Table 17). Similarly, the above between-groups analyses (see Table 16) indicated no phase effects on the self-report ICS-48 Response Inhibition subscale (Study 1) or for total EOC on the GoNogo task (Study 2).

However, to further examine cycle phase effects in response inhibition in the laboratory, a repeated measures ANOVA was conducted with EOC on the GoNogo task after each mood prime (baseline, sad, happy, fear) as the within-subjects variable and cycle phase (follicular or luteal) as the between-subjects variable. For variables to reach normality, a square root transformation was used. A visual inspection of the means revealed that women in the follicular phase had more EOC compared to women in the luteal phase after the mood primes (see Table 18). However, the repeated measures analysis yielded no cycle phase effect, $F(1, 42) = 1.21$, $p = .278$, $\eta^2 = .028$; or cycle phase by mood prime interaction, $F(3, 40) = 1.67$, $p = .183$, $\eta^2 = .113$.

**Table 17**

*Menstrual Cycle Phase Effects for Self-Report (Study 1) Measures of Inhibitory Control as a Function of Time (1, 2) and Cycle Phase Testing Order [Follicular-Luteal (FL), Luteal-Follicular (LF)]: Means (SDs), Global Repeated Measures MANOVA, and Follow-up ANOVAs*

| | | | **Global MANOVA** | | | |
|---|---|---|---|---|---|---|
| | | | df | *F* | *p* | $\eta^2$ |
| | | Group | 4, 30 | 2.401 | .072[t] | .243 |
| | | Time | 4, 30 | 0.060 | .993 | .008 |
| | | Group X Time | 4, 30 | 0.977 | .435 | .115 |
| | Means (*SD*s) | | **ANOVAs** | | | |
| | Group FL | Group LF | | df | *F* | *p* | $\eta^2$ |
| **Response Inhibition** | (*n* = 23) | (*n* = 20) | | | | | |
| Time 1 | 77.65 (16.69) | 69.79 (20.84) | Time | 1, 41 | 0.14 | .714 | .003 |
| Time 2 | 76.93 (17.43) | 68.70 (22.16) | Group x Time | 1, 41 | 0.01 | .943 | < .001 |
| **Deferred Gratification** | (*n* = 24) | (*n* = 20) | | | | | |
| Time 1 | 95.29 (15.69) | 80.31 (22.22) | Time | 1, 42 | 0.02 | .892 | < .001 |
| Time 2 | 96.78 (22.92) | 78.01 (20.21) | Group x Time | 1, 42 | 0.42 | .521 | .010 |
| **Reversal Learning** | (*n* = 20) | (*n* = 19) | | | | | |
| Time 1 | 98.95 (28.49) | 76.31 (36.25) | Time | 1, 37 | 0.23 | .635 | .006 |
| Time 2 | 87.65 (30.60) | 72.21 (30.19) | Group x Time | 1, 37 | 0.04 | .845 | .039 |
| **Emotional Reactivity** | (*n* = 20) | (*n* = 19) | | | | | |
| Time 1 | 119.01 (24.70) | 113.19 (32.30) | Time | 1, 37 | 0.04 | .850 | .001 |
| Time 2 | 117.34 (26.73) | 116.15 (25.68) | Group x Time | 1, 37 | 0.47 | .498 | .012 |

Note. Global Repeated Measures ANOVA included all four types of Inhibitory Control at Time 1 and Time 2. Menstrual phase effects were examined with group X time interactions. Follicular phase means are shaded in grey [t] = trend ($p < .10$), *p < .05. **p < .01. *** p < .001

**Table 18**

*Menstrual Cycle Phase Effects for Errors of Commission (EOC) at Baseline and After Each Mood Prime for Naturally Cycling Women in the Follicular and Luteal Phase: Untransformed Means (SD) and Follow-Up Univariate ANOVA Results*

| Mood Prime | Follicular ($n$ = 26) | Luteal ($n$ = 18) | Covariate | df | $F$ | $p$ | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Baseline | 4.62 (3.23) | 4.78 (3.69) | N | 1, 43 | 0.02 | .878 | .001 |
| Sad | 4.12 (2.44) | 3.67 (3.11) | N | 1, 43 | 0.36 | .553 | .008 |
| | 4.14 (0.47) | 3.63 (0.57) | Y[a] | 1, 43 | 0.64 | .428 | .015 |
| Happy | 3.73 (2.43) | 2.83 (2.20) | N | 1, 43 | 1.57 | .218 | .036 |
| | 3.76 (0.38) | 2.80 (0.46) | Y[a] | 1, 43 | 2.55 | .118 | .059 |
| Fear | 4.46 (2.25) | 3.06 (2.44) | N | 1, 43 | 5.16* | .028 | .109 |
| | 4.49 (0.39) | 3.02 (0.47) | Y[a] | 1, 43 | 7.65** | .008 | .157 |

Note. [a]baseline scores were used as the covariate. For the analyses with baseline as a covariate ([a]), means are reported with their respective standard error in parentheses.

[t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

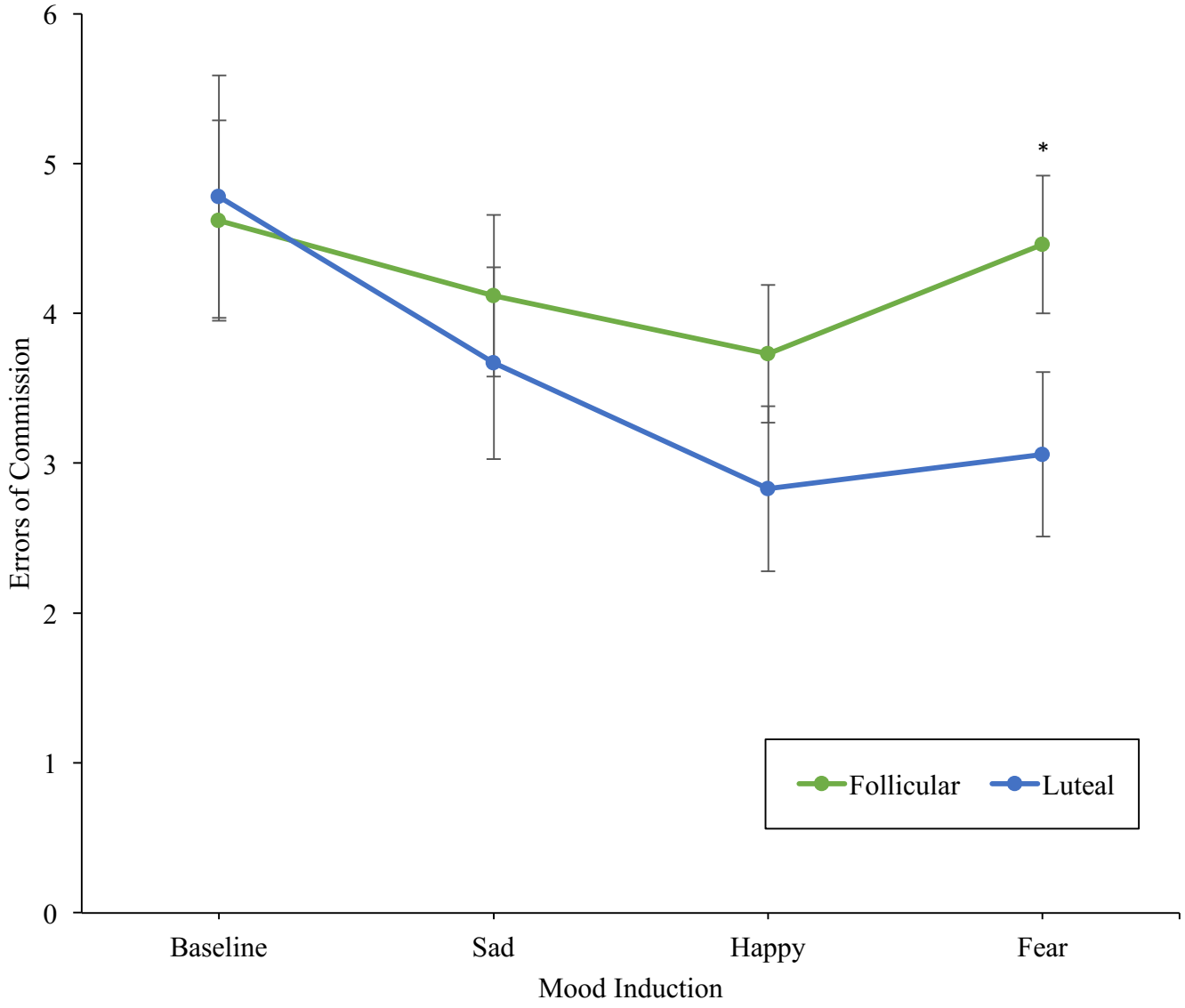
Interestingly, group differences were found when follow-up univariate ANOVAs were conducted. One-way ANOVAs were run with EOC as the DV and group (cycle phase) as the IV with and without baseline as a covariate (see Table 18). Results revealed a phase effect after the fear mood induction with women in the follicular phase demonstrating more EOC (i.e., more problems with response inhibition) than women in the luteal phase both with ($p$ = .008) and without baseline as a covariate ($p$ = .028) (see Figure 7). No group differences were found at baseline or after the sad or happy mood inductions.

Partial support was found for this hypothesis as women in the follicular phase showed less response inhibition (less inhibitory control) than women in the luteal phase, but only after a fear mood induction.

To further investigate both the potential role of estrogen in response inhibition and the sex difference in EOC after fear (see Figures 3 and 4), a MANOVA was run with group [men ($n$ = 30), women in the luteal phase ($n$ = 18), women in the follicular phase ($n$ = 26)] as the IV and EOC after sad, happy, and fear mood inductions as the DV. Variables were normally distributed after square root transformations. The EOC after baseline was used as a covariate. The overall model demonstrated a group effect, $F(6, 138) = 2.52$, $p$ = .024, $\eta^2$ = .099. Follow-up pairwise comparisons revealed that, after the fear mood induction, naturally cycling women in the follicular phase ($M$ = 4.10, SE = 0.46) had higher EOC compared to both naturally cycling women in the luteal phase ($M$ = 3.59; SE = 0.55; $p$ = .008) and men ($M$ = 3.10; SE = 0.43; $p$ < .001). There were no differences between men and women in the luteal phase ($p$ = .723). There were also no group differences at baseline, or after the sad or happy mood inductions (all $p$ < .05).

**Figure 7**

*Cycle Phase Effect: Errors of Commission at Baseline and After Mood Inductions*




Note. This figure shows the errors of commission of naturally cycling women in the follicular and luteal phase at baseline, and after three mood inductions. Women in the follicular phase had higher errors of commission than women in the luteal phase after the fear mood induction ($p = .028$). The error bars represent the stand error for each data point. *$p < .05$

***Hypothesis 5: Menstrual Cycle Effects on Deferred Gratification: Naturally cycling women in the luteal phase will exhibit more problems with deferred gratification compared to the follicular phase.*** The above repeated-measures MANOVA for Study 1 revealed no group by time effect (no phase effect) (see Table 17). The above between-subjects MANOVA (see Table 16) also indicated no group/phase differences in self-report (Study 1) or laboratory measures (Study 2) of deferred gratification. It is noteworthy that there was a trend towards significance for the self-report ICS-48 Deferred Gratification subscale ($p$ = .076), with women in the follicular phase showing higher scores (more problems) than women in the luteal phase. This was in the opposite direction to the hypothesis. Thus, there was no support for this hypothesis.

Given that one's financial situation may have affected decisions related to spending or deferring a hypothetical monetary award, analyses were re-run with an Income Questions scale (see Measures) as a covariate (see Table 16). For Study 1, the addition of income as a covariate did not change the outcome, as the trend towards significance for the self-report ICS-48 Deferred Gratification scale remained ($p$ = .092), with women in the follicular phase showing higher scores (more problems) than women in the luteal phase. However, when Income Questions were added as a covariate for the Study 2 laboratory task, a trend towards significance appeared with women in the luteal phase showing higher scores (more problems) than women in the follicular phase ($p$ = .094). Nevertheless, there were no significant menstrual cycle effects for deferred gratification, and no support for this hypothesis.

***Hypothesis 6: Menstrual Cycle Effects on Emotional Reactivity: Naturally cycling women in the luteal phase will demonstrate more emotional reactivity compared to the follicular phase.*** As indicated in the above between-subjects MANOVA (Table 16) and repeated measures analyses (Table 17), there were no cycle phase effects in emotional reactivity for Study

1 or Study 2. Given the above-noted sex effects for negative but not positive emotional reactivity, phase effects in emotional reactivity was further explored with separate variables reflecting positive and negative emotional reactivity from the ICS-48 in Study 1 (see Table 19 for Means and *SD*s). For the between-subjects analyses, two univariate ANOVAs were conducted with phase as the IV, and ICS-48 positive emotional reactivity and negative emotional reactivity subscales as the respective DVs. There were no phase effects for positive, $F(1, 105) = 0.58$, $p = .448$, $\eta^2 = .006$; or negative, $F(1, 102) = 0.24$, $p = .624$, $\eta^2 = .002$, emotional reactivity scores.

This hypothesis was also examined using two repeated-measures ANOVAs with time (Time 1 and Time 2) as the within-subjects variables and testing order group (follicular-luteal, luteal-follicular) as the between-subjects variable. The DVs were Positive Emotional Reactivity and Negative Emotional Reactivity scores. There was no phase effect (no group X time effect) for positive, $F(1, 41) = 0.557$, $p = .460$, $\eta^2 = .013$; or negative, $F(1, 37) = 0.81$, $p = .375$, $\eta^2 = .021$, emotional reactivity scores (see Table 19 for means and *SD*s). Cycle phase effects in emotional reactivity were further examined with laboratory measures of emotional reactivity: PANAS NA scores after each mood prime, EIAT Negative Emotional Reactivity scores, and EIAT Negative Emotional Reactivity response times (RTs).

*PANAS NA Scores.* Emotional reactivity was examined with PANAS NA scores across mood primes as the DV. Variables were inspected for normality. All variables reached normality after a log transformation. Given normality issues and the fact that positive mood is not germane to the hypotheses, NA after happy mood induction was not included in the analysis. To examine changes in NA across the negative mood primes within each group, a repeated measures ANOVA was conducted with phase (follicular, luteal) as the between-subjects variable and

**Table 19**

*Untransformed Means (SDs) for the Positive and Negative Emotion Questions from the Inhibitory Control 48-hours (ICS-48) Emotional Reactivity Scale as a Function of Cycle Phase (Follicular vs. Luteal) at Time 1 and Cycle Phase Order [Follicular-Luteal (FL), Luteal-Follicular (LF)] across Times 1 and 2*

| | Cycle Phase at Time 1 | |
|---|---|---|
| | Follicular ($n$ = 50) | Luteal ($n$ = 53) |
| Time 1 ICS-48 Emotional reactivity: Positive emotions | 38.05 (10.49) | 39.61 (10.51) |
| Time 1 ICS-48 Emotional reactivity: Negative emotions | 70.91 (25.33) | 68.09 (32.33) |
| | Cycle Phase Order Groups (Across Time 1 and Time 2) | |
| | Group FL ($n$ = 20) | Group LF ($n$ = 19) |
| ICS-48 Emotional reactivity: Positive emotions: | | |
| Time 1 | 39.70 (8.47) | 39.99 (12.65) |
| Time 2 | 44.83 (8.29) | 42.99 (9.09) |
| ICS-48 Emotional reactivity: Negative emotions: | | |
| Time 1 | 68.66 (28.37) | 64.31 (35.68) |
| Time 2 | 57.79 (27.26) | 60.58 (26.03) |

Note. Higher scores mean more emotional reactivity.

mood prime (baseline, sad, fear) as the within subjects variable (see Table 20 for means and *SD*s). The repeated measures ANOVA revealed that there was no phase effect, $F(1, 42) = 0.03$, $p = .873$, $\eta^2 = .001$; or cycle phase by mood prime interaction, $F(2, 41) = 0.18$, $p = .835$, $\eta^2 = .009$.

*EIAT Speed of Negative Emotional Associations.* The speed of negative emotional associations at baseline and after each mood prime were examined for normality. Speed scores reached normality after a log transformation. Visual inspection of the means showed that women in the luteal phase had faster speed scores compared to women in the follicular phase after the mood primes, but not at baseline (see Table 20). However, the repeated measures ANOVA with cycle phase as the between subjects' variable and mood prime (baseline, sad, happy, fear) as the within subjects' variable found no cycle phase effect, $F(1, 42) = 0.07$, $p = .796$, $\eta^2 = .002$; and no phase by prime effect, $F(3, 40) = 0.922$, $p = .439$, $\eta^2 = .065$.

*EIAT Accuracy of Negative Emotional Associations.* The accuracy of negative emotional association scores were normally distributed across the groups at baseline and after each mood prime. A visual inspection of the means showed that women in the luteal phase had lower accuracy scores compared to women in the follicular phase after the mood primes, but not at baseline (see Table 20). A repeated measures ANOVA with phase (follicular, luteal) as the between subjects variable and accuracy scores after each mood prime (baseline, sad, happy, fear) as the within subjects variable did not find a phase effect, $F(3, 40) = 0.62$, $p = .607$, $\eta^2 = .044$; or a phase by mood prime effect, $F(3, 40) = 0.62$, $p = .607$, $\eta^2 = .044$. Thus, there was no evidence of cycle phase effects for mood reactivity in the lab, or changes in phase effects across mood primes.

**Table 20**

*Untransformed Means (SDs) for PANAS NA, and Speed and Accuracy of Negative Emotional Association Scores at Baseline and After Each Mood Prime as a Function of Cycle Phase Group (Follicular or Luteal)*

| PANAS NA | Follicular ($n$ = 26) | Luteal ($n$ = 18) |
|---|---|---|
| Baseline | 1.56 (0.56) | 1.65 (0.75) |
| Sad | 1.97 (0.73) | 1.97 (0.77) |
| Fear | 2.27 (0.81) | 2.24 (0.93) |
| Speed of negative emotional Associations (EIAT) | | |
| Baseline | 0.25 (0.28) | 0.31 (0.22) |
| Sad | 0.12 (0.15) | 0.10 (0.09) |
| Happy | 0.11 (0.15) | 0.04 (0.10) |
| Fear | 0.06 (0.10) | 0.04 (0.08) |
| Accuracy of negative emotional associations (EIAT) | | |
| Baseline | 0.00 (3.22) | -0.11 (1.97) |
| Sad | 0.27 (2.39) | 0.00 (1.19) |
| Happy | -1.19 (2.15) | -0.56 (1.15) |
| Fear | -0.77 (1.97) | -1.06 (1.26) |

Note. Speed and Accuracy of Negative Emotional Association Scores were from the Emotional Implicit Association Task (EIAT). EIAT speed scores = self.neg RT – self.pos RT. EIAT accuracy scores = self.neg correct – self.pos correct. For EIAT speed scores, lower scores imply more emotional reactivity (i.e., makes faster associations between negative emotion words and the self). For EIAT accuracy scores, higher scores imply more emotional reactivity (i.e., makes more correct associations between negative emotion words and the self). PANAS NA = Positive and Negative Affect Schedule Negative Affect Scale.

### *Oral Contraceptive Effects on Inhibitory Control*

**Examination of Oral Contraceptive Effects on Global Inhibitory Control.** Data for OC users, nonusers, and men in Study 1 and Study 2 were screened for normality. All distributions met assumptions of normality for both studies. Means, *SD*s, and results from the global MANOVA and follow-up univariate ANOVAs for Study 1 are presented in the top half of Table 21. A visual inspection of the means indicated that OC users had higher mean scores (i.e., more problems with inhibitory control) than nonusers and men on all measures of inhibitory control except for emotional reactivity. Also, OC users and nonusers both had higher means than men on all measures of inhibitory control. The global MANOVA revealed a nonsignificant trend towards a group effect ($p = .051$) (see top half of Table 21). Follow-up univariate ANOVAs revealed a group effect for emotional reactivity, with men having lower scores (i.e., less emotional reactivity) compared to both OC users ($p = .003$) and nonusers ($p = .001$). As OC users and non-users did not differ ($p = .757$), the group differences reflect the sex difference already noted earlier.

Results from the MANOVA and follow-up univariate ANOVAs for Study 2 can be seen in the bottom half of Table 21. A visual inspection of the means indicates a lack of consistency with respect to group differences. The global MANOVA revealed no group effect (see bottom half of Table 21). The univariate ANOVAs also revealed no group effects, however there was a trend towards a group effect for PANAS NA change scores (i.e., emotional reactivity) ($p = 0.75$) with OC users having greater NA change compared to men ($p = .025$); but no differences between OC users and nonusers ($p = .399$), or nonusers and men ($p = .114$).

**Table 21**

*Oral Contraceptive Effects for Self-Report (Study 1) and Laboratory Measures (Study 2) of Inhibitory Control: Means (SDs) and MANOVA/ANOVA Results*

| | M(*SD*) | | | | | | |
|---|---|---|---|---|---|---|---|
| | OC | Nonuser | Men | df | *F* | *p* | $\eta^2$ |
| | | | **Study 1 MANOVA** | | | | |
| ICS-48 Scales | (*n* = 102) | (*n* = 103) | (*n* = 57) | 8, 514 | 1.95[t] | .051 | .029 |
| | | | Univariate ANOVAS | | | | |
| Response inhibition | 77.18 (21.57) | 75.14 (18.62) | 73.77 (18.60) | 2, 261 | 0.59 | .554 | .005 |
| Deferred gratification | 91.91 (18.16) | 88.35 (20.09) | 88.30 (16.15) | 2, 261 | 1.16 | .314 | .009 |
| Reversal learning | 87.35 (30.63) | 85.79 (30.62) | 78.91 (25.40) | 2, 261 | 1.57 | .211 | .012 |
| Emotional reactivity | 116.82 (25.45)$_a$ | 117.96 (28.61) | 103.78 (23.64)$_a$ | 2, 261 | 5.99** | .003 | .044 |
| | | | **Study 2 MANOVA** | | | | |
| Laboratory Tasks | (*n* = 36) | (*n* = 46) | (*n* = 30) | 8, 214 | 1.35 | .219 | .048 |
| | | | Univariate ANOVAs | | | | |
| Response inhibition (EOC) | 13.61 (7.11) | 16.78 (10.05) | 13.47 (8.04) | 2, 111 | 1.89 | .155 | .034 |
| Deferred gratification (Impulsive choice) | 20.58 (11.32) | 21.74 (12.03) | 22.13 (12.30) | 2, 111 | 0.16 | .853 | .003 |
| Reversal learning (PRL) | 8.11 (3.54) | 7.44 (3.38) | 8.03 (1.97) | 2, 111 | 0.58 | .564 | .010 |
| Emotional Reactivity (PANAS NA change score) | 0.79 (0.64) | 0.68 (0.63) | 0.46 (0.46) | 1, 111 | 2.65[t] | .075 | .046 |

Note. Untransformed means are reported for all variables. Higher scores reflect either more problems with inhibitory control or greater reactivity. EOC = Errors of Commission. PRL = probabilistic reversal learning task. PANAS NA = Negative Affect score on the Positive and Negative Affect Schedule (Watson et al., 1988). The change score is the mean change in NA scores after the two negative mood primes (i.e., the mean of: NA after baseline subtracted from NA after sad induction, and NA after happy induction subtracted from NA after fear induction). $_a$ OC users and men differ ($p = .025$), [t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

***Oral Contraceptive Effects on Emotional Reactivity: Differences in Emotional Reactivity between OC users, Nonusers, and Men Were Explored.*** As reported above in the global examination of OC effects on inhibitory control, there were group differences for the ICS-48 Emotional Reactivity subscale (Study 1) and a trend towards a group difference for the PANAS NA change score (Study 2) (See Table 21). Below, group differences in emotional reactivity were further explored using additional self-report and laboratory measures of emotional reactivity.

For self-report measures (Study 1), group differences in emotional reactivity were further explored using separate variables reflecting positive and negative emotional reactivity from the ICS-48. Group differences in emotional reactivity were also explored with trait-like measures that captured emotional reactivity in the past two-months (i.e., the emotional control subscale on the BRIEF-A scale, and the Perth emotional reactivity scale). Visual inspection of the means in Table 22 suggest that both OC users and nonusers have higher scores (i.e., more reactivity) than men on all measures (see Table 22). A MANOVA was conducted with group (OC users, nonusers, men) as the IV and the four noted DVs. All variables met assumptions of normality.

There was an overall group effect, $F(8, 470) = 3.72$, $p < .001$, $\eta^2 = .060$, and follow-up univariate ANOVAs revealed group differences for all measures of emotional reactivity, except for positive emotional reactivity (see Table 22). However, pairwise comparisons revealed that men had significantly lower scores than OC users and nonusers at the $p < .001$ level for both the BRIEF-A Emotional Control subscale and the Perth Emotional Reactivity scale, and men had significantly lower scores than both OC users ($p = .015$) and nonusers ($p = .003$) on the ICS-48 Negative Emotional reactivity subscale. There were no group differences between OC users and nonusers (all $p > .05$).

**Table 22**

Oral Contraceptive (OC) Effects: Means (*SD*s) and Follow-Up Univariate ANOVA Results on Positive, Negative, and Trait-Like Measures of Emotional Reactivity (Study 1)

| Emotional Reactivity Measure | Mean(*SD*) | | | df | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| | OC user (*n* = 94) | Nonuser (*n* = 96) | Men (*n* = 50) | | | | |
| ICS-48 Emotional reactivity: Positive emotions | 35.55 (9.22) | 38.55 (10.27) | 37.08 (7.94) | 2, 239 | 1.14 | .322 | .010 |
| ICS-48 Emotional Reactivity: Negative emotions | 67.44 (24.48)$_a$ | 70.10 (29.43)$_b$ | 56.16 (22.25)$_{a,b}$ | 2, 239 | 4.85** | .009 | .039 |
| Emotional Control subscale of BRIEF-A scale | 17.43 (4.84)$_a$ | 17.99 (4.71)$_b$ | 14.16 (4.02)$_{a, b}$ | 2, 239 | 12.01*** | <.001 | .092 |
| Perth Emotional Reactivity scale | 93.69 (11.21)$_a$ | 94.53 (13.38)$_b$ | 85.18 (13.27)$_{a, b}$ | 2, 239 | 10.14*** | <.001 | .079 |

Note. Higher scores reflect higher emotional reactivity (i.e., less emotional inhibitory control). $_a$ OC users and Men differ, $_b$ Nonusers and Men differ. $^t$ = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

Additional laboratory measures of emotional reactivity in Study 2 were examined for group differences: PANAS NA scores after each mood prime, EIAT Negative Emotional Reactivity correct scores, and EIAT Negative Emotional Reactivity response times (RTs). See Tables 23 and 24 for means and *SD*s for each of the emotional reactivity variables for Study 2.

*PANAS NA Scores*. Log transformations were used to normalize the PANAS NA scores related to the baseline condition and the sad and fear mood inductions. Due to normality issues, NA (happy) was excluded from analysis. Visual inspection of the untransformed means indicated that both groups of women reported higher scores (i.e., more reactivity) than men after the sad and fear mood inductions, but not at baseline (see Table 23).

A repeated measures ANOVA with group (OC users, nonusers, men) as the between subjects variable and NA scores (baseline, sad, and fear) as the within subjects variables revealed a trend towards a group by mood prime interaction effect, $F(4, 220) = 2.18$, $p = .072$, $\eta^2 = .038$. There was no group effect found, $F(2, 110) = 1.06$, $p = .351$, $\eta^2 = .019$. Three follow-up one-way ANOVAs were conducted with group as the IV and PANAS NA scores as the DV. The repeated measures variable was condition (baseline, fear, sad). These ANOVAs were run with and without baseline NA as a covariate (see Table 23). The group differences in PANAS NA scores after the fear mood induction. Follow-up pairwise comparisons revealed that men had lower PANAS NA compared to OC users ($p = .033$), and nonusers ($p = .017$), but there were no differences between OC users and nonusers ($p = .867$). Similarly, when baseline was used as a covariate, men had lower PANAS NA compared to OC users ($p = .016$), and nonusers ($p = .017$), but there were no differences between OC users and nonusers ($p = .884$). There were no group differences at baseline, or after the sad mood induction.

**Table 23**

*Oral Contraceptive Effects for PANAS NA at Baseline and After the Sad and Fear Mood Primes: Means (SDs) and Follow-Up Univariate ANOVA Results*

| **PANAS NA Scores** | OC users (*n* = 36) | Nonusers (*n* = 46) | Men (*n* = 31) | Covariate | df | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|---|---|
| Baseline | 1.38 (0.36) | 1.55 (0.63) | 1.47 (0.41) | N | 2, 112 | 0.78 | .460 | .014 |
| Sad | 1.86 (0.59) | 1.89 (0.74) | 1.79 (0.56) | N | 2, 112 | 0.12 | .887 | .002 |
| | 1.91 (0.10) | 1.86 (0.09) | 1.79 (0.11) | Y[a] | 2, 112 | 0.36 | .702 | .006 |
| Fear | 2.21 (0.81) | 2.25 (0.84) | 1.79 (0.80) | N | 2, 112 | 3.40* | .037 | .058 |
| | 2.24 (0.13) | 2.22 (0.11) | 1.79 (0.14) | Y[a] | 2, 112 | 3.79* | .026 | .065 |

Note. PANAS NA = Negative Affect score from the Positive and Negative Affect Schedule. Higher scores imply greater emotional reactivity (i.e., less inhibitory control in this area).

[a]baseline was used as the covariate. For these analyses ([a]), means are reported with their respective standard error in parentheses. [t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$.

**Table 24**

*Oral Contraceptive Effects: Untransformed Means (SDs) for EIAT Speed and Accuracy of Negative Emotional Associations at Baseline and After Each Mood Prime*

| Mood Induction | OC Users ($n$ = 36) | Nonusers ($n$ = 46) | Men ($n$ = 31) |
|---|---|---|---|
| Speed of negative emotional associations | | | |
| Baseline | 0.30 (0.23) | 0.29 (0.25) | 0.37 (0.36) |
| Sad | 0.12 (0.14) | 0.12 (0.14) | 0.06 (0.18) |
| Happy | 0.08 (0.10) | 0.07 (0.15) | 0.10 (0.17) |
| Fear | 0.05 (0.08) | 0.06 (0.11) | 0.05 (0.13) |
| Accuracy of negative emotional associations | | | |
| Baseline | -0.69 (2.48) | -0.09 (2.68) | -0.29 (2.13) |
| Sad | -0.25 (1.83) | -0.02 (2.13) | -1.13 (1.89) |
| Happy | -1.22 (1.73) | -0.76 (2.02) | -0.81 (2.01) |
| Fear | -0.64 (1.59) | -0.76 (1.77) | -0.81 (1.81) |

Note. EIAT = Emotional Implicit Association Task. EIAT speed scores = self.neg RT – self.pos RT. EIAT accuracy scores = self.neg correct – self.pos correct. For the speed of negative emotional association scores, lower scores imply more emotional reactivity (i.e., makes faster associations with negative emotion words and the self). For the accuracy of negative emotional association scores, higher scores imply more emotional reactivity (i.e., makes more correct associations with negative emotion words and the self). PANAS NA = Negative Affect score from the Positive and Negative Affect Scale. $^{t}$ = trend ($p < .10$), *$p <$ .05. **$p < .01$. *** $p < .001$.

*EIAT Speed of Negative Emotional Associations.* The speed of negative emotional self-association scores at baseline and after each mood prime were normally distributed after Log transformations. Visual inspection of the untransformed means indicated a lack of consistent group differences with OC users and nonusers having similar speed scores across the laboratory session (see Table 24). A repeated measures ANOVA with group (OC users, nonusers, and men) as the between subjects variable found no evidence of a group, $F(2, 109) = 0.12$, $p = .891$, $\eta^2 = .002$; or a group by prime effect, $F(6, 216) = 1.08$, $p = .375$, $\eta^2 = .029$.

*EIAT Accuracy of Negative Emotional Associations.* The accuracy of negative emotional association scores were normally distributed across groups. Visual inspection of the untransformed means indicated that men had the lowest scores (least negative emotional reactivity) compared to OC users and nonusers after the sad and fear mood primes, while OC users had the lowest scores (least reactivity) compared to nonusers and men at baseline and after the happy mood prime (see Table 24).

To examine changes in accuracy scores across mood primes for each group, a repeated measures ANOVA was conducted with group (OC users, nonusers, men) as the between subjects variable and accuracy of negative emotional associations after each mood prime (baseline, sad, happy, fear) as the within subjects' variables. There was no group effect, $F(2, 110) = 1.78$, $p = .174$, $\eta^2 = .031$; or group by prime effect found, $F(6, 218) = 0.96$, $p = .453$ $\eta^2 = .026$.

There was no evidence that OC users and nonusers differed on any measure of inhibitory control.

# Discussion

## Summary of the Results

Group differences (sex differences, cycle phase effects, and OC effects) in inhibitory control (response inhibition, deferred gratification, reversal learning, emotional reactivity) were examined across two studies. For each group comparison, a global examination of inhibitory control was conducted followed by analyses related to specific hypotheses. This comprehensive project is the first to examine group differences in four types of inhibitory control using both laboratory and self-report measures.

### *Sex Differences*

The global examination revealed that women were more emotionally reactive than men based on emotional reactivity ratings over the past 48-hours (Study 1) and NA reactivity in the lab to mood primes (Study 2). No sex differences were found for response inhibition, deferred gratification, or reversal learning in Study 1 or 2.

Hypothesis 1 was not supported as women did not make more EOC than men after the happy mood induction. Instead, women made more EOC than men after negative mood inductions (sad, fear), suggesting more response inhibition difficulties during negative moods. Partial support was found for Hypothesis 2 as women reported more trait-like problems with reversal learning (i.e., on the Perseverative Thinking Questionnaire (PTQ) and a similar trend on the Shift Subscale of the BRIEF-A), but no sex differences were found for laboratory measures or recent 48-hour self-report of reversal learning problems.

Hypothesis 3 was supported (i.e., women were more emotionally reactive than men). Women reported higher emotional reactivity than men on a measure of emotional reactivity over the past 48 hours and on trait-like measures (i.e., Emotional Control subscale of the BRIEF-A,

Perth Emotional Reactivity Scale). However, sex differences on the 48-hour measure were due to negative emotional reactivity (no effect for positive emotional reactivity). Laboratory results (Study 2) also generally supported Hypothesis 3 and suggested that the sex effect was found only after negative mood inductions (sad or fear). Women had higher negative affect reactivity than men across the negative mood primes in the laboratory session, but this effect was driven by women having higher NA reactivity only after the fear mood induction (not the sad mood induction). On the EIAT task, sex differences were only found with the sad mood induction (not fear), but they were mixed: Women were more emotionally reactive based on accuracy of negative emotional association scores while men were more emotionally reactive based on faster speed of negative emotional associations.

***Cycle Phase Effects***

The global examination did not reveal any cycle phase effects for any type of inhibitory control (response inhibition, deferred gratification, reversal learning, or emotional reactivity) when either between-subjects or within-subjects designs were used to evaluate (a) self-reported behaviour over the past 48 hours or (b) laboratory measures. There was partial support for Hypothesis 4 as women in the follicular phase had more problems with response inhibition than women in the luteal phase, but only in terms of EOC after the fear mood induction (not sad). As already noted, there was no phase effect for response inhibition problems reported over the previous 48 hours. There was no support for Hypothesis 5, as the luteal phase was not associated with more deferred gratification problems than the follicular phase. Hypothesis 6 was also not supported, as there was no evidence of greater emotionally reactivity in the luteal than follicular phase.

### *OC Effects*

There was no evidence of any effects of OCs on any of the four types of inhibitory control for self-report or performance-based lab measures. While group differences were found, these only reflected the above-noted sex differences.

## Sex Differences in Inhibitory Control

Sex differences in inhibitory control were examined for all four types of inhibitory control. Sex differences were predicted for Response Inhibition (Hypothesis 1), Reversal Learning (Hypothesis 2) and Emotional Reactivity (Hypothesis 3). The results for each of these hypotheses are discussed below. No sex differences were expected for Deferred Gratification. The results from this project were consistent with previous research in that no sex differences were found on either the self-report or laboratory tasks measuring deferred gratification (e.g., Cross et al., 2011; Grissom et al., 2019).

### *Sex Differences in Response Inhibition: Women Made More Errors of Commission after Negative Mood Induction*

The results did not support the hypothesis that women would have more EOC than men after the happy mood induction (Hypothesis 1). Instead, it was found that women had more EOC than men after the sad and fear inductions. The hypothesis was, in part, based on previous research in our laboratory which found that women made more EOC than men after happy mood induction (Keir & Oinonen, 2016b). However, while the current findings did not fully support the hypothesis or replicate the Keir and Oinonen (2016) findings, they were consistent in suggesting that women make more EOCs than men only in an emotional context (i.e., not in neutral/baseline conditions). As we found no sex differences at baseline (i.e., prior to emotion induction), this is consistent with previous studies that found no sex differences in performance

on GoNogo tasks without emotion inductions (Gaillard et al., 2021; Omura & Kusumoto, 2015; Ramos-Loyo et al., 2016; Weafer & de Wit, 2014; Yuan et al., 2008). Similarly, no differences were found on the self-report measure of Response Inhibition (ICS-48 Response Inhibition Scale) which examined problems in response inhibition in the past 48-hours independent of emotion induction. Further, one important difference between this current project and the previous study was that Keir and Oinonen (2016b) did not have baseline measures of performance on the GoNogo task. Thus, they could not control for performance on the task independent of mood induction and thus may have missed important sex differences in EOC after negative emotion induction. Indeed, the current project found sex differences in EOC after fear mood induction only when baseline EOC was used as a covariate. Thus, Keir and Oinonen (2016b) might have found similar results following negative mood induction if a baseline condition/covariate had been used.

The current results were also consistent with previous findings suggesting that estrogen is associated with lower response inhibition (Alkanat et al., 2021; Colzato et al., 2010; Griskova-Bulanova et al., 2016; Hatta & Nagaya, 2009; Milivojevic et al., 2016). A recent comprehensive review by Bangasser et al. (2019) suggested that higher estrogen is related to poorer response inhibition, specifically after negative mood induction. Based on a review of human and rodent studies, Bangasser et al. (2019) concluded that estradiol increases female vulnerability to stress-induced hyperarousal by increasing the production of norepinephrine (a neurotransmitter released in response to stress) in the locus coeruleus (a nucleus which regulates arousal). An increase in norepinephrine is involved in the sympathetic “fight or flight” response which is marked by increased arousal, orienting to novel or threatening stimuli, selective attention, and vigilance (Southwick et al., 1999), all of which can be associated with increased reactivity (i.e.,

lower response inhibition). Indeed, Bangasser et al. (2019) reported that hyperarousal can lead to inappropriate or persistent responses to irrelevant stimuli in the environment. Thus, the increased EOC in women in this study may be explained by estrogen's effect on the norepinephrine system leading to hyperarousal and false positive error responses to stimuli following negative mood induction.

Regarding men's response to stress, Bangasser et al. (2019) reviewed preliminary evidence that testosterone reduces the synthesis and release of norepinephrine, which overall reduces stress responsivity in men. Thus, while the negative emotion induction in Study 2 may have increased women's stress reactions due to an effect of estradiol lowering response inhibition, this effect may have been reduced in men due to their higher testosterone. Bangasser et al. (2019) also noted that lower norepinephrine release in men's response to stress was associated with attentional deficits. This suggests that, while women respond to stress by over-responding (i.e., errors of commission) and attending to a stimulus, men may respond to stress by missing relevant stimuli or cues (Bangasser et al., 2019).

Several studies have found similar sex differences in arousal and attentional responses to negative emotional stimuli. For example, Wilhelm et al. (2017) found that women's psychophysiological reactions to negative emotion or threat was indicative of defensive and stress-induced hyperarousal (i.e., "fight or flight") while men's responses were indicative of sustained orientation marked by predominate parasympathetic activation which facilitates the intake of sensory information. Filkowski et al. (2017) found via fMRI that, following emotion induction, men recruit brain areas related to volitional control indicative of emotion suppression and, possibly, lower arousal. Also, Gard and Kring (2007) found women had a prolonged startle response compared to men even after the removal of negative stimuli. Together, these studies

indicate that women respond to negative stimuli with more arousal (Bangasser et al. 2019; Fiklowski et al., 2017; Whilhelm et al., 2017), and they are affected by negative stimuli for longer compared to men (Gard & Kring, 2007).

Thus, after experiencing negative emotions women's hyperarousal may lead to an over-reaction or over-response to stimuli leading to more EOC (i.e., pressing a button when one is meant to inhibit a button press). Conversely, the above studies indicate that men respond to negative stimuli with reduced arousal (Bangasser et al. 2019, Wilhelm et al., 2017), increased orienting responses (Wilhelm et al., 2017), as well as with more effortful control over their emotional reactions (Filkowski et al., 2017). This increased control of emotional reactions coupled with lower arousal may have enhanced the men's performance on the GoNogo task in Study 2 by reducing their reactivity and increasing their inhibitory control.

Both sustained orientation and defensive arousal are adaptive responses to negative stimuli. Increased orientation allows one to take in more sensory information, and allocate attentional resources in preparation for a response. This is adaptive as it allows one to assess the situation optimally prior to reacting. However continued orientation may also reduce focus on an important stimulus in favour of attending to multiple stimuli. In the defense cascade model, an orientating response is typically the first stage of threat response which turns into a defensive response as the threat increases (Lang et al., 1997). A defensive response allows one to focus attention on threatening stimuli and take swift action. An over-defensive reaction could lead to responding to false alarms, such as pressing a button when not necessary in the case of the GoNogo task. However, a defensive response is adaptive in the context of threat and fear as it would allow one to be reactive to stimuli to better defend oneself. From a survival perspective, it would be safer to over-react to a non-threat than to under-react to an actual threat. Thus,

women's higher commission errors following negative mood induction may reflect an adaptive response.

The estrogen explanation for higher EOC in women compared to men is also supported by the findings of higher EOC in the follicular phase compared to the luteal phase (see below). Nevertheless, because levels of hormones were not collected in this study, it cannot be determined with certainty that estrogen itself is directly related to performance on the GoNogo task. To further explore whether estrogen is a factor in the sex differences in response inhibition, future studies could examine estradiol levels in women across the menstrual cycle as a function of performance on a GoNogo task after negative mood induction. If higher EOC are found with higher levels of estradiol, this would provide further support for a role of estrogen in reducing response inhibition.

In addition to measuring estrogen levels, future research could examine performance on a GoNogo task after negative mood inductions that vary in intensity. If EOC increase as the intensity of the negative emotion increases, it would further support the idea that EOC are reflective of a defensive response. This design could also be used to determine the threshold at which men and women change from an orienting response to a defense response.

This is the first study that we are aware of to examine sex differences in response inhibition using both laboratory (performance-based) and self-report measures. This is a strength of the present research because the construct was examined in multiple ways. Interestingly, bivariate correlations indicated that laboratory measures of response inhibition (i.e., EOC scores) were positively correlated with several self-report measures of response inhibition (See Table 4 in the Results section). These positive correlations suggest that both self-report and laboratory measures capture some similar variance in the response inhibition construct. Given the present

finding of sex differences in EOC after negative emotion induction and no sex differences in EOC or self-reported response inhibition without mood induction, future studies could examine if self-report measures of response inhibition also differ as a function of emotion induction.

### *Sex Differences in Reversal Learning: Women Reported Poorer Reversal Learning Compared to Men Only on Self-Report Measures*

The results provided partial support for the hypothesis that women would show deficits in reversal learning compared to men (Hypothesis 2). There were no sex differences in performance on the lab-based Probabilistic Reversal Learning Task. However, on self-report measures, women reported more problems with reversal learning on the Perseverative Thinking Questionnaire (PTQ) (and nonsignificant trends towards this sex difference on the BRIEF-A Shift subscale and the ICS-48 Reversal Learning Scale). This was the first study that we are aware of to examine sex differences in self-reported measures of reversal learning.

The lack of sex differences on the laboratory measure of reversal learning was inconsistent with the findings from Evans and Hampson (2015), despite an attempt to replicate their task and analysis strategy. One probable reason for this discrepancy is that a coding error in the present study resulted in an inability to capture data from the feedback contingency that provided 20% incorrect feedback (and 80% correct feedback). Instead, data was only collected for the feedback contingency condition that provided 10% incorrect feedback (and 90% correct feedback). Also, this current study included one 6-minute condition with two reversal pairs whereas the Evans and Hampson (2015) study included eight 6-minute conditions. Having fewer conditions could have reduced the sensitivity of the task to detect sex differences relative to the Evans and Hampson task. Thus, the exact design and analysis as intended from the Evans and Hampson (2015) study was not replicated.

Also, although probabilistic feedback was still provided (90% correct, 10% incorrect feedback), it was only provided for the easier of the two feedback contingencies. This may also explain why results were inconsistent with Halari et al. (2005), which involved a more challenging reversal learning task (e.g., a task that required reversal of an overlearned forward counting task); yet were consistent with Overman (2004) and Sheild et al. (2016) who included simpler tasks (e.g., a simple card sort task). Nevertheless, the average correct score on the reversal trials for participants in this study was 59% correct (M = 11.89, *SD* = 3.57) which does not indicate a ceiling effect. Given no evidence of a ceiling effect, the results may be a valid reflection of a lack of sex difference on tasks of reversal learning.

Overall, there is a paucity of human research on reversal learning, making it difficult to draw conclusions about sex differences in this area. Even in animal research there are inconsistencies with some studies finding a male advantage on reversal learning tasks (e.g., Bissonette et al., 2012; Eddy et al., 2013; Mihalick et al. 2000), yet other studies using similar tasks finding no sex differences (Harte & Edwards, 2010; Mazza et al., 2018) or a male advantage only when rats were exposed to early life stressors (Goodwill et al., 2018). These inconsistencies in both animal and human research, and the results from this current study, suggest that men and women may have relatively equal capabilities in this area of inhibitory control and that sex differences may only occur when the tasks are especially sensitive or challenging. Also, given that human reversal learning tasks need to be particularly sensitive to detect sex differences, the results from these tasks may not generalize to daily "real world" tasks outside of the laboratory. That is, the challenging laboratory tasks may not have ecological validity.

One strength of this study is that, through self-report measures, reversal learning was measured based on everyday tasks and situations. Results revealed that women endorsed more problems with perseverative thinking on the PTQ than men, which provided partial support for the hypothesis. However, it is important to note that perseveration is only one component of reversal learning. Reversal learning for this study was operationally defined as the ability to inhibit a response previously rewarded but now punished or no longer rewarded. This included cognitive flexibility, perseveration, and compulsive responding (Bari & Robbins, 2013). The Probabilistic Reversal Learning task directly measured the ability to inhibit a previously rewarded response. Meanwhile, the PTQ captured one's awareness of their own difficulties with perseveration. For example, items from the PTQ include statements such as: "*I have kept thinking about the same issue all the time*", "*The same thoughts keep going through my mind again and again*", and "*I get stuck on certain issues and can't move on*". Interestingly, bivariate correlations revealed that the self-report reversal learning measures in this study did not correlate with scores on the Probabilistic Reversal Learning Task ($r(153) = -.027$, $p = .839$*;* see Table 6). This may provide some evidence that the Probabilistic Reversal Learning Task lacks ecological validity. Alternatively, the lack of a strong positive correlation could indicate that the self-report and laboratory measures examine different constructs or different nonoverlapping aspects of reversal learning.

Further examination of the reversal learning questionnaires revealed that, rather than being related to the Probabilistic Reversal Learning Task, the PTQ, BRIEF-A and ICS-48 Reversal Learning Scale were positively correlated with self-report and laboratory measures of emotional reactivity (e.g., ICS-48 Emotional Reactivity Scale, PERS, BRIEF-A Emotional Control Subscale, Baseline PANAS NA score, and PANAS NA after sad induction; See

Appendix K). In mood and emotion research, perseverative thinking is related to rumination which has been shown to increase negative mood and is associated with difficulties regulating mood (Nolen-Hoeksema, 2012; Querstret & Cropley, 2013). Also, rumination has been consistently found to be elevated in women relative to men (Nolen-Hoeksema, 2012). Thus, it is questionable to what degree the PTQ measures emotional reactivity versus reversal learning. To explore this, future research could create a reversal learning questionnaire that covers all aspects of reversal learning to examine which aspects are related to or separate from emotional reactivity. This could help to validate self-report as a method of measuring reversal learning.

One limitation of self-report measures of reversal learning is that respondents would require a high degree of self-awareness and meta-cognition to identify oneself as having difficulty shifting mental sets, solving problems, and perseverating (or ruminating). Thus, these measures may not capture individuals with difficulties in reversal learning that are beyond their personal awareness. Also, results found a sex effect only for the PTQ which involves some retrospective bias because it measures problems with reversal learning in the previous two-months. The PTQ may be less reliable than a measure that captures problems with reversal learning in the previous 48-hours (i.e., the ICS-48 Reversal Learning Scale).

Future studies should continue to examine sex differences in reversal learning using probabilistic feedback to reduce the chance of a ceiling effect. These studies could also help to determine the degree to which task difficulty is related to sex differences in reversal learning. Additionally, future research could examine sex differences in reversal learning after mood primes as perseverative responding may be related to negative emotional reactivity and stress or negative emotions may create an additional challenge to task completion thus making laboratory reversal learning tasks more sensitive in detecting sex differences.

### *Sex Differences in Emotional Reactivity: Women Were More Emotionally Reactive than Men*

The results supported the hypothesis that women were overall more negatively emotionally reactive than men (Hypothesis 3) based on questionnaires that measured recent emotional reactivity in daily life (Study 1) and negative affect after negative mood induction in the laboratory (Study 2). Sex differences on the EIAT, an implicit measure of emotional reactivity, were inconsistent, providing only partial support for the hypothesis. Results for the EIAT will be discussed separately from the other measures.

In Study 1, women were more emotionally reactive than men based on a questionnaire that assessed emotional reactivity in the previous 48-hours (ICS-48 Emotional Reactivity Scale), and on questionnaires that measured emotional reactivity over the previous two weeks (PERS, BRIEF-A Emotional Control Subscale). Further, when questions on the ICS-48 Emotional Reactivity Scale were separated based on positive or negative emotional reactivity, sex differences were found only for negative emotional reactivity. These results were consistent with previous research that found women were more emotionally reactive than men in daily life. For instance, Brebner (2003) examined emotional experiences over a month and found that women reported a higher frequency of both negative and positive emotions compared to men, and women rated negative emotions as more intense than men did. Thus, while the frequency of all emotions is higher in women than men, emotional reactivity (including how intensely the emotion is experienced) only differs between men and women when it comes to negative emotions. These results are also consistent with Grossman and Wood (1993a) who found that women had higher ratings of fear and sadness compared to men.

The Study 1 finding that women experience negative emotions as more intense than men was consistent with the findings from Study 2 where woman had higher PANAS NA scores and

NA change scores after the fear mood induction compared to men. These results are consistent with previous research that found women were more emotionally reactive than men on both self-report and physiological reactions to negative emotional stimuli (Bianchin & Angrilli, 2012; Bradley et al., 2001; Domes et al., 2010; Gard & Kring, 2007; Grossman & Wood, 1993).

Previous research suggests that one of the reasons women are more emotionally reactive than men is because women have more difficulty overriding their negative emotional reactions. For example, Filkowski et al. (2017) found that, when faced with emotional stimuli, women demonstrated enhanced subcortical sensitivity consistent with patterns related to harm avoidance, while men recruited more frontal regions indicative of volitional control processes. Also, Gard and Kring (2007) found that, compared to men, women continued to exhibit a startle response after the presentation of negative stimuli, indicating a prolonged stress response and prolonged engagement in aversive motivational systems compared to men. Thus, women appear more affected by negative emotional stimuli.

Ultimately the idea that women may have enhanced emotional experiences while men suppress their experiences is also consistent with Bangasser et al. (2019), Whilhem et al. (2017), and Rattel et al. (2020), all of whom identified that men and women engage different motivational systems when met with aversive stimuli. Moreover, as discussed above (see Hypothesis 1) estrogen enhances the release of norepinephrine which activates a defensive response that can be measured via heart rate, skin conductance response, respiration, and facial muscle movement in humans, and levels of norepinephrine in the locus coeruleus in rats (Bangasser et al., 2019). Also, Rattel et al. (2020) found that these physiological reactions were concordant with their self-report emotional reactions which, as the researchers concluded, further indicates that women pay attention to and are more aware of their emotional reactions. Indeed, as

discussed for Hypothesis 1, this increased defensive response following negative emotions is adaptive from an evolutionary sense as it allows women to react to potential danger even if the cost is an increase in the false alarm rate. Also, as discussed with respect to Hypothesis 1, this may help women respond to stimuli (e.g., during a GoNogo task).

One unexpected finding was that there were no sex differences in PANAS NA after the sad mood induction. Most previous laboratory studies of emotional reactivity examined all negative emotional stimuli together, rather than separately, making it difficult to know whether men and women respond differently to specific mood inductions (e.g., Bianchin & Angrilli, 2012; Bradley et al. 2001; Domes et al. 2010; Filkowski et al 2017; Gard & Kring 2007). However, of the studies that examined specific mood inductions, sex differences were found after sad mood induction. For instance, both Rattel et al. (2020) and Wilhelm et al. (2017) found that women had higher emotional reactivity to threat and loss films compared to men. However, consistent with our findings, they found this sex difference to be stronger in threat-related rather than loss-related films. It makes sense that sadness-based stimuli would not activate the defense system in women in the same way as fear-based stimuli. In the current study, the fear mood induction may have met women's threshold to activate the defensive motivational system while the sad stimuli may not have. Perhaps the sad mood induction in this study was not intense or arousing enough to elicit sex differences in self-reported affect. This suggests that women are not reactive to the same degree for all negative emotions.

Nevertheless, as reflected in the findings for Hypothesis 1, women made more EOC after both the fear and sad induction. Perhaps the sad stimuli still created a negative emotional response in women that affected their reactivity, but not enough for their self-reported ratings to increase. Also, women may be generally more comfortable with experiencing sad emotions,

while they find fear-based emotions less tolerable and more threatening. Future research may benefit by collecting information on tolerance of negative emotions. Also, as suggested in the discussion of Hypothesis 1, future research would benefit from collecting data on different types of negative stimuli at different levels of intensity to determine sex differences in the threshold of reactivity to negative emotions.

Another possible reason that men demonstrate lower emotional reactivity than women, especially with respect to self-report may be the effects of gender roles and socially desirable responding. However, when PIM (a measure of positive impression management) was used as a covariate, the results did not change indicating that socially desirable responding was not a driver of these sex differences. Nevertheless, the effect of gender roles and gender expectations were not examined in this study. In their review on sex differences in emotions, Wester et al. (2002) found that men indicated less willingness to express fear due to situational pressures to appear masculine. Those findings are consistent with the current results indicating sex differences specifically after the fear mood induction. To examine the extent to which gender roles and emotion suppression play a role in reactivity scores, future research could examine gender roles, gender identity, as well as measures of emotional suppression. These measures could be explored as covariates or moderators.

The EIAT was included in this study as an implicit measure of emotional reactivity which aimed to avoid sex differences that may occur due to social desirability in self-report measures. Because this was a novel task created for this study (i.e., not yet empirically validated) and because interpretation of the task relies on interpretation of associations (i.e., assumptions), this task was used as an exploratory and supplementary measure of emotional reactivity. One strength of the EIAT speed and accuracy of negative self-association scores is they examine

negative reactivity relative to positive reactivity, thereby controlling for overall reactivity. This is another strength relative to self-report measures that do not control for overall reactivity or positive reactivity.

The results partially supported the hypothesis in that women demonstrated more negative emotional reactivity than men based on higher accuracy of negative relative to positive emotional self-associations after the sad mood induction. These results are consistent with other findings from the current project that also suggested women are more negatively emotionally reactive than men following negative stimuli (i.e., PANAS NA scores and the EOC scores). However, sex differences in accuracy on the EIAT were only found after the sad mood induction (not the fear mood induction), which contrasts with the results from the PANAS NA scores which only found higher scores in women after the fear mood induction (not the sad mood induction). One possible explanation for this discrepancy is that the fear mood induction was overall more arousing or emotion-inducing than the sad mood induction, possibly causing women to make more mistakes during the EIAT with negative self-associations, reducing their correct scores, and diminishing the sex difference. This is possible given the above suggestion that hyperarousal following fear induction may have led to more EOC in women in the GoNogo task (see Hypothesis 1).

Unlike the relative accuracy of negative emotional associations, results from the speed of negative emotional associations revealed that men were more emotionally reactive compared to women based on faster self-associations with negative emotion words relative to positive emotion words after the sad mood induction. These results contrast with most previous research and the self-report findings in Study 1 as they suggest that men are more emotionally reactive than women. However, there may be other explanations for the faster RTs in men with negative

vs. positive self-associations after sad mood induction. For example, although sad mood induction increased women's ability to correctly associate negative words with themselves (relative to positive words), it may have slowed down their response times relative to men. Unlike the fear mood induction, where we may expect hyperarousal and faster response times, perhaps sad mood induction had a different effect (e.g., a depressogenic effect) on reaction times as the sad stimuli were less threatening. Thus, perhaps fear mood induction sped up women's response times to negative words, thereby reducing the sex difference, while sad mood induction slowed down women's response times to negative words creating the observed sex difference in EIAT response times.

The order of mood inductions may be another reason why sex differences were found after the sad, but not fear, induction. An examination of the means (see top half of Table 15) reveals that both men and women appeared to get faster at making the associations across the course of the laboratory session, yet men appeared to get faster at a quicker pace than women. Thus, rather than these scores indicating men are more negatively emotionally reactive, it may mean they learned to make negative self-associations faster, while women learned to make the negative self-associations more accurately. One limitation of the lack of counterbalancing of mood prime order for this task is that it is unknown if the effects are due to the sad mood prime or if they are due to men and women learning the task in different ways. While creating mood primes of comparable intensity can be tricky, future studies using this task should counterbalance mood prime order to help determine the effect of the mood primes on task performance.

A caveat to the interpretation of the EIAT is that this was a novel task adapted from Xu et al.'s (2014) depression IAT and anxiety IAT. Because this is not an established measure of emotional reactivity, it is possible that the test does not measure what it was intended to measure.

For instance, the EIAT task requires cognitive skills such as correctly categorizing words, making incongruent categorizations (e.g., “me and sad” after a happy mood induction), shifting sets when word categories change (flexibility), motor speed (response times), and working memory (remembering the correct categories to response quickly). Thus, rather than emotional reactivity, the EIAT may be measuring one or several of these cognitive abilities.

Moreover, although the EIAT is a novel task, some of the general criticisms of the IAT also apply. For example, a paper by Fideler et al. (2000) identified that one of the problems with the IAT is that it equates an association with an attitude. In doing so, the attitude is reduced to a one-dimensional construct that may instead be related to many things. The EIAT takes the assumption slightly further as it also assumes the association is related to the most recent mood induction. Rather than reflecting reactivity based on the recent mood prime, certain emotion words may be commonly associated with the self or others based on pop-culture references, personal life history, frequency of word use, or many other possibilities all of which do not necessarily equate to emotional reactivity in the moment.

Finally, examination of the validity of the speed and accuracy of negative emotional self-associations (Table 7 and Table 9) did not show a consistent relationship with other validated measures of emotional reactivity. These tables showed that the EIAT accuracy scores may be a more valid measure of emotional reactivity compared to the EIAT speed scores because the accuracy scores showed more positive correlations with other measures of emotional reactivity (Table 7), and the means were more often in the expected direction when compared to baseline or the previous mood induction (Table 9). Nevertheless, it is difficult to validate an implicit measure of emotional reactivity based on correlations with explicit self-report measures given that self-report measures may be affected by social desirability. Future studies could further

examine the validity of the EIAT as a measure of emotional reactivity by combining this task with other, more established implicit measures of emotional reactivity such as heart rate, respiration, and skin conductance.

**Cycle Phase Effects on Inhibitory Control**

Menstrual cycle phase effects were predicted for Response Inhibition (Hypothesis 4), Deferred Gratification (Hypothesis 5) and Emotional Reactivity (Hypothesis 6). There was no hypothesis regarding menstrual effects on reversal learning as this was the first study to examine reversal learning in humans across different cycle phases. Further, animal research that examined gonadal hormones and reversal learning provided inconsistent and often contradictory results (e.g., Arad & Weiner, 2012; Gibbs et al., 2011; Kromrey et al., 2015; Voytko, 2000). In this project there were no cycle phase effects for either self-report or performance-based reversal learning (i.e., ICS-48 Reversal Learning Scale and Probabilistic Reversal Learning Task).

***Cycle Phase Effects on Response Inhibition: Women in the Follicular Phase Made More Errors of Commission (EOC) Than Women in the Luteal Phase After Fear Mood Induction***

The results provided partial support for Hypothesis 4 that women in the follicular phase would demonstrate more problems with response inhibition compared to the luteal phase. While there were no cycle phase effects in self-report measures of response inhibition (e.g., ICS-48 Response Inhibition Scale), for the laboratory GoNogo task, follicular phase women had more EOC than luteal phase women after the fear mood induction. These results were partially supported by studies that found that response inhibition improved in animals and women when progesterone levels were high (Griskova-Bulanova et al., 2016; Swalve et al., 2016) or when both progesterone and estrogen levels were high (i.e., the luteal phase) (Colzato et al., 2010; Hatta & Nagaya, 2009; Milivojevic et al., 2016), and decreased when only estrogen levels were

high (i.e., the follicular phase) (Colzato et al., 2010; Milivojevic et al., 2016). However, previous research did not examine response inhibition as a function of mood induction.

The EOC results were also similar to the results from Hypothesis 1 which found that women had higher EOC after negative mood induction (fear and sad) compared to men, and Hypothesis 3 which found that women were more emotionally reactive to the fear mood induction compared to men. Also, an additional analysis comparing women in follicular and luteal phases to men revealed that only the follicular group (and not the luteal group) had more EOC compared to men after fear mood induction. This further supports the explanation that estradiol (higher in females than males and higher in the follicular than the luteal phase) is related to lowered response inhibition (Colzato et al., 2010; Milivojevic et al., 2016), especially after fear induction (Bangasser et al., 2019). These findings also highlight the need for future research on sex differences in response inhibition to ensure they use naturally cycling women and relatively equal numbers of women in the follicular and luteal phase.

However, while estrogen effects or cycle phase effects, may explain sex differences in EOC after fear mood induction, there were no menstrual cycle effects after the sad mood induction. One reason may be because the sad mood induction was not as threatening or arousing as the fear mood induction. As Bangasser et al. (2019) noted, estrogen has a specific relationship with threat detection and the activation of the defense system. Perhaps this defensive system is not activated to the same degree following sad mood and thus, menstrual cycle effects were not observed. This may also imply that the sex differences in EOC after sad mood induction may be related to factors other than gonadal hormones. Future studies could explore this by examining EOC after sad mood induction in women across their menstrual cycle and observe any patterns related to EOC and fluctuating estradiol levels. Also, because the fear mood induction was

always presented last, it is possible that there was a cumulative effect of emotion induction across the laboratory session. However, because the happy emotion was always presented prior to the fear induction and after the sad induction, there are limited concerns regarding a cumulative effect of negative emotions.

There were no menstrual phase effects found with self-report measures of response inhibition. This was the case even with the more sensitive repeated-measures design. As mentioned above in the discussion of Hypothesis 1, the lack of a phase effect may be because the self-report items were completed in the absence of negative mood induction. Perhaps cycle phase effects in response inhibition occur only under certain conditions, such as when afraid. Another possibility is that even though self-report and laboratory measures of response inhibition are correlated, the self-report measures may not have been as sensitive or well-controlled as laboratory measures to detecting group differences (due to different life experiences). Also, the self-report items used to measure response inhibition captured a variety of ways in which response inhibition may manifest in everyday scenarios (e.g., talking out of turn, holding back laughter, keeping a secret, or acting without thinking). On the other hand, the laboratory task measured one single behaviour (i.e., a button press). Thus, perhaps cycle phase effects in response inhibition only occur for the type of response inhibition behaviours measured by EOC in the GoNogo task. Future research could examine cycle phase effects on specific subtypes of response inhibition behaviours on the ICS-48 Response Inhibition Scale to determine the types of response inhibition scenarios that reveal sex, menstrual cycle, or OC effects.

***Cycle Phase Effects on Deferred Gratification: There Were No Cycle Phase Effects for Self-report or Laboratory Measures of Deferred Gratification***

Results did not support the hypothesis that women in the luteal phase would have more problems with deferred gratification than women in the follicular phase (Hypothesis 5). Results were inconsistent with Kaighobadi and Stevens (2013), Diekhoff (2015), and Smith et al. (2014), whose studies found an increase in deferred gratification in the follicular phase based on performance on delay discounting tasks in the laboratory. However, it is important to note that Kaighobadi and Stevens (2013) found lower impulsive choice in the mid-late follicular phase (compared to the same women in their mid-late luteal phase) only after their participants were exposed to attractive male faces. At baseline, with no exposure to male faces, there was no menstrual cycle effect on delay discounting; which is consistent with the findings on our delay discounting task. Additionally, Smith et al. (2014) and Diekhoff (2015) only examined deferred gratification within the follicular phase. Both studies found a decrease in impulsive choice in the late follicular phase only when compared to the same women during menstruation (i.e., the early follicular phase). Neither Smith et al. (2014) nor Diekhoff (2015) examined women in the luteal phase, making it difficult to draw direct comparisons with the findings of the current studies.

The results were also inconsistent with Elder et al. (2007), Pine and Fletcher (2011), and Gailliot et al. (2010) whose studies found more impulsive choice (i.e., decreased deferred gratification) in the luteal phase based on self-report measures. Methodological differences between these studies and this current project may provide insight into the differing outcomes. Elder et al. (2007) found that binge eating was associated with a decrease in estradiol and an increase in progesterone, however they only examined women with bulimia nervosa. Thus, their participants may not be directly comparable to the participants in this project. Furthermore, there may be something different about the effects of estradiol on eating behaviour. Pine and Fletcher (2011) examined a non-clinical population and found that spending habits were most controlled

during their follicular phase (days 1-11), less so during ovulation (days 12-16), and the least controlled in their luteal phase (days 17-28). However, their examination of deferred gratification was limited to spending behaviour via the RSSS, whereas the current study examined several behaviours related to deferred gratification. Additionally, 25% of the sample in the Pine and Fletcher (2011) study were currently on OCs which may have affected the extent to which cyclical fluctuations in gonadal hormones were present and whether participants were ovulating. Only naturally cycling women were included in the current project when examining cycle phases.

However, Gailliot et al. (2010) conducted a review and found multiple sources of evidence that the luteal phase was related to problems in several areas related to inhibitory control such as emotional control, increased alcohol and substance use, caffeine, and altered food preferences and cravings. One of the reasons why data from the current study may differ from the Gailliot et al. (2010) review was because the items included in this project measured slightly different behaviours related to deferred gratification. For instance, unlike Gailliot (2010) the current study did not examine deferred gratification related to alcohol, nicotine, or other substances and Gailliot et al. (2010) did not measure behaviours related to spending. It is possible that stronger menstrual cycle effects are associated with specific types of deferred gratification behaviours such as deferring gratification related to alcohol use. Gailliot et al. (2010) also did not report their sample demographics from their review and whether participants were on OCs or some other type of hormonal contraceptive. These factors may affect deferred gratification behaviours.

Another potential explanation for the failure to find cycle phase effects in the current studies may be high variability in deferred gratification behaviours across the different parts of

the follicular phase (e.g., early, mid, late). Both Smith et al. (2014) and Diekhoff (2015) found more impulsive choice in a laboratory task in women during menstruation (early follicular) compared to when they were in their late follicular phase. By placing all women in the follicular phase together, differences within the follicular portion of the cycle may have hidden any differences with the luteal phase. Indeed, menstruation and its associated physical symptoms such as fatigue and cramping may have important effects on deferring gratification with respect to comfort-related behaviours such as food, pleasure, and spending. Also, the menstrual phase is likely an important area of study for this type of inhibitory control, and future studies should include the menstrual phase when examining different types of deferred gratification.

The self-report measures of deferred gratification differ from the laboratory task in that the self-report measures examine recently lived experiences and behaviours while the delay discounting task measures a hypothetical scenario. Further, the self-report items measure the ability to resist impulses related to comfort and pleasure (i.e., reward vs. no reward) such as spending money to attain attractive (yet unneeded or impractical) items, eating “junk” food, relaxing when tasks should be done, and avoidance of physically difficult tasks. Meanwhile, the Delay Discounting task measures impulses related to a hypothetical monetary reward (i.e., reward now vs reward later). The delay discounting task may be more sensitive to capturing individuals favouring the delayed reward because the risks associated with impulsivity on the delay discounting task are relatively low. That is, there is no loss when choosing between $10 now rather than $15 in two weeks, as both choices provide a reward. Thus, if someone is consistently choosing the delayed reward with low risk attached to the immediate reward, they are likely to be high deferrers of gratification. Conversely, the self-report items may be sensitive to capturing individuals who favour impulsive choice such as spending money unwittingly,

avoiding responsibilities, or consuming foods that may have negative health consequences are all associated with an inherent risk.

This was the first study to examine menstrual cycle effects in deferred gratification using both self-report and laboratory measures. This is a strength as it included a more ecologically valid recent history measure as well as concurrent lab-based measure, thus providing a breadth of information and by which cycle effects on deferred gratification could be captured. Future studies should continue to include both measures of deferred gratification to capture different aspects of this important construct. Also, given that certain aspects of deferred gratification may be more relevant to certain cycle phases, future research should examine all categories of deferred gratification (e.g., spending, eating, physical pleasure) separately and across the menstrual cycle. Additionally, like the Gailliot et al. (2010) review, future research should include deferred gratification for substances such as alcohol and nicotine as deferring gratification for these substances may be more difficult in the luteal phase.

***Cycle Phase Effects on Emotional Reactivity: There were no Cycle Phase Effects for Self-report or Laboratory Measures of Emotional Reactivity***

Results did not support the hypothesis that women in the luteal phase would demonstrate higher emotional reactivity than the follicular phase (Hypothesis 6). Instead, no cycle effects were found for either self-report or laboratory measures of emotional reactivity. These results were inconsistent with previous literature that indicated women in the mid-luteal phase were more emotionally reactive compared to women in the follicular phase (Andreano & Cahill, 2008; Childs et al., 2010; Chung et al., 2016; Lusk et al., 2017) and that higher estrogen was related to lower emotional reactivity (Albert et al., 2015; Ziomkiewicz et al., 2012).

One possible reason the results were not consistent with past studies is that this project examined the full follicular (days 1-14) and full luteal (days 15-28) phases while previous studies by Andreano and Cahill (2008), Chung et al. (2016), and Lusk et al. (2017) compared the mid-luteal (days 18-24 or 20-25) and early follicular (days 2-6 or 2-7) phases. Although this study planned to examine these phases, a change had to be made due to small sample sizes in these phases. Thus, the examination of the broader cycle phases may explain why the results from this project were not consistent with past results.

However, an examination of means from both the ICS-48 Emotional Reactivity Scale and PANAS NA scores revealed that naturally cycling women in the early follicular phase had higher scores than all other phases of the menstrual cycle including the mid-luteal phase. Thus, even with a larger sample size, our findings may not have been consistent with previous findings and instead, higher emotional reactivity may have been found in the early follicular phase. One possible reason why increased emotional reactivity may be found in the early follicular phase is that negative emotional experiences may coincide with the negative physiological symptoms associated with menstruation (e.g., menstrual cramping). It is possible that the sample in this project experienced more negative symptoms associated with menstruation than other samples. Also, it is possible that the samples in the previous studies experienced more negative symptoms related to PMS (i.e., in the mid-to-late luteal phase) compared to the sample in this project. Future research could include data regarding physiological and emotional symptoms during menstruation and the pre-menstrual phase as covariates.

Only two previous studies compared the entire follicular and luteal phases and they revealed opposing results. Childs et al. (2010) found that women in the luteal phase had higher emotional ratings during the Trier Social Stress Test compared to women in the follicular phase,

and men. Meanwhile, Dernt et al. (2008) found that women in the follicular phase had stronger brain activation (bilateral amygdala, temporal and hippocampal regions) to emotional faces compared to women in the luteal phase. Thus, perhaps emotional reactivity is not as consistent in the luteal phase as previously thought and symptoms during menstruation (i.e., early follicular phase) may impact emotional reactivity to a higher degree. However, the Dernt et al. (2008) study did not collect data on self-report emotions, thus making these results difficult to directly compare to Childs et al. (2010) and the current project.

Both Albert et al. (2015) and Ziomkiewicz et al. (2012) found that estrogen is related to lower emotional reactivity. To examine the possibility that low estrogen is related to higher emotional reactivity, future research should examine emotional reactivity across all six phases of the menstrual cycle (i.e., early-, mid-, and late- phases of the follicular and luteal phases).

**Oral Contraceptive Effects on Inhibitory Control**

OC effects on inhibitory control were explored for all four types of inhibitory control. No directional hypotheses were made as there was limited research with respect to OC use and inhibition. Of the four types of inhibitory control, OC effects on emotional reactivity had the most past research and thus is discussed below as separate exploratory analyses. As there were no previous published studies that examined the effects of OC use on deferred gratification or reversal learning, the results from this project were the first to suggest no OC effects on self-report or laboratory measures of deferred gratification and reversal learning. Also, there were only two previous studies that examined OC effects on response inhibition, one of which is an unpublished study from our laboratory (Gingnell et al., 2016; Keir & Oinonen, 2016b). The results from this current project were consistent with those studies in that no difference in EOC were found between OC users and nonusers. Although there were no OC effects for inhibitory

control, these findings are an important contribution to the literature because they may help inform women's decisions regarding hormonal contraceptive use and possible side effects.

***Exploratory Examination of Differences in Emotional Reactivity between OC users, Nonusers, and Men***

Results revealed no group differences between OC users and nonusers on self-report or laboratory measures of emotional reactivity, and the analyses only revealed the already-noted sex differences in self-report and laboratory measures of emotional reactivity.

Most previous research examined positive or negative mood changes from OC use (e.g., increased symptoms of depression) rather than OC effects on emotional reactivity (i.e., behaviours, emotions, and thoughts in reaction to a specific emotional event or stimuli). These studies found mixed results with some finding that OC use led to positive mood changes (e.g., Huber et al., 2008; Kurshan & Epperson, 2006), and some finding that OC use led to negative mood changes (e.g., Lisofsky et al., 2017; Skovlund et al., 2016). However, mood changes from OC use may not necessarily translate into changes in emotional reactivity. Only five studies and one review examined the effects of OC use on emotional reactivity. However, this current project was the first to examine both OC effects on emotional reactivity to emotional stimuli in the laboratory and emotional reactivity via self-report outside of the laboratory (both trait and state emotional reactivity measures).

Besides this current project, Hamstra et al. (2017) is one of the few studies that examined OC effects on self-reported emotional reactivity outside of the laboratory. They found that when asked to rate themselves over the past week, OC users and had less affective lability, less rumination, and fewer negative cognitions across the four sampling time points (across the menstrual cycle) compared to nonusers. These results were inconsistent with the results from

Study 1 which found no OC effect on emotional reactivity for either the past 48-hours (e.g., ICS-48 Emotional Reactivity Scale) or the past two-months (BRIEF-A Emotional Control scale, PERS). Hamstra et al. suggested that OC use had mood stabilizing, or blunting effects on emotional reactivity. However, findings from this project do not support this claim. One important difference between Study 1 from this project and the Hamstra et al. study are the different sampling time points. One relative strength of this project is we assessed emotional reactivity in the past two-months to capture more trait-like differences in emotional reactivity as well as in the past 48-hours to capture recent state-like reactivity that may be due to hormonal fluctuations. The one-week timeline in the Hamstra study may have been too lengthy of a time to capture recent behaviour and may have been subject to more retrospective bias relative to a 48-hour timeline. Nevertheless, these inconsistent results indicate that future research is needed to examine OC effects on self-reported emotional reactivity using multiple sampling time-frames.

In terms of laboratory studies examining OC users with controlled emotional stimuli, the research is mixed with some finding that OC use is related to decreased negative emotional reactivity (Peterson & Cahill), decreased positive reactivity (Jarva & Oinonen, 2007), or increased negative emotional reactivity (Armbuster et al., 2017; Gingnell et al., 2013b) compared to nonusers. A recent review also found mixed results regarding OC use and neural correlates related to fear and stress processing (Montoya & Bos, 2017). Of these studies, only the Jarva and Oinonen (2007) and Armbruster et al., (2017) studies are directly comparable to this project's Study 2 because they examined OC effects on emotional reactivity after mood induction in a controlled laboratory environment.

Most comparable to Study 2 was the Jarva and Oinonen (2007) study that examined OC effects on emotional reactivity following laboratory mood inductions for positive affect,

jealousy, social ostracism, parental feelings. Consistent with our findings, Oinonen and Jarva found no group differences following any of the emotion inductions. However, they did find that OC users had less PA reactivity than nonusers across all mood primes (based on PANAS PA change scores). Positive affect change was not examined in this study and so our results cannot be directly compared to this specific finding. Future research should continue to examine OC effects on mood reactivity to both positive and negative emotion inductions.

Findings from our Study 2 were also partially consistent with findings from Armbruster et al. (2017). In the Armbruster et al. study, they found no difference between OC users and nonusers in self-reported emotional reactions to the negative, neutral, or positive photographs. This is consistent with the findings from Study 2 of this project. However, Armbruster et al. also found that, compared to nonusers, OC users had lower physiological responses to the stimuli (e.g., decreased skin conductance response, decreased acoustic startle response) yet they had higher subjective arousal ratings following the startle response. Thus, OC users' physiological responses were incongruent with their subjective ratings of their experience. One strength of this current project relative to the Armbruster et al. study, was that this project used videos to induce emotions which are a more emotionally arousing medium than photographs (Biele & Grabowska, 2006). Future studies should also examine OC effects on emotional reactivity with stimuli that evoke various arousal levels. It is possible that OC effects on emotional reactivity appear at certain arousal levels (e.g., not too low, or not too high).

One strength related to the analyses of OC effects in this study is that OC users and nonusers were also compared to men. This is a strength because if both groups of women differ from men, it bolsters the argument that sex differences exist. Conversely, if only certain groups of women differ from men, it may suggest that OC use or nonuse is driving the observed sex

difference. Nevertheless, one limitation of this study related to the examination of OC effects is it was a between-subjects design. Because there may be differences between women who choose to take OCs compared to women who choose not to take OCs, a within-subjects design or placebo controlled design would remove this possible confound. Future studies should examine the same women before and after OC use to make more direct conclusions regarding OCs effect on emotional reactivity.

Overall, our studies' findings demonstrate that OC users do not differ from nonusers on any of the types of inhibitory control (response inhibition, deferred gratification, reversal learning, and emotional reactivity). This is a positive outcome for OC users as we found no evidence for reduced inhibitory control with OC use. Results from this study contribute to the literature on OC use and may help to inform women's contraceptive choices.

**Limitations**

There were several limitations to this study that are worth addressing. One limitation of this study is sample representativeness. Almost all the participants in the study were young university students taking a psychology course. Thus, this sample may not be representative of the larger population of Canada and findings may not be generalizable to less privileged nonstudents. Also, as psychology has a predominately female student population, men taking psychology courses may be different in some ways (e.g., more emotionally self-aware) compared to a larger population of men. Moreover, as the mean age of participants was 21 years, findings related to inhibitory control may not be applicable to men and women who are older in age and less educated. However, it is worth noting the early 20s is a time of high OC use and thus the sample is a relevant one. Finally, most of the sample was made up of individuals of Caucasian, or European heritage (77.7%), who were university educated (58.3%). Although efforts to recruit

outside of the university setting was made, many of the participants still fell within this general age, ethnicity, and education level.

Another limitation of the current study was that the small sample size of women in different phases of the menstrual cycle did not allow for comparison of specific cycle phases within the luteal and follicular phases. This also limited the degree to which the current results could be compared to previous studies that examined specific cycle phases. Also, examining the entire follicular or luteal phase could have diminished important hormonal effects because of the variability in hormone fluctuations within the follicular and luteal phases. Future studies should examine inhibitory control as a function of estradiol or progesterone levels. While beyond the scope of the current studies, including hormone levels would have allowed for another method to categorize or confirm cycle phases and would have provided stronger evidence for any role of estradiol in sex differences or cycle phase effects. Specifically, estradiol levels could have supported the conclusions drawn from the sex differences and cycle phase differences in EOC. Further, although not a focus of this current study, future research should also examine the role of androgens in inhibitory control as they do fluctuate across the menstrual cycle and are suppressed by oral contraceptives. Thus, androgens cannot be rule out as a contributing factor to any of the group differences in inhibitory control.

Additionally, some analyses were limited due to low power which may partly explain why expected group differences were not found (e.g., no sex differences on the reversal learning task, no cycle effects for deferred gratification), as low power increases the risk of Type II errors (i.e., false negatives). Nevertheless, in this project, the sample sizes and effect sizes, which ranged from small to medium ($\eta^2$ range: <.001 to .081), were comparable to similar self-report

studies (e.g., Hamstra et al., 2017; Pine & Fletcher, 201) and laboratory studies (e.g., Childs et al., 2010; Evans & Hampson, 2015; Jarva & Oinonen, 2007).

Further, although the set order of mood inductions was intentional to reduce the number of conditions, the lack of counterbalancing is a limitation as it may have introduced confounds involving fatigue and/or practice effects. While this did not impact the examination of sex, OC effects, or cycle phase, it did affect the examination of how these group effects interact with different mood primes. Future studies should replicate this study design using counterbalancing. Also, future research should include additional measures of affect at the end of the cognitive tasks. If the mood effects lasted the full duration of the cognitive tasks, this would provide evidence that the mood inductions were effective, and that the tasks were completed under the condition intended.

Finally, a limitation is related to the implicit measure of emotional reactivity. While this study did include a well-established measure of affect (i.e., the PANAS), the EIAT has yet to be validated. Future studies could include physical sensations and approach/avoid reactions as well as physiological measures of affect such as heart rate and galvanic skin response in the analysis as additional non-self-report measures of emotional reactivity. These measures may reduce bias in data from those who are reluctant to endorse NA and PA (e.g., gender bias and social desirability bias), and they may bolster and validate findings from an implicit measure such as the EIAT.

**Strengths**

There were several notable strengths to this dissertation that are worth addressing. First, this project was a comprehensive two-study design that examined four different types of inhibitory control both via self-report and laboratory tasks. Moreover, this study compared

inhibitory control between three hormonally-relevant sets of groups (men vs women; follicular vs. luteal; OC users vs. nonusers vs. men). This project is the first that we are aware of to comprehensively examine the role of sex and hormonal factors across such a broad array of inhibitory control constructs.

Additionally, the analyses in this project included both between- and within-subjects designs. Doing so maximized the benefits from each design. For example, a between-subjects design allowed maximization of the sample size for each group while also benefitting from comparing two different hormonally relevant groups. Also, within-subjects analyses provided analyses with higher power/sensitivity and the ability to compare participants with themselves at different times points (e.g., menstrual cycle phase), or after different mood inductions. Because participants were compared with themselves, one is more confident that score differences can be attributed to the different time point (e.g., menstrual cycle phase) or different mood inductions.

One noteworthy strength of Study 2 was the use of baselines measures for all cognitive laboratory tasks and the fact that many analyses were conducted both with and without the baseline measure as a covariate. Including baseline performance measures allowed examination of group differences prior to any mood primes, and provided the option of a covariate when examining emotion induction effects to control for any group differences in baseline performance effects. Thus, when baseline performance was used as a covariate, results reflected group differences as function of mood primes and independent of baseline performance on the task. Without the covariate, results have ecological validity as they reflect actual group differences.

Another strength was the decision to examine cognition within the context of different moods as this provides some ecological validity to the design. Indeed, outside of the laboratory

setting, one may expect to encounter a variety of different mood-inducing experiences throughout the day or over a period of time. Understanding how various controlled emotional experiences influence inhibitory control processes, and the role exogenous hormones can have on these effects, may be an integral part of deciding on a hormonal contraceptive method.

Moreover, very few studies have examined cognition in a controlled laboratory design where each participant is exposed to the same mood prime in the same order. While this strength is tempered by the lack of counterbalancing of mood prime order (sad, happy, fear) the design was intentional so as to reduce the number of conditions.

Additionally, the studies in this project included a relatively large sample size ($N$ = 191 for Study 1 and $N$ = 126 for Study 2) including relatively large and equal numbers of OC users, nonusers, and men ($n$s = 64, 67, and 43, respectively for Study 1; and $n$s = 35, 44, and 31, respectively for Study 2). These samples sizes are comparable to other published self-report and laboratory studies (e.g., Armbruster et al., 2017; Childs et al., 2010; Evans & Hampson, 2015; Hamstra et al., 2017).

Another strength of this study is the use of mood induction primes that showed evidence of validity (i.e., the mood induction videos induced the intended mood change as reflected in the levels and direction of PA and NA). The validity of the mood induction was an integral strength in this study as it indicates that the participants reacted to the inductions in the appropriate and predicted ways. This provides us with confidence that cognition or performance was in fact examined within the context of particular types of mood (i.e., sadness, happiness, fear). In addition, mood congruent music played throughout the videos and into the cognitive tasks. This helped ensure mood was prolonged for as long as possible, thus increasing the chances that

performance on the cognitive and perceptual tasks was influenced by the mood primes and intended mood state.

A final strength of this study was the inclusion of two qualitatively different negative mood primes: sadness and fear. Previous research has indicated that negative affect is variable, and that responses to fear may be qualitatively and quantifiably different than other types of negative mood inductions (e.g., Bangasser et al., 2019; Wilhelm et al., 2017). Our inclusion of two measures of negative affect allowed for an examination of group differences in both sad and fearful contexts, and provided some evidence that these two emotional states may be differentially affected by sex and cycle phase effects in terms of impacting inhibitory control.

## Summary and Conclusion

In this project, the results for response inhibition revealed that women had more EOC (i.e., problems with response inhibition) than men after the sad and fear mood induction, and women in the follicular phase had more EOC than women in the luteal phase after fear (but not sad) mood induction. There were no other sex, cycle phase, or OC effects for the self-report or laboratory measures of response inhibition. For deferred gratification, there were no sex, cycle phase, or OC effects on any self-report or laboratory measure. For reversal learning, women demonstrated more problems with perseverative thinking than men based on the PTQ, however no other sex differences appeared with any other self-report or laboratory measure of reversal learning. There were also no cycle phase or OC effects on any measure of reversal learning. Finally, for emotional reactivity, women were more emotionally reactive than men on all self-report measures of emotional reactivity (except for positive reactivity). Women also had more NA reactivity than men across the laboratory mood primes and had more NA than men after the

fear (but not sad) mood induction. There were no cycle phase or OC effects on any measure of emotional reactivity.

These studies found minimal effects of cycle phase and OC use on the executive functions related to inhibitory control. The lack of OC and cycle phase effects may help women in making choices about contraception and the findings provide important information about the stability of cognitive functioning across the menstrual cycle. The findings that fear mood induction is related to higher negative affect score and more EOC in women compared to men, and higher EOC in the follicular compared to luteal phase are in line with research that suggests that estrogen is related to hyperarousal after fear mood induction (Bangasser et al., 2019; Wilhelm et al., 2017). Future studies could examine performance on response inhibition tasks and fear reactivity as a function of estradiol levels in OC users and nonusers across the menstrual cycle. If higher EOC are associated with higher levels of estradiol, this would provide further support for estrogen's role in reducing response inhibition. Also, future studies should examine OC effects on different types of inhibitory control using a within-subjects design.

**References**

Aasen, I., Kolli, L., & Kumari, V. (2005). Sex effects in prepulse inhibition and facilitation of the acoustic startle response: Implications for pharmacological and treatment studies. *Journal of Psychopharmacology*, *19*(1), 39-45.

Abel, K., Waikar, M., Pedro, B., Hemsley, D., & Geyer, M. (1998). Repeated testing of prepulse inhibition and habituation of the startle reflex: A study in healthy human controls. *Journal of Psychopharmacology*, *12*(4), 330-337.

Aguilar, R., Gil, L., Flint, J., Gray, J. A., Dawson, G. R., Driscoll, P., ... & Tobeña, A. (2002). Learned fear, emotional reactivity and fear of heights: A factor analytic map from a large F2 intercross of Roman rat strains. *Brain Eesearch Bulletin*, *57*(1), 17-26.

Albert, J., López-Martín, S., & Carretié, L. (2010). Emotional context modulates response inhibition: Neural and behavioral data. *NeuroImage*, *49*(*1*), 914-921. doi:10.1016/j.neuroimage.2009.08.045

Almey, A., Arena, L., Oliel, J., Shams, W. M., Hafez, N., Mancinelli, C., ... & Brake, W. G. (2017). Interactions between estradiol and haloperidol on perseveration and reversal learning in amphetamine-sensitized female rats. *Hormones and Behavior*, *89*, 113-120.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.).

Andreano, J. M., Arjomandi, H., & Cahill, L. (2008). Menstrual cycle modulation of the relationship between cortisol and long-term memory. *Psychoneuroendocrinology*, *33*(6), 874-882.

Anker J. J., Gliddon L. A., & Carroll, M. E. (2008). Impulsivity on a Go/No-go task for intravenous cocaine or food in male and female rats selectively bred for high and low saccharin intake. *Behavioural Pharmacology*, *19*, 615–629

Anshu, K., Nair, A., Kumaresan, U., Kutty, B., Srinath, S., & Laxmi, T. (2017). Altered attentional processing in male and female rats in a prenatal valproic acid exposure model of autism spectrum disorder. *Autism Research*, *10*, 1929–1944.

Arad, M., & Weiner, I. (2012) Abnormally rapid reversal learning and reduced response to antipsychotic drugs following ovariectomy in female rats. *Psychoneuroendocrinology*, 37(2), 200-212.

Armario, A., Gavaldà, A., & Martí, J. (1995). Comparison of the behavioural and endocrine response to forced swimming stress in five inbred strains of rats. *Psychoneuroendocrinology, 20*(8), 879-890.

Armbruster, D., Kirschbaum, C., & Strobel, A. (2017). The not-so-bitter pill: Effects of combined oral contraceptives on peripheral physiological indicators of emotional reactivity. *Hormones and Behavior*, *94*, 97-105.

Bagozzi, R. P., & Moore, D. J. (2011). On the dimensionality and construct validity of the affect intensity measure. *Applied Psychology*, *18*(*1*), 3-18.

Bailey, J. M., Gaulin, S., Agyei, Y., & Gladue, B. A. (1994). Effects of gender and sexual orientation on evolutionarily relevant aspects of human mating psychology. *Journal of Personality and Social Psychology*, *66*(6), 1081.

Bangasser, D. A., Eck, S. R., & Ordoñes Sanchez, E. (2019). Sex differences in stress reactivity in arousal and attention systems. *Neuropsychopharmacology*, *44*(1), 129-139.

Bannbers, E., Gingnell, M., Engman, J., Morell, A., Sylvén, S., Skalkidou, A., ... Poromaa, I. S. (2012). Prefrontal activity during response inhibition decreases over time in the postpartum period. *Behavioural Brain Research*, *241*, 132-138.

Bannbers, E., Kask, K., Wikström, J., & Poromaa, I. S. (2010). Lower levels of prepulse inhibition in luteal phase cycling women in comparison with postmenopausal women. *Psychoneuroendocrinilogy*, *35*(3), 422-429.

Bari, A., & Robbins, T. W. (2013). Inhibition and impulsivity: Behavioral and neural basis of response control. *Progress in Neurobiology*, *108*, 44-79.

Batur, P., Elder, J., & Mayer, M. (2003). Update on contraception: Benefits and risks of the new formulations. *Cleveland Clinic Journal of Medicine*, *70*(*8*), 681-682.

Bayless, D., Darling, J., Stout, W., & Daniel, J. (2012). Sex differences in attentional processes in adult rats as measured by performance on the 5-choice serial reaction time task. *Behaviour and Brain Research*, *235*, 48–54.

Bayless, D. W., Darling, J. S., & Daniel, J. M. (2013). Mechanisms by which neonatal testosterone exposure mediates sex differences in impulsivity in prepubertal rats. *Hormones and Behavior*, *64*(5), 764-769.

Becerra, R., & Campitelli, G. (2013). Emotional reactivity: Critical analysis and proposal of a new scale. *International Journal of Applied Psychology*, *3*(6), 161-168.

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. 1073191117694455.

Bem, S. L. (1974). The measurement of psychological androgyny. *Journal of Consulting and Clinical Psychology, 42*, 155–162.

Berk, M., Dodd, S., Kauer-Sant'Anna, M., Malhi, G. S., Bourin, M., Kapczinski, F., & Norman, T. (2007). Dopamine dysregulation syndrome: implications for a dopamine hypothesis of bipolar disorder. *Acta Psychiatrica Scandinavica*, *116*(s434), 41-49.

Bianchin, M., & Angrilli, A. (2012). Gender differences in emotional responses: A psychophysiological study. *Physiology & Behavior*, *105*(4), 925-932.

Biele, C., & Grabowska, A. (2006). Sex differences in perception of emotion intensity in dynamic and static facial expressions. *Experimental Crain Research*, *171*(1), 1-6.

Biggio, G., & Purdy, R. H. (Eds.). (2001). *Neurosteroids and brain function* (Vol. 46). San Diego, CA: Academic Press.

Bissonette, G. B., Lande, M. D., Martins, G. J., & Powell, E. M. (2012). Versatility of the mouse reversal/set-shifting test: Effects of topiramate and sex. *Physiology & Behavior*, *107*(5), 781-786.

Blake, K. R., Dixson, B. J., O'dean, S. M., & Denson, T. F. (2016). Standardized protocols for characterizing women's fertility: A data-driven approach. *Hormones and Behavior*, *81*, 74-83.

Boettiger, C. A., Mitchell, J. M., Tavares, V. C., Robertson, M., Joslyn, G., D'Esposito, M., & Fields, H. L. (2007). Immediate reward bias in humans: Fronto-parietal networks and a role for the catechol-O-methyltransferase 158Val/Val genotype. *Journal of Neuroscience*, *27*(52), 14383-14391.

Bouma, E. M., Riese, H., Ormel, J., Verhulst, F. C., & Oldehinkel, A. J. (2009). Adolescents' cortisol responses to awakening and social stress; effects of gender, menstrual phase and oral contraceptives. The TRAILS study. *Psychoneuroendocrinology*, *34*(6), 884-893.

Borgström, A., Kask, K., Gulinello, M., Odlind, V., & Sundström-Poromaa, I. (2008). Patients with adverse mood effects from combined oral contraceptives have lower levels of prepulse inhibition than healthy controls. *Psychoneuroendocrinology*, *33*(4), 487-496.

Broverman, D. M., Klaiber, E. L., & Kobayashi, Y. (1968). Roles of activation and inhibition in sex differences in cognitive abilities. *Psychological Review*, *75*(1), 23.

Brand, T., & Slob, A. K. (1988). Peripubertal castration of male rats, adult open field ambulation and partner preference behavior. *Behavioural Brain Research*, *30*(2), 111-117.

Braff, D. L., Geyer, M. A., & Swerdlow, N. R. (2001). Human studies of prepulse inhibition of startle: Normal subjects, patient groups, and pharmacological studies. *Psychopharmacology*, *156*(2-3), 234-258.

Bradley, M. M., Codispoti, M., Sabatinelli, D., & Lang, P. J. (2001). Emotion and motivation II: Sex differences in picture processing. *Emotion*, *1*(3), 300-319.

Brebner, J. (2003). Gender and emotions. *Personality and Individual Differences*, *34*(3), 387-394.

Breslau, N., Davis, G. C., Andreski, P., Peterson, E. L., & Schultz, L. R. (1997). Sex differences in posttraumatic stress disorder. *Archives of General Psychiatry*, *54*(11), 1044-1048.

Broos, N., Schmaal, L., Wiskerke, J., Kostelijk, L., Lam, T., Stoop, N., ... & van den Brink, W. (2012). The relationship between impulsive choice and impulsive action: A cross-species translational study. *PloS one*, *7*(5), e36781.

Burke, N. N., Coppinger, J., Deaver, D. R., Roche, M., Finn, D. P., & Kelly, J. (2016). Sex differences and similarities in depressive-and anxiety-like behaviour in the Wistar-Kyoto rat. *Physiology & Behavior*, *167*, 28-34.

Burton, C., Fletcher, P. (2012). Age and sex differences in impulsive action in rats: The role of dopamine and glutamate. *Behaviour and Brain Research*, *230*, 21–33.

Butera, P. C. (2010). Estradiol and the control of food intake. *Physiology & Behavior*, *99*(2), 175-180.

Campbell, T., Gillaspy, J. A., Jr., & Thompson, B. (1997). The factor structure of the Bem sex-role inventory (BSRI): Confirmatory analysis of long and short forms. *Educational and Psychological Measurement, 57*(1), 118-124.

Cardinal, R. N., Pennicott, D. R., Lakmali, C., Robbins, T. W., & Everitt, B. J. (2001). Impulsive choice induced in rats by lesions of the nucleus accumbens core. *Science*, *292*(5526), 2499-2501.

Carroll, M. E., Kohl, E. A., Johnson, K. M., & LaNasa, R. M. (2013). Increased impulsive choice for saccharin during PCP withdrawal in female monkeys: Influence of menstrual cycle phase. *Psychopharmacology*, *227*(3), 413-424.

Carver, C. M., & Reddy, D. S. (2013). Neurosteroid interactions with synaptic and extrasynaptic GABAA receptors: Regulation of subunit plasticity, phasic and tonic inhibition, and neuronal network excitability. *Psychopharmacology*, *230*(2), 151-188.

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*(2), 319.

Chen, A., Xu, P., Wang, Q., Luo, Y., Yuan, J., Yao, D., & Li, H. (2008). The timing of cognitive control in partially incongruent categorization. *Human Brain Mapping*, *29*(9), 1028-1039.

Childs, E., Dlugos, A., & De Wit, H. (2010). Cardiovascular, hormonal, and emotional responses to the TSST in relation to sex and menstrual cycle phase. *Psychophysiology*, *47*(3), 550-559.

Chung, K. C., Peisen, F., Kogler, L., Radke, S., Turetsky, B., Freiherr, J., & Derntl, B. (2016). The influence of menstrual cycle and androstadienone on female stress reactions: An fMRI study. *Frontiers in Human Neuroscience*, *10*, 1-13.

Ciampoli, M., Contarini, G., Mereu, M., Papaleo, F. (2017). Attentional control in adolescent mice assessed with a modified five choice serial reaction time task. *Scientific Reports*, *7*, 9936-9947.

Cohen, J. D., & Servan-Schreiber, D. (1992). Context, cortex, and dopamine: A connectionist approach to behavior and biology in schizophrenia. *Psychological Review*, *99*(1), 45.

Colley, A., Mulhern, G., Maltby, J., & Wood, A. M. (2009). The short form BSRI: Instrumentality, expressiveness and gender associations among a United Kingdom sample. *Personality and Individual Differences*, *46*(3), 384-387.

Colzato, L. S., Hertsig, G., van den Wildenberg, W. P., & Hommel, B. (2010). Estrogen modulates inhibitory control in healthy human females: Evidence from the stop-signal paradigm. *Neuroscience*, *167*(3), 709-715.

Colzato, L. S., & Hommel, B. (2014). Effects of estrogen on higher-order cognitive functions in unstressed human females may depend on individual variation in dopamine baseline levels. *Frontiers in Neuroscience*, *8*, 65-79.

Carver, C. M., & Reddy, D. S. (2013). Neurosteroid interactions with synaptic and extrasynaptic GABAA receptors: Regulation of subunit plasticity, phasic and tonic inhibition, and neuronal network excitability. *Psychopharmacology*, *230*(2), 151-188

Cross, C. P., Copping, L. T., & Campbell, A. (2011). Sex differences in impulsivity: A meta-analysis. *Psychological Bulletin*, *137*(1), 97-119.

Dalley, J. W., Fryer, T. D., Brichard, L., Robinson, E. S., Theobald, D. E., Lääne, K., ... & Abakumova, I. (2007). Nucleus accumbens D2/3 receptors predict trait impulsivity and cocaine reinforcement. *Science*, *315*(5816), 1267-1270.

Dawson, M. E., Hazlett, E. A., Filion, D. L., Nuechterlein, K. H., & Schell, A. M. (1993). Attention and schizophrenia: Impaired modulation of the startle reflex. *Journal of Abnormal Psychology*, *102*(4), 633-645.

De Roover, K., & Vermunt, J. K. (2019). On the exploratory road to unraveling factor loading non-invariance: A new multigroup rotation approach. *Structural Equation Modeling: A Multidisciplinary Journal*, *26*(6), 905-923.

del Campo, N., Chamberlain, S. R., Sahakian, B. J., & Robbins, T. W. (2011). The roles of dopamine and noradrenaline in the pathophysiology and treatment of attention-deficit/hyperactivity disorder. *Biological Psychiatry*, *69*(12), e145-e157.

Diekhof, E. K. (2015). Be quick about it. Endogenous estradiol level, menstrual cycle phase and trait impulsiveness predict impulsive choice in the context of reward acquisition. *Hormones and Behavior*, *74*, 186-193.

Diergaarde, L., Pattij, T., Poortvliet, I., Hogenboom, F., de Vries, W., Schoffelmeer, A. N., & De Vries, T. J. (2008). Impulsive choice and impulsive action predict vulnerability to distinct stages of nicotine seeking in rats. *Biological Psychiatry*, *63*(3), 301-308.

Domes, G., Schulze, L., Böttger, M., Grossmann, A., Hauenstein, K., Wirtz, P. H., ... & Herpertz, S. C. (2010). The neural correlates of sex differences in emotional reactivity and emotion regulation. *Human Brain Mapping*, *31*(5), 758-769.

Domonkos, E., Borbélyová, V., Csongová, M., Bosý, M., Kačmárová, M., Ostatníková, D., ... & Celec, P. (2017). Sex differences and sex hormones in anxiety-like behavior of aging rats. *Hormones and Behavior*, *93*, 159-165.

Donkers, F. C., & Van Boxtel, G. J. (2004). The N2 in go/no-go tasks reflects conflict monitoring not response inhibition. *Brain and Cognition*, *56*(2), 165-176.

Eddy, M. C., Rifken, K. M., Toufexis, D. J., & Green, J. T. (2013). Gonadal hormones and voluntary exercise interact to improve discrimination ability in a set-shift task. *Behavioural Neuroscience*, *127*, 744-754.

Edler, C., Lipson, S. F., & Keel, P. K. (2007). Ovarian hormones and binge eating in bulimia nervosa. *Psychological Medicine*, *37*(1), 131-141.

Ehring, T., Zetsche, U., Weidacker, K., Wahl, K., Schönfeld, S., & Ehlers, A. (2011). The Perseverative Thinking Questionnaire (PTQ): Validation of a content-independent measure of repetitive negative thinking. *Journal of Behavior Therapy and Experimental Psychiatry*, *42*(2), 225-232.

Elliot, A. J., & Thrash, T. M. (2002). Approach-avoidance motivation in personality: Approach and avoidance temperament and goals. *Journal of Personality and Social Psychology*, *82*, 804–818.

Epperson C. N., Pittman B., Czarkowski K. A., Stiklus S., Krystal J. H., & Grillon C. (2007). Luteal-phase accentuation of acoustic startle response in women with premenstrual dysphoric disorder. *Neuropsychopharmacology*, *32*, 2190–2198.

Eubig, P. A., Noe, T. E., Floresco, S. B., Sable, J. J., & Schantz, S. L. (2014). Sex differences in response to amphetamine in adult Long–Evans rats performing a delay-discounting task. *Pharmacology, Biochemistry and Behavior, 118*, 1-9.

Evans, K. L., & Hampson, E. (2015). Sex differenced on prefrontally-dependent cognitive tasks. *Brain and Cognition*, *93*, 42-53.

Evans, D. E., & Rothbart, M. K. (2007). Developing a model for adult temperament. *Journal of Research in Personality*, *41*(4), 868-888.

Farde, L. (1997). Brain imaging of schizophrenia—the dopamine hypothesis. *Schizophrenia Research*, *28*(2), 157-162.

Featherstone, R. E., Kapur, S., & Fletcher, P. J. (2007). The amphetamine-induced sensitized state as a model of schizophrenia. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, *31*(8), 1556-1571.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage Publications Ltd.

Filkowski, M. M., Olsen, R. M., Duda, B., Wanger, T. J., & Sabatinelli, D. (2017). Sex differences in emotional perception: Meta-analysis of divergent activation. *NeuroImage*, *147*, 925-933.

Fischer, A. H., Rodriguez Mosquera, P. M., Van Vianen, A. E., & Manstead, A. S. (2004). Gender and culture differences in emotion. *Emotion*, *4*(1), 87.

Follesa, P., Porcu, P., Sogliano, C., Cinus, M., Biggio, F., Mancuso, L., . . . & Concas, A. (2002). Changes in GABAA receptor γ2 subunit gene expression induced by long-term administration of oral contraceptives in rats. *Neuropharmacology, 42*(3), 325-336.

Frank, M. J., Seeberger, L. C., & O'reilly, R. C. (2004). By carrot or by stick: Cognitive reinforcement learning in parkinsonism. *Science*, *306*(5703), 1940-1943.

Furnham, A., & Okamura, R. (1999). Your money or your life: Behavioral and emotional predictors of money pathology. *Human Relations*, *52*(9), 1157-1177.

Frye, C. A., Petralia, S. M., & Rhodes, M. E. (2000). Estrous cycle and sex differences in performance on anxiety tasks coincide with increases in hippocampal progesterone and 3α, 5α-THP. *Pharmacology Biochemistry and Behavior*, *67*(3), 587-596.

Gailliot, M. T., Hildebrandt, B., Eckel, L. A., & Baumeister, R. F. (2010). A theory of limited metabolic energy and premenstrual syndrome symptoms: Increased metabolic demands during the luteal phase divert metabolic resources from and impair self-control. *Review of General Psychology, 14*(3), 269-282.

García-Cueto, E., Rodríguez-Díaz, F. J., Bringas-Molleda, C., López-Cepero, J., Paíno-Quesada, S., & Rodríguez-Franco, L. (2015). Development of the gender role attitudes scale (GRAS) amongst young spanish people. *International Journal of Clinical and Health Psychology*, *15*(1), 61-68.

Gard, M. G., & Kring, A. M. (2007). Sex differences in the time course of emotion. *Emotion*, *7*(2), 429-440.

Gogos, A., & van den Buuse, M. (2003). Castration reduces the effect of serotonin-1A receptor stimulation on prepulse inhibition in rats. *Behavioral Neuroscience*, *117*(6), 1407-1415.

Gogos, A., & van den Buuse, M. (2007). The importance of baseline in identifying 8-OH-DPAT-induced effects on prepulse inhibition in rats. *British Journal of Pharmacology*, *150*(6), 750–757.

Gogos, A., van den Buuse, M., & Rossell, S. (2009). Gender differences in prepulse inhibition (PPI) in bipolar disorder: Men have reduced PPI, women have increased PPI. *International Journal of Neuropsychopharmacology*, *12*(9), 1249-1259.

Gogos, A., Kwek, P., Chavez, C., & van, d. B. (2010). Estrogen treatment blocks 8-hydroxy-2-dipropylaminotetralin-and apomorphine-induced disruptions of prepulse inhibition: Involvement of dopamine $D_1$ or $D_2$ or serotonin 5-HT 1A, 5-HT 2A, or 5-$HT_7$ receptors. *The Journal of Pharmacology and Experimental Therapeutics, 333*(1), 218-227

Gogos, A., Kwek, P., & van den Buuse, M. (2012). The role of estrogen and testosterone in female rats in behavioral models of relevance to schizophrenia. *Psychopharmacology*, *219*(1), 213-224.

Gogos, A., & van den Buuse, M. (2015). Comparing the effects of 17β-oestradiol and the selective oestrogen receptor modulators, raloxifene and tamoxifen, on prepulse inhibition in female rats. *Schizophrenia Research*, *168*(3), 634-639.

Gogos, A. (2013) Natural and synthetic sex hormones: Effects on higher-order cognitive function and prepulse inhibition. *Biological Psychology*, *93*(1), 17–23.

Goldsmith, R. E., & Walters, H. (1989). A validity study of the affect intensity measure. *Journal of Social Behavior and Personality*, *4*(*1*), 133.

Goodwill, H. L., Manzano-Nieves, G., LaChance, P., Teramoto, S., Lin, S., Lopez, C., ... & Bath, K. G. (2018). Early life stress drives sex-selective impairment in reversal learning by affecting parvalbumin interneurons in orbitofrontal cortex of mice. *Cell Reports*, *25*(9), 2299-2307.

Gibbs, R. B., Chipman, A. M., Hammond, R., & Nelson, D. (2011). Galanthamine plus estradiol treatment enhances cognitive performance in aged ovariectomized rats. *Hormones and behavior*, *60*(5), 607-616.

Gingnell, M., Morell, A., Bannbers, E., Wikström, J., & Poromaa, I. S. (2012). Menstrual cycle effects on amygdala reactivity to emotional stimulation in premenstrual dysphoric disorder. *Hormones and Behavior*, *62*(4), 400-406.

Gingnell, M., Engman, J., Frick, A., Moby, L., Wikström, J., Fredrikson, M., & Sundström-Poromaa, I. (2013a). Oral contraceptive use changes brain activity and mood in women with previous negative affect on the pill—a double-blinded, placebo-controlled randomized trial of a levonorgestrel-containing combined oral contraceptive. *Psychoneuroendocrinology*, *38*(7), 1133-1144.

Gingnell, M., Bannbers, E., Wikström, J., Fredrikson, M., & Sundström-Poromaa, I. (2013b). Premenstrual dysphoric disorder and prefrontal reactivity during anticipation of emotional stimuli. *European Neuropsychopharmacology*, *23*(11), 1474-1483.

Gingnell, M., Bannbers, E., Engman, J., Frick, A., Moby, L., Wikström, J., & Sundström-Poromaa, I. (2016). The effect of combined hormonal contraceptives use on brain reactivity during response inhibition. *The European Journal of Contraception & Reproductive Health Care*, *21*(2), 150-157.

Glickstein, S. B., DeSteno, D. A., Hof, P. R., & Schmauss, C. (2004). Mice lacking dopamine D2 and D3 receptors exhibit differential activation of prefrontal cortical neurons during tasks requiring attention. *Cerebral Cortex*, *15*(7), 1016-1024.

Glover, E. M., Jovanovic, T., Mercer, K. B., Kerley, K., Bradley, B., Ressler, K. J., & Norrholm, S. D. (2012). Estrogen levels are associated with extinction deficits in women with posttraumatic stress disorder. *Biological Psychiatry*, *72*(1), 19-24.

Glover, E. M., Mercer, K. B., Norrholm, S. D., Davis, M., Duncan, E., Bradley, B., ... & Jovanovic, T. (2013). Inhibition of fear is differentially associated with cycling estrogen levels in women. *Journal of Psychiatry & Neuroscience, 38*(5), 341.

Gouveia Jr, A., Afonseca, T. L., Maximino, C., Dominguez, R., & Morato, S. (2008). Influence of gender and estrous cycle in the forced swim test in rats. *Psychology & Neuroscience*, *1*(2), 191.

Graham, B. M., & Milad, M. R. (2013). Blockade of estrogen by hormonal contraceptives impairs fear extinction in female rats and women. *Biological Psychiatry*, *73*(4), 371-378.

Graham, B. M., & Milad, M. R. (2014). Inhibition of estradiol synthesis impairs fear extinction in male rats. *Learning & Memory*, *21*(7), 347-350.

Graham, B. M., & Daher, M. (2016). Estradiol and progesterone have opposing roles in the regulation of fear extinction in female rats. *Neuropsychopharmacology*, *41*(3), 774-780.

Gratz, K. L., & Roemer, L. (2004). Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the difficulties in emotion regulation scale. *Journal of Psychopathology and Behavioral Assessment*, *26*(1), 41-54.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology, 74,* 1464–480.

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the implicit association test: An improved scoring algorithm. *Journal of Personality and Social Psychology*, *85*(2), 197.

Griskova-Bulanova, I., Griksiene, R., Voicikas, A., & Ruksenas, O. (2016). Go and NoGo: Modulation of electrophysiological correlates by female sex steroid hormones. *Psychopharmacology*, *233*(13), 2607-2615.

Grissom, N. M., Herdt, C., Desilets, J., Lidsky-Everson, J., & Reyes, T. (2015). Dissociable deficits of executive function caused by gestational adversity are linked to specific transcriptional changes in the prefrontal cortex. *Neuropsychopharmacology*, *40*, 1353–1363.

Grissom, N. M., & Reyes, T. M. (2019). Let's call the whole thing off: Evaluating gender and sex differences in executive function. *Neuropsychopharmacology*, *44*(1), 86-96.

Grossman, M., & Wood, W. (1993). Sex differences in intensity of emotional experience: A social role interpretation. *Journal of Personality and Social Psychology*, *65*(5), 1010.

Gulinello, M., Orman, R., & Smith, S. S. (2003). Sex differences in anxiety, sensorimotor gating and expression of the α4 subunit of the GABAA receptor in the amygdala after progesterone withdrawal. *European Journal of Neuroscience*, *17*(3), 641-648.

Halari, R., Hines, M., Kumari, V., Mehrotra, R., Wheeler, M., Ng, V., & Sharma, T. (2005). Sex differences and individual differences in cognitive performance and their relationship to endogenous gonadal hormones and gonadotropins. *Behavioral Neuroscience*, *119*(1), 104.

Hamstra, D. A., de Kloet, E. R., Quataert, I., Jansen, M., & Van der Does, W. (2017). Mineralocorticoid receptor haplotype, estradiol, progesterone and emotional information processing. *Psychoneuroendocrinology*, *76*, 162-173.

Harte, L. C., & Dow-Edwards, D. (2010). Sexually dimorphic alterations in locomotion and reversal learning after adolescent tetrahydrocannabinol exposure in the rat. *Neurotoxicology and Teratology*, *32*(5), 515-524.

Hatta, T., & Nagaya, K. (2009). Menstrual cycle phase effects on memory and Stroop task performance. *Archives of Sexual Behavior*, *38*(5), 821.

Hampshire, A., Chamberlain, S. R., Monti, M. M., Duncan, J., & Owen, A. M. (2010). The role of the right inferior frontal gyrus: Inhibition and attentional control. *Neuroimage*, *50*(3), 1313-1319.

Hawkins, S. M., & Matzuk, M. M. (2008). The Menstrual Cycle. *Annals of the New York Academy of Sciences*, *1135*(1), 10-18.

Hazlett, E. A., Buchsbaum, M. S., Haznedar, M. M., Singer, M. B., Germans, M. K., Schnur, D. B., ... & Troyer, B. T. (1998). Prefrontal cortex glucose metabolism and startle eyeblink modification abnormalities in unmedicated schizophrenia patients. *Psychophysiology*, *35*(2), 186-198.

Hoerger, M., Quirk, S. W., & Weed, N. C. (2011). Development and validation of the Delaying Gratification Inventory. *Psychological Assessment*, *23*(3), 725-739.

Holloway, J. L., Beck, K. D., & Servatius, R. J. (2011). Facilitated acquisition of the classically conditioned eyeblink response in females is augmented in those taking oral contraceptives. *Behavioural Brain Research*, *216*(1), 301-307.

Howes, O. D., & Kapur, S. (2009). The dopamine hypothesis of schizophrenia: Version III—the final common pathway. *Schizophrenia Bulletin*, *35*(3), 549-562.

Hoyer, J., Burmann, I., Kieseler, M. L., Vollrath, F., Hellrung, L., Arelin, K., ... & Sacher, J. (2013). Menstrual cycle phase modulates emotional conflict processing in women with and without premenstrual syndrome (PMS)–a pilot study. *PloS one*, *8*(4), e59780.

Huang, G. Z., & Woolley, C. S. (2012). Estradiol acutely suppresses inhibition in the hippocampus through a sex-specific endocannabinoid and mGluR-dependent mechanism. *Neuron, 74*(5), 801-808.

Huber, J. C., Heskamp, M. L. S., & Schramm, G. A. (2008). Effect of an oral contraceptive with chlormadinone acetate on depressive mood. *Clinical Drug Investigation*, *28*(12), 783-791.

Hwang, M. J., Zsido, R. G., Song, H., Pace-Schott, E. F., Miller, K. K., Lebron-Milad, K., ... & Milad, M. R. (2015). Contribution of estradiol levels and hormonal contraceptives to sex differences within the fear network during fear conditioning and extinction. *BMC Psychiatry*, *15*(1), 295.

Inghilleri, M., Conte, A., Curra, A., Frasca, V., Lorenzano, C., & Berardelli, A. (2004). Ovarian hormones and cortical excitability. An rTMS study in humans. *Clinical Neurophysiology*, *115*(5), 1063-1068.

Izquierdo, A., & Jentsch, J. D. (2012). Reversal learning as a measure of impulsive and compulsive behavior in addictions. *Psychopharmacology*, *219*(2), 607-620.

Jabbi, M., Swart, M., & Keysers, C. (2007). Empathy for positive and negative emotions in the gustatory cortex. *Neuroimage*, *34*(4), 1744-1753.

Jackson, J. J., & Kirkpatrick, L. A. (2007). The structure and measurement of human mating strategies: Toward a multidimensional model of sociosexuality. *Evolution and Human Behavior*, *28*(6), 382-391.

Jarva, J. A., & Oinonen, K. A. (2007). Do oral contraceptives act as mood stabilizers? Evidence of positive affect stabilization. *Archives of Women's Mental Health*, *10*(5), 225-234.

Jentsch, J. D., & Taylor, J. R. (2003). Sex-related differences in spatial divided attention and motor impulsivity in rats. *Behavioral Neuroscience*, *117*(1), 76-83.

Jöchle, W. (1973). Coitus-induced ovulation. *Contraception, 7,* 523-564

Johnston, A. L., & File, S. E. (1991). Sex differences in animal tests of anxiety. *Physiology & Behavior*, *49*(2), 245-250.

Jovanovic, T., Szilagyi, S., Chakravorty, S., Fiallos, A. M., Lewison, B. J., Parwani, A., . . . Duncan, E. J. (2004). Menstrual cycle phase effects on prepulse inhibition of acoustic startle. *Psychophysiology, 41*(3), 401-406.

Kaighobadi, F., & Stevens, J. R. (2013). Does fertility status influence impulsivity and risk taking in human females? Adaptive influences on intertemporal choice and risky decision making. *Evolutionary Psychology*, *11*(3), 147470491301100314.

Kask, K., Gulinello, M., Bäckström, T., Geyer, M. A., & Sundström-Poromaa, I. (2008). Patients with premenstrual dysphoric disorder have increased startle response across both cycle phases and lower levels of prepulse inhibition during the late luteal phase of the menstrual cycle. *Neuropsychopharmacology*, *33*(9), 2283-2290.

Keir, N., & Oinonen, K. A. (2016a, June). *Sex differences in cognitive performance: Oral contraceptives may affect disinhibition and response reactivity*. Poster presented at the annual conference of the Association of Psychological Science conference, Chicago, IL.

Keir, N. & Oinonen, K. A. (2016b). *The effects of oral contraceptives on emotional reactivity and cognition* (Unpublished master's thesis). Lakehead University, Thunder Bay.

Koch, M. (1998). Sensorimotor gating changes across the estrous cycle in female rats. *Physiology & Behavior*, *64*(5), 625-628.

Kimura, D. (1996). Sex, sexual orientation and sex hormones influence human cognitive function. *Current Opinion in Neurobiology*, *6*(2), 259-263.

Kinsey, A., Pomeroy, W., and Martin, C. (1948). *Sexual Behavior in the Human Male*. Philadelphia: W.B. Saunders.

Kirby, K. N., & Maraković, N. N. (1996). Delay-discounting probabilistic rewards: Rates decrease as amounts increase. *Psychonomic Bulletin & Review*, *3*(1), 100-104.

Kirmizioglu, Y., Doğan, O., Kuğu, N., & Akyüz, G. (2009). Prevalence of anxiety disorders among elderly people. *International Journal of Geriatric Psychiatry*, *24*(9), 1026-1033.

Kromrey, S. A., Czoty, P. W., & Nader, M. A. (2015). Relationship between estradiol and progesterone concentrations and cognitive performance in normally cycling female cynomolgus monkeys. *Hormones and Behavior*, *72*, 12-19.

Kumari, V., Gray, J. A., Gupta, P., Luscher, S., & Sharma, T. (2003). Sex differences in prepulse inhibition of the acoustic startle response. *Personality and Individual Differences*, *35*(4), 733-742.

Kumari, V., Aasen, I., & Sharma, T. (2004). Sex differences in prepulse inhibition deficits in chronic schizophrenia. *Schizophrenia Research*, *69*(2), 219-235.

Kumari, V., Aasen, I., Papadopoulos, A., Bojang, F., Poon, L., Halari, R., & Cleare, A. J. (2008). A comparison of prepulse inhibition in pre-and postmenopausal women and age-matched men. *Neuropsychopharmacology*, *33*(11), 2610-2618.

Kurshan, N., & Epperson, C. N. (2006). Oral contraceptives and mood in women with and without premenstrual dysphoria: A theoretical model. *Archives of Women's Mental Health*, *9*(*1*), 1-14.

Lacreuse, A., Chang, J., Metevier, C. M., LaClair, M., Meyer, J. S., & Ferris, C. M. (2014). Oestradiol modulation of cognition in adult female marmosets (Callithrix jacchus). *Journal of Neuroendocrinology*, *26*(5), 296-309.

Lacreuse, A., Gullstrand, J., & Fagot, J. (2016). Sex differences in inhibitory control in socially-housed baboons (Papio papio). *Behavioural Brain Research*, *312*, 231-237.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). *Motivated attention: affect, activation, and action*. In P. J. Lang, R. F. Simons, & M. Balaban (Eds.). Attention and orienting: Sensory and motivational processes (pp. 97–135). New Jersey: Lawrence Erlbaum Associates.

Lang, P. J. (2005). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. *Technical Report*.

Lebron-Milad, K., & Milad, M. R. (2012). Sex differences, gonadal hormones and the fear extinction network: Implications for anxiety disorders. *Biology of Mood & Anxiety Disorders*, *2(1), 3.*

Lehmann, J., Pryce, C. R., & Feldon, J. (1999). Sex differences in the acoustic startle response and prepulse inhibition in Wistar rats. *Behavioural Brain Research*, *104*(1), 113-117.

Levine, E. J. (2012). An introduction to neuroendocrine systems. In Fink, G., Pfaff, D. W., Levine, J. E. (Eds.), *Handbook of Neuroendocrinology* (3 – 19). London: Eslevier.

Liakakis, G., Nickel, J., & Seitz, R. J. (2011). Diversity of the inferior frontal gyrus—a meta-analysis of neuroimaging studies. *Behavioural Brain Research*, *225*(1), 341-347.

Lindstrom, D. (2010). Schaum's Easy Outline of Statistics, Second Edition (Schaum's Easy Outlines) 2nd Edition. McGraw-Hill Education.

Linnman, C., Rougemont-Bücking, A., Beucke, J. C., Zeffiro, T. A., & Milad, M. R. (2011). Unconditioned responses and functional fear networks in human classical conditioning. *Behavioural Brain Research*, *221*(1), 237-245.

Lisofsky, N., Riediger, M., Gallinat, J., Lindenberger, U., & Kühn, S. (2017). Hormonal contraceptive use is associated with neural and affective changes in healthy young women. *NeuroImage*, *134*, 597-606.

Liu, Q., Wang, Y., Van Heck, C. H., & Qiao, W. (2017). Stress reactivity and emotion in premenstrual syndrome. *Neuropsychiatric Disease and Treatment*, *13*, 1597.

Lonsdorf, T. B., Haaker, J., Schümann, D., Sommer, T., Bayer, J., Brassen, S., ... & Kalisch, R. (2015). Sex differences in conditioned stimulus discrimination during context-dependent fear learning

and its retrieval in humans: The role of biological sex, contraceptives and menstrual cycle phases. *Journal of Psychiatry & Neuroscience*, *40*(6), 368.

Lukkes, J., Thompson, B., Freund, N., Andersen, S. (2016). The developmental interrelationships between activity, novelty preferences, and delay discounting in male and female rats. *Developmental Psychobiology*, *58*, 231–242.

Lusk, B. R., Carr, A. R., Ranson, V. A., & Felmingham, K. L. (2017). Women in the midluteal phase of the menstrual cycle have difficulty suppressing the processing of negative emotional stimuli: An event-related potential study. *Cognitive, Affective, & Behavioral Neuroscience*, 1-18.

MacLeod, C. M. (2007). The concept of inhibition in cognition. *Inhibition in Cognition*, 3-23.

Majewska, M. D., Harrison, N. L., Schwartz, R. D., Barker, J. L., & Paul, S. M. (1986). Steroid hormone metabolites are barbiturate-like modulators of the GABA receptor. *Science*, *232*(4753), 1004-1007.

Maki, P. M. (2006). Hormone therapy and cognitive function: Is there a critical period for benefit? *Neuroscience*, *138*(3), 1027-1030.

Malloy, T. E. (2010). Bem sex role inventory. *Corsini Encyclopedia of Psychology*.

Männistö, P. T., & Kaakkola, S. (1999). Catechol-O-methyltransferase (COMT): biochemistry, molecular biology, pharmacology, and clinical efficacy of the new selective COMT inhibitors. *Pharmacological Reviews*, *51*(4), 593-628.

Marcondes, F. K., Miguel, K. J., Melo, L. L., & Spadari-Bratfisch, R. C. (2001). Estrous cycle influences the response of female rats in the elevated plus-maze test. *Physiology & Behavior*, *74*(4), 435-440.

Marcondes, F. K., Bianchi, F. J., & Tanno, A. P. (2002). Determination of the estrous cycle phases of rats: Some helpful considerations. *Brazilian Journal of Biology*, *62*(4A), 609-614.

Marečková, K., Perrin, J. S., Nawaz Khan, I., Lawrence, C., Dickie, E., McQuiggan, D. A., ... & Imagen Consortium. (2014). Hormonal contraceptives, menstrual cycle and brain response to faces. *Social Cognitive and Affective Neuroscience*, *9*(2), 191-200.

Mei, X., Tian, L., Xue, Z., & Li, X. (2017). A working memory task reveals different patterns of impulsivity in male and female college students. *Behavioural Processes*, *138*, 127-133.

Merck Research Laboratories (2003). *Merck Manual of Medical Information*. Beers, M. H. & Fletcher A. J. eds. Whitehouse Station: N.J.

Merz, C. J., Tabbert, K., Schweckendiek, J., Klucken, T., Vaitl, D., Stark, R., & Wolf, O. T. (2012). Neuronal correlates of extinction learning are modulated by sex hormones. *Social Cognitive and Affective Neuroscience*, *7*(7), 819-830.

Merz, C. J., Tabbert, K., Schweckendiek, J., Klucken, T., Vaitl, D., Stark, R., & Wolf, O. T. (2012). Oral contraceptive usage alters the effects of cortisol on implicit fear learning. *Hormones and Behavior*, *62*(4), 531-538.

Micevych, P., & Sinchak, K. (2008). Synthesis and function of hypothalamic neuroprogesterone in reproduction. *Endocrinology*, *149*(6), 2739-2742.

Mihalick, S. M., Langlois, J. C., & Krienke, J. D. (2000). Strain and sex differences on olfactory discrimination learning in C57BL/6J and DBA/2J inbred mice (Mus musculus). *Journal of Comparative Psychology*, *114*(4), 365.

Milad, M. R., Orr, S. P., Lasko, N. B., Chang, Y., Rauch, S. L., & Pitman, R. K. (2008). Presence and acquired origin of reduced recall for fear extinction in PTSD: Results of a twin study. *Journal of Psychiatric Research*, *42*(7), 515-520.

Milad, M. R., Igoe, S. A., Lebron-Milad, K., & Novales, J. E. (2009). Estrous cycle phase and gonadal hormones influence conditioned fear extinction. *Neuroscience*, *164*(3), 887-895.

Milivojevic, V., Fox, H. C., Sofuoglu, M., Covault, J., & Sinha, R. (2016). Effects of progesterone stimulated allopregnanolone on craving and stress response in cocaine dependent men and women. *Psychoneuroendocrinology*, *65*, 44-53.

Miller, D. I., & Halpern, D. F. (2014). The new science of cognitive sex differences. *Trends in Cognitive Sciences*, *18*(1), 37-45.

Mitchell, J. M., Fields, H. L., D'esposito, M., & Boettiger, C. A. (2005). Impulsive responding in alcoholics. *Alcoholism: Clinical and Experimental Research*, *29*(12), 2158-2169.

Mitra, S., Bastos, C. P., Bates, K., Pereira, G. S., & Bult-Ito, A. (2016). Ovarian sex hormones modulate compulsive, affective and cognitive functions in a non-induced mouse model of obsessive-compulsive disorder. *Frontiers in Behavioral Neuroscience*, *10*, 215.

Molina-Hernández, M., Téllez-Alcántara, N. P., Olivera-López, J. I., & Jaramillo, M. T. (2013). Estrous cycle variation in anxiolytic-like effects of topiramate in Wistar rats in two animal models of anxiety-like behavior. *Pharmacology Biochemistry and Behavior*, *103*(3), 631-636.

Moos, R. H. (1968). The development of a menstrual distress questionnaire. *Psychosomatic medicine*, *30*(6), 853-867.

Mora, S., Dussaubat, N., & Díaz-Véliz, G. (1996). Effects of the estrous cycle and ovarian hormones on behavioral indices of anxiety in female rats. *Psychoneuroendocrinology*, *21*(7), 609-620.

Morey, L. C. (1991). *Personality Assessment Inventory (PAI)*. John Wiley & Sons, Inc..

Morey, L. C. (2007). *Personality Assessment Inventory professional manual* (2nd ed.). Lutz, FL: Psychological Assessment Resources.

Munster, K., Schmidt, L., & Helm, P. (1992). Length and variation in the menstrual cycle—a cross-sectional study from a Danish county. *BJOG: An International Journal of Obstetrics & Gynaecology*, *99*(5), 422-429.

Myers, K. M., Ressler, K. J., & Davis, M. (2006). Different mechanisms of fear extinction dependent on length of time since fear acquisition. *Learning & Memory*, *13*(2), 216-223.

Nolen-Hoeksema, S. (2012). Emotion regulation and psychopathology: The role of gender. *Annual Review of Clinical Psychology*, *8*, 161-187.

Oinonen, K. A. (2009). Putting a finger on potential predictors of oral contraceptive side effects: 2D: 4D and middle-phalangeal hair. *Psychoneuroendocrinology*, *34*(5), 713-726.

Oinonen, K. A., & Mazmanian, D. (2002). To what extent do oral contraceptives influence mood and affect? *Journal of Affective Disorders*, *70*, 229-240.

Olvera-Hernández, S., Chavira, R., & Fernández-Guasti, A. (2013). Sex-and endocrine-stage-differences in middle-aged rats in an animal model of OCD. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, *44*, 81-87.

Omura, K., & Kusumoto, K. (2015). Sex differences in neurophysiological responses are modulated by attentional aspects of impulse control. *Brain and Cognition*, *100*, 49-59.

Overman, W. H. (2004). Sex differences in early childhood, adolescence, and adulthood on cognitive tasks that rely on orbital prefrontal cortex. *Brain and Cognition*, *55*(1), 134-147.

Ostaszewski, P. M., & Pisula, W. (1994). Sex and strain differences in anxiety, emotional reactivity, exploration, and need for stimulation in rats. *Polish Psychological Bulletin, 25*(2), 137-146.

Papaleo, F., Erickson, L., Liu, G., Chen, J., & Weinberger, D. R. (2012). Effects of sex and COMT genotype on environmentally modulated cognitive control in mice. *Proceedings of the National Academy of Sciences*, *109*, 20160–20165.

Papousek, I., Schulter, G., & Lang, B. (2009). Effects of emotionally contagious films on changes in hemisphere-specific cognitive performance. *Emotion*, *9*(*4*), 510.

Patton, J. H., & Stanford, M. S. (1995). Factor structure of the Barratt impulsiveness scale. *Journal of Clinical Psychology*, *51*(6), 768-774.

Pedersen, S. D., Brar, S., Faris, P., & Corenblum, B. (2007). Polycystic ovary syndrome: Validated questionnaire for use in diagnosis. *Canadian Family Physician*, *53*(6), 1041-1047.

Penton-Voak, I. S., Perrett, D. I., Castles, D. L., Kobayashi, T., Burt, D. M., Murray, L. K., & Minamisawa, R. (1999) Menstrual cycle alters face preference. *Nature*, *399*, 741-742. doi: 10.1037/0022-3514.95.5.1113

Petersen, N., Kilpatrick, L. A., Goharzad, A., & Cahill, L. (2014). Oral contraceptive pill use and menstrual cycle phase are associated with altered resting state functional connectivity. *Neuroimage*, *90*, 24-32.

Petersen, N., & Cahill, L. (2015). Amygdala reactivity to negative stimuli is influenced by oral contraceptive use. *Social Cognitive and Affective Neuroscience*, *10*(9), 1266-1272.

Pine, K. J., & Fletcher, B. C. (2011). Women's spending behaviour is menstrual-cycle sensitive. *Personality and Individual Differences*, *50*(1), 74-78.

Pope, C. J., Oinonen, K., Mazmanian, D., & Stone, S. (2017). The hormonal sensitivity hypothesis: A review and new findings. *Medical Hypotheses*, *102*, 69-77.

Poromaa, I. S., & Segebladh, B. (2012). Adverse mood symptoms with oral contraceptives. *Acta Obstetricia et Gynecologica Scandinavica*, *91*(4), 420-427.

Porcu, P., Mostallino, M. C., Sogliano, C., Santoru, F., Berretti, R., & Concas, A. (2012). Long-term administration with levonorgestrel decreases allopregnanolone levels and alters GABA A receptor subunit expression and anxiety-like behavior. *Pharmacology Biochemistry and Behavior*, *102*(2), 366-372.

Plante, D. T., Jensen, J. E., Schoerning, L., & Winkelman, J. W. (2012). Reduced γ-Aminobutyric Acid in Occipital and Anterior Cingulate Cortices in Primary Insomnia: a Link to Major Depressive Disorder? *Neuropsychopharmacology*, *37*(6), 1548–1557.

Rahman, Q., Kumari, V., & Wilson, G. D. (2003). Sexual orientation-related differences in prepulse inhibition of the human startle response. *Behavioral Neuroscience*, *117*(5), 1096.

Ramos-Loyo, J., Angulo-Chavira, A., Llamas-Alonso, L. A., & González-Garrido, A. A. (2016). Sex differences in emotional contexts modulation on response inhibition. *Neuropsychologia*, *91*, 290-298.

Rapkin, A. (2003). A review of treatment of premenstrual syndrome & premenstrual dysphoric disorder. *Psychoneuroendocrinology*, *28*, 39-53.

Rapkin, A. J., Biggio, G., & Concas, A. (2006). Oral contraceptives and neuroactive steroids. *Pharmacology Biochemistry and Behavior*, *84*(4), 628-634.

Rasmusson, A. M., Pinna, G., Paliwal, P., Weisman, D., Gottschalk, C., Charney, D., . . . Guidotti, A. (2006). Decreased cerebrospinal fluid allopregnanolone levels in women with posttraumatic stress disorder. *Biological Psychiatry, 60*(7), 704-713.

Rattel, J. A., Mauss, I. B., Liedlgruber, M., & Wilhelm, F. H. (2020). Sex differences in emotional concordance. *Biological Psychology*, 151-200.

Reddy, D. S. (2010). Neurosteroids: Endogenous role in the human brian and therapeutic potentials. *Progress in Brain Research*, *186*, 113-123.

Renard, G. M., Suarez, M. M., Levin, G. M., & Rivarola, M. A. (2005). Sex differences in rats: Effects of chronic stress on sympathetic system and anxiety. *Physiology & Behavior*, *85*(3), 363-369.

Renard, G. M., Rivarola, M. A., & Suárez, M. M. (2007). Sexual dimorphism in rats: Effects of early maternal separation and variable chronic stress on pituitary-adrenal axis and behavior. *International Journal of Developmental Neuroscience*, *25*(6), 373-379.

Richards, M. A., & Oinonen, K. A. (2011). Age at menarche is associated with divergent alcohol use patterns in early adolescence and early adulthood. *Journal of Adolescence*, *34*(5), 1065-1076.

Richards, M. A., & Oinonen, K. A. (2022). Psychometric Properties of a DSM-5-Based Screening Tool for Women's Perceptions of Premenstrual Symptoms. *Psychological Reports*, *125*(2), 1186-1217.

Roberts, D. C. S., Bennett, S. A. L., & Vickers, G. J. (1989). The estrous cycle affects cocaine self-administration on a progressive ratio schedule in rats. *Psychopharmacology*, *98*(3), 408-411.

Roberts, G. M., Newell, F., Simões-Franklin, C., & Garavan, H. (2008). Menstrual cycle phase modulates cognitive control over male but not female stimuli. *Brain Research*, *1224*, 79-87.

Rohleder, N., Wolf, J. M., Piel, M., & Kirschbaum, C. (2003). Impact of oral contraceptive use on glucocorticoid sensitivity of pro-inflammatory cytokine production after psychosocial stress. *Psychoneuroendocrinology*, *28*(3), 261-273.

Rollema, H., Lu, Y., Schmidt, A. W., Sprouse, J. S., & Zorn, S. H. (2000). 5-HT 1A receptor activation contributes to ziprasidone-induced dopamine release in the rat prefrontal cortex. *Biological Psychiatry*, *48*(3), 229-237.

Roth, P. L., & Switzer, F. S. (1995). A Monte Carlo analysis of missing data techniques in a HRM setting. *Journal of Management*, *21*(5), 1003-1023.

Rupprecht, R. (2003). Neuroactive steroids: Mechanisms of action and neuropsychopharmacological properties. *Psychoneuroendocrinology*, *28*(2), 139-168.

Roth, R. M., & Gioia, G. A. (2005). *Behavior rating inventory of executive function--adult version*. Lutz, FL: Psychological Assessment Resources.

Sanders, S. A., Graham, C. A., Bass, J. L., & Bancroft, J. (2001). A prospective study of the effects of oral contraceptives on sexuality and well-being and their relationship to discontinuation. *Contraception*, *64*(1), 51-58.

Sayin, A., Derinöz, O., Yüksel, N., Şahin, S., & Bolay, H. (2014). The effects of the estrus cycle and citalopram on anxiety-like behaviors and c-fos expression in rats. *Pharmacology Biochemistry and Behavior*, *124*, 180-187.

Schag, K., Teufel, M., Junne, F., Preissl, H., Hautzinger, M., Zipfel, S., & Giel, K. E. (2013). Impulsivity in binge eating disorder: food cues elicit increased reward responses and disinhibition. *PLoS One*, *8*(10), e76542.

Schell, A. M., Dawson, M. E., Hazlett, E. A., & Filion, D. L. (1995). Attentional modulation of startle in psychosis-prone college students. *Psychophysiology*, *32*(3), 266-273.

Schwartz, N.B. (1969). A model for the regulation of ovulation in the rat. *Recent Progresses in Hormone Research*, *25*, 1-55.

Severino, G. S., Fossati, I. A., Padoin, M. J., Gomes, C. M., Trevizan, L., Sanvitto, G. L., ... & Lucion, A. B. (2004). Effects of neonatal handling on the behavior and prolactin stress response in male and female rats at various ages and estrous cycle phases of females. *Physiology & Behavior*, *81*(3), 489-498.

Sheppes, G., Scheibe, S., Suri, G., Radu, P., Blechert, J., & Gross, J. J. (2014). Emotion regulation choice: A conceptual framework and supporting evidence. *Journal of Experimental Psychology: General*, *143*(1), 163.

Shields, G. S., Trainor, B. C., Lam, J. C., & Yonelinas, A. P. (2016). Acute stress impairs cognitive flexibility in men, not women. *Stress*, *19*(5), 542-546.

Short, M. M., Mazmanian, D., Oinonen, K., & Mushquash, C. J. (2016). Executive function and

self-regulation mediate dispositional mindfulness and well-being. *Personality and Individual Differences*, *93*, 97-103

Siegel, G. J., Agranoff, B. W., Albers, R. W., Fisher, S. K., & Uhler, M. D. (Eds.) (1999). *Basic neurochemistry: Molecular, cellular, and medical aspects, 6th edition.* Philidelphia, PA: Lippencot-Raven.

Simpson, J. A., & Gangestad, S. W. (1991). Individual differences in sociosexuality: Evidence for convergent and discriminant validity. *Journal of Personality and Social Psychology*, *60*(6), 870.

Skovlund, C. W., Mørch, L. S., Kessing, L. V., & Lidegaard, Ø. (2016). Association of hormonal contraception with depression. *JAMA Psychiatry*, *73*(11), 1154-1162.

Smethells, J. R., & Carroll, M. E. (2015). Discrepant effects of acute cocaine on impulsive choice (delay discounting) in female rats during an increasing-and adjusting-delay procedure. *Psychopharmacology*, *232*(14), 2455-2462.

Smith, M. J., Keel, J. C., Greenberg, B. D., Adams, L. F., Schmidt, P. J., Rubinow, D. A., & Wassermann, E. M. (1999). Menstrual cycle effects on cortical excitability. *Neurology*, *53*(9), 2069-2069.

Smith, C. T., Sierra, Y., Oppler, S. H., & Boettiger, C. A. (2014). Ovarian cycle effects on immediate reward selection bias in humans: a role for estradiol. *Journal of Neuroscience*, *34*(16), 5468-5476.

Swalve, N., Smethells, J. R., & Carroll, M. E. (2016). Progesterone attenuates impulsive action in a Go/No-Go task for sucrose pellets in female and male rats. *Hormones and Behavior*, *85*, 43-47.

Swerdlow, N. R., Auerbach, A., Monroe, S. M., Hartson, H., Geyer, M. A., & Braff, D. L. (1993). Men are more inhibited than women by weak prepulses. *Biological Psychiatry*, *34*, 253–260.

Swerdlow, N. R., Hartman, P. L., & Auerbach, P. P. (1997). Changes in sensorimotor inhibition across the menstrual cycle: implications for neuropsychiatric disorders. *Biological Psychiatry*, *41*(4), 452-460.

Swerdlow, N. R., Geyer, M. A., Hartman, P. L., Sprock, J., Auerbach, P. P., Cadenhead, K., ... & Braff, D. L. (1999). Sex differences in sensorimotor gating of the human startle reflex: All smoke? *Psychopharmacology*, *146*(2), 228-232.

Strelau, J. (1996). The regulative theory of temperament: Current status. *Personality and Individual Differences*, *20*(2), 131-142.

Sumiyoshi, T., Stockmeier, C. A., Overholser, J. C., Dilley, G. E., & Meltzer, H. Y. (1996). Serotonin1A receptors are increased in postmortem prefrontal cortex in schizophrenia. *Brain Research*, *708*, 209–214.

Sutton, S. K., & Davidson, R. J. (1997). Prefrontal brain asymmetry: A biological substrate of the behavioral approach and inhibition systems. *Psychological Science*, *8*, 204–210.

Takahashi, H., Matsuura, M., Koeda, M., Yahata, N., Suhara, T., Kato, M., & Okubo, Y. (2007). Brain activations during judgments of positive self-conscious emotion and positive basic emotion: Pride and joy. *Cerebral Cortex*, *18*(4), 898-903.

Thakkar, K. N., Congdon, E., Poldrack, R. A., Sabb, F. W., London, E. D., Cannon, T. D., & Bilder, R. M. (2014). Women are more sensitive than men to prior trial events on the Stop-signal task. *British Journal of Psychology*, *105*(2), 254-272.

Torres, A., Gómez-Gil, E., Vidal, A., Puig, O., Boget, T., & Salamero, M. (2006). Diferencias de género en las funciones cognitivas e influencia de las hormonas sexuales. *Actas Españolas de Psiquiatría*, *34*(6), 408-415.

Trainor, B. C., Takahashi, E. Y., Campi, K. L., Florez, S. A., Greenberg, G. D., Laman-Maharg, A., ... & Steinman, M. Q. (2013). Sex differences in stress-induced social withdrawal: Independence from adult gonadal hormones and inhibition of female phenotype by corncob bedding. *Hormones and Behavior*, *63*(3), 543-550.

van Broekhoven, F., Bäckström, T., van Luijtelaar, G., Buitelaar, J. K., Smits, P., & Verkes, R. J. (2007). Effects of allopregnanolone on sedation in men, and in women on oral contraceptives. *Psychoneuroendocrinology, 32*(5), 555-564.

Võikar, V., Kõks, S., Vasar, E., & Rauvala, H. (2001). Strain and gender differences in the behavior of mouse lines commonly used in transgenic studies. *Physiology & Behavior*, *72*(1), 271-281.

Vošlajerová Bímová, B., Mikula, O., Macholán, M., Janotová, K., & Hiadlovská, Z. (2016). Female house mice do not differ in their exploratory behaviour from males. *Ethology*, *122*(4), 298-307.

Voytko, M. L. (2000). The effects of long-term ovariectomy and estrogen replacement therapy on learning and memory in monkeys (Macaca fascicularis). *Behavioral Neuroscience*, *114*(6), 1078.

Wainwright, S. R., Workman, J. L., Tehrani, A., Hamson, D. K., Chow, C., Lieblich, S. E., & Galea, L. A. (2016). Testosterone has antidepressant-like efficacy and facilitates imipramine-induced neuroplasticity in male rats exposed to chronic unpredictable stress. *Hormones and Behavior*, *79*, 58-69.

Wang, L., LaBar, K. S., Smoski, M., Rosenthal, M. Z., Dolcos, F., Lynch, T. R., ... & McCarthy, G. (2008). Prefrontal mechanisms for executive control over emotional distraction are altered in major depression. *Psychiatry Research: Neuroimaging*, *163*(2), 143-155.

Walf, A. A., & Frye, C. A. (2007). The use of the elevated plus maze as an assay of anxiety-related behavior in rodents. *Nature Protocols*, *2*(2), 322-328.

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

Weafer, J., & de Wit, H. (2014). Sex differences in impulsive action and impulsive choice. *Addictive Behaviors*, *39*(11), 1573-1579.

Wester, S. R., Vogel, D. L., Pressly, P. K., & Heesacker, M. (2002). Sex differences in emotion: A critical review of the literature and implications for counseling psychology. *The Counseling Psychologist*, *30*(4), 630-652.

Wever, R. A. (1984). Sex differences in human circadian rhythms: intrinsic periods and sleep fractions. *Experientia*, *40*(11), 1226-1234.

Wharton, W., Hirshman, E., Merritt, P., Doyle, L., Paris, S., & Gleason, C. (2008). Oral contraceptives and androgenicity: Influences on visuospatial task performance in younger individuals. *Experimental and Clinical Psychopharmacology*, *16*(*2*), 1.

Wilcox, A. J., Dunson, D., & Baird, D. D. (2000). The timing of the "fertile window" in the menstrual cycle: Day specific estimates from a prospective study. The *BMJ*, *321*(7271), 1259-1262.

Wilhelm, F. H., Rattel, J. A., Wegerer, M., Liedlgruber, M., Schweighofer, S., Kreibig, S. D., ... & Blechert, J. (2017). Attend or defend? Sex differences in behavioral, autonomic, and respiratory response patterns to emotion–eliciting films. *Biological Psychology*, *130*, 30-40.

Workman, J. L., Crozier, T., Lieblich, S. E., & Galea, L. A. (2013). Reproductive experience does not persistently alter prefrontal cortical-dependent learning but does alter strategy use dependent on estrous phase. *Hormones and Behavior*, *64*(3), 439-447.

van den Bos, R., Homberg, J., & de Visser, L. (2013). A critical review of sex differences in decision-making tasks: Focus on the Iowa Gambling Task. *Behavioural Brain Research*, *238*, 95-108.

van Heusden, A. M., & Fauser, B. C. J. M. (1999). Activity of the pituitary-ovarian axis in the pill-free interval during use of low-dose combined oral contraceptives. *Contraception*, *59*(4), 237-243.

Vilagut, G. (2014). Test-retest reliability. *Encyclopedia of quality of life and well-being research*, 6622-6625.

Yap, B. W., & Sim, C. H. (2011). Comparisons of various types of normality tests. *Journal of Statistical Computation and Simulation*, *81*(12), 2141-2155.

Yuan, J., He, Y., Qinglin, Z., Chen, A., & Li, H. (2008). Gender differences in behavioral inhibitory control: ERP evidence from a two-choice oddball task. *Psychophysiology*, *45*(6), 986-993.

Zald, D. H., Cowan, R. L., Riccardi, P., Baldwin, R. M., Ansari, M. S., Li, R., ... & Kessler, R. M. (2008). Midbrain dopamine receptor availability is inversely associated with novelty-seeking traits in humans. *Journal of Neuroscience*, *28*(53), 14372-14378.

Zimmerman, Y., Eijkemans, M. J. C., Bennink, H. C., Blankenstein, M. A., & Fauser, B. C. J. M. (2014). The effect of combined oral contraception on testosterone levels in healthy women: A systematic review and meta-analysis. *Human Reproduction Update*, *20*(1), 76-105.

Ziomkiewicz, A., Wichary, S., Bochenek, D., Pawlowski, B., & Jasienska, G. (2012). Temperament and ovarian reproductive hormones in women: Evidence from a study during the entire menstrual cycle. *Hormones and Behavior*, *61*(4), 535-540.

Zohar, J., Mueller, E. A., Insel, T. R., Zohar-Kadouch, R. C., & Murphy, D. L. (1987). Serotonergic responsivity in obsessive-compulsive disorder: Comparison of patients and healthy controls. *Archives of General Psychiatry*, *44*(11), 946-951.

Zohar, J., Zohar-Kadouch, R. C., & Kindler, S. (1992). Current concepts in the pharmacological treatment of obsessive-compulsive disorder. *Drugs*, *43*(2), 210-218.

Zsido, R. (2014). Contributions of estradiol and hormonal contraceptive use to sex differences during fear extinction recall. The *Harvard Undergrad Research Journal*, *7*(2), 15-23.

# Appendix A

## Research Ethics Board (REB) Approval Letter

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

June 20, 2018

**Principal Investigator**: Dr. Kirsten Oinonen
**Student Investigator**: Nicole Keir
Health and Behavioural Sciences\Psychology
Lakehead University
955 Oliver Road
Thunder Bay, ON P7B 5E1

Dear Dr. Oinonen and Ms. Keir:

**Re: Romeo File No: 1466525**
**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, "Hormones and Inhibition: The Effects of Sex, Menstrual Cycle Phase, and Hormonal Contraceptives on Inhibitory Control".

Ethics approval is valid until June 20, 2019. Please submit a Request for Renewal to the Office of Research Services via the Romeo Research Portal by May 20, 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

## Time 1 Questionnaire

*For all Copyrighted measures, only the title and reference are reported. Items are not reported for Copyrighted measures.*

**Demographics**

- Today's date (dd/mm/yyyy): _____
- What is your age _____
- What is your Sex?
-
- Are you currently taking Oral Contraceptives (OCs) (i.e., the "birth control pill") There will be more questions regarding OC use later in the survey.
  YES NO Not applicable, I am Male

- Please choose the response that best represents your ethnic background. Check all that apply.
  .

_White, or Euro-American/Canadian
_South Asian (e.g., East Indian, Pakistani, Sri Lankan, etc.)
_Chinese
_Black, Afro-Caribbean, or African-American/Canadian
_Filipino
_First Nations (North American Indian), Métis or Inuk (Inuit)
_Latin American
_Arab
_Southeast Asian (e.g., Vietnamese, Cambodian, Laotian, Thai, etc.)
_West Asian (e.g., Iranian, Afghan, etc.)
_Korean
_Japan
_Other (please specify)

- Please check the box that best describes the **highest level of education** that you have completed:
  [ ] some elementary [ ] completed high school [ ] some university
  [ ] completed grade 8[ ] some college [ ] completed a university degree
  [ ] some high school [ ] completed college[ ] some graduate studies
  [ ] completed a graduate degree

- How many hours of sleep did you get last night? _____hours
- During the past 24 hours, how many minutes were you physically active at a moderate to intense level?

  [ ] 0 minutes
  [ ] 1 to 15 minutes
  [ ] 16 to 30 minutes
  [ ] 31 to 45 minutes
  [ ] 46 or more minutes

- Did you consume any alcohol in the last 24 hours?
  YES NO

- If yes, how many drinks did you consume? (e.g., ONE drink is equal to 1oz of distilled alcohol i.e., vodka rum, whiskey etc., a 5oz glass of wine, or a 12oz bottle of beer)

  Please indicate: _____

- If yes, have you had any drinks today (since waking up)?
  YES NO

- If yes, how many drinks did you consume? (e.g., ONE drink is equal to a 1oz distilled alcohol i.e., vodka rum, whiskey etc., 5oz glass of wine, or12oz bottle of beer)

  Please indicate: _____

If you are or ever were a University/College student what is/was your Major? (e.g., psychology, biology, english)

_____

**PARTICIPANT CODE**

The following questions will be used to make a unique participant code for you. This code will be used to link your answers from this survey to your answer to the second survey, should you choose to complete both. This will ensure anonymity of your answers.

On what DAY were you born? July 16, 1985 – 16 is the DAY

_____
What are the FIRST THREE letters of you mother's FIRST name?

_____
What is the FIRST letter of your middle name? (if you do not have a middle name please put the letter 'X')

**HEALTH INFORMATION**

- Are you currently taking any antidepressant medication(s)?
  YES NO
  *If YES, what medication(s) are you taking? (please specify)*

- Are you currently taking any medication(s) other than antidepressants?
  YES NO
  *If YES, what medications are you taking? (please specify)*

- Have you ever been diagnosed with or treated for depression?
  YES NO MAYBE

- Have you ever had any head injuries (e.g., concussion)?
  YES NO MAYBE

- Have you ever been hit on the head and lost consciousness for any period of time?
  YES NO MAYBE

- Have you ever hit on the head and experienced post-concussion symptoms?
  YES NO MAYBE

- Have you ever hit on the head and then noticed changes in your own behaviour and abilities that did not return to normal?
  YES NO MAYBE

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

---

**Current Functioning Questions**

- Please indicate the type of grades your typically received in high school

Mostly As
Mostly As and Mostly Bs
Mostly Bs
Mostly Bs and Cs
Mostly Cs
Mostly Cs and Ds
Mostly Ds

- Please indicate the type of grades your typically received/are receiving in post-secondary education

Mostly As
Mostly As and Mostly Bs
Mostly Bs
Mostly Bs and Cs
Mostly Cs
Mostly Cs and Ds
Mostly Ds
I did not attend post-secondary school

**When answering the following questions consider your behaviour and attitudes in general over THE PAST TWO MONTHS. Later, you will be asked to answer some similar questions regarding your attitudes and behaviour of the past 48 hours. However, for now, please consider yourself in general over THE PAST TWO MONTHS.**

**Behaviour Rating Inventory of Executive Functioning –Adult Version BRIEF-A**

Roth, P. L., & Switzer, F. S. (1995). A Monte Carlo analysis of missing data techniques in a HRM setting. *Journal of Management*, *21*(5), 1003-1023.

**Consider how true the following statements are for you in the past TWO MONTHS:**

**Inhibitory Control from the Effortful Control Subscale of the Adult Temperament Questionnaire**

Evans, D. E., & Rothbart, M. K. (2007). Developing a model for adult temperament. *Journal of Research in Personality*, *41*(4), 868-888.

**For each statement indicate to what extent you strongly agree or strongly disagree. Think about yourself in the past TWO MONTHS.**

**Deferred Gratification Inventory (DGI)**

Hoerger, M., Quirk, S. W., & Weed, N. C. (2011). Development and validation of the Delaying Gratification Inventory. *Psychological Assessment*, *23*(3), 725-739.

**Please indicate the extent to which you agree with the following statements. Think about yourself in the past TWO MONTHS:**

**Recent Spending and Saving Scale (RSSS)**

Pine, K. J., & Fletcher, B. C. (2011). Women's spending behaviour is menstrual-cycle sensitive. *Personality and Individual Differences*, *50*(1), 74-78.

**Income Questions**

**Please indicate the degree to which the following statements describe your current financial situation**

- I am comfortable financially

| Strongly Disagree | Moderately Disagree | Somewhat Disagree | Somewhat Agree | Moderately Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |

- I am not able to afford the basic necessities (e.g., food, rent)

| Strongly Disagree | Moderately Disagree | Somewhat Disagree | Somewhat Agree | Moderately Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |

- I can afford the basic necessities (e.g., food, rent) but not much else

| Strongly Disagree | Moderately Disagree | Somewhat Disagree | Somewhat Agree | Moderately Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |

- I have a lot money to spend on anything I'd like

| Strongly Disagree | Moderately Disagree | Somewhat Disagree | Somewhat Agree | Moderately Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |

**These questions ask you to describe how you *typically* think about negative experiences or problems. Please read the following statements and rate the extent to which they apply to you when you think about negative experiences or problems. Think about the PAST TWO MONTHS in general.**

**Perseverative Thinking Questionnaire**

Ehring, T., Zetsche, U., Weidacker, K., Wahl, K., Schönfeld, S., & Ehlers, A. (2011). The Perseverative Thinking Questionnaire (PTQ): Validation of a content-independent measure of repetitive negative thinking. *Journal of Behavior Therapy and Experimental Psychiatry*, *42*(2), 225-232.

**This questionnaire is designed to measure different aspects of how you typically react to experiencing emotional events. Please score the following statements according to how much they apply or do not apply to you on a typical day OVER THE PAST TWO MONTHS.**

**Perth Emotional Reactivity Scale**

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. 1073191117694455.

**Has there been a MAJOR or LIFE ALTERING event that has strongly affected your mood in the PAST TWO MONTHS? (e.g., death of parental figure, parental divorce, physical or sexual assault)?**

YES NO

**If yes, please check all that apply:**

_Death of someone I was in a close relationship with (e.g., friend, family, romantic partner)

_Divorce (I went through a divorce)

_Parental divorce (my parents divorced)

_Physical or sexual assault

_Natural disaster where I live (e.g., hurricane)

_Other (I don't wish to specify)

_Other (please specify)

**Consider how often the following items occur in the LAST MONTH.**

**Perceived Stress Scale**

**In the LAST MONTH…**

- How often have you been upset because of something that happened unexpectedly?

Never Almost never Sometimes Fairly Often Very Often
1 2 3 4 5

- How often have you felt that you were unable to control the important things in your life?

Never Almost never Sometimes Fairly Often Very Often
1 2 3 4 5

- How often have you felt nervous and stressed?

Never Almost never Sometimes Fairly Often Very Often
1 2 3 4 5

- How often have you felt confident about your ability to handle your personal problems?

Never Almost never Sometimes Fairly Often Very Often
1 2 3 4 5

- How often have you felt that things were going your way?

Never Almost never Sometimes Fairly Often Very Often
1 2 3 4 5

- How often have you found that you could not cope with all the things that you had to do?

Never Almost never Sometimes Fairly Often Very Often
1 2 3 4 5

- How often have you been able to control irritations in your life?

Never Almost never Sometimes Fairly Often Very Often
1 2 3 4 5

- How often have you felt that you were on top of things?

Never Almost never Sometimes Fairly Often Very Often
1 2 3 4 5

- How often have you been angered because of things that happened that were outside of your control?

| Never | Almost never | Sometimes | Fairly Often | Very Often |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

- How often have you felt difficulties were piling up so high that you could not overcome them?

| Never | Almost never | Sometimes | Fairly Often | Very Often |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**For each item, indicate how much you agree or disagree with what the item says with respect to the PAST TWO MONTHS. Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses.**

***The Behavioral Inhibition System (BIS) and Behavioural Activation System (BAS) Scales.***

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*(2), 319.

**People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Do not spend too much time on any statement. Answer quickly and honestly. Think about the LAST TWO MONTHS in particular.**

**Barratt Impulsiveness Scale**

Patton, J. H., & Stanford, M. S. (1995). Factor structure of the Barratt impulsiveness scale. *Journal of Clinical Psychology*, *51*(6), 768-774.

**Think about your general behaviour and attitudes in the PAST FEW YEARS...**

**Open Sex Role Inventory**

- I have studied how to win at gambling.

Disagree Neutral Agree

1 2 3 4 5

- I have thought about dying my hair.

Disagree Neutral Agree

1 2 3 4 5

- I have thrown knives, axes or other sharp things.

Disagree Neutral Agree

1 2 3 4 5

- I give people handmade gifts.

Disagree Neutral Agree

1 2 3 4 5

- I have day dreamed about saving someone from a burning building.

Disagree Neutral Agree

1 2 3 4 5

- I get embarrassed when people read things I have written.

Disagree Neutral Agree

1 2 3 4 5

- I have been very interested in historical wars.

Disagree Neutral Agree

1 2 3 4 5

- I know the birthdays of my friends.

Disagree Neutral Agree

1 2 3 4 5

- I like guns.

Disagree Neutral Agree

1 2 3 4 5

- I am happiest when I am in my bed.

Disagree Neutral Agree

1 2 3 4 5

- I did not work very hard in school.

Disagree Neutral Agree

1 2 3 4 5

- I use lotion on my hands.

Disagree Neutral Agree

1 2 3 4 5

- I would prefer a class in mathematics to a class in pottery.

Disagree Neutral Agree

1 2 3 4 5

I dance when I am alone.

Disagree Neutral Agree

1 2 3 4 5

- I have thought it would be exciting to be an outlaw.

Disagree Neutral Agree

1 2 3 4 5

- When I was a child, I put on fake concerts and plays with my friends.

Disagree Neutral Agree

1 2 3 4 5

- I have considered joining the military.

Disagree Neutral Agree

1 2 3 4 5

- I get dizzy when I stand up sharply.

Disagree Neutral Agree

1 2 3 4 5

- I do not think it is normal to get emotionally upset upon hearing about the deaths of people you did not know.

Disagree Neutral Agree

1 2 3 4 5

- I sometimes feel like crying when I get angry.

Disagree Neutral Agree

1 2 3 4 5

- I do not remember birthdays.

Disagree Neutral Agree

1 2 3 4 5

- I save the letters I get.

Disagree Neutral Agree

1 2 3 4 5

- I playfully insult my friends.

Disagree Neutral Agree

1 2 3 4 5

- I oppose medical experimentation with animals.

Disagree Neutral Agree

1 2 3 4 5

- I could do an impressive amount of push-ups.

Disagree Neutral Agree

1 2 3 4 5

- I jump up and down in excitement sometimes.

Disagree Neutral Agree

1 2 3 4 5

- I think a natural disaster would be kind of exciting.

Disagree Neutral Agree

1 2 3 4 5

- I wear a blanket around the house.

Disagree Neutral Agree

1 2 3 4 5

- I have burned things up with a magnifying glass.

Disagree Neutral Agree

1 2 3 4 5

- I think horoscopes are fun.

Disagree Neutral Agree

1 2 3 4 5

- I don't pack much luggage when I travel.

Disagree Neutral Agree

1 2 3 4 5

I have thought about becoming a vegetarian.

Disagree Neutral Agree

1 2 3 4 5

- I hate shopping.

Disagree Neutral Agree

1 2 3 4 5

- I have kept a personal journal.

Disagree Neutral Agree

1 2 3 4 5

- I have taken apart machines just to see how they work.

Disagree Neutral Agree

1 2 3 4 5

- I take lots of pictures of my activities.

Disagree Neutral Agree

1 2 3 4 5

- I have played a lot of video games.

Disagree Neutral Agree

1 2 3 4 5

- I leave nice notes for people now and then.

Disagree Neutral Agree

1 2 3 4 5

- I have set fuels, aerosols or other chemicals on fire, just for fun.

Disagree Neutral Agree

1 2 3 4 5

- I really like dancing.

Disagree Neutral Agree

1 2 3 4 5

- I take stairs two at a time.

Disagree Neutral Agree

1 2 3 4 5

- I bake sweets just for myself sometimes.

Disagree Neutral Agree

1 2 3 4 5

- I think a natural disaster would be kind of exciting.

Disagree Neutral Agree

1 2 3 4 5

- I decorate my things (e.g., stickers on laptop)

Disagree Neutral Agree

1 2 3 4 5

**Please rate yourself on each item. Think about yourself in the past FEW YEARS.**

**Bem Sex Role Inventory**

Bem, S. L. (1974). The measurement of psychological androgyny. *Journal of Consulting and Clinical Psychology, 42*, 155–162.

**Sexual Orientation**

- Please rate yourself on the following rating scale:
  1 Exclusively heterosexual
  2 Predominantly heterosexual, only incidentally homosexual
  3 Predominantly heterosexual, but more than incidentally homosexual
  4 Equally heterosexual and homosexual
  5 Predominantly homosexual, but more than incidentally heterosexual
  6 Predominantly homosexual, only incidentally heterosexual
  7 Exclusively homosexual
  8 None of the above (e.g., pansexual, demisexual)

- Please indicate your degree of **sexual attraction** to women.

1 2 3 4 5 6 7 8 9
Not at all attracted to women — Extremely attracted to women

- Please indicate your degree of **sexual attraction** to men.

1 2 3 4 5 6 7 8 9
Not at all attracted to men — Extremely attracted to men

- Some people describe themselves as “asexual”. This means that one does not feel any sort of sexual attraction or sexual desire towards any men or any women. Do you think this describes you?
  [ ] Yes [ ] No [ ] Maybe

**Please respond honestly to the following questions:**

**Multidimensional Sociosexuality Inventory (SOI)**

Jackson, J. J., & Kirkpatrick, L. A. (2007). The structure and measurement of human mating strategies: Toward a multidimensional model of sociosexuality. *Evolution and Human Behavior*, *28*(6), 382-391.

**For the following questions, please think of your behaviour in <u>the last 48 HOURS (i.e., the past 2 days)</u>**

**Please read each statement carefully and give your best estimate of how well it describes you IN THE PAST 48 HOURS. If an item does not apply to you, please indicate “neither true nor false”**

**In the past 48 hours (2 days) it has been…**

- Easily able to keep a secret.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Easily able to hold back my laughter in a situation when laughter wouldn't be appropriate.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- able to resist buying an attractive item in a store

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- able to resist talking out of turn, even when I'm excited and want to express an idea.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- able to resist jumping right into something I've been excited about before I've considered the possible consequences.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- able to resist my cravings for food drink, etc.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- easily able to inhibit fun behavior that would be inappropriate.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

## In the past 48 hours (2 days) I have….

- Used a curse word in a situation where it may have been inappropriate

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Had difficulty waiting my turn in a conversation

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Interrupted others while they were talking

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Said things without thinking

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Had difficulty holding my tongue when irritated

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had trouble sitting still

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had problems waiting my turn

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- made inappropriate sexual comments

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- made decisions that get me into trouble (legally, financially, socially)

| Extremely | Quite untrue | Slightly untrue | Neither true | Slightly true | Quite True | Extremely |
|---|---|---|---|---|---|---|

Untrue nor false true
1 2 3 4 5 6 7

- been easily distracted

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- rushed through things

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- been impulsive

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- had trouble changing from one activity or task to another

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- had trouble accepting different ways to solve problems with work friends, or tasks

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- had trouble thinking of a different way to solve a problem when stuck

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- been bothered by having to deal with changes

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- been disturbed by unexpected changes in my daily routine

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- had difficulty getting over a problem

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- had angry outbursts

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- overreacted emotionally

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- had emotional outbursts for little reason

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- reacted more emotionally to situations than my friends

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true

1 2 3 4 5 6 7

- overreacted to small problems

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- been emotionally upset easily

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- has frequent mood changes

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- talked at the wrong time

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- not thought consequences before doing something

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- Been able to resist junk food when I want to.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- Been able to control my physical desires.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- Disliked taking turns with other people.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- Had a hard time sticking with a special, healthy diet.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- Tried to consider how my actions affect others.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- Had difficulty resisting buying things I cannot afford.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- Tried to work hard in school so that I could have a better future.

Extremely | Quite untrue | Slightly untrue | Neither true | Slightly true | Quite True | Extremely

Untrue nor false true
1 2 3 4 5 6 7

- Had a difficult time waiting to eat my favourite food.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Spent my money wisely.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- tried to take the easy way out.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Easily been able to resist candy and bowls of snack foods.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- given up physical pleasure or comfort to reach my goals.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- eaten until I made myself sick.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- had difficulty motivating myself to accomplish long-term goals

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- tried to eat healthy because it pays off in the long run.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- put off doing a physically demanding chore

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- managed my money well.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- been able to wait until it is meal time before eating something, even if I'm hungry.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- lied or made excuses in order to go do something more pleasurable.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

## In the past 48 hours (2days) ...

- My spending has been out of control

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have bought something I wouldn't normally buy because it was on sale

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have regretted buying something

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have spent more than I could afford

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have gone shopping for something and come home with something completely different

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have bought something on impulse

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have bought something that I am unlikely to wear/use

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have felt shame or guilt after a shopping trip.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have worried about money.

| Extremely | Quite untrue | Slightly untrue | Neither true | Slightly true | Quite True | Extremely |
|---|---|---|---|---|---|---|

Untrue nor false true
1 2 3 4 5 6 7

- I have stuck to a budget

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- My spending has been careful and controlled.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- The same thoughts keep going through my mind again and again.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Thoughts intrude into my mind.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I can’t stop dwelling on them.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I think about many problems without solving any of them.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I haven’t been able to do anything else while thinking about my problems.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- My thoughts repeat themselves.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Thoughts come to my mind without me wanting them to.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I get stuck on certain issues and can’t move on.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I keep asking myself questions without finding an answer.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- My thoughts prevent me from focusing on other things.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I keep thinking about the same issue all the time.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Thoughts just pop into my mind.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I feel driven to continue dwelling on the same issue.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- My thoughts are not much help to me.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- My thoughts take up all my attention

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

## In the past 48 hours (2 days) …

- It has been easy to get happy

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- My emotions have gone automatically from neutral to positive

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have become enthusiastic about things very quickly

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have felt good about positive things in an instant

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|

1 2 3 4 5 6 7

- I have reacted to good news very quickly

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- It has been easy for me to get upset

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- I have been disappointed very easily

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- I have been frustrated very easily

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- My emotions have gone from neutral to negative very quickly

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- I have been pessimistic about negative things very quickly

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- When I've been happy, the feeling has stayed with me for quite a while

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- When I've been feeling positive, I have stayed like that for good part of the day

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- When I've been feeling upset, it has taken me quite a while to snap out of it

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- It has taken me a long time to get over an anger episode

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true

1 2 3 4 5 6 7

- It has been hard for me to recover from frustration

Extremely | Quite untrue | Slightly untrue | Neither true | Slightly true | Quite True | Extremely

Untrue nor false true
1 2 3 4 5 6 7

- Once I've been in a negative mood, it has been hard to snap out of it.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- When I've been annoyed about something, it has ruined my entire day

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have experienced positive feelings very intensely

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have experienced joy very deeply

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have experienced the feeling of frustration very deeply

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have experienced the feeling of anger very powerfully

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have felt negative feelings feel very intensely

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

## In the past 48 hours (2 days) I have…

- been clear about my feelings

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- paid attention to how I feel

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Experienced my emotions as overwhelming and out of control

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- no idea how I am feeling

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely

Untrue nor false true
1 2 3 4 5 6 7

- difficulty making sense out of my feelings

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- been attentive to my feelings

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- known exactly how I am feeling

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- cared about what I am feeling

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- been confused about how I feel

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- acknowledged my emotions when I've been upset

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- become angry with myself for feeling upset

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- become embarrassed for feeling upset

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- have had difficulty getting work done because I've been upset

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have become out of control due to feeling upset

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Been able to get things done despite being upset

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Planned tasks carefully.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- done things without thinking.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- made-up my mind quickly.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- been happy-go-lucky.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- had trouble "paying attention."

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- had "racing" thoughts.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- been self-controlled.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- concentrated easily.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- been able to sit still when I needed to

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- said things without thinking.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- acted "on impulse"

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- only been able to think about one thing at a time.

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

**For the following questions, please think about your behaviour in the past 48-hours compared to how you may USUALLY behave**

**In the past 48 hours I have…**

- been impulsive or uninhibited in a way that may have been negative (e.g., interrupted someone, acted before thinking of the potential negative consequences)?

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- been impulsive or uninhibited in a way that may have been positive (e.g., dancing in front of people, speaking up in class, complimenting someone, approaching or flirting with someone attractive)

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- said something that I immediately regretted saying as I know I should not have said it (e.g., betrayed a secret, said something offensive to someone, told a story that I had not planned to tell anyone).

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- done something that I knew I should not do at the time but I could not resist the temptation (e.g., to flirt with, or engage in some sort of sexual activity with someone when I knew I should not do so at that time). Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- had difficulty stopping myself from doing something enjoyable or fun in the moment even though I knew it would make it harder to meet my long-term goals

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- had difficulty stopping myself from doing something enjoyable or fun in the moment even though I knew that the "payoff" or benefits would be higher if I waited.

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- not been able to stop myself from indulging in pleasurable behaviours even though I knew it would make it harder for me to meet my goals.

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- had difficulty being flexible when problem solving (e.g., difficulty trying a new strategy) or tended to repeat strategies that hadn't worked in the past

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- had difficulty dealing with changes in the environment, schedule, or people

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- became frustrated when trying to change my behaviour or learn new things

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- been reactive or expressive with negative emotions (e.g., yelling or swearing at someone)

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- been reactive or expressive with positive emotions (e.g., yelling in excitement, or expressing joy)

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- been very reactive in expressing my emotions and later regretted it.

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

**For the following questions, think about your general behaviour and attitudes in the PAST FEW YEARS**

**Validity (NIM/PIM)**

Morey, L. C. (1991). *Personality Assessment Inventory (PAI)*. John Wiley & Sons, Inc..

**SEX/GENDER**

- What Gender do you identify with?

Man Woman Nonbinary Neither (specify)_____

- What is your biological sex?

Male (XY) Female (XX) Neither (specify) _____

**Women-specific questions**

Reproductive Questions:

- Have you ever been pregnant? (Only say YES if you were 100% sure)
  YES NO
- If yes, how many times have you been pregnant? _____
- How many children have you given birth to? _____
- Are you currently pregnant?
  YES NO MAYBE
- Are you currently breast-feeding or lactating?
  YES NO
- Are you a woman who is going through, or has gone through menopause?
  YES NO MAYBE

Have you had your period (menses) in the last 12 months?

(*Select "NO" ONLY IF you HAVE NOT had your period in the last 12 months or more*)

YES NO

***Some women experience changes in mood and physical functioning during the week prior to their menstrual period. As best as you can, please indicate the frequency, severity, and level of impairment encountered for the following 11 symptoms during your pre-menstrual phase over the past year.***

***DSM-5-Based Screening Measure of Premenstrual Symptoms***

Richards, M. A., & Oinonen, K. A. (2022). Psychometric Properties of a DSM-5-Based Screening Tool for Women's Perceptions of Premenstrual Symptoms. *Psychological Reports*, *125*(2), 1186-1217.

**Menstrual cycle Phase:**

- What is the average length of your menstrual cycle right now (i.e., How many days are there from the first day of one period to the first day of your next period – (most people range between 25 and 35)? _____ days

- What is your average length of menstruation/bleeding **when you are not taking oral contraceptives**? (i.e., how many days does your period last? Most people's periods last between 1 and 10 days.) _____ days

- Which statement best describes your menstrual cycle **when you are not taking oral contraceptives**?

[ ] I never have my period.
[ ] My period is very unpredictable. Sometimes very few days pass before I get my next period, sometimes months pass before I get my next period.
[ ] My period is somewhat unpredictable. I usually get my period within four to seven days of when I expect it.
[ ] My period is somewhat predictable. I usually get my period within two or three days of when I expect it.
[ ] My period is very predictable. I can predict within one day when my next period will start.

- How old were you when you first started menstruating (started your period)? _____ years old

**Please use this calendar to answer the following questions regarding your menstrual period.**


- Referring to the calendar above, please indicate the first day of your last menstrual period (i.e., When was the FIRST DAY of your most recent period?). If you are not completely sure, please estimate the day that you believe you started menstruating on.

DATE: dd/mm/yy _____

- How confident are you that the above-indicated day was the first day of your last period?

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

- Refer to the calendar above to please indicate your estimation of the first day of your NEXT menstrual period. If you are not completely sure, please estimate the day that you believe you will start menstruating on.

DATE: dd/mm/yy _____

- How confident are you that the above-indicated day is the day that you will next get your period?

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

- Are you currently menstruating today?

YES NO

- If you are currently menstruating today, how many days have menstruated?

1 2 3 4 5 6 7 8 9 10 more than 10

**PCOS Questions**

Pedersen, S. D., Brar, S., Faris, P., & Corenblum, B. (2007). Polycystic ovary syndrome: Validated questionnaire for use in diagnosis. *Canadian Family Physician*, *53*(6), 1041-1047.

- **Have you ever taken Oral Contraceptives (i.e., the "birth control pill")?**
  ***Only say YES if you have EVER taken "the birth control pill", questions about other forms of hormonal contraceptives will appear later in the survey.***

YES NO

***Some individuals experience both negative and positive side effects from taking Oral Contraceptives (i.e., the "birth control pill"). Indicate on the following page any of the following PHYSICAL and EMOTIONAL side effects that you may have experienced when taking Oral Contraceptives (i.e., the "birth control pill"). If you are not currently taking Oral Contraceptives, think about when you WERE taking them.***

***For each symptom, please indicate the BRAND of Oral Contraceptive you were using at the time you experienced the symptom. Also, please indicate what action you took as a result of the symptom.***

***Remember, if you are not currently taking Oral Contraceptives, think about when you WERE taking them.***

***Physical Symptoms from OCs Questionnaire.***

- **Please indicate whether or not you have experienced the following PHYSICAL symptoms while on Oral Contraceptives.**

  **IF you HAVE experienced the symptom, please indicate the BRAND of Oral Contraceptive (i.e., which brand of the "birth control pill") you were using at the time you experienced the symptom. If you experience the symptom on more than one brand, choose the brand that the symptom was worse on OR if the symptom was experienced equally on all brands, choose the one you took most recently.**

  **Then, please indicate the ACTION you took as a result of this symptom.**

  **If you have NOT experienced the symptom, please indicate "NO" in the first column.**

Nausea/Vomiting: YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Headaches: YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Breast size increase YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Breast size decrease YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now

___ Other? Please specify

Decreased ability to orgasm YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Weight loss YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
_____ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Increased ability to orgasm YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Weight gain YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Increased sex drive/arousal YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Decreased sex drive/arousal YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Fewer menstrual cramps YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More menstrual cramps YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Tiredness/fatigue YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Dizziness/Faintness YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

High blood pressure YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Painful or tender breasts YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Irregular heartbeat YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Swelling of breast or abdomen YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Discontinued Oral Contraceptive use
___ Switched OC brand because of this symptom
___ Experienced symptom but did not change OC use
___No action taken, symptoms continue now
___ Other? Please specify

Clearer complexion YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Complexion Problems (e.g., acne) YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:

___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Complete loss of periods YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Heavier periods ( bleeding) YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Lighter periods ( bleeding) YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Breakthrough bleeding YES NO If yes, which brand: _____
(bleeding between periods)

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Slept more than usual YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom

___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Slept less than usual YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

***Emotional symptoms from OCs Questionnaire.***

- **Please indicate whether or not you have ever experienced the following EMOTIONAL symptoms while on Oral Contraceptives (i.e., the "birth control pill").**

  **IF you HAVE experienced the symptom, please indicate the BRAND of Oral Contraceptive you were using at the time you experienced the symptom. If you experience the symptom on more than one brand, choose the brand that the symptom was worse on OR if the symptom was experienced equally on all brands, choose the one you took most recently.**

  **Then, please indicate the ACTION you took as a result of this symptom.**

  **If you have NOT experienced the symptom, please indicate "NO" in the first column.**

Positive Mood change YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Negative mood change YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More jealous YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More moody YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Less jealous YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Less moody YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Depression YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Sadness YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Lower self-esteem YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More pessimistic YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More optimistic YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Higher self-esteem YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More irritable YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur

___No action taken, symptoms continue now
___ Other? Please specify

Less irritable YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Cried more than usual YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Cried less than usual YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Feelings of inferiority YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More sensitive to criticism YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Less sensitive to criticism YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More self-critical YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Less self-critical YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More content/happy YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More aggressive YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Less aggressive YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:

___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

More Impulsive YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

Less impulsive YES NO If yes, which brand: _____

If yes, what action did you take as a result of this symptom?:
___ Completely discontinued Oral Contraceptive use
___ Switched OC brand or type of contraceptive because of this symptom
___ No action taken, symptoms no longer occur
___No action taken, symptoms continue now
___ Other? Please specify

- In what way do you feel Oral Contraceptive use has affected your mood? If you are not currently taking Oral Contraceptives, think about when you WERE taking them.
-

| Very Negatively | Slightly Negatively | In no way at all | Slightly Positively | Very Positively |
|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 |

- Have you ever stopped oral contraceptive use due to reasons other than physical or emotional symptoms?
  YES NO If yes, indicate the reason:

_No, I have never stopped Oral Contraceptive use for reasons other than physical or emotional symptoms
_I have never stopped Oral Contraceptive use for any reason
_Yes, because my current sexual relationship ended
_Yes, I had/have desire to become pregnant
_Yes, because I was/am concerned about hormones
_Yes, because Oral Contraceptives were/are too hard to use
_Yes, because Oral Contraceptives were/are Too expensive
_Yes, because I had/have a Medical condition (Specify below )
_Other (specify below): _____

- Have negative mood side effects ever influenced you to stop taking oral contraceptives?

  YES NO

- If you have ever **discontinued oral contraceptives or switched brands** due to mood side effects, approximately how many days or months did you experienced these negative mood side effects before discontinuing/switching use?
  _____ months and _____ days

- Do you have a biological mother or sister who has experienced negative mood effects while taking oral contraceptives? YES NO UNSURE

**OC use History**

- At what age did you first start using oral contraceptives? _____ years

- Why did you **start** taking oral contraceptives? (Check all that apply)
  [ ] Birth Control [ ] Treat acne
  [ ] For cycle regularity [ ] Other: _____
  [ ] Due to a hormonal medical condition (Specify): _____
  [ ] I was taking another medication that could have produced birth defects

- For how long have you taken oral contraceptives in total (i.e., the total amount of time you have taken on any/all brands of OCs)?

  _____ years and _____ months

- How many different types/brands of oral contraceptives have you taken? _____ types/brands

- Please select all of the different types of oral contraceptives you have used? (select all that apply)

| | | | | | |
|---|---|---|---|---|---|
| Alesse | Demulen 50 | Levlite | MinEstrin 1/20 | Ortho 10/11 | Select 1/35 |
| Apri | Demulen 30 | Levora | Mircette | Ortho 7/7/7 | Synphasic |
| Aranelle | Diane 35 | Linessa | Natizia | OrthoCept | Tri-Cyclen |
| Aviane | Enpresse | Lo-Femenol | Next Choice | Ortho-Novum | Tri-Cyclen Lo |
| Azurette | Estrope FE | Lo Ovral | Nordette | Ovral | TriNessa |
| Beyaz | Errin | LoEstrin | Norlevo | Portia | Triquilar |
| Brevicon | Gianvi | Lybrel | Nor-QD | Previfem | Triphasil |
| Caziant | Heather | Low-Ogestrel | Nora-BE | Reclipsen | Velivet |
| Camila | Jencycla | Marvelon | Ocella | Safyral | Yasmin |
| Cyclen | Jolivette | Micronor | Ortho 0.5/35 | Seasonique | Yaz |
| Desogen | Kariva | Min-Ovral | Ortho 1/35 | Seasonale | Other (please specify) |

- **Are you currently taking oral contraceptives (i.e., the birth control pill)?**
  YES NO

- **For how many years OR months have you been taking your current oral contraceptive?**
  YEARS_____
  MONTHS_____

  - If you have **previously taken OCs** but are not taking them right now, how many years and months has it been **since you last took OCs**?
    _____ years and _____months

  - Why are you currently taking OCs? (Check all that apply)
    [ ] Birth Control [ ] Treat acne
    [ ] For cycle regularity [ ] Other: _____
    [ ] Due to a hormonal medical condition (Specify): _____
    [ ] I am currently taking another medication that could produce birth defects

- Please indicate the type of OC you are **currently** taking.

| | | | | | |
|---|---|---|---|---|---|
| Alesse | Demulen 50 | Levlite | MinEstrin 1/20 | Ortho 10/11 | Select 1/35 |
| Apri | Demulen 30 | Levora | Mircette | Ortho 7/7/7 | Synphasic |
| Aranelle | Diane 35 | Linessa | Natizia | OrthoCept | Tri-Cyclen |
| Aviane | Enpresse | Lo-Femenol | Next Choice | Ortho-Novum | Tri-Cyclen Lo |
| Azurette | Estrope FE | Lo Ovral | Nordette | Ovral | TriNessa |
| Beyaz | Errin | LoEstrin | Norlevo | Portia | Triquilar |
| Brevicon | Gianvi | Lybrel | Nor-QD | Previfem | Triphasil |
| Caziant | Heather | Low-Ogestrel | Nora-BE | Reclipsen | Velivet |
| Camila | Jencycla | Marvelon | Ocella | Safyral | Yasmin |
| Cyclen | Jolivette | Micronor | Ortho 0.5/35 | Seasonique | Yaz |
| Desogen | Kariva | Min-Ovral | Ortho 1/35 | Seasonale | Other (please specify) |

- Do you believe Oral Contraceptives are currently affecting your mood in a **negative** way?
  YES NO

- Are you planning on STOPPING OC use?
- YES NO

If yes, when are you planning on stopping OC use? 1-2 weeks
3-4 weeks
2 months
3 months
4 months
5 months
6 months or more

- Are you planning on STARTING OC use?
- YES NO

If yes, when are you planning on starting OC use? 1-2 weeks
3-4 weeks
2 months
3 months
4 months
5 months
6 months or more

- If you have stopped taking Oral Contraceptives (OCs), how many years OR months has it been since you last took OCs?

  YEARS_____
  MONTHS_____

- Are you currently taking a hormonal contraceptive that is not oral? (i.e., a hormonal contraceptive that is NOT "the pill")? (e.g., contraceptive patch, vaginal ring, DepoProvera, hormonal implants, etc.)
  YES NO

- If Yes, please specify what you are currently taking:
  _Contraceptive patch
  _Vaginal ring
  _DepoProvera
  _Hormonal Implants
  _Hormonal IUD (intrauterine device)
  _Other (please specify)

- How long have you been taking the above specified hormonal contraceptive?

YEARS_____
MONTHS_____

- If you are NOT currently taking ANY hormonal contraceptives, how long has it been since you last took ANY hormonal contraceptive? (e.g., oral contraceptive, contraceptive patch, vaginal ring, DepoProvera, hormonal implants, etc.)

YEARS_____
MONTHS_____

- **Confirm you are currently NOT taking Oral contraceptives (i.e., the birth control pill)**

__CONFIRM

- Have you ever taken a contraceptive that contained hormones but that was not taken orally or by mouth? (e.g., contraceptive patch, vaginal ring, DepoProvera, hormonal implants, etc.)?
  YES NO IF YES, Specify _____

- If you have EVER taken a hormonal contraceptive other than oral contraceptives, please indicate which ones you have EVER taken. Check all that apply.

_Birth control implants (e.g., Nexplanon)
_Birth control patch (e.g., Ortho Evra)
_Birth control shot (e.g., Depo-Provera)
_Birth control vaginal ring (e.g., Nuva ring)
_Hormonal IUD (e.g., Mirena) -this does NOT include copper IUD

- If you have EVER taken a hormonal contraceptive other than oral contraceptives, please indicate which ones you have EVER taken. Check all that apply.

_Birth control implants (e.g., Nexplanon)
_Birth control patch (e.g., Ortho Evra)
_Birth control shot (e.g., Depo-Provera)
_Birth control vaginal ring (e.g., Nuva ring)
_Hormonal IUD (e.g., Mirena) -this does NOT include copper IUD

- Are you CURRENTLY taking any hormonal contraceptives other than oral contraceptives (e.g., contraceptive patch, vaginal ring, DepoProvera, hormonal implants, etc.)?

_No
_Yes
If yes, (please specify)

- If you are CURRENTLY taking a hormonal contraceptive other than oral contraceptives, please indicate which one you are taking.

_Birth control implants (e.g., Nexplanon)
_Birth control patch (e.g., Ortho Evra)
_Birth control shot (e.g., Depo-Provera)
_Birth control vaginal ring (e.g., Nuva ring)
_Hormonal IUD (e.g., Mirena) -this does NOT include copper IUD

- Have you taken an emergency contraception pill (i.e., Plan B) in the last 6 months?

Yes
No

**Thank you for completing this survey! Please go to the next page to review the debriefing form.**

**IF YOU REQUIRE BONUS POINTS via SONA, please continue to the next page and be sure to indicate "DONE" after reviewing the debriefing form. YOU WILL NOT BE ASSIGNED BONUS POINTS UNLESS YOU PRESS THE "DONE" BUTTON.**

**********

## Appendix C

## Additional Time 1 Questionnaires

**BEM Sex Role Inventory (BSRI).** The BSRI (Bem, 1974) is a self-report measure of an individual's masculinity and femininity based on societal stereotypes about gender. The scale consists of 20 feminine items (e.g., *compassionate, soft spoken*), 20 masculine items (e.g., *athletic, assertive*), and 20 neutral items (e.g., *truthful, likeable*) for a total of 60 items. Each item is rated on a scale from 1 (*never or almost never true*) to 7 (*always or almost always true*). If respondents score above a mean score of 4 on the masculine and feminine scales, they are considered androgynous (Bem, 1981). The neutral items are not further interpreted. Thus, only the masculine and feminine items were included. The BSRI has Cronbach's alpha from .86 to .87 for the masculinity scale and from .84 to .87 for the femininity scale (Campbell et al., 1997). However confirmatory factor analyses of the masculinity and femininity scales have produced poor fits (Colley et al., 2009). For this sample, the masculinity and femininity scales had Cronbach's alphas of .85 ($N = 465$) and.82 ($N = 476$), respectively.

**Open Sex Role Inventory (OSRI).** The OSRI is a modernized measure of masculinity and femininity modelled off the BEM Sex Role Inventory (De Roover & Vermunt, 2019). It consists of 40 self-report items that are rated on a scale from 1 (*disagree*) to 5 (*agree*). There is a minimum possible score of 20 and maximum possible score of 100 for each of the femininity and masculinity scales. The approach taken to develop the OSRI was to collect a list of questions that showed a large gender difference, then analyze them with factor analysis to see if Bem's two factor solution could be fit. An initial screening procedure looked at 2,610 self-report items and the items from that list with the highest correlation with gender were used in the final measure.

This scale has primarily been used for educational and entertainment purposes and had yet to be validated in research. For this sample, the masculinity scale had a Cronbach's alpha of .814 ($N$ = 475) and the femininity scale had a Cronbach's alpha of .835 ($N$ = 483).

**Sexual Orientation Questionnaire.** This questionnaire consists of five questions assessing an individual's sexual orientation, in terms of interest in men, women, and individual's sexual attraction to individuals regardless of sex or gender.

**Multidimensional Sociosexuality Inventory (MDSOI).** The MDSOI (Jackson & Kirkpatrick, 2007) is a self-report measure with 25 questions designed to capture individual differences in the tendency to have casual uncommitted sexual relationships or to require commitment/love before sex. Twenty items tap into restricted (e.g., *I would never consider having a brief sexual relationship with someone*) or unrestricted (e.g., *I believe in taking sexual opportunities when I find them*) attitudes regarding sociosexual relationships. Respondents rate each item from 1 (*strongly disagree*) to 7 (*strongly agree*). The remaining five questions were open-ended and collected information regarding social sexual behaviour (e.g., *with how many different partners have you had sex on one and only one occasion*?). Ten items are summed together to calculate the Short-Term Mating Orientation (STMO) score and seven items are summed together to create the Long-Term Mating Orientation score (LTMO). For the Previous Sexual Behaviours (PSB) score, three items are transformed to Z-scores before aggregating them for a total score. For the STMO and LTMO scores, higher scores indicate a higher preference for that strategy. For the PSB, higher numbers indicate more sexual partners. Jackson and Kirkpatrick (2007) found good internal consistency for the STMO, the LTMO, and the PSB scales (Cronbach alphas = .95, .88, and .83, respectively) ($n$ = 167 males and 161 females).

Confirmatory factor analyses have also indicated that the inventory represents distinctive facets of sociosexual orientation with low to moderate positive intercorrelations (.17 to .55).

DSM-5-Based Screening Measure of Premenstrual Symptoms. A 33-item screening tool for assessing premenstrual symptoms was used to assess the degree to which participants met the American Psychological Association's (APA) Diagnostic and Statistical Manual-5 (DSM-5; APA, 2013) criteria for pre-menstrual dysphoric disorder (Richards & Oinonen, 2021). The scale can also be used as a subclinical continuous measure of premenstrual symptom severity. For each of the eleven criteria or set of symptoms listed in the DSM-5, participants are asked three questions assessing: (1) the frequency in months (from 0 to 12) with which each set of symptoms is experienced, (2) the degree to which each symptom impairs work, school, or interpersonal performance/functioning, and (3) the severity with which each symptom is experienced. Impairment and Severity questions were rated using a four-point Likert scales anchored by 0 (*not at all*) on one end, and 4 (*extremely*) and frequency was rated from 0 to 12 months. All questions ask women to estimate whether the described symptoms have occurred during the week prior to their menstrual period over the past 12 months. Total scores for the frequency subscale can range from 0 to 132, and the total scores for the impairment and severity subscales can range from 0 to 44, and total score for the sum of all scales can range from 0 to 220, with higher scores indicating a greater number, frequency, and severity of premenstrual symptoms. This measure shows internal consistency (Cronbach's alpha = .92, $N$ = 326 women; Richards & Oinonen, 2021). This scale also reliably differentiates between women low and high on PMS symptoms as measured by the Menstrual Distress Questionnaire (Moos, 1968). In this study, this scale was administered twice approximately two-weeks apart (mean days = 17, $SD$ = 38.83) to examine test-retest reliability. A bivariate correlation revealed good test-retest reliability of the Total

Score between Time 1 and Time 2, $r(151) = .817$, $p < .001$. Test-retest reliability for the frequency, severity, and impairment scales were .824, .751, and .776, respectively.

Polycystic Ovarian Syndrome (PCOS) Questionnaire. The PCOS questionnaire consists of 5 items designed to measure symptoms associated with a diagnosis of PCOS (Pederson et al., 2007). Items measure length of cycle, growth of dark coarse hair on face and body (e.g., chin, chest), obesity, nipples discharge, and severity of acne on face and body.

Physical Symptoms from OCs Questionnaire. The Physical Symptoms from OCs Questionnaire is a 26-item questionnaire that requires participants to indicate if they have experienced certain physical symptoms related to OC use. The list of potential physical symptoms from OCs was taken from questionnaires that have been developed and used within the Health Hormones and Behaviour lab in past studies (e.g., Oinonen, 2009). Symptoms include both negative and positive physical symptoms such as: nausea, headaches, more menstrual cramps, clearer complexion, and fewer menstrual cramps. If the respondent indicated they had experienced a physical symptom from OC use (yes/no), they would then indicate which brand of OC they were taking when they experienced the symptom, and what action they took as a result of this symptom. The potential actions taken as a result of the symptom appeared in a drop-down menu list with the following options: "*completely discontinued oral contraceptive use, switched OC brand or type of contraceptive because of this symptom*, *no action taken, symptoms no longer occur*, and *no action taken and symptoms continue now".*

Emotional Symptoms from OCs Questionnaire. The Emotional Symptoms from OCs Questionnaire is a 26-item questionnaire that requires participants to indicate if they have experienced a certain emotional symptom related to OC use. The list of potential emotional symptoms from OCs were taken from questionnaires that have been developed and used within

the Health Hormones and Behaviour lab in past studies (Oinonen, 2009). Symptoms include both negative and positive emotional symptoms such as: irritability, sadness, negative mood change, decreased irritability, and positive mood change. If the respondent indicated they have experienced an emotional symptom from OC use, the respondent was then required to indicate which brand of OC they were taking when they experienced the symptom, and what action they took because of this symptom.

## Appendix D

## Time 2 Questionnaire

*For all Copyrighted measures, only the title and reference are reported. Items are not reported for Copyrighted measures.*

Today's date (dd/mm/yyyy): _____

- What is your age _____

  - How many hours of sleep did you get last night? _____hours
  - During the past 24 hours, how many minutes were you physically active at a moderate to intense level?

    [ ] 0 minutes
    [ ] 1 to 15 minutes
    [ ] 16 to 30 minutes
    [ ] 31 to 45 minutes
    [ ] 46 or more minutes

  - Did you consume any alcohol in the last 24 hours?
    YES NO

  - If yes, how many drinks did you consume? (e.g., ONE drink is equal to 1oz of distilled alcohol i.e., vodka rum, whiskey etc., a 5oz glass of wine, or a 12oz bottle of beer)

    Please indicate: _____

  - If yes, have you had any drinks today (since waking up)?
    YES NO

  - If yes, how many drinks did you consume? (e.g., ONE drink is equal to a 1oz distilled alcohol i.e., vodka rum, whiskey etc., 5oz glass of wine, or12oz bottle of beer)

    Please indicate: _____

  - Have you changed your hormonal contraceptive (e.g., the birth control pill, nuva ring, hormonal IUD) use since completing the first questionnaire (approximately 2 weeks ago)?
    YES NO NOT APPLICABLE, I AM MALE

- Have you taken any emergency contraception pill (i.e., Plan B) since completing the first questionnaire (approximately 2 weeks)?
  YES NO NOT APPLICABLE, I AM MALE

- Have you had any changes in medications since completing the first questionnaire (approximately 2 weeks)?
  YES NO If YES, Specify_____

**Participant CODE**

The following questions will be used to make a unique participant code for you. This code will be used to link your answers from this survey to your answer to the second survey, should you choose to complete both. This will ensure anonymity of your answers.

On what DAY were you born? July 16, 1985 – 16 is the DAY

_____

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

_____

What is the FIRST letter of your middle name?

___

**For the following questions, please think of your behaviour in the past 48 HOURS (i.e., the past 2 days)**

**Please read each statement carefully and give your best estimate of how well it describes you IN THE PAST 48 HOURS. If an item does not apply to you, please indicate "neither true nor false"**

**In the past 48 hours it has been…**

- Very easy for me to keep a secret.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Very easy for me to hold back my laughter in a situation when laughter wouldn't be appropriate.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Very easy for me to resist buying an attractive item in a store

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Very easy for me to resist talking out of turn, even when I'm excited and want to express an idea.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Very easy for me to resist jumping right into something I've been excited about before I've considered the possible consequences.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Very easy for me to resist my cravings for food drink, etc.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Very easy for me to inhibit fun behavior that would be inappropriate.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

## In the past 48 hours I have….

- Used a curse word in a situation where it may have been inappropriate

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Had difficulty waiting my turn in a conversation

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Interrupted others while they were talking

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Said things without thinking

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Had difficulty holding my tongue when irritated

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had trouble sitting still

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had problems waiting my turn

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- made inappropriate sexual comments

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- made decisions that get me into trouble (legally, financially, socially)

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- been very distracted

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- rushed through things

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- been impulsive

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had trouble changing from one activity or task to another

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had trouble accepting different ways to solve problems with work friends, or tasks

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had trouble thinking of a different way to solve a problem when stuck

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- been bothered by having to deal with changes

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- been disturbed by unexpected changes in my daily routine

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had difficulty getting over a problem

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had angry outbursts

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- overreacted emotionally

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had emotional outbursts for little reason

| Extremely | Quite untrue | Slightly untrue | Neither true | Slightly true | Quite True | Extremely |
|---|---|---|---|---|---|---|

Untrue nor false true
1 2 3 4 5 6 7

- reacted more emotionally to situations than my friends

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- overreacted to small problems

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- been emotionally upset easily

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- had frequent mood changes

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- talked at the wrong time

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- not thought about the consequences before doing something

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Been able to resist junk food when I want to.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Been able to control my physical desires.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Disliked taking turns with other people.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Had a hard time sticking with a special, healthy diet.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Tried to consider how my actions affect others.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Had difficulty resisting buying things I cannot afford.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely

Untrue nor false true
1 2 3 4 5 6 7

- Tried to work hard in school so that I could have a better future.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Had a difficult time waiting to eat my favourite food.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Spent my money wisely.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- tried to take the easy way out.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- been able to resist candy and bowls of snack foods very easily

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- given up physical pleasure or comfort to reach my goals.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- eaten until I made myself sick.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- had difficulty motivating myself to accomplish long-term goals

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- tried to eat healthy because it pays off in the long run.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- put off doing a physically demanding chore

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- managed my money well.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- been able to wait until it is meal time before eating something, even if I'm hungry.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- lied or made excuses in order to go do something more pleasurable.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

## In the past 48 hours…

- My spending has been out of control

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have bought something I wouldn't normally buy because it was on sale

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have regretted buying something

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have spent more than I could afford

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have gone shopping for something and come home with something completely different

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have bought something on impulse

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have bought something that I am unlikely to wear/use

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have felt shame or guilt after a shopping trip.

| Extremely | Quite untrue | Slightly untrue | Neither true | Slightly true | Quite True | Extremely |
|---|---|---|---|---|---|---|

Untrue nor false true
1 2 3 4 5 6 7

- I have worried about money.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have stuck to a budget

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- My spending has been careful and controlled.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- The same thoughts keep going through my mind again and again.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Thoughts intrude into my mind.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have been dwelling on these thoughts.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have thought about many problems without solving any of them.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I haven’t been able to do anything else while thinking about my problems.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- My thoughts have repeated themselves.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Thoughts have come to my mind without me wanting them to.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have been stuck on certain issues and can’t move on.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have repeatedly asked myself questions without finding an answer.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- My thoughts have prevented me from focusing on other things.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have kept thinking about the same issue all the time.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- Thoughts have just popped into my mind.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have felt driven to continue dwelling on the same issue.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- My thoughts have not been much help to me.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- My thoughts have taken up all my attention

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

## In the past 48 hours …

- It has been easy to get happy

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- My emotions have gone automatically from neutral to positive

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- I have become enthusiastic about things very quickly

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|

1 2 3 4 5 6 7

- I have felt good about positive things in an instant

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 2 3 4 5 6 7

- I have reacted to good news very quickly

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 2 3 4 5 6 7

- It has been easy for me to get upset

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 2 3 4 5 6 7

- I have been disappointed very easily

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 2 3 4 5 6 7

- I have been frustrated very easily

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 2 3 4 5 6 7

- My emotions have gone from neutral to negative very quickly

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 2 3 4 5 6 7

- I have been pessimistic about negative things very quickly

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 2 3 4 5 6 7

- When I've been happy, the feeling has stayed with me for quite a while

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 2 3 4 5 6 7

- When I've been feeling positive, I have stayed like that for good part of the day

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 2 3 4 5 6 7

- When I've been feeling upset, it has taken me quite a while to snap out of it

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 2 3 4 5 6 7

- It has taken me a long time to get over an anger episode

Extremely | Quite untrue | Slightly untrue | Neither true | Slightly true | Quite True | Extremely

Untrue nor false true
1 2 3 4 5 6 7

- It has been hard for me to recover from frustration

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Once I've been in a negative mood, it has been hard to snap out of it.

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- When I've been annoyed about something, it has ruined my entire day

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have experienced positive feelings very intensely

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have experienced joy very deeply

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have experienced the feeling of frustration very deeply

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have experienced the feeling of anger very powerfully

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- I have felt negative feelings feel very intensely

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

## In the past 48 hours I have…

- been clear about my feelings

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- paid attention to how I feel

Extremely Quite untrue Slightly untrue Neither true Slightly true Quite True Extremely
Untrue nor false true
1 2 3 4 5 6 7

- Experienced my emotions as overwhelming and out of control

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- no idea how I am feeling

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- difficulty making sense out of my feelings

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- been attentive to my feelings

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- known exactly how I am feeling

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- cared about what I am feeling

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- been confused about how I feel

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- acknowledged my emotions when I've been upset

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- become angry with myself for feeling upset

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- become embarrassed for feeling upset

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- have had difficulty getting work done because I've been upset

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- I have become out of control due to feeling upset

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- Been able to get things done despite being upset

Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true
1 | 2 | 3 | 4 | 5 | 6 | 7

- Planned tasks carefully.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- done things without thinking.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- made-up my mind quickly.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- been happy-go-lucky.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had trouble “paying attention.”

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- had “racing” thoughts.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- been self-controlled.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- concentrated easily.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- been able to sit still when I needed to

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- said things without thinking.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- acted “on impulse”

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- only been able to think about one thing at a time.

| Extremely Untrue | Quite untrue | Slightly untrue | Neither true nor false | Slightly true | Quite True | Extremely true |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**For the following questions, please think about your behaviour in the past 48-hours compared to how you may USUALLY behave**

**In the past 48 hours I have…**

- been impulsive or uninhibited in a way that may have been negative (e.g., interrupted someone, acted before thinking of the potential negative consequences)?

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- been impulsive or uninhibited in a way that may have been positive (e.g., dancing in front of people, speaking up in class, complimenting someone, approaching or flirting with someone attractive)

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- said something that I immediately regretted saying as I know I should not have said it (e.g., betrayed a secret, said something offensive to someone, told a story that I had not planned to tell anyone).

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- done something that I knew I should not do at the time but I could resist the temptation (e.g., to flirt with, or engage in some sort of sexual activity with someone when I knew I should not do so at that time). Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- had difficulty stopping myself from doing something enjoyable or fun in the moment even though I knew it would make it harder to meet my long-term goals

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- had difficulty stopping myself from doing something enjoyable or fun in the moment even though I knew that the "payoff" or benefits would be higher if I waited.

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- not been able to stop myself from indulging in pleasurable behaviours even though I knew it would make it harder for me to meet my goals.

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- had difficulty being flexible when problem solving (e.g., difficulty trying a new strategy) or tended to repeat strategies that hadn't worked in the past

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- had difficulty dealing with changes in the environment, schedule, or people

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- became frustrated when trying to change my behaviour or learn new things

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- been reactive or expressive with negative emotions (e.g., yelling or swearing at someone)

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- been reactive or expressive with positive emotions (e.g., yelling in excitement, or expressing joy)

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- been very reactive in expressing my emotions and later regretted it.

Much less than usual Less than usual Same as usual More than usual Much more than usual

1 2 3 4 5

- What is your biological sex?

Male (XY) Female (XX) Neither (specify) _____

**Women-specific questions**

- 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.


- How confident are you that the above-indicated day was the first day of your last period?

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

- Using the calendars below, please **indicate** your estimation of the **first** day of your **NEXT** menstrual period. If you are not completely sure, please estimate the day that you believe you will start menstruating on.


- How confident are you that the above-indicated day is the day that you will next get your period?

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

- Are you currently menstruating today?

YES NO

- If you are currently menstruating today, how many days have menstruated?

1 2 3 4 5 6 7 8 9 10 more than 10

**For the following questions, please note the term "Oral Contraceptives" refers to hormonal contraceptives (i.e., birth control) that are taken ORALLY (i.e., by mouth). Thus, the term "Oral Contraceptives" (or OC) refers to "the birth control pill". Hormonal contraceptives refer to ANY type of birth control methods that use hormones but are not taken orally (e.g., the patch, depo-provera, hormonal IUD). A copper IUD, a condom, or a diaphragm are NOT included as they are non-hormonal methods of contraception. For the purposes of this survey, we are only interested in hormonal methods of birth control.**

- Are you currently taking oral contraceptives?

YES NO

- Are you currently taking any hormonal contraceptives other than oral contraceptives (e.g., contraceptive patch, vaginal ring, DepoProvera, hormonal implants, etc.)?

  YES NO If YES, specify_____

- Are you planning on STOPPING OC use?

YES NO

If yes, when are you planning on stopping OC use? 1-2 weeks
3-4 weeks
2 months
3 months
4 months
5 months
6 months or more

- Are you planning on STARTING OC use?
- YES NO

If yes, when are you planning on starting OC use? 1-2 weeks
3-4 weeks
2 months
3 months
4 months
5 months
6 months or more

***DSM-5-Based Screening Measure of Premenstrual Symptoms***

Richards, M. A., & Oinonen, K. A. (2022). Psychometric Properties of a DSM-5-Based Screening Tool for Women's Perceptions of Premenstrual Symptoms. *Psychological Reports*, *125*(2), 1186-1217.

## Appendix E

## The Positive and Negative Affect Schedule (PANAS)

*Items are not reported for Copyrighted measures.*

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

# Appendix F

## Recruitment Materials: Email Invitations

### F.1 Email Invitation for Study 1, Time 1 for Participants Using SONA

**The Hormones, Emotions, and Reactivity (HER) Study**

You are invited to participate in a psychology study being conducted at Lakehead University looking at factors that can help us understand individual differences in emotions and reactivity. We are looking for men and women who are 18 years of age or older, to complete a 40 to 60-minute initial online questionnaire and a 20 to 30-minute follow-up questionnaire two weeks later. The initial questionnaire can be completed by clicking on the link below.

Two weeks following completion of the initial questionnaire, participants will be contacted via email and asked to participate in the follow-up questionnaire. All responses will be kept anonymous and confidential.

**All participants will be entered in a draw for a chance to win one of two $50 prepaid Visa gift cards!**

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

Please follow the link provided (below) and log in via SONA. You will receive **1-full bonus point** for completing this questionnaire.

https://lupsych.sona-systems.com/default.aspx?p_return_experiment_id=169

Thank-you, your time and participation are greatly appreciated.

Sincerely,

Nicole Keir, M.A.
Ph.D. Student
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

**F. 2 Email Invitation for Study 1, Time 1 for Participants Not Using SONA**

**The Hormones, Emotions, and Reactivity (HER) Study**

You are invited to participate in a psychology study being conducted at Lakehead University looking at factors that can help us understand individual differences in emotions and reactivity. We are looking for men and women who are 18 years of age or older, to complete a 40 to 60-minute initial online questionnaire and a 20 to 30-minute follow-up questionnaire two weeks later. The initial questionnaire can be completed by clicking on the link below.

Two weeks following completion of the initial questionnaire, participants will be contacted via email and asked to participate in the follow-up questionnaire. All responses will be kept anonymous and confidential.

**All participants will be entered in a draw for a chance to win one of two $50 prepaid Visa gift cards!**

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

Please follow the link below to participate in the online questionnaire:
https://www.surveymonkey.com/r/HERConsentA

If you have any questions regarding this study please email Nicole Keir at (email removed).

Thank-you, your time and participation are greatly appreciated.

Sincerely,

Nicole Keir, M.A.
Ph.D. Student
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

**F. 3 Email invitation Study 1, Time 2 for Participants Using SONA**

Dear participant,

Thank you for your participation in Part 1 of the HER (Hormones, Emotions, and Reactivity) Study! You are now invited to participate in Part 2 of the study. Part 2 consists of a 20- to 25-minute online questionnaire.

Please follow the link provided (below) and log in via SONA. You will receive **1-full bonus point** for completing this 20-minute questionnaire.

YOU WILL NEED TO ENTER A PASSWORD TO COMPLETE THE QUESTIONNAIRE.
Please complete within the next 48 hours.
The Password to complete the questionnaire is**: Hormones1**

https://lupsych.sona-systems.com/default.aspx?p_return_experiment_id=169

Thank you for your contribution to research on health, hormones, and behaviour!

Sincerely,

Nicole Keir, M.A.
Ph.D. Student
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

**F.4 Email invitation Study 1, Time 2 for Participants Not Using SONA**

Dear participant,

Thank you for your participation in Part 1 of the HER (Hormones, Emotions, and Reactivity) Study! You are now invited to participate in Part 2 of the study. Part 2 consists of a 20- to 25-minute online questionnaire.

Please follow the link provided (below):

https://www.surveymonkey.com/r/HERConsentB

Thank you for your contribution to research on health, hormones, and behaviour!

Sincerely,

Nicole Keir, M.A.
Ph.D. Student
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

**F.5 Email Invitation for Study 2 for Participants Using SONA**

**The Hormones, Emotions, and Reactivity (HER) Study**

You are invited to participate in a psychology study being conducted at Lakehead University looking at factors that can help us understand individual differences in emotions and reactivity. We are looking for men and women who are 18 years of age or older, to complete a ONE laboratory session that will involve a variety of fun emotional and perceptual tasks as well as a questionnaire. **Click on the link below to sign up for a time slot for the HER Laboratory Study today!**

Two weeks following completion of the initial questionnaire, participants will be contacted via email and asked to participate in the follow-up questionnaire. All responses will be kept anonymous and confidential.

**Participants will receive 2 full bonus points for participation in this study. Also, all participants will be entered in a draw for a chance to win one of two $50 prepaid Visa gift cards!**

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

Please follow the link provided (below) and log in via SONA.

https://lupsych.sona-systems.com/default.aspx?p_return_experiment_id=169

Thank-you, your time and participation are greatly appreciated.

Sincerely,

Nicole Keir, M.A.
Ph.D. Student
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

**F.6 Email Invitation for Study 2 for Participants Not Using SONA**

**The Hormones, Emotions, and Reactivity (HER) Study**

You are invited to participate in a psychology study being conducted at Lakehead University looking at factors that can help us understand individual differences in emotions and reactivity. We are looking for men and women who are 18 years of age or older, to complete ONE laboratory session that will involve a variety of fun emotional and perceptual tasks as well as a questionnaire. **Please email** (email removed) **to sign up for a time slot for the HER Laboratory Study today!**

Two weeks following completion of the initial questionnaire, participants will be contacted via email and asked to participate in the follow-up questionnaire. All responses will be kept anonymous and confidential.

**All participants will be entered in a draw for a chance to win one of two $50 prepaid Visa gift cards!**

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

Thank-you, your time and participation are greatly appreciated.

Sincerely,

Nicole Keir, M.A.
Ph.D. Student
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

## Appendix G

## Recruitment Materals: Posters

### G.1 Recruitment Poster for Study 1

Lakehead UNIVERSITY

HHAB Lab
Health Hormones Behaviour

# The Hormones, Emotions and Reactivity Study

Researchers in the department of Psychology are looking for **YOU** to participate in a study on **HORMONES, EMOTIONS, AND REACTIVITY STUDY!**

Participants will complete ONE 30-40-minute initial questionnaire followed by ONE 20-minute follow-up questionnaire two weeks later!

*Participants who qualify for BONUS POINTS towards their psychology grade will receive up to 2.0 bonus points!

Additionally, all participants will be entered in a draw for a chance to win a $50 AMAZON gift card.

For more information and details on how to participate please sign onto SONA and look for the **HORMONES, EMOTIONS, AND REACTIVITY STUDY**

OR email: (email removed)

This is a GREAT way to contribute to health and hormone research!!

**Take a picture of this poster to help you remember!**

This study has received ethical approval by the Lakehead University Research Ethics Board, (807) 343-8934 or research@lakeheadu.ca

**G.2 Recruitment Poster for Study 2**

Lakehead UNIVERSITY

HHAB Lab
Health Hormones Behaviour

# The Hormones, Emotions and Reactivity Study

Researchers in the department of Psychology are looking for **YOU** to participate in a study on **HORMONES, EMOTIONS, AND REACTIVITY STUDY!**

Participants will participate in ONE laboratory session where they will complete a Quesionnaite and a variety of fun emotional and perceptual tasks*.

Participants who qualify for BONUS POINTS towards their psychology grade will receive up to 2.0 bonus points!

Additionally, all participants will be entered in a draw for a chance to win a $50 AMAZON gift card.

For more information and details on how to participate please sign onto SONA and look for the **HORMONES, EMOTIONS, AND REACTIVITY STUDY**

OR email: (email removed)

This is a GREAT way to contribute to health and hormone research!!

**Take a picture of this poster to help you remember!**

*All participants will be contacted two weeks after the lab session to complete a 20-minute online follow-up questionnaire

This study has received ethical approval by the Lakehead University Research Ethics Board, (807) 343-8934 or research@lakeheadu.ca

# Appendix H

## Letters to Participants

### H.1 Letter to Participants for Study 1 Time 1

THE HORMONES, EMOTIONS AND REACTIVITY (HER) STUDY - PART ONE

Dear potential participant,

You are being invited to participate in the Hormones, Emotions, and Reactivity (HER) Study. The purpose of this study is to examine individual differences in hormones, emotions, and reactivity. This study is being conducted by Nicole Keir and Dr. Kirsten Oinonen from the Health Hormones and Behaviour Laboratory (HHABLAB) in the Department of Psychology at Lakehead University. A part of this project will be used to complete a Doctoral Dissertation for Nicole Keir. Additional exploratory research questions in the same area may also be examined. The study will consist of one initial questionnaire that will take approximately 45 to 60 minutes to complete and one follow-up questionnaire that will take approximately 20 to 30-minutes to complete.

Lakehead University students in relevant undergraduate Psychology courses will receive one bonus point after completion of the initial questionnaire and another after the completion of the follow-up questionnaire for a total of 2-full bonus points towards their Undergraduate Psychology mark, if relevant.

Additionally, all participants will be entered in a draw for a chance to win a $50 pre-paid Visa gift card!

Both questionnaires may involve answering personal questions about your health, reproductive history, emotions, and personality. Benefits to participation in this research project involve a better understanding of the processes of psychological research, possible benefits from personal insight, as well as a general contribution to the field of psychology and the area of hormones, emotion, and cognition. There are no obvious risks involved in participating in this study. However, some participants may feel uncomfortable answering personal questions or have new positive or negative thoughts about oneself after answering the questions (i.e., new personal insight). A debriefing form will be provided to all participants that will include resources for mental health services should any participant feel the need to seek out emotional or psychological support.

This study is open to Lakehead University students 16 years or older as well as members of the general public who are 18 years or older. Your participation is entirely voluntary and you may refuse to participate in any part of the study, decline to answer any question, or withdraw from the study at any time without penalty. All records of your participation will be kept in strict confidence and any reports of the study will not identify you as a participant.

We have asked for your email address so you can be contacted to participate in the follow-up session. However, your email address or ANY personal information will not connected to any of your responses on the questionnaire. Your information will only be used to contact you for the follow-up questionnaire and will not be given out to any third parties. No one, including the researchers, will be able to connect any information gathered to a specific individual and all data will be presented in aggregate form. There is no obligation to provide an email address, however it is necessary in order to be contacted for the Follow-up Questionnaire. Please note that the online survey tool used in the study, (Survey Monkey), is hosted by a server located in the USA. The US Patriot Act permits U.S. law enforcement officials, for the purpose of anti-terrorism investigation, to seek a court order that allows access to the personal records of any person without the person's knowledge. In view of this we cannot absolutely guarantee the full confidentiality and anonymity of your data. With your consent to participate in this study, you acknowledge this.

As per university requirements, all data will be stored for at least five years by Dr. Oinonen at Lakehead University and remain anonymous and confidential. Only approved members of the HHAB Lab will have access to the anonymized dataset. In any instance where data are requested for meta-analyses, or where publication of a paper requires that data be posted in a repository, only a minimal dataset will be provided/posted and every effort will be made to ensure that all indirect identifiers are removed (e.g., a unique age or a unique combination of age and gender). If you have any questions or concerns regarding this study please contact Nicole Keir or Dr. Kirsten Oinonen. This study has been reviewed and approved by Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research team, please contact Sue Wright at the Research Ethics Board at (807) 343- 8283 or research@lakeheadu.ca.

Upon completion of the study, interested participants are welcome to contact one of the researchers to request a summary of the results.

Enter email here: _____

Follow this link to the Consent form and Questionnaire:

https://www.surveymonkey.com/r/HerStudy

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

Nicole Keir, M.A.
Ph.D. Student
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

**H.2 Letter to Participants for Study 1 TIME 2**

THE HORMONES, EMOTIONS AND REACTIVITY (HER) STUDY - PART TWO

Dear potential participant,

You are being contacted as you previously completed the initial (phase 1) questionnaire for the Hormones, Emotions, and Reactivity (HER) Study approximately two weeks ago.
You are now being invited to participate in the Follow-up phase of the study. The purpose of this study is to examine individual differences in hormones, emotions, and reactivity. This study is being conducted by Nicole Keir and Dr. Kirsten Oinonen from the Health Hormones and Behaviour Laboratory (HHABLAB) in the Department of Psychology at Lakehead University. A part of this project will be used to complete a Doctoral Dissertation for Nicole Keir. Additional exploratory research questions in the same area may also be examined. Upon completion of this questionnaire Lakehead University students will receive one 1.0 bonus point on top of the one 1.0 bonus point you have already received from your participation in the Initial questionnaire. Thus, Lakehead University psychology students can receive a total of 2.0 bonus points towards specific undergraduate psychology courses, if applicable.

Also, all participants are eligible to win 1 of 2 $50 pre-paid Visa giftcards!

Like the initial questionnaire, this follow-up questionnaire may involve answering personal questions about your health, reproductive history, emotions, and personality. Benefits to participation in this research project involve a better understanding of the processes of psychological research, possible benefits from personal insight, as well as a general contribution to the field of psychology and the area of hormones, emotion, and cognition. There are no obvious risks involved in participating in this study. However, some participants may feel uncomfortable answering personal questions or have new positive or negative thoughts about oneself after answering the questions (i.e., new personal insight). A debriefing form will be provided to all participants that will include resources for mental health services should any participant feel the need to seek out emotional or psychological support after their participation in the study.

This study is open to Lakehead University students 16 years or older as well as members of the general public who are 18 years or older. Your participation is entirely voluntary and you may refuse to participate in any part of the study, decline to answer any question, or withdraw from the study at any time without penalty. All records of your participation will be kept in strict confidence and any reports of the study will not identify you as a participant.

We have asked for your email address which was used to contact you to participate in this follow-up session. However, your email address is not connected to any of your responses on the questionnaire. Your information will not be given out to any third parties. No one, including the researchers, will be able to connect any information gathered to a specific individual. Please note that the online survey tool used in the study, (Survey Monkey), is hosted by a server located in

the USA. The US Patriot Act permits U.S. law enforcement officials, for the purpose of anti-terrorism investigation, to seek a court order that allows access to the personal records of any person without the person's knowledge. In view of this we cannot absolutely guarantee the full confidentiality and anonymity of your data. With your consent to participate in this study, you acknowledge this. As per university requirements, all data will be stored for at least five years by Dr. Oinonen at Lakehead University and remain anonymous and confidential. Only approved members of the HHAB Lab will have access to the anonymized data. In any instance where data are requested for meta-analyses, or where publication of a paper requires that data be posted in a repository, only a minimal dataset will be provided/posted and every effort will be made to ensure that all indirect identifiers are removed (e.g., a unique age or a unique combination of age and gender). If you have any questions or concerns regarding this study please contact Nicole Keir (nkeir@lakeheadu.ca) or Dr. Kirsten Oinonen (koinonen@lakeheadu.ca). This study has been reviewed and approved by Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research team, please contact Sue Wright at the Research Ethics Board at (807) 343-8283 or research@lakeheadu.ca.

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.

To continue with the phase 2 of the study, please provide your email address below, and then click on the link to begin the Follow-up Questionnaire. Please remember that your email address cannot be linked to any of your answers on the questionnaires.

Email Address: _____

Follow this link to the Questionnaire:

https://www.surveymonkey.com/r/HERfollowup

Nicole Keir, M.A.
Ph.D. Student
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

**H.3 Letter to Participants for Study 2**

THE HORMONES, EMOTIONS AND REACTIVITY (HER) STUDY – LAB STUDY

You are being invited to participate in the Hormones, Emotions, and Reactivity (HER) Study. The purpose of this study is to examine individual differences in hormones, emotions, and reactivity. This study is being conducted by Nicole Keir and Dr. Kirsten Oinonen from the Health Hormones and Behaviour Laboratory (HHABLAB) in the Department of Psychology at Lakehead University. A part of this project will be used to complete a Doctoral Dissertation for Nicole Keir. Additional exploratory research questions in the same area may also be examined. The study will consist of one initial questionnaire that will take approximately 45 to 60 minutes to complete and one follow-up questionnaire that will take approximately 20 to 30-minutes to complete. If you are participating in the LAB study, the study will consist of ONE laboratory study that will take approximately 2 hours to complete.

Additionally, two weeks after the laboratory study, you will be contacted to complete a 20 to 30-minute follow-up questionnaire that can be completed online (i.e., it is not a laboratory session). Lakehead University students in relevant undergraduate Psychology courses will receive one bonus point after completion of the initial questionnaire and another after the completion of the follow-up questionnaire for a total of 2-full bonus points towards their Undergraduate Psychology mark, if relevant. If you are in the LAB study, you will receive two bonus point after completion of the laboratory session and one bonus point after the completion of the follow-up questionnaire for a total of 3-full bonus points. Additionally, all participants will be entered in a draw for a chance to win a $50 pre-paid Visa gift card!

Both questionnaires may involve answering personal questions about your health, reproductive history, emotions, and personality. Benefits to participation in this research project involve a better understanding of the processes of psychological research, possible benefits from personal insight, as well as a general contribution to the field of psychology and the area of hormones, emotion, and cognition. There are no obvious risks involved in participating in this study. However, some participants may feel uncomfortable answering personal questions or have new positive or negative thoughts about oneself after answering the questions (i.e., new personal insight). A debriefing form will be provided to all participants that will include resources for mental health services should any participant feel the need to seek out emotional or psychological support.

This study is open to Lakehead University students 16 years or older as well as members of the general public who are 18 years or older. Your participation is entirely voluntary and you may refuse to participate in any part of the study, decline to answer any question, or withdraw from the study at any time without penalty. All records of your participation will be kept in strict confidence and any reports of the study will not identify you as a participant.

Your personal information will not connected to any of your responses on the questionnaire. Your email address (provided via SONA) will only be used to contact you for the follow-up

questionnaire and will not be given out to any third parties. No one, including the researchers, will be able to connect any information gathered

Please note that the online survey tool used in the study, (Survey Monkey), is hosted by a server located in the USA. The US Patriot Act permits U.S. law enforcement officials, for the purpose of anti-terrorism investigation, to seek a court order that allows access to the personal records of any person without the person's knowledge. In view of this we cannot absolutely guarantee the full confidentiality and anonymity of your data. With your consent to participate in this study, you acknowledge this.

As per university requirements, all data will be stored for at least five years by Dr. Oinonen at Lakehead University and remain anonymous and confidential. Only approved members of the HHAB Lab will have access to the anonymized dataset. In any instance where data are requested for meta-analyses, or where publication of a paper requires that data be posted in a repository, only a minimal dataset will be provided/posted and every effort will be made to ensure that all indirect identifiers are removed (e.g., a unique age or a unique combination of age and gender). If you have any questions or concerns regarding this study please contact Nicole Keir or Dr. Kirsten Oinonen. This study has been reviewed and approved by Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research team, please contact Sue Wright at the Research Ethics Board at (807) 343-8283 or research@lakeheadu.ca. Upon completion of the study, interested participants are welcome to contact one of the researchers to request a summary of the results.

Enter email here: _____

Follow this link to the Consent form and Questionnaire:

https://www.surveymonkey.com/r/HerStudy

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

Nicole Keir, M.A.
Ph.D. Student
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

Dr. Kirsten Oinonen Ph.D., C. Psych
Associate Professor
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

## Appendix I

## Consent Form for All Participants

THE HORMONES, EMOTIONS AND REACTIVITY (HER) STUDY – CONSENT FORM

I have read and understood the Information Letter and agree to participate in this study investigating individual differences with respect to hormones, emotions, and reactivity. I understand that my participation is entirely voluntary: I can leave the experiment at any time and this will have no bearing on any remuneration I will receive, nor will it have any undesirable consequences.

The following points have been explained to me:
1. I have been selected to participate in a study run by members of the HHAB Lab in the Department of Psychology at Lakehead University so that I may contribute to the understanding of individual differences with respect to hormones, emotions, and reactivity.
2. The procedure will be as follows:
*For those completing JUST the online questionnaires: I will complete one 45 to 60-minute online questionnaire. Two weeks later, I will be contacted to complete a follow-up 20 to 30-minute online questionnaire. In the questionnaires, I will be asked to answer questions regarding my health,
reproductive history, emotions, and personality.
*For those completing the Laboratory Study: I will complete several cognitive and perceptual tasks in the HHABLAB for approximately 45 minutes. After the tasks, I will the complete a 45 to 60-minute online questionnaire (described above). Two weeks later, I will be contacted to complete another 20 to 30- minute online questionnaire.
3. I am a volunteer and can withdraw at any time from this study and I may choose to not answer any question in the study
4. There are no known serious risks involved in participating in this study. However, experiencing positive and negative changes in mood will likely occur during the session. The benefits I may expect from the study are: (a) a greater understanding of research methods, (b) an opportunity to contribute to scientific research, (c) possible insight into myself, and (d) course credit (up to 2.0 or 3.0 bonus points for undergraduate psychology students), and (e) potential to win a $50 pre-paid Visa gift card
5. All of the data collected will remain strictly confidential. My responses will not be associated with my name. Instead, my data will be associated with a code number when the researchers store the data. Additionally, all data will remain anonymous in any publication or public presentation.
6. I have the right to withdraw from the study at any time and I have the right withdraw any data submitted until the point at which data has been linked and participant codes removed.
7. The data will be stored securely for at least 5 years by Dr. Oinonen at Lakehead University
8. For the duration of the study, the researchers and I will have some communication via the e-mail address(es) that I have provided. This information will not be used for any other reason.
9. Upon completion of my participation, I will receive a more detailed written explanation about the rationale underlying this experiment (i.e., a Debriefing form).

10. The experimenter(s) will answer any other questions about the research either now or during the course of the experiment (other than specific questions about the hypotheses). If I have any other questions or concerns, I can address them to the experimenter(s) Nicole Keir (nkeir@lakeheadu.ca) or to the research director, Dr. Kirsten Oinonen 807-343-8096, (koinonen@lakeheadu.ca).
11. If I am interested in receiving a summary of the results upon completion of the study, I can contact the researchers via email (above)
12. In the future, anonymized data may be shared with other researchers or posted in appropriate online repositories for the purpose of conducting meta-analyses or for peer review.

*I have read and understood the above information and agree to participate in this study on Hormones, Emotions, and Reactivity: Y N

# Appendix J

# Debriefing Forms

## J.1 Debriefing Form after Time 1 Questionnaire

**DEBRIEFING FORM: THE HORMONES, EMOTIONS AND REACTIVITY (HER) STUDY (Time 1)**

Thank you for participating in the initial phase of our study on hormones, emotions and reactivity. The study is being conducted by Nicole Keir and Dr. Oinonen, at Lakehead University. The data you have contributed will be used as part of Nicole Keir's Doctoral Dissertation. It may also be used to examine related additional exploratory research questions in the laboratory.

**In two weeks' time, you will be contacted (via the email address you provided) to participate in the second part of the study.** The second part of this study involves completing a follow-up questionnaire. Those who complete the second phase will receive an additional bonus point toward their undergraduate psychology course, if applicable. Additionally, all participants will be entered in a draw for a chance to win a $50 pre-paid Visa gift card!

All your responses will be coded to conceal your identity on the questionnaires and all data will remain anonymous. If you have any questions, please feel free to contact Nicole Keir or Dr. Oinonen at the contact information below. 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. Please note that providing your email address does not jeopardize your anonymity.

This study has been reviewed and approved by Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research team, please contact Sue Wright at the Research Ethics Board at (807) 343-8283 or research@lakeheadu.ca.

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

In case you have any concerns about your mood and would like to see a mental health professional, we have provided you with a list of such resources on the attached sheet.

Nicole Keir, M.A.
Ph.D. Student
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

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

**Mental Health Resource Sheet**

Sometimes people can feel upset when thinking about their mood. Thus, it is possible that something occurred during your participation in the study that may have upset you. 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 Health and Counseling Centre: 343-8361

· Family Services Thunder Bay: 626-1880

· Catholic Family Development Centre: 345-7323

· Emergency services are available at the Thunder Bay Health Sciences Centre

· Thunder Bay Crisis Response (24 hours): 346-8282.

· Find a local crisis line via https://suicideprevention.ca/need-help/ or http://www.yourlifecounts.org/need-help/crisis-lines

**Thank you for your participation! Please Press the "DONE" button in order to get bonus points through SONA**

## J.2 Debriefing Form after Time 1 Questionnaire

**DEBRIEFING FORM: THE HORMONES, EMOTIONS AND REACTIVITY (HER) STUDY (Time 2)**

We appreciate your participation in our study, and thank you for spending your time to help us with our research. The purpose of this study was to investigate how sex and hormones affect emotions and inhibitory control. Specifically, we were interested in whether sex, menstrual cycle phase, or use of oral contraceptives (OCs) would affect individuals' ability to inhibit certain behaviours (e.g., stop themselves from expressing frustration when it may be inappropriate, or stopping themselves from choosing pleasurable food to meet a future goal of health and fitness). For example, previous research has indicated that women in the mid-follicular phase of their menstrual cycle (i.e., 1-2 weeks after menstruation) are better able to defer gratification compared to other times during their menstrual cycle (i.e.,1-2 weeks before menstruation). Also, women have been shown to be more emotionally reactive compared to men in some situations. Please see the references below if you are interested in reading more about this issue.

In order to determine women's menstrual cycle phases when they participated in the study, you will be emailed once per week for the next four weeks (for a total of four emails). You will be given a link and we will ask that you enter information regarding the start date of your NEXT menstrual period. Because we cannot link your email address to any personal information ALL participants (including men) will receive these emails. However, the information is only relevant to individuals that are currently menstruating.

In case you have any concerns about your mood and would like to see a mental health professional, we have provided you with a list of such resources on the attached sheet.

Given that this study involves some aspects of which you were not fully informed at the start, it is very important that you not discuss your experiences with other students until the end of the term. If participants have prior knowledge of our specific predictions it could influence the results, and the data we collect would not be useable.

Should you have further questions, do not hesitate to contact Nicole Keir or Dr. Kirsten Oinonen, using the information listed below. This study has been reviewed and approved by Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research team, please contact Sue Wright at the Research Ethics Board at (807) 343-8283 or research@lakeheadu.ca.

We hope that you have enjoyed participating in our study, and thank you very much for your assistance. As noted on the consent form, anyone interested in receiving a summary of the results of the study at its completion can email one of the researchers (see below) with this request.

Principal Investigators:

Nicole Keir, M.A.
Ph.D. Student
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

Dr. Kirsten Oinonen Ph.D., C. Psych.
Associate Professor
Department of Psychology
Lakehead University
955 Oliver Road
Thunder Bay, Ontario P7B 5E1
email: (email removed)

**Mental Health Resource Sheet**

Sometimes people can sometimes feel upset when thinking about their mood. Thus, it is possible that something occurred during your participation in the study that may have upset you. 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 Health and Counseling Centre: 343-8361

· Family Services Thunder Bay: 626-1880

· Catholic Family Development Centre: 345-7323

· Emergency services are available at the Thunder Bay Health Sciences Centre

· Thunder Bay Crisis Response (24 hours): 346-8282.

· Find a local crisis line via https://suicideprevention.ca/need-help/ or http://www.yourlifecounts.org/need-help/crisis-lines

The following are some references in case you are interested in reading more about research that is related to the study that you just participated in:

Colzato, L. S., & Hommel, B. (2014). Effects of estrogen on higher-order cognitive functions in unstressed human females may depend on individual variation in dopamine baseline levels. From Sex Differences in Neuroscience to a Neuroscience of Sex Differences: New Directions and Perspectives, 66. https://www.ncbi.nlm.nih.gov/pubmed/24778605

Evans, K. L., & Hampson, E. (2015). Sex-dependent effects on tasks assessing reinforcement learning and interference inhibition. Frontiers in Psychology, 6. https://www.ncbi.nlm.nih.gov/pubmed/26257691

Gingnell, M., Engman, J., Frick, A., Moby, L., Wikström, J., Fredrikson, M., & Sundström-Poromaa, I. (2013). Oral contraceptive use changes brain activity and mood in women with previous negative affect on the pill—A double-blinded, placebo-controlled randomized trial of a levonorgestrel-containing combined oral contraceptive. Psychoneuroendocrinology, 38(7), 1133-1144. https://www.ncbi.nlm.nih.gov/pubmed/23219471

Pine, K. J., & Fletcher, B. C. (2011). Women's spending behaviour is menstrual-cycle sensitive. Personality and individual differences, 50(1), 74-78. https://www.sciencedirect.com/science/article/pii/S0191886910004289

## Appendix K

## Bivariate Correlations Between Study 1 and Study 2 Variables

**Table K**

| | ICS-48 RI | ICS-48 DG | ICS-48 RL | PTQ | BRIEF Shift | ICS-48 ER | PERS | BRIEF Emo con | EOC Total | DG Task | PRL | NA Change | Base NA | Sad NA | Fear NA | EIAT Acc | EIAT speed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ICS-48 RI | 1 | | | | | | | | | | | | | | | | |
| ICS-48 DG | **.573*** ** | 1 | | | | | | | | | | | | | | | |
| ICS-48 RL | **.440*** ** | **.429*** ** | 1 | | | | | | | | | | | | | | |
| PTQ | **.267*** ** | **.360*** ** | **.743*** ** | 1 | | | | | | | | | | | | | |
| BRIEF Shift | **.331*** ** | **.285*** ** | **.450*** ** | **.414*** ** | 1 | | | | | | | | | | | | |
| ICS-48 ER | **.471*** ** | **.335*** ** | **.675*** ** | **.516*** ** | **.437*** ** | 1 | | | | | | | | | | | |
| PERS | **.246*** ** | **.175** ** | **.335*** ** | **.416*** ** | **.343*** ** | **.547*** ** | 1 | | | | | | | | | | |
| BRIEF Emo | **.366*** ** | **.342*** ** | **.463*** ** | **.488*** ** | **.508** ** | **.624*** ** | **.549*** ** | 1 | | | | | | | | | |
| EOC total | **.226*** | .179[t] | .155 | .169[t] | **.110** | **.192*** | .081 | .109 | 1 | | | | | | | | |
| DG Task | **-.187*** | -.004 | -.155 | -.072 | -.090 | -.110 | -.053 | .036 | -.098 | 1 | | | | | | | |
| PRL | **-.300** ** | -.153 | -.142 | **-.198*** | -.082 | -.158[t] | -.161 | -.097 | -.015 | -.066 | 1 | | | | | | |
| NA Change | .060 | **.223*** | -.022 | .038 | .153 | -.042 | .018 | .051 | **.214*** | -.004 | .116 | 1 | | | | | |
| Base NA | **.309** ** | .130 | **.383*** ** | **.376*** ** | **.276** ** | .394*** | .089 | **.269** ** | **.188*** | .021 | -.200* | -.205* | 1 | | | | |
| Sad NA | **.257** ** | **.225*** | **.202*** | **.287** ** | **.201*** | **.227*** | .105 | **.242** ** | **.232*** | .089 | -.077 | .643*** | .338*** | 1 | | | |
| Fear NA | .147 | **.226*** | .116 | .182[t] | **.284** ** | .114 | .060 | .161[t] | **.304** ** | -.053 | .073 | .798*** | .257** | .541*** | 1 | | |
| EIAT Acc | .055 | .004 | .052 | .111 | -.012 | **.169** | .032 | .060 | .074 | .044 | -.026 | .047 | -.015 | .080 | .025 | 1 | |
| EIAT speed | .114 | .139 | .073 | -.087 | .028 | .076 | .028 | .023 | -.020 | -.076 | .155 | .124 | -.049 | .078 | .064 | -.204* | 1 |

Note. ICS-48 = Inhibitory Control Scale 48-hours. RI = Response Inhibition. DG = Deferred Gratification. RL = Reversal Learning. ER = Emotional Reactivity. PTQ = Perseverative Thinking Questionnaire. BRIEF Shift = the Behaviour Rating Inventory of Executive Function for Adults (BRIEF-A) Shift subscale. PERS = Perth Emotional Reactivity Scale. BRIEF Emo = the BRIEF-A Emotional Control subscale. EOC total = total Errors of commission on the GoNogo task. DG task = the Delay Discounting task (the laboratory task for deferred gratification). PRL = the Probabilistic Reversal Learning Task (the laboratory task for reversal learning). NA change = the Positive and Negative Affect Schedule (PANAS) Negative Affect (NA) change score across the laboratory mood primes. Base NA = PANAS NA score at baseline. Sad NA, Happy NA, and Fear NA = the PANAS NA score after the specified mood prime. EIAT Acc = Accuracy of negative emotional associations (score from a laboratory task of emotional reactivity). EIAT speed = speed of negative emotional associations. N range for Study 1 was 303-311. N range for Study 2 was 115-116. $^{t}$ = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

## Appendix L

## Potential Covariate Analyses for Study 1

**Table L.1**

*Associations Between Time 1 and Time 2 ICS-48 Response Inhibition (RI) Scores and Potential Covariates: Means (SD), and Relationships (r, F, t)*

| | Time 1 | | | | Time 2 | | | |
|---|---|---|---|---|---|---|---|---|
| Potential Covariates | Mean (*SD*) | df | Statistic | *p* | Mean (*SD*) | df | Statistic | *p* |
| Correlations (*r*) | | | | | | | | |
| Age | 21.13 (4.46) | 311 | -.072 | .206 | | | | |
| Alcohol (24 hours) | 0.34 (1.13) | 311 | .066 | .244 | 7.56 (1.53) | 109 | .118 | .220 |
| Sleep (24 hours) | 7.15 (1.48) | 310 | -.153** | .007 | 0.38 (1.21) | 108 | .103 | .291 |
| ANOVAs (*F*) | | | | | | | | |
| Exercise past 24 hours (min) | | 4, 309 | 1.695 | .151 | | 4, 108 | 1.045 | .388 |
| 0 (*n* = 54) | 74.23 (20.68) | | | | 0 (*n* = 18) | 69.72 (19.96) | | |
| 1-15 (*n* = 75) | 77.41 (20.63) | | | | 1-15 (*n* = 35) | 75.70 (22.06) | | |
| 16-30 (*n* = 66) | 71.56 (22.07) | | | | 16-30 (*n* = 22) | 79.33 (27.69) | | |
| 31-45 (*n* = 46) | 78.16 (18.85) | | | | 31-45 (*n* = 13) | 74.26 (17.64) | | |
| ≥ 46 (*n* = 69) | 79.75 (18.62) | | | | ≥ 46 (*n* = 21) | 83.73 (23.49) | | |
| *t*-tests (*t*) | | | | | | | | |
| Head Injury Hx | | 284 | 1.788[t] | .075 | | | | |
| Yes (*n* = 76) | 79.08 (20.65) | | | | | | | |
| No (*n* = 210) | 74.20 (20.32) | | | | | | | |
| Recent Major Life Event | | 306 | 0.160 | .873 | | | | |
| Yes (*n* = 56) | 76.55 (20.00) | | | | | | | |
| No (*n* = 252) | 76.07 (20.53) | | | | | | | |

Note. ICS-48 refers to Inhibitory Control Scale 48-hours. Higher scores reflect more problems with response inhibition. Alcohol consumption in the past 24 hours, hours of sleep, and amount of physical exercise (minutes/week) were time-specific variables and they were examined as possible covariates for both Time 1 and Time 2 ICS-48 scores. Age, history of head injury, and recent major life event were variables that remain unchanged from Time 1 and Time 2 and were only examined as possible covariates with Time 1 ICS-48 scores. [t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table L.2**

*Examination of Time 1 and Time 2 ICS-48 Deferred Gratification (DG) Scale: Means (SD), and Relationships (r, F, t) with Potential Covariates*

| | Time 1 | | | | Time 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Potential Covariates | Mean (*SD*) | | df | Statistic | *p* | Mean (*SD*) | | df | Statistic | *p* |
| **Correlations** | | | | | | | | | | |
| Age | 21.13 (4.46) | | 313 | -.102 | .073 | | | | | |
| Alcohol past 24 hours | 0.34 (1.13) | | 313 | .114* | .043 | 7.56 (1.53) | | 186 | -.050 | .499 |
| Sleep past 24 hours | 7.15 (1.48) | | 312 | .018 | .756 | 0.38 (1.21) | | 187 | .105 | .151 |
| **ANOVAs** | | | | | | | | | | |
| Exercise past 24 hours (min) | | | 4, 311 | 0.994 | .411 | | | 4, 185 | 3.14* | .016 |
| | | | 4, 311 | 1.117 | .348 | | | | | |
| 0 (*n* = 52) | 89.55 (16.47) | | | | | 0 (*n* = 32) | 98.72 (22.10) | | | |
| 1-15 (*n* = 77) | 92.65 (18.41) | | | | | 1-15 (*n* = 49) | 90.46 (20.33) | | | |
| 16-30 (*n* = 68) | 86.31 (21.33) | | | | | 16-30 (*n* = 34) | 87.19 (17.64) | | | |
| 31-45 (*n* = 46) | 90.15 (19.94) | | | | | 31-45 (*n* = 22) | 96.36 (25.04) | | | |
| ≥ 46 (*n* = 69) | 89.95 (19.16) | | | | | ≥ 46 (*n* = 49) | 84.22 (18.68) | | | |
| ***t*-tests** | | | | | | | | | | |
| History of Head Injury | | | 286 | 1.973* | .049 | | | | | |
| Yes (*n* = 75) | 94.04 (18.62) | | | | | | | | | |
| No (*n* = 213) | 88.91 (19.75) | | | | | | | | | |
| Recent Major Life Event | | | 308 | 1.286 | .199 | | | | | |
| Yes (*n* = 56) | 92.85 (18.03) | | | | | | | | | |
| No (*n* = 254) | 89.30 (19.51) | | | | | | | | | |

Note. ICS-48 refers to Inhibitory Control Scale 48-hours. Higher scores reflect more problems with deferred gratification. Alcohol consumption in the past 24 hours, hours of sleep, and amount of physical exercise (minutes/week) were time-specific variables and they were examined as possible covariates for both Time 1 and Time 2 ICS-48 scores. Age, history of head injury, and recent major life event were variables that remain unchanged from Time 1 and Time 2 and were only examined as possible covariates with Time 1 ICS-48 scores. $^{t}$ = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table L.3**

*Examination of Time 1 and Time 2 ICS-48 Reversal Learning (RL) Scale: Means (SD), and Relationships (r, F, t) with Potential Covariates*

| | Time 1 | | | | Time 2 | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean (*SD*) | df | Statistic | *p* | Mean (*SD*) | df | Statistic | *p* |
| Correlations | | | | | | | | |
| Age | 21.13 (4.46) | 311 | -.094[t] | .096 | | | | |
| Alcohol past 24 hours | 0.34 (1.13) | 311 | -.051 | .370 | 7.56 (1.53) | 104 | .100 | .312 |
| Sleep past 24 hours | 7.15 (1.48) | 310 | -.066 | .244 | 0.38 (1.21) | 103 | .010 | .920 |
| ANOVAs | | | | | | | | |
| Exercise past 24 hours (min) | | 4, 309 | 0.992 | .412 | | 4, 103 | 0.542 | .706 |
| 0 (*n* = 54) | 83.33 (25.83) | | | | 0 (*n* = 18) | 85.00 (36.86) | | |
| 1-15 (*n* = 76) | 85.90 (30.15) | | | | 1-15 (*n* = 32) | 87.02 (34.08) | | |
| 16-30 (*n* = 66) | 83.14 (33.42) | | | | 16-30 (*n* = 20) | 91.25 (29.81) | | |
| 31-45 (*n* = 46) | 90.61 (25.94) | | | | 31-45 (*n* = 13) | 85.92 (28.58) | | |
| ≥ 46 (*n* = 68) | 79.89 (30.33) | | | | ≥ 46 (*n* = 21) | 98.10 (32.54) | | |
| *t*-tests | | | | | | | | |
| History of Head Injury | | 283 | -0.112 | .911 | | | | |
| Yes (*n* = 78) | 83.83 (28.74) | | | | | | | |
| No (*n* = 207) | 84.27 (30.13) | | | | | | | |
| Recent Major Life Event | | 306 | 2.311* | .021 | | | | |
| Yes (*n* = 58) | 92.24 (30.49) | | | | | | | |
| No (*n* = 250) | 82.32 (29.20) | | | | | | | |

Note. ICS-48 refers to Inhibitory Control Scale 48-hours. Higher scores reflect more problems with reversal learning. Alcohol consumption in the past 24 hours, hours of sleep, and amount of physical exercise (minutes/week) were time-specific variables and they were examined as possible covariates for both Time 1 and Time 2 ICS-48 scores. Age, history of head injury, and recent major life event were variables that remain unchanged from Time 1 and Time 2 and were only examined as possible covariates with Time 1 ICS-48 scores.

[t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table L.4**

*Examination of Time 1 and Time 2 ICS-48 Emotional Reactivity (ER) Scale: Means (SD), and Relationships (r, F, t) with Potential Covariates*

| | Time 1 | | | | Time 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean (*SD*) | | df | Statistic | *p* | Mean (*SD*) | | df | Statistic | *p* |
| **Correlations** | | | | | | | | | | |
| Age | 21.13 (4.46) | | 308 | -.150** | .008 | | | | | |
| Alcohol past 24 hours | 0.34 (1.13) | | 308 | .027 | .643 | 7.56 (1.53) | | 107 | .097 | .321 |
| Sleep past 24 hours | 7.15 (1.48) | | 307 | -.041 | .474 | 0.38 (1.21) | | 106 | .059 | .546 |
| **ANOVAs** | | | | | | | | | | |
| Exercise past 24 hours (min) | | | 4, 306 | 0.180 | .949 | | | 4, 106 | 0.463 | .763 |
| 0 (*n* = 52) | 113.07 (23.96) | | | | | 0 (*n* = 17) | 114.06 (34.09) | | | |
| 1-15 (*n* = 74) | 114.79 (24.32) | | | | | 1-15 (*n* = 35) | 122.75 (29.80) | | | |
| 16-30 (*n* = 66) | 116.75 (29.21) | | | | | 16-30 (*n* = 21) | 113.93 (26.80) | | | |
| 31-45 (*n* = 46) | 116.73 (29.21) | | | | | 31-45 (*n* = 13) | 115.92 (28.08) | | | |
| ≥ 46 (*n* = 69) | 115.44 (26.76) | | | | | ≥ 46 (*n* = 21) | 120.14 (24.90) | | | |
| ***t*-tests** | | | | | | | | | | |
| History of Head Injury | | | 282 | -0.562 | .574 | | | | | |
| Yes (*n* = 76) | 113.91 (27.21) | | | | | | | | | |
| No (*n* = 208) | 115.92 (26.53) | | | | | | | | | |
| Recent Major Life Event | | | 303 | 1.056 | .292 | | | | | |
| Yes (*n* = 57) | 118.69 (25.10) | | | | | | | | | |
| No (*n* = 248) | 114.59 (26.76) | | | | | | | | | |

Note. ICS-48 refers to Inhibitory Control Scale 48-hours. Higher scores reflect more problems with emotional reactivity. Alcohol consumption in the past 24 hours, hours of sleep, and amount of physical exercise (minutes/week) were time-specific variables and they were examined as possible covariates for both Time 1 and Time 2 ICS-48 scores. Age, history of head injury, and a recent major life event were variables that remain unchanged from Time 1 and Time 2 and were only examined as possible covariates with Time 1 ICS-48 scores.

$^{t}$ = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

## Appendix M

## Potential Covariate Analyses for Study 2

**Table M.1**

*Examination of Errors of Commission (EOC): Means (SD), and Relationships (r, F, t) with Potential Covariates [Response Inhibition]*

| | Mean (*SD*) | df | Statistic | *p* |
|---|---|---|---|---|
| | | Correlations | | |
| Age | 20.75 (4.01) | 124 | .005 | .966 |
| Alcohol past 24 hours | 0.28 (1.17) | 124 | -.060 | .131 |
| Sleep past 24 hours | 6.98 (1.46) | 124 | -.136 | .506 |
| | | ANOVAs | | |
| Exercise past 24 hours (in minutes) | | 4, 123 | 0.482 | .749 |
| 0 (*n* = 23) | 13.17 (6.59) | | | |
| 1-15 (*n* = 33) | 16.48 (10.37) | | | |
| 16-30 (*n* = 23) | 13.74 (8.74) | | | |
| 31-45 (*n* = 14) | 15.71 (9.16) | | | |
| ≥ 46 (*n* = 31) | 15.42 (8.04) | | | |
| | | *t*-tests | | |
| History of Head Injury | | 109 | 1.632 | .106 |
| Yes (*n* = 26) | 17.31 (8.87) | | | |
| No (*n* = 85) | 14.40 (8.79) | | | |
| Recent Major Life Event | | 121 | 0.038 | .970 |
| Yes (*n* = 22) | 14.68 (8.25) | | | |
| No (*n* = 101) | 15.09 (8.87) | | | |

Note. Higher scores reflect more problems with response inhibition

$^{t}$ = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table M.2**

*Examination of Impulsive Choice (Deferred Gratification) Lab Test Scores: Means (SD), and Relationships (r, F, t) with Potential Covariates*

| | Means (*SD*) | df | statistic | *p* |
|---|---|---|---|---|
| | | Correlations | | |
| Age | 20.75 (4.01) | 125 | .017 | .853 |
| Alcohol past 24 hours | 0.28 (1.17) | 125 | -.081 | .370 |
| Sleep past 24 hours | 6.98 (1.46) | 125 | -.010 | .910 |
| | | ANOVAs | | |
| Exercise past 24 hours (in minutes) | | 4, 124 | 0.327 | .859 |
| 0 (*n* = 24) | 20.08 (11.97) | | | |
| 1-15 (*n* = 33) | 20.64 (13.92) | | | |
| 16-30 (*n* = 23) | 20.17 (11.04) | | | |
| 31-45 (*n* = 14) | 20.21 (11.39) | | | |
| $\geq$ 46 (*n* = 31) | 23.13 (10.77) | | | |
| | | *t*-tests | | |
| History of Head Injury | | 110 | -0.804 | .423 |
| Yes (*n* = 27) | 19.81 (10.81) | | | |
| No (*n* = 85) | 21.92 (12.14) | | | |
| Recent Major Life Event | | 122 | 1.615 | .109 |
| Yes (*n* = 22) | 24.82 (10.27) | | | |
| No (*n* = 102) | 20.34 (12.08) | | | |

Note. Higher scores reflect more problems with deferred gratification

[t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table M.3**

*Examination of Reversal Learning Lab Test Scores: Means (SD), and Relationships (r, F, t) with Potential Covariates*

| | Mean (*SD*) | df | statistic | *p* |
|---|---|---|---|---|
| | | Correlations | | |
| Age | 20.75 (4.01) | 126 | -.048 | .593 |
| Alcohol past 24 hours | 0.28 (1.17) | 126 | -.045 | .620 |
| Sleep past 24 hours | 6.98 (1.46) | 126 | -.039 | .666 |
| | | ANOVAs | | |
| Exercise past 24 hours (in minutes) | | 4, 125 | 0.961 | .432 |
| 0 (*n* = 24) | 7.38 (3.33) | | | |
| 1-15 (*n* = 33) | 7.85 (4.00) | | | |
| 16-30 (*n* = 23) | 7.78 (1.98) | | | |
| 31-45 (*n* = 14) | 9.43 (3.37) | | | |
| ≥ 46 (*n* = 31) | 7.69 (3.54) | | | |
| | | *t*-tests | | |
| History of Head Injury | | 111 | -1.501 | .136 |
| Yes (*n* = 27) | 7.00 (3.14) | | | |
| No (*n* = 86) | 8.15 (3.58) | | | |
| Recent Major Life Event | | 123 | 1.045 | .298 |
| Yes (*n* = 22) | 8.59 (3.81) | | | |
| No (*n* = 103) | 7.75 (3.30) | | | |

Note. Higher scores reflect more problems with reversal learning

$^{t}$ = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table M.4**

*Examination of PANAS NA Change Score (Emotional Reactivity) in the Lab: Means (SD), and Relationships (r, F, t) with Potential Covariates*

| | Mean (*SD*) | df | statistic | *p* |
|---|---|---|---|---|
| | | Correlations | | |
| Age | 20.75 (4.01) | 125 | -.126 | .162 |
| Alcohol past 24 hours | 0.28 (1.17) | 125 | -.131 | .144 |
| Sleep past 24 hours | 6.98 (1.46) | 125 | -.022 | .809 |
| | | ANOVAs | | |
| Exercise past 24 hours (in minutes) | | 4, 124 | 0.956 | .434 |
| 0 (*n* = 24) | .72 (.70) | | | |
| 1-15 (*n* = 33) | .76 (.58) | | | |
| 16-30 (*n* = 23) | .53 (.42) | | | |
| 31-45 (*n* = 14) | .55 (.48) | | | |
| ≥ 46 (*n* = 31) | .79 (.68) | | | |
| | | *t*-tests | | |
| History of Head Injury | | 110 | -0.108 | .914 |
| Yes (*n* = 27) | .67 (.62) | | | |
| No (*n* = 85) | .69 (.56) | | | |
| Recent Major Life Event | | 122 | 1.615 | .109 |
| Yes (*n* = 22) | .79 (.65) | | | |
| No (*n* = 102) | .67 (.59) | | | |

Note. Higher scores reflect higher emotional reactivity

$^{t}$ = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

## Appendix N

## Group Equivalency Analyses

**Table N.1**

*Examination of Group Differences for Sex: Means (SDs), and Relationships (F, $\chi^2$) with Potential Covariates*

| | Mean (*SD*) | | df | *F* | *p* |
|---|---|---|---|---|---|
| | | ANOVAs | | | |
| | Men (*n* = 76) | Women (*n* = 295) | | | |
| Age (years) | 21.32 (4.57) | 21.08 (4.43) | 1, 370 | 0.162 | .688 |
| Alcohol past 24 hours | 0.47 (1.64) | 0.30 (0.95) | 1, 371 | 1.370 | .243 |
| Sleep past 24 hours | 7.22 (1.33) | 7.13 (1.52) | 1, 370 | 0.229 | .633 |
| | | Chi Square | | | |
| | Frequencies (%) | | df | $\chi^2$ | *p* |
| Exercise past 24 hours (in minutes) | | | 4 | 9.348[t] | .053 |
| 0 | 12 (15.8) | 54 (18.3) | | | |
| 1-15 | 12 (15.8) | 80 (27.1) | | | |
| 16-30 | 14 (18.4) | 66 (22.4) | | | |
| 31-45 | 15 (19.7) | 37 (12.5) | | | |
| ≥ 46 | 23 (30.3) | 57 (19.3) | | | |
| History of Head Injury | | | 1 | 0.091 | .763 |
| Yes | 18 (25.0) | 72 (26.8) | | | |
| No | 54 (75.0) | 197 (73.2) | | | |
| Recent Major Life Event | | | 1 | 2.891 | .089 |
| Yes | 8 (11.8) | 57 (20.8) | | | |
| No | 60 (88.2) | 217 (79.2) | | | |

Note.

[t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table N.2**

*Examining Differences Between Cycle Phase Groups: Means (SDs), and Relationships (F, $\chi^2$) with Potential Covariates*

| | Mean (*SD*) | | df | *F* | *p* |
|---|---|---|---|---|---|
| | | ANOVAs | | | |
| | Follicular (*n* = 54) | Luteal (*n* = 54) | | | |
| Age (years) | 20.93 (4.52) | 22.44 (5.49) | 1, 107 | 2.465 | .119 |
| Alcohol past 24 hours | 0.13 (55) | 0.15 (.56) | 1, 107 | 0.030 | .863 |
| Sleep past 24 hours | 6.96 (1.40) | 7.15 (1.61) | 1, 107 | 0.408 | .525 |
| | | Chi Square | | | |
| | Frequencies (%) | | df | $\chi^2$ | *p* |
| Exercise past 24 hours (in minutes) | | | 4 | 7.42 | .115 |
| 0 | 14 (25.9) | 5 (9.3) | | | |
| 1-15 | 15 (27.8) | 15 (27.8) | | | |
| 16-30 | 12 (22.2) | 14 (25.9) | | | |
| 31-45 | 6 (11.1) | 5 (9.3) | | | |
| ≥ 46 | 7 (13.0) | 15 (27.8) | | | |
| History of Head Injury | | | 1 | 0.209 | .647 |
| Yes | 11 (23.4) | 10 (19.6) | | | |
| No | 36 (76.6) | 41 (80.4) | | | |
| Recent Major Life Event | | | 1 | 0.089 | .770 |
| Yes | 9 (16.7) | 10 (18.9) | | | |
| No | 45 (83.3) | 43 (81.1) | | | |

Note.

[t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$

**Table N.3**

*Examination of Differences in Oral Contraceptive Groups: Means (SD), and Relationships (F, $\chi^2$) for Potential Covariates*

| | Mean (*SD*) | | | df | *F* | *p* |
|---|---|---|---|---|---|---|
| | | | ANOVAs | | | |
| | OC Users (*n* = 111) | Nonusers (*n* = 110) | Men (*n* = 76) | | | |
| Age (years) | 20.34 (3.512) | 21.71 (5.09) | 21.32 (4.57) | 2, 295 | 2.746 | .066 |
| Alcohol past 24 hours | 0.44 (1.29) | 0.16 (0.57) | 0.47 (1.65) | 2, 296 | 2.092 | .125 |
| Sleep past 24 hours | 7.26 (1.49) | 7.01 (1.55) | 7.22 (1.33) | 2, 295 | 1.997 | .401 |
| | | | Chi Square | | | |
| | Frequencies (%) | | | df | $\chi^2$ | *p* |
| Exercise past 24 hours (minutes) | | | | 8 | 9.372 | .312 |
| 0 | 22 (19.8) | 17 (15.7) | 12 (15.8) | | | |
| 1-15 | 28 (25.2) | 31 (28.7) | 12 (15.8) | | | |
| 16-30 | 20 (18.0) | 26 (24.1) | 14 (18.4) | | | |
| 31-45 | 18 (16.2) | 13 (11.8) | 15 (19.7) | | | |
| ≥ 46 | 23 (20.7) | 21 (19.1) | 23 (30.3) | | | |
| History of Head Injury | | | | 2 | 0.477 | .788 |
| Yes | 28 (27.5) | 23 (23.2) | 18 (25.0) | | | |
| No | 74 (72.5) | 76 (76.8) | 54 (75.0) | | | |
| Recent Major Life Event | | | | 2 | 2.302 | .316 |
| Yes | 21 (19.1) | 22 (20.3) | 8 (11.8) | | | |
| No | 89 (80.1) | 86 (79.6) | 60 (88.2) | | | |

Note.

[t] = trend ($p < .10$), *$p < .05$. **$p < .01$. *** $p < .001$