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Ego Depletion and Changes in the Premenstrual Phase: Impaired Self-Control as a Common Source

Heather Maranges

THE FLORIDA STATE UNIVERSITY

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EGO DEPLETION AND CHANGES IN THE PREMENSTRUAL PHASE

IMPAIRED SELF-CONTROL AS A COMMON SOURCE

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HEATHER M. MARANGES

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Dr. Roy Baumeister
Thesis Director

Dr. Trisha Terebelski
Outside Committee Member

Dr. Orenda Johnson
Committee Member

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Heather M. Maranges

Florida State University

Author Note

Heather M Maranges, Department of Psychology, The Florida State University

Correspondence concerning this article should be addressed to Heather M. Maranges, Department of Psychology, Florida State University, 1107 W Call St, Tallahassee, FL 32304. Email Hmm10c@my.fsu.edu

Abstract

What accounts for the stark changes in emotion, cognition, and behavior in women during the premenstrual phase of the menstrual cycle? I hypothesize that, in addition to the effects of hormones, a lack of self-control may account for these changes. The metabolically expensive activity of the premenstrual phase diverts energy from metabolically expensive self-regulatory processes, making the use of self-control more difficult. In this article, I experimentally test this hypothesis with the dual-task paradigm common to self-control research. That is, participants perform one task that requires and depletes self-control—the Stroop task—followed by another task that requires self-control—a dependent measure. I randomly assigned 34 undergraduate women to either a control or ego depletion condition and to participate either during the premenstrual or postmenstrual phase of their menstrual cycles. I measured total affect, critical thinking, and aggression. Results, while preliminary, are consistent with the hypothesis that self-control depletion is not only linked to emotional, cognitive, and behavioral changes in the premenstrual phase, but also exaggerates these changes. I offer an explanation for my findings and conclude with a discussion of future work and implications.

Keywords: ego depletion; self-control; premenstrual syndrome; PMS; menstrual cycle

Whether resisting that chocolate cake after work when you have strictly followed a diet all day, willing yourself to go to the gym, inhibiting the road rage when that guy cuts you off, forcing yourself to sit down and read this paper, or helping a friend with his advanced math homework, we have all experienced the difficulty of using self-control after we have already been using it. This inability or unwillingness to use self-control after expending it on a prior task is called ego depletion and has been well documented by researchers.

Likewise, most women have experienced similar difficulties using their usual level of self-control in the week preceding their periods (see Gailliot, Hildebrandt, Eckel, & Baumeister). The emotional, cognitive, and behavioral changes that occur in cases of low self-control are similar to those that occur in the premenstrual phase. For example, both have been tied to difficulty regulating emotions, negative affect, and increased stress. Inability to concentrate and perform higher order thinking arise from both. Further, drug use and abuse, aggressive behavior, and crime occur more often in low self-control individuals and in the premenstrual phase versus other phases of the menstrual cycle.

In considering a phase of the menstrual cycle, it is important to understand the hormone fluctuations that denote that particular phase. Estrogen and progesterone rise in the middle of the luteal phase and their decline marks the late luteal phase. The late luteal phase precedes menses, lasts about a week, and is referred to as the premenstrual phase. Although I examine changes in this premenstrual phase when estrogen and progesterone decrease, most research examines these sex hormones when they increase in the midluteal phase. Both estrogen and progesterone have been tied to changes in emotions, cognition, and behavior[1].

Although these hormonal shifts and countless other biological factors undeniably cause

[1] However, the majority of this research has been done with rats and other animals, limiting generalizability of results. I review here only research on the effects of these hormones in humans or in animals in cases of strong generalizability due to particular biological similarities of the animals tested to humans.

and contribute to the phases of the menstrual cycle and their symptoms, a resource allocation model also makes sense of the emotional, cognitive, and behavioral changes of the premenstrual phase. These changes cannot be fully accounted for by hormonal fluctuations, yet have been accounted for in other contexts by low self-control.

In order to supplement and clarify the myriad documented results of and the similarities between low self-control and the premenstrual phase, I experimentally test the hypotheses that the emotional, cognitive, and behavioral changes that occur in women in the premenstrual (or late luteal) phase of the menstrual cycle can result in part from self-regulatory failure. In the sections below, I review how the ramifications of self-control failure—intensified emotionality, cognitive deficits, and impulsive behavior—mirror changes in the premenstrual phase. Manipulating self-control levels with a depleting task, I compare total affect, critical thinking, and aggressive behavior of premenstrual and postmenstrual participants. I find that ego depletion negatively affects cognition and control of aggression; that women have less positive emotionality in the premenstrual phase versus the postmenstrual phase; and that having used prior self-control exaggerates expected differences between women in the premenstrual and postmenstrual phase in all three dependent measures.

Background

Premenstrual Syndrome

In their extreme, notable changes in women's emotions, cognition, and behavior during the premenstrual phase are captured by "premenstrual syndrome" or PMS. A consistently applied clinical definition for PMS has not been established yet. However, PMS can be understood as a grouping of uncomfortable symptoms that occur within the week before menses and subside after menses begins: physical symptoms such as cramping, breast swelling and tenderness;

emotional symptoms such as irritability, nervous tension, and depression; and cognitive symptoms such as confusion (Freemen, 1996; Freemen, 2003). The negative consequences of ego depletion and PMS or changes in the premenstrual phase parallel each other: both have been tied to mood swings[2]; stress[3]; impaired attention or concentration[4]; increased intake of alcohol[5], nicotine and caffeine[6]; increased aggression[7]; and increased criminal acts[8].

The Role of Hormones in Emotions, Cognition, and Behavior

Both estrogen and progesterone effect the emotions, cognition, and behavior of women in different ways throughout life and throughout the menstrual cycle. It is important to note what these sex hormones can and cannot account for. For example, estrogen not only rises and falls within the menstrual cycle of women, but also decreases over time and with menopause, when women stop ovulation and menstruation. Research has shown that the decrease in estrogen that comes with menopause and in postmenopausal women results in the degradation of cognition and positive emotionality (see meta-analyses, Hogervorst et al., 2000). Estrogen functions as a neuroprotective hormone, and hormone therapy with estrogen has had modest effects on verbal memory, attention, and reasoning, and decreases the risk of dementia (Hogervorst et al., 2000). Within the menstrual cycle, estrogen shows similar positive effects.

Estrogen's rises in the midluteal phase has been tied to increased activity in brain regions

[2] Mood Swings: (Baker, Best, Manfredi, Demers, & Wolf, 1995; Bloch, Schmidt, & Rubinow, 1997; Dalton, 1999; George, 2009; Rubinow et al., 1986)

[3] Stress: (Tangney et al., 2004; Beck, Gevirtz, & Mortola, 1990; Deuster, Adera, & South-Paul, 1999; Gallant, Popiel, Hoffman, Chakraborty, & Hamilton, 1992; Schechter, Bachmann, Vaitukaitis, Phillips, & Saperstein, 1989;Schmidt Grover, Hoban, & Rubinow, 1990 Deuster, Adera, & South-Paul, 1999; Epstein et al., 2006; Evans et al., 1998; Mello, Mendelson, & Lex, 1990; Svikis et al., 2006; Tobin et al., 1994 ;Epstein et al., 2006; Chait, 1986; Muraven, Collins, & Neinhaus, 2002)

[4] Concentration: (George, 2009; Zhao et al., 1998; Solis-Ortiz, Guevara, & Corsi-Cabrera, 2004; Schmeichel, 2007).

[5] Alcohol: (Baumeister et al., 1994; Allen, Hatsukami, Christianson, & Nelson, 1996; Carpenter, Upadhyaya, LaRowe, Saladin, & Brady, 2006; Craig, Parrott, & Coomber, 1992; DeBon, Klesges, & Klesges, 1995; Marks et al., 1994; Mello, Mendelson, & Palmieri, 1987; Snively, Ahijevych, Bernhard, &Wewers, 2000; Steinberg & Chereck, 1989)

[6] Caffeine and Nicotine: (Rossignol, 1985; Rossignol & Bonnlander, 1991; Caan et al., 1993; Marks et al., 1994; Pomerleau, Cole, Lumley, Marks, & Pomerleau, 1994; Rossignol & Bonnlander, 1990; Marks et al., 1994)

[7] Aggression: (DeWall, Baumeister, Gailliot, & Maner, 2008; DeWall, Baumeister, Stillman, & Gailliot, 2007; Stucke & Baumeister, 2006; Dougherty, Bjork, Chereck, Moeller, & Huang,, 1997; Ritter, 2003; Hartlage & Arduino, 2002; Woods, Lentz, Mitchell, Shaver, & Heitkemper, 1998;Van Goozen, Frijda, Weigan, Endert, & Van de Poll, 1996; Bond, Critchlow, &Wingrove, 2003; D'Orbán & Dalton, 1980)

[8] Crime: Gottfredson & Hirschi, 1990; Pratt & Cullen, 2000; Wallach & Rubin, 1972; Benedek, 1985; Chait, 1986; Dalton, 1982, 1986; Easteal, 1991; Edwards, 1982, 1988; Meehan & MacRae, 1986; Pahl-Smith, 1985; Spitz, 1987; Brunetti & Taff, 1984; D'Orban, 1983; D'Orban & Dalton, 1980; Ellis & Austin, 1971, as cited in Easteal, 1991)

that deal with the conscious control of affect[9]. The purely cognitive effects of estrogen include improvement in conceptual implicit memory (Maki, Rick, & Rosenbaum, 2002), an increase in blow flow to regions associated with a word-stem-completion and a mental rotation task (Dietrich et al., 2001), a decline in the ability to perform a mental rotation task (Hausmann et al., 2000), and an increase cortical excitability (Smith et al., 1999). Further Estrogen plays a role in relationship-related behavior. When estrogen increases, so does sexual behavior and other behaviors tied to an increase in oxytocin[10] binding, such as maternal behavior, in rats (McCarthy, 1994). Increased estrogen in the midluteal phase also affects automatic responses, such as the startle response[11]. Estrogen's effects seem to be counterbalanced by those of progesterone.

Progesterone also rises in the midluteal phase before it decreases to its lowest point in the late luteal and menstrual phases. Less research has been done on the effects of progesterone on emotions, cognitions, and behavior in humans. However, like estrogen, it has been tied to increased binding of oxytocin, particularly in the ventromedial nucleus, which is responsible for feeding, fear, thermoregulation, and sexual behvatior (Schumacher et al., 1990). Unlike estrogen, progesterone reduces cortical excitability and, perhaps balancing out estrogen's effects, seems to affect behavior as an anti-anxiety drug would (Smith et al., 1999). Also contrasting estrogen's effects, progesterone influences activity of the amygdala, hippocampus, and prefrontal cortex such that it impairs memory for biologically salient stimuli and encoding and retrieval processes (van Wingen et al., 2007). The effects of estrogen and progesterone during the late luteal phase

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[9] Specifically, activation in the anterior cingulate cortex and dorsolateral prefrontal cortex (DLPFC) while inhibiting emotional responses to positive words. The anterior cingulate cortex controls some autonomic processes, such as those regulating blood pressure and heart rate, and cognitive functions such as error detection and monitoring (Bush, Luu, & Posner, 2000), which affects performance on the Stroop task, for example. This brain region also plays a role in reward-based learning (Bush et al., 2002), emotional awareness that has been tied to consciousness (Lane et al., 1998), and processing pain and its collateral affect (Rainville et al., 1997). The prefrontal cortex is considered the home of executive function (Miyake et al., 2000).

[10] Oxytocin is a hormone also associated with sexual behavior, pair-bonding, whether with mate or child, social recognition, and anxiety, and functions similarly in most mammals (Gimpl & Fahrenholz, 2001).

[11] Specifically, increased estrogen is tied to decreases in prepulse inhibition, which is a neurological phenomenon in which the reaction to a strong startling stimulus is inhibited by a weak prestimulus (Swerdlow, Hartman, & Auerbach, 1997). That is, increased estrogen levels are tied to an automatic reaction that would be decreased by the prestimulus if estrogen levels were lower.

largely cancel each other out. Although most research has examined the effects of *increases* in these hormones, we can reasonably predict the opposite effects for when they *decrease,* such as in the premenstrual phase.

Menstruation in women on oral contraceptives results from withdrawal from these hormones. During the premenstrual and menstrual phases created by this controlled hormone withdrawal, these women experience pelvic pain, headaches, bloating or swelling, and breast tenderness (Sulak et al., 2000), often considered symptoms of premenstrual syndrome (Freemen, 1996; Freemen, 2003).

Self-Control, Resource Allocation, and the Late Luteal Phase

Self-control can be understood as the ability to alter one's thoughts, emotions, urges, and impulses and to override habitual behaviors or incipient responses (Baumeister, Muraven, & Tice 2000). Research has shown that repeated demands for self-control lead to a depreciating ability to perform well on cognitive and behavioral tasks requiring further self-control, suggesting that self-regulatory powers come from a limited resource which can be used up or depleted (Baumeister, Bratslavky, Muraven, & Tice, 1998; Muraven, Tice, & Baumeister, 1998; Baumeister et al., 2006, 2007, 2008). The "limited resource model" of self-control proposes that self-control is a limited resource that can be used up. Following extended use of self-control, an individual may be unable to continue implementing self-control on later tasks. Ego depletion refers to this state of diminished self-control "strength." The "strength model" of self-control also proposes that self-control is analogous to a muscle. A muscle requires energy to do work, can be strengthened with exercise, and can become tired when used over extended periods of time. Similarly, acts of self-control require a reservoir of energy; self-control can be improved over time by engaging more often in acts of self-control; and self-control resource can become depleted, thereby reducing further use of self-control on subsequent tasks (Baumeister & Heatherton, 1996; Baumeister, Bratlavsky, Muraven, & Tice, 1998; Baumeister, Vohs, & Tice, 2007; Muraven & Baumeister 200; Vohs & Heatherton, 2000).

Motivation has been found to interact with depletion effects (Muraven & Baumeister, 2000). In a state of ego depletion, an individual may view their reduced and remaining self-regulatory resources as more valuable. Consequently, additional tasks requiring self-control may seem less important, reducing motivation to perform these costly tasks and instead seek easier-to-gain instant gratification (Inzlicht & Schmeichel, 2012). Given a sufficient incentive to perform additional tasks requiring self-control or increasing the valuation of task outcome, individuals can temporarily overcome ego depletion and spend remaining self-regulatory resources (Muraven & Slessareva, 2003, Stewart et al., 2009). In line with this, ego depletion can also be understood through the paradigm of resource allocation. Beedie and Lane (2012) have argued that the brain has sufficient resources for self-control but that ego depletion arises when individuals selectively allocate these resources based on their motivations and priorities. Research has suggested that this is not a deliberative or conscious process but rather done continually and automatically (Muraven & Slessareva, 2003), a biologically based process. I argue that the energy demands of the premenstrual phase confound this allocation process.

Theory

During the late luteal phase, metabolic expenditures of the ovaries increase, energy is subsequently diverted from the brain, and a state similar to ego depletion may result. The metabolic demands of the ovaries increase by about 7-16% during the late luteal phase, with progesterone and estrogen rising about a week before a woman's period (Aschoff & Pohl, 1970; Webb 1981, 1986). Higher-level cognitive processes, overriding impulses, regulating emotions, focusing attention, and thinking critically all require self-control and are metabolically expensive (Fairclough & Houston, 2004; Gailliot et al., 2007; Gailliot & Baumeister, 2007). As they do in a state of ego depletion, emotion-regulation, cognition, and controlling aggressive behavior suffer during the premenstrual phase[12].

Self-Control, the Premenstrual Phase, and Emotion-Regulation

Emotion-regulation, which deteriorates in the premenstrual phase, falls under the umbrella of self-regulation (Baumeister, Heatherton, & Tice, 1994; Tangney et al., 2004). Sudden mood swings, increased negative affect, and depression are characteristic of premenstrual syndrome[13] (American College of Obstetricians and Gynecologists, 2000; American Psychiatric Association, 1994). Self-control also allows people to cope with and reduce stress (Tangney et al., 2004), but during the luteal phase subjective stress and perceived stressors significantly increase[14].

This past research underscores the similar emotional effects of low self-control and the premenstrual phase. If it is the case that low self-control can account for women's inability to regulate negative emotions in the late luteal phase, then we can expect that premenstrual women will feel more negative affect than postmenstrual women and that this difference will be exaggerated in the depletion condition, with depleted premenstrual participants feeling the most negative.

Self-Control, the Premenstrual Phase, and Cognition

Some cognitive processes degrade in the premenstrual phase as well as in the absence of self-control. Issues with emotion regulation in the premenstrual phase can be coupled with concentration issues (George, 2009; Zhao et al., 1998; Solis-Ortiz, Guevara, & Corsi-Cabrera,

[12] See footnotes 1-7

[13] (See American College of Obstetricians and Gynecologists, 2000; American Psychiatric Association, 1994; Hartlage & Arduino, 2002; Limosin, Gorwood, & Ades, 2001; Natale & Albertazzi, 2006; Symonds, Gallagher, Thompson, & Young, 2004), anxiety (e.g., Bailey & Cohen, 1999; Bloch et al., 1997; Evans, Haney, Levin, Folton, & Fischman, 1998; Zhao, Wang, Qu, & Wang, 1998)

[14] (Beck, Gevirtz, & Ortola, 1990; Duester, Adera, & South-Paul, 1999; Gallant, Popiel, Hoffman, Chakraborty, & Hamilton, 1992; Schechter, Bachman, Vaitukaitis, Phillips, & Saperstein, 1989; Fontana & Palfai, 1994)

2004). Research has shown that to effectively concentrate or direct one's attention requires self-control (Schmeichel, 2007). Recognition memory and verbal fluency have been shown to decline in the premenstrual phase (Sayegh et al., 1995; Symonds, Gallagher, Thompson, & Young, 2004). Higher order and more complex tasks, such as logical reasoning, are impaired when an individual is ego depleted (Schmeichel, Vohs, & Baumeister, 2003). Further, the use of heuristics is characteristic of cognition during ego depletion since heuristics serve to free a person from the self-control-expensive processes of higher thinking (Baumeister & Vonasch, 2014).

Research has shown that concentration and problem solving requiring critical thinking demand self-control and that these cognitive tasks also become more difficult during the premenstrual phase. If self-control depletion accounts for the degradation of critical thinking and cognition in women during the premenstrual phase, then we can expect that premenstrual women will perform the critical thinking cognitive task more poorly than postmenstrual women and that this difference will be exaggerated in the depletion condition, with depleted premenstrual participants performing most poorly on the cognition task.

Self-Control, the Premenstrual Phase, and Adverse Behavior

Problematic behaviors, including substance use and abuse, not only arise from impaired self-control but also occur more often in the premenstrual phase than any other phase of the menstrual cycle. Strong evidence suggests that individuals often use self-control to resist consumption of alcohol, nicotine, caffeine, and controlled drugs (Baumeister et al., 1994). In the premenstrual phase, we see decreased self-control when linked to these behaviors: smoking (Snively et al., 2000; Carpenter et al., 2006;Allen et al., 1996; Craig et al., 1992; Steinberg & Chereck, 1989) and symptoms of nicotine withdrawal increase during the luteal phase. Not only does caffeine intake increase during the luteal phase, but it can also be predicted by more severe

PMS symptoms (Rossignol 1985; Rossignol & Bonnlander 1991).

In addition to substance use and abuse, aggressiveness increases in the premenstrual phase. Aggression, an important link between emotion and action, increases during self-regulatory failure as well. Research has shown that people often use self-control to avoid acting aggressively and that they are more aggressive when in a state of ego depletion (Baumeister et al., 2006, 2007, 2008). Premenstrual syndrome comes with increases in aggression, anger, and even violence (Dougherty et al., 1997; Ritter, 2003; Hartlage & Arduino 2002; Woods et al., 1998; Van Goozen et al., 1996; Bond et al. 2003; D'Orban & Dalton, 1980). Further, poor self-control is the leading cause of criminal behavior (Gottfredson & Hirschi, 1990; Pratt & Cullen, 2000). It is not surprising then that a disproportionately large number of criminal acts and arrests of women occur during the luteal phase or are attributed to symptoms of PMS[15].

Adverse behavior, such as substance use and abuse and aggressive actions, increase not only when individuals have low levels of self-control but also when women are in the premenstrual phase of the menstrual cycle. Supposing that increases in aggression during the premenstrual phase arise in women due to low levels of self-control, we can predict that premenstrual women will behave more aggressively than postmenstrual women and that this difference will be exaggerated in the depletion condition, with depleted premenstrual participants behaving most aggressively.

Glucose and Caloric Compensation

That these emotional, cognitive, and behavioral changes during the late luteal phase resemble those during ego depletion suggests a shared biological energy source. Research has shown that symptoms of both premenstrual syndrome and of ego depletion can be alleviated somewhat by

[15] (Wallach & Rubin, 1972; Benedick, 1985; CHair, 1986, Dalton, 1982, 1986; Eastel 1991; Edwards, 1982, 1988; Mechan & MacRae, 1986; Pahl-Smith, 1985; Spitz, 1987; Brunetti & Taff, 1984; D'Orban, 1980, 1983; Ellis & Austin 1971).

intake of glucose (Rossignol & Bonnlander, 1991; Gailliot et al., 2008) and exercise (Steege & Blumenthal, 1993;Prior & Vigna, 1987), which can increase strength of self-control over time (Oaten & Cheng, 2006). Women consume more calories before than after their periods presumably to compensate for the increased metabolic use of energy resources[16]. Women who compensate calorically have fewer signs of PMS (Evans et al., 1998). Drinking a carbohydrate-rich beverage, for example, significantly decreases self-reported depression, anger, confusion, and carbohydrate cravings while also improving memory word recognition in premenstrual women (Sayegh, et al., 1995).

Taken together, these points suggest that ego depletion and changes in the late luteal phase of the menstrual cycle are both based in a biological energy allocation process and may be related. If this is the case, we can expect that women who calorically compensate by eating more than usual will be less ego depleted, feel more positive affect, perform better on cognitive tasks, and will be less aggressive than those who do not calorically compensate, eating as much as usual or less than usual.

Methods

Past research indicates that the emotional, cognitive, and behavioral changes that occur in women in the premenstrual phase of the menstrual cycle can result in part from self-control depletion. I sought to empirically test this hypothesis. Specifically, I tested the multipart hypothesis that premenstrual women will show the more negative affect, more difficulty in cognitive processing, and more aggressive behavior than postmenstrual women; and that women who are both premenstrual and depleted will show the most significant degeneration of positive emotions, cognitive processing, and inhibition of aggressive behavior. I also examined whether

[16] (Allen, Hatsukami, Christianson, & Brown, 2000; Barr, Janelle, & Prior, 1995; Buffenstein, Poppitt, McDevitt, & Prentice, 1995; Christensen & Oei, 1989; Cross, Marley, Miles, & Willson, 2001; Johnson, Corrigan, Lemmon, Bergeron, & Crusco, 1994; Li, Tsang, & Lui, 1999; Verri et al., 1997).

caloric compensation or birth control significantly affect depletion, PMS symptomatology, affect, cognition, and aggression.

Design

The design was 2 (random assignment to depletion condition or control condition) x 2 (random assignment to premenstrual or postmenstrual). Women were tested within a week before their period or within a week after their periods. Participants were randomly assigned to the depletion group or the control group. I used the dual task paradigm characteristic of ego depletion studies in which one task that requires self-control served as the independent variable to deplete participants before they did a second dependent variable task that also required self-control (Baumeister et al., 1998).

Participants

Participants were 34 undergraduate women between the ages of 18 and 25. There were 18 women in the control condition (8 premenstrual, 10 postmenstrual) and 16 in the depletion condition (8 premenstrual, 8 postmenstrual). All participating women had a regular monthly menses and never had been pregnant. Women on birth control were allowed to participate so long as they met the former criteria. Half of the participantes were on birth control.

By flipping a coin, women were randomly assigned to participate in the study during their premenstrual phase or postmenstrual phase. Pretest data about the beginning, end, and length of participants' last periods allowed me to predict their next menses. I predicted their next menses by counting 28 days after the first day of their last menses. Participants were scheduled to come in either within the week before their periods or within the week after their periods depending on their random assignment to the premenstrual phase or postmenstrual phase, respectively. Participants were compensated with one hour of extra credit for their introduction to psychology class.

Procedure

Participants signed up to participate in a study examining the Menstrual Cycle and Cognition on Sona-systems[17], filled out the pretest on their cycles, and were contacted by my research assistants via email to be scheduled. Participants were instructed not to consume caffeine three hours before coming into the lab to remove its confounding effects on ego depletion. Women participated individually in a closed lab room and were told the study examines links between the menstrual cycle, cognition, and emotions. After giving informed consent, participants answered pretest questions, including those on demographics, personality (The Big 5, Ten-Item Personality Inventory-(TIPI); Gosling, Rentfrow, & Swann, 2003), expected PMS Symptomatology (The 17-item Daily Symptom Report; Freeman, DeRubeis, & Rickels, 1996), exercise habits, height, weight, caloric intake, and birth control (see Appendix B).

Participants then performed the Stroop task, the independent variable and ego depletion manipulation (Stroop, 1935). In this task participants were asked to name the color in which a color-word was written, rather than what the word means (e.g. if the word “Red” was written in a green font, selecting *green* and not *red*). Resisting the impulse to read the word and instead to note the color of the letters required self-control. The experimenter directed the participants to respond as quickly and accurately as they could to the words that appeared on a screen.

The experimenter pointed out four keys on the number keypad that were covered in the following letters: R for red, G for green, Y for yellow, and B for blue. In our lab, R was on the 4

[17] Sona-systems is a cloud-based subject pool software for universities. Florida State University researchers can post studies for which students can sign up to participate.

key, G on 5, Y on 1, and B on 2. The experimenter directed the participant to click the key on the number pad that corresponded with the color of the text of the word rather than the color that the word spelled out. Participants in the experimental group responded to 96 incongruent trials of the Stroop task (e.g., the word “Red” never appeared in a red font) while participants in the control group responded to 96 congruent trials of the Stroop task (e.g., the word “Red” always appeared in a red font).

Self-control depletion was assessed with a four-item manipulation check (see Appendix B). The participants were prompted to inform the experimenter when they completed the Stroop task. The experimenter then entered the lab room and set up the white noise blast task (Bushman, 1995; Bushman & Baumeister, 1998; Anderson & Dill, 2000), which served as a dependent measure of aggression. This task required self-control in that participants seek to regulate their emotions, behave in a socially acceptable manner, and focus their attention on reacting quickly.

Participants were told to race an opponent in another room (actually the computer) to click on a visual cue (a box on the screen going from green to yellow to red). Participants were also told that whoever reacts slower will hear a blast of white noise as a punishment. Each participant chose the intensity and duration of this noise blast for each trial, a direct action indicating aggression level. All participants completed 25 trials, of which they automatically won 13 and lost 12. The participants were directed to inform the experimenter of when they had completed this task.

When participants completed the noise blast task, the experimenter entered the lab room, typed the password, and directed the participant to answer the rest of the questions. Participants answered questions from the three-item Cognitive Reflection Test (CRT), a dependent measure of cognition. The CRT tapped into intuitive thinking and heuristics (mental shortcuts) in addition to tapping into cognitive reflection—whether participants reflected on their answers and realized their intuitive answers were not correct—as originally intended (Frederick, 2005; see Appendix B). Participants also answered questions from the 17-item Daily Symptom Report, adapted for a one-time administration in the lab (DSR; Watson, Clark, & Tellegen, 1988; see Appendix B), which served as a dependent measure of PMS symptomatology. This questionnaire tapped into emotional, cognition, behavioral, and physical signs of PMS (Freeman, DeRubeis & Rickels, 1996). Participants then answered questions from the short form Positive and Negative Affect Schedule, the dependent measure of affect (Watson, Clark & Tellegen, 1988; Thompson, 2007; see Appendix B). The participants were then instructed to let the experimenter know when they had finished. The experimenter then entered the lab room, thanked them for their participation, and debriefed them.

Results

Depletion

To test for differences in self-control depletion between groups, I used a two-way analyses of variance (ANOVA). This showed no main effect for condition (control $M=.56$, $SD=1.29$; depletion $M=.25$, $SD= 1.23$; $F(1,30)= .497$, $p=.49$). The main effect of menstrual cycle phase was not significant; however, premenstrual participants ($M=.69$, $SD=1.13$) were more depleted than their postmenstrual counterparts ($M=.17$, $SD=1.34$; $F(1,30)= 2.08$, $p=.16$).

The interaction between condition and phase was significant ($F(1,30)=5.01$, $p<.05$). I used a contrast for further analyses, finding premenstrual participants ($M=1.00$, $SD=.92$) significantly more depleted than postmenstrual participants ($M= -.50$, $SD=1.07$) within the depletion group ($F(1,30)=6.43$, $p<.05$; see Figure 1), but not within the control group (premenstrual $M=.38$, $SD=1.30$; postmenstrual $M=.70$, $SD=1.33$; $F(1,30)=.34$, $p=.57$). Another contrast showed a significant difference between postmenstrual participants within the control condition (M=.70 , SD=1.33) and postmenstrual participants the depletion condition (M= -.50, SD=1.07; $F(1,30)=4.57$, $p<.05$). The difference between the less depleted premenstrual participants within the control condition (M=.38, SD=1.30) and the more depleted premenstrual participants within the depletion condition (M=1.00, SD=.92) was not significant ($F(1,30)=1.12$, $p=.30$).

Although there was no main effect of condition, that phase of the menstrual cycle significantly affected self-control depletion supports my hypothesis. Specifically, this finding is in line with the prediction that premenstrual women have less self-control than women in another phase of the menstrual cycle. Also as predicted, premenstrual women within the depletion condition had the lowest self-control of any group.

PMS Symptomatology

To measure PMS Symptomatology, I asked participants how they *believed* they feel before and after their periods (asked before manipulation) and also how they *currently* feel (asked after manipulation). To test for differences in *actual* PMS symptomatology, I used a two-way analyses of variance (ANOVA) and found no main effect of menstrual phase (premenstrual M=22.31, SD=5.08; postmenstrual M=22.50, SD=4.19; $F(1,30)=.00$, $p=.99$). There was not a significant main effect of condition; however, the control group showed nonsignificantly more signs of PMS (M= 23.56, SD=5.38) than the depletion group (M= 21.13, SD=3.10; $F(1,30)=2.28$, $p=.14$). The interaction between the two was not significant either (control pre M=23.13, SD= 6.29; control post M=23.9, SD=4.86; depletion pre M=21.5, SD=3.78; depletion post M=20.75, SD=2.43; $F(1,30)=.23$, $p=.63$).

Although menstrual phase did not affect Premenstrual Syndrome symptomatology, depleted individuals showed nonsignificantly more symptoms of PMS. This is consistent with the hypothesis that self-control may underlie the emotional, cognitive, and behavioral changes that occur in women in the premenstrual phase.

Repeating the ANOVA, I compared *assumed* (how they *believed* they experience) PMS symptomatology of their current phase (premenstrual or postmenstrual) to *actual* symptomatology of their current phase. An ANOVA showed a main effect for phase on overestimation of state PMS symptomatology ($F(1,30)=13.12$, $p<.001$). Premenstrual participants largely overestimated their PMS symptomatology ($M=13.44$, $SD=7.49$), while postmenstrual participants only marginally overestimated their PMS symptomatology ($M=2.28$, $SD=9.55$; see Figure 2).

There was no main effect for condition ($F(1,30)=.04$, $p=.85$) and no significant interaction ($F(1,30)=.96$, $p=.34$). However, state PMS symptomatology was closer to expected for premenstrual participants within the depletion condition ($M=12.25$, $SD=7.76$) relative to their counterparts in the control condition ($M=14.625$, $SD=7.54$). On the other hand, postmenstrual participants in the depletion condition ($M=4.25$, $SD=6.80$) showed more overestimating than those in the control group ($M=.70$, $SD=11.41$). Further analyses via contrasts showed the difference between premenstrual participants in the control and depletion groups was not significant ($F(1,30)=.29$, $p=.59$), nor was the difference between postmenstrual participants in the control and depletion groups ($F(1,30)=.73$, $p=.40$).

Premenstrual women significantly overestimated their state PMS symptomatology relative to postmenstrual women, who much more accurately predicted their symptoms. Self-control depletion affects state PMS symptomatology in premenstrual women such that they showed more symptoms, getting closer to their predicted PMS symptomatology; whereas, self-control depletion affected postmenstrual women such that they showed less PMS symptomatology. Depletion seemed to exaggerate the presence of symptoms for premenstrual women while exaggerating the absence of symptoms for postmenstrual women.

Affect

To calculate the total affect variable scores, I added up the positive and negative emotions of the PANAS separately, then subtracted the total negative score from the total positive score. Lower scores indicated more negative affect. To compare affect between groups, I used two-way analyses of variance (ANOVA), finding no main effect of condition (control $M=6.5$, $SD=1.03$; depletion $M=6.13$, $SD=1.09$; $F(1,30)=.08$, $p=.70$). Analysis showed a significant main effect of phase at the 90% confidence interval level, with premenstrual women ($M=5.06$, $SD=1.08$) feeling more negative than postmenstrual women ($M=7.61$, $SD=1.03$; $F(1,30)=2.89$, $p=.10$).

The ANOVA revealed a nearly significant interaction between condition and phase ($F(1,30)=2.67$, $p=.11$). Depletion seems to have intensified emotionality, consistent with other findings (Baumeister & Vohs, 2014). Participants within the control group felt equally positive, however depletion exaggerated expected difference of affect in premenstrual and postmenstrual participants. Further analyses via contrasts showed that premenstrual participants felt significantly less positive affect ($M=3.63$, $SD=1.54$) than postmenstrual participants ($M=8.63$, $SD=1.14$) within the depletion group ($F(1,30)=5.28$, $p<.05$; see Figure 3). A contrast did not show a significant difference between the premenstrual participants ($M=6.50$, $SD=1.54$) and postmenstrual participants within the control group ($M=6.60$, $SD=1.38$; $F(1,30)=.00$, $p=.96$). A further contrast showed a difference between the premenstrual participants in the control group ($M=6.50$, $SD=1.54$) and the premenstrual participants in the depletion condition ($M=3.63$, $SD=1.54$), though not significant ($F(1,30)=1.7$, $p=.20$).

These findings support the hypothesis that premenstrual women would feel more negative emotions than postmenstrual women and that premenstrual women in the depletion condition would feel the most negative. Further, self-control depletion exaggerated expected differences between premenstrual women and postmenstrual women and between premenstrual women in the depletion condition relative to those in the control condition, as hypothesized.

Cognition

To compare cognition between groups, I used a two-way analysis of variance (ANOVA) to compare number of questions correct on the Cognitive Reflection Task for each group. This ANOVA showed a difference between conditions on number of questions correct, though not significant ($F(1,30)=2.01$, $p=.17$; see Figure 4). Participants in the control group ($M=.73$, $SD=1.07$) answered more questions than those in the depletion group ($M=.25$, $SD=.78$). There was no main effect of menstrual phase (premenstrual $M= .44$, $SD=.89$; postmenstrual $M=.54$, $SD=1.04$; $F(1,30)=.09$, $p=.77$).

The interaction between condition and phase was not significant ($F(1,30)=.20$, $p=.66$). However, a contrast showed a difference between cognition in control and depleted premenstrual participants, with premenstrual women in the control condition ($M=.75$, $SD=1.17$) cognizing more effectively than those in the depletion condition ($M=.13$, $SD=.35$), though not significant $F(1,30)=1.65$, $p=.21$; see figure 4). Expected differences were again exaggerated by ego depletion. Further contrasts revealed no significant differences between premenstrual participants ($M=.75$, $SD=1.17$) and postmenstrual participants ($M=.70$, $SD=1.06$) within the control group ($F(1,30)=.01$, $p=.91$), nor between premenstrual participants ($M=.13$, $SD=.35$) and postmenstrual participants within the depletion group ($M=.38$, $SD=1.06$; $F(1,30)=.265$, $p=.61$). These results are consistent with the hypothesis that premenstrual women will cognize less effectively than postmenstrual women and that self-control depletion will exaggerate this difference, with depleted premenstrual women cognizing the least effectively.

Aggression

To calculate participants' aggression scores, I multiplied the mean duration and intensity (each out of ten, Dm*Im) of all the noise blast trials. To measure differences between groups in aggression, I used a two-way analysis of variance (ANOVA). This showed a nonsignificant difference in aggression level based on condition ($F(1,30)=1.97$, $p=.17$), with the depletion group ($M=37.45$, $SD=25.10$) acting more aggressively than the control group ($M=26.57$, $SD=17.43$). There was no main effect of phase (premenstrual $M=31.48$, $SD=25.65$; postmenstrual $M=31.93$, $SD=18.97$; $F(1,30).04$, $p=.85$; see Figure 5).

There was no significant interaction between phase and condition ($F(1,30)=.29$, $p=.59$). However, control premenstrual participants ($M=27.91$, $SD=13.29$) were more aggressive than control postmenstrual participants ($M=25.33$,$SD=20.47$). A contrast revealed this was a nonsignificant difference ($F(1,30)=.06$, $p=.80$). Aggression level of both premenstrual and postmenstrual groups increased in the depletion condition relative to their counterparts in the control condition. A contrast showed a nonsignificant difference between aggression in the premenstrual control ($M=27.91$, $SD=13.29$) group and premenstrual depletion group ($M=34.60$, $SD=33.77$; $F(1,30)=.34$, $p=.56$). Another contrast showed a difference between the postmenstrual participants' aggression in the control group ($M=25.23$, $SD=20.47$) and depletion group ($M=40.29$, $SD=13.81$), but this difference was not significant ($F(1,30)=2.07$, $p=.16$; see Figure 5). Depletion again exaggerated expected differences.

Aggression level of postmenstrual women in the depletion group ($M=40.29$, $SD=13.81$) exceeded that of the premenstrual women in the depletion group ($M=34.60$, $SD=33.77$). A contrast shows this difference was not significant (F(1,30)=.265, p=.61). Six of the 34 participants did not adjust their settings above a 1 or 2 beyond the first trial. Of these, no one combination of groups (either pre- or post-menstrual in either control or depletion group) made up the majority.

Although results did not show that premenstrual women were overall more aggressive, they did show that premenstrual women were more aggressive than their postmenstrual counterparts in both the control and depletion conditions, as predicted. Consistent with my hypothesis, premenstrual women in the depletion condition were the most aggressive group.

Caloric Compensation

To measure whether or not participants calorically compensated, each was asked how much she ate the prior day relative to "usual." This was answered on a five-point Likert scale ranging from *much less than usual* to *much more than usual* (see Appendix B). The percentages of the sample who fell within each category is illustrated in Figure 6 (see Appendix A). No women chose *much less than usual.* The only three women who ate *much more than usual* were in their premenstrual phases.

Food compensation did not significantly affect depletion effects, although the group of premenstrual women that ate *much more than usual* was the only group to score a nonpositive mean on a depletion scale from -2 to 2 (M=.00, SD=1.7; see Table 1). To test for whether caloric compensation affected depletion, I used a one-way analysis of variance (ANOVA), which yielded no difference between participants within the different caloric compensation groups on depletion (F(3,30)=.61, p=.61).

An ANOVA yielded no significant difference among different caloric compensation groups in PMS symptomatology (F(3,30)=1.00, p=.41), although those who ate the least 2-*a little* *less than what I usually eat* and those who ate the most 5-*much more than I usually eat* scored highest on the PMS scale (see Appendix A, Table 2 for means). The more an individual ate, the more likely she was to overestimate her state PMS symptomatology; that is, women who ate less than usual showed PMS symptomatology closer to their expected level than did women who ate more than usual. An ANOVA showed differences in how well participants predicted their PMS symptomatology—with higher scores indicating larger overestimation of symptoms and lower scores indicating more accurate predictions—between the participants who ate *(5) much more than usual* (M=18.33, SD=8.08) and those who ate *(2) a little less than what I usually eat* (M=4.44, SD=9.34), *(3) what I usually eat* (M=6.57, SD=9.58), and *(4) a little more than I usually eat* (M=8.62, SD=11.76). However these differences were not significant ($F(13,10)=1.53$, $p=.22$; see Table 3).

Caloric compensation did not have an effect on affect ($F(3,30)=.13$, $p=.94$; see Appendix A for means). Caloric compensation did not affect cognition. An ANOVA showed no significant effect of caloric compensation on number of correct answers on the Cognitive Reflection Test ($F(3,30)=.41$, $p=.75$; see Appendix A, Table 4 for means). Another ANOVA indicated caloric compensation did not affect aggression ($F(3,30)=.16$, $p=.92$; see Appendix A, Table 5 for means).

Respective findings do not support the hypotheses that women who calorically compensate will be less depleted, show fewer signs of PMS symptomatology, feel more positive affect, cognize more effectively, and be less aggressive than their non-compensating counterparts. However, I did find that the only women to eat *much more than usual* are in their premenstrual phases. This is consistent with extant findings that show women are more likely to eat more in the late luteal phase (Evans et al., 1998). Further, these women who ate *much more* *than usual* overestimated their state PMS symptomatology much more than women who ate the usual or less than usual.

Birth Control

To test whether birth control affected any of the dependent variables of interest, I used a one-way analyses of variance (ANOVA) for each. No significant differences existed between the group of participants on birth control and the group of participants not on birth control on measures of depletion, PMS symptomatology, affect, cognition, or aggression. There was no significant effect of birth control on depletion effects (non-BC M=.47, SD=1.23; BC M=.35, SD=1.32; F(1,32)=.07, p=.79). Likewise, an ANOVA showed no significant effect of birth control on affect (non-BC M=6.94, SD=1.10; BC M=5.77, SD=1.10; F(1,32)=.57, p=.45). Birth control had no effect on state PMS symptomatology (non-BC M=21.59, SD=1.10; BC M=23.24, SD=1.10; F(1,32)=1.11, p=.30) nor on how well a participant could predict their state PMS symptomatology (non-BC M=6.00, SD=2.49; BC M=9.059, SD=2.49; F(1,32)=.75, p=.39). Cognition was not affected by birth control (non-BC M=.35, SD=.23; BC M=.65, SD=.23; F(1,32)=.79, p=.38), and birth control did not affect aggression (non-BC M=29.94, SD=5.54; BC M=33.40, SD=5.38 F(1,32)=.20, p=.66).

These findings support the hypothesis that birth control would not affect depletion, PMS symptomatology, affect, cognition, or aggression. The hormone fluctuations within women on birth control differ from hormone fluctuations of women not on birth control. This difference did not affect any dependent measures. This supports the hypothesis that self-control depletion can at least somewhat account for differences in these measures between women in the late luteal phase and in another phase of the menstrual cycle since hormones do not fully account for them.

Discussion

This study tested whether the emotional, cognitive, and behavioral changes of the premenstrual phase can occur because of limited or alternatively-allocated self-control resources, as in ego depletion. I hypothesized that premenstrual women would show less positive emotionality, less effective cognition, and more aggression than postmenstrual women; and that women who are both premenstrual and in the ego depletion condition would show the most significant decline in positive emotions, in cognitive processing, and in inhibiting aggressive behavior. I also examined whether caloric compensation or birth control significantly affect depletion, PMS symptomatology, affect, cognition, and aggression.

Consistent with my hypothesis, I found that premenstrual participants were more depleted than postmenstrual participants ($F(1,30)= 2.08$, $p=.16$) and that using self-control on a prior task (such as in the Stroop task) accentuates this difference ($F(1,30)=5.01$, $p<.05$). Although I failed to find differences between groups in state PMS symptomatology, I found that women in the premenstrual phase *believed* their symptoms were largely worse than they *actually* were ($F(1,30)=13.12$, $p<.001$). Postmenstrual participants overestimated their PMS symptoms also, but not by as much. However, depletion somewhat closed this gap: premenstrual women's PMS symptomatology was closer to what they expected, while postmenstrual women's PMS symptomatology was much less than what they expected. Perhaps premenstrual women's *actual* presence of PMS symptoms was made more salient by ego depletion, while postmenstrual women's *actual* absence of these symptoms was made more salient. This fits with the recent research suggesting that ego depletion intensifies subjective feelings (Baumeister & Vohs, 2014). Parallelling this, I found that premenstrual women felt nearly significantly less positive emotion than postmenstrual women ($F(1,30)=2.89$, $p=.10$) and that using self-control on a prior task greatly exaggerated this difference ($F(1,30)=2.67$, $p=.11$). These findings are consistent with extant research and my hypothesis.

Although there was no significant difference between premenstrual and postmenstrual participants on the measure of cognitive function, there was a closer to significant difference based on condition ($F(1,30)=2.01$, $p=.17$). Control participants correctly answered more Cognitive Reflection Test questions than did depleted participants, consistent with other research on self-control and cognition (Schmeichel, Vohs, & Baumeister, 2003; Baumeister & Vonasch, 2014). Again, depletion effects exaggerated expected differences: premenstrual participants in the control condition answered more questions correct than did their counterparts in the depletion condition ($F(1,30)=1.65$, $p=.21$).

Consistent with research showing that people often use self-control to avoid acting aggressively and that they are more aggressive when in a state of ego depletion (Baumeister et al., 2006, 2007, 2008), I found that depleted individuals were more aggressive than individuals in the control condition ($F(1,30)=1.97$, $p=.17$). Although not a significant difference, premenstrual participants were more aggressive than postmenstrual participants. Both premenstrual and postmenstrual groups within the depletion condition were more aggressive than their control counterparts, with the difference between premenstrual participants in each group closer to significance ($F(1,30)=2.07$, $p=.16$). This is consistent with findings linking self-regulation and the premenstrual phase to aggressiveness (Dougherty et al., 1997; Ritter, 2003; Hartlage & Arduino 2002; Woods et al., 1998; Van Goozen et al., 1996; Bond et al. 2003; D'Orban & Dalton, 1980).

Caloric compensation did not significantly affect depletion, PMS symptomatology, affect, cognition, or aggression. However, the only participants to calorically compensate the most were all premenstrual and those who compensated by eating more than usual showed fewer signs of PMS relative to their own expectations than did those who ate the usual or less ($F(13,10)=1.53$, $p=.22$). Birth control had no effect on measures of depletion, PMS symptomatology, affect, cognition, or aggression.

These findings are consistent with the multitude of support for the limited resource model of self-control. Current research links the premenstrual phase and self-control in that findings are consistent with the hypothesis that depletion of self-control accentuates the negative affect, difficulty performing higher level thinking, and aggression that increase in women during the premenstrual phase. However, this research and its implications are limited by the small number of participants. Findings in this study consistently indicate that self-control depletion exaggerates expected differences between premenstrual participants and postmenstrual participants and between premenstrual participants and their counterparts who have not used up self-control. This is the case for differences in measures of PMS symptomatology overestimation, affect, cognition, and aggression. However, these differences are not significant, yet none exceed a p-value of .22. Further research should and will be done on this topic to overcome this sample size limitation. In addition to a larger sample size, research incorporating hormone level tests, more measures of discrete types of cognition, and brain scanning technology may shed more light on which particular cognitive changes hormones and self-control failure can and cannot account for.

Conclusion

In sum, current findings are consistent with the hypothesis that emotional state, critical thinking, and aggression are different in women during the premenstrual phase versus the postmenstrual phase and that these changes are exaggerated by self-control depletion. These findings and extant research on premenstrual changes and ego depletion do not suggest that women are completely unable to function at a level that allows for normal productivity, but rather points to the importance of awareness of these changes and of what can alleviate them. For example, when self-control had been used up, women showed PMS symptomatology closer to expected than women who had not used their self-control. This suggests that having a larger reservoir of self-control allows women to combat the symptoms of PMS that they expect to have.

Perhaps it may be optimal for women to not exhaust their self-control with many more tasks and to do lists than usual during the late luteal phase. That is, right before a woman's period, she should not start dieting. Similarly, I found that women who calorically compensated during the premenstrual phase showed the fewest symptoms of PMS relative to what they expected compared with women who did not eat *much more than usual*. This research combines with extant research to suggest that women can somewhat stave off symptoms of PMS by eating more and giving their bodies the energy they need. By understanding the interplay among self-control, metabolic resources, and the physiology of the menstrual cycle, it may be possible to curtail the negative effects of physiological changes in the premenstrual phase.

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Appendix A: Tables and Figures

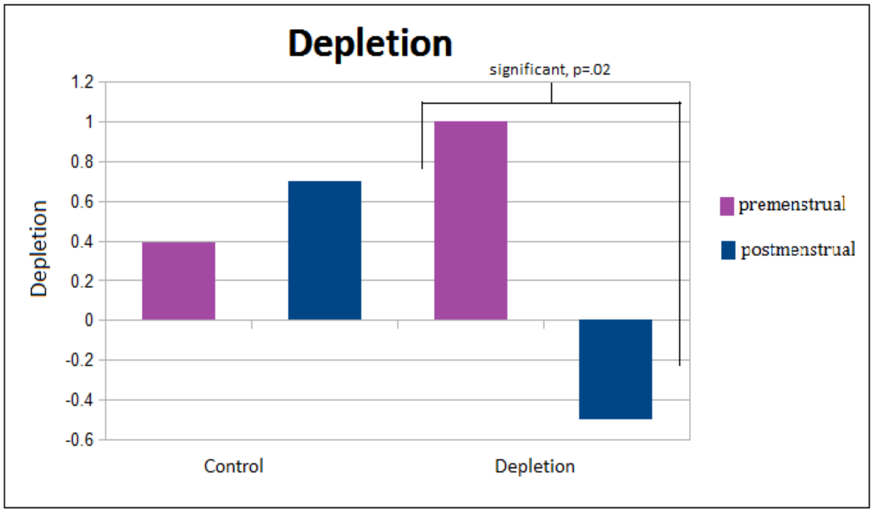


Figure 1. This chart illustrates the near-significant difference between premenstrual and postmenstrual groups in level of depletion (p=.16) and highlights the significant difference between these groups within the depletion condition (p=.02).

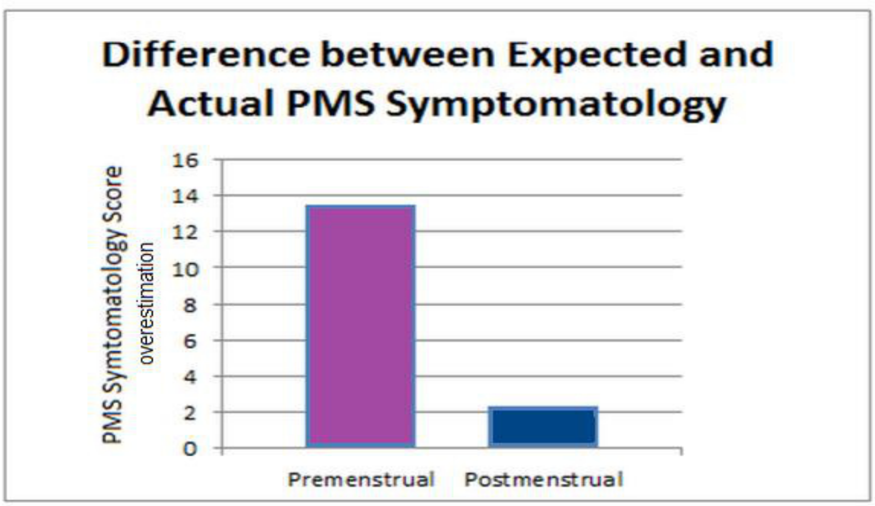


Figure 2. This figure illustrates how women in the premenstrual phase expected their PMS symptoms to be much worse than they actually were, while postmenstrual women very closely estimated their PMS symptomatology, (p=.00).

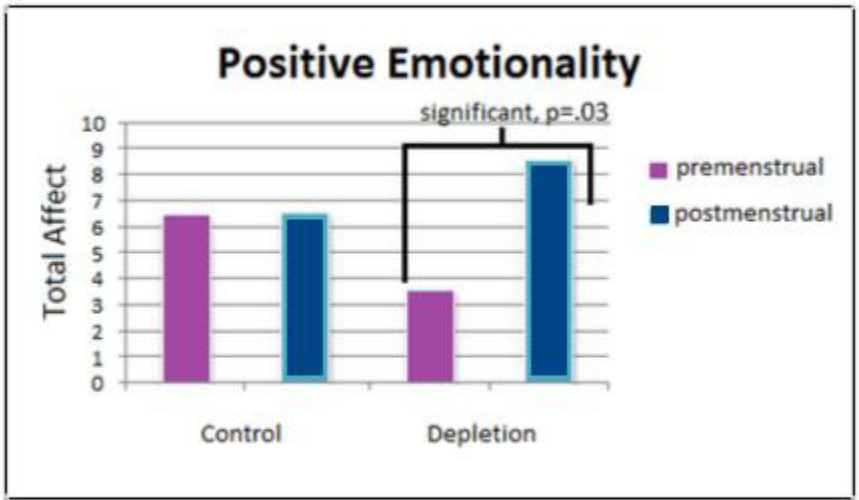


Figure 3. This chart shows the significant main effect of phase (p=.10), with premenstrual participants feeling significantly less positive than postmenstrual participants. This chart also highlights the signifcant difference between premenstrual and postmenstrual participants within the depletion group (p=.03), within the interaction(p=.11). Depletion exagerates expected results.

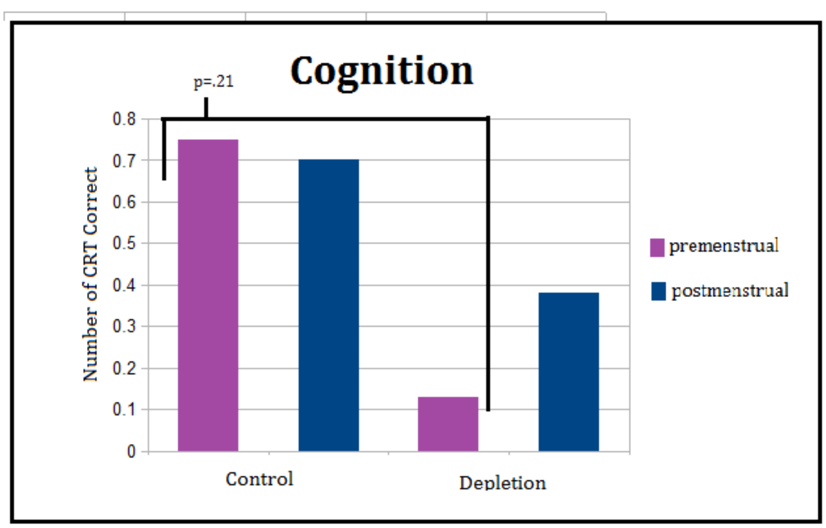


Figure 4. This chart shows the near significant difference between control and depletion groups in mean number of Cognitive Reflection Test questions answered correctly (p=.17) The near significant difference between premenstrual women in the control condition and in the depletion condition is highlighted.

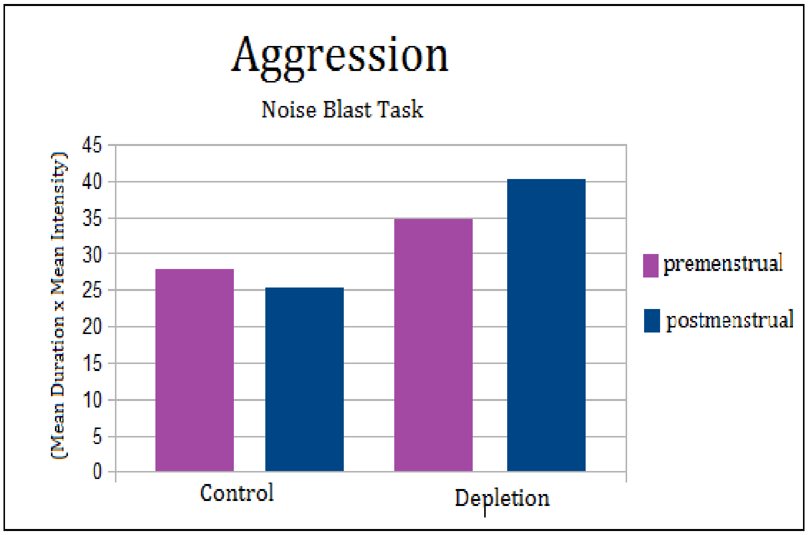


Figure 5. This figure shows that depleted participants were near-significantly more aggressive than control participants (p=.17). Postmenstrual participants in depletion group were near-significantly more aggressive than their control counterparts (p=.16).

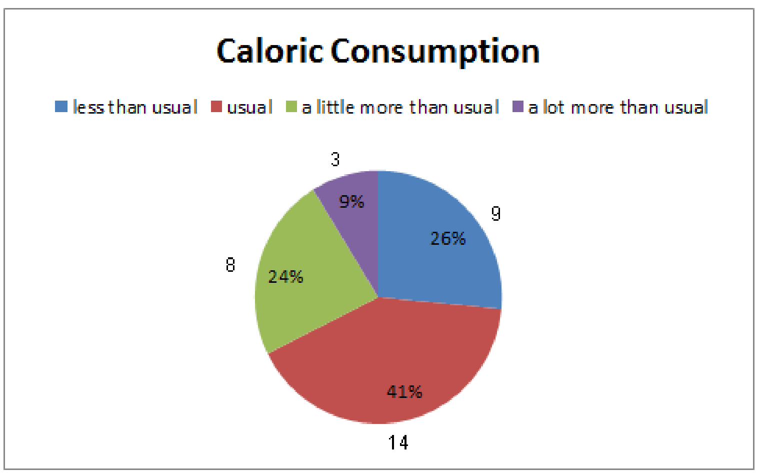


Figure 6. This figure shows the percentage of participants that self-reported their caloric compensation for each level.

Table 1

Caloric Compensation's Effect on Affect

Compensation	Mean	SD
2	7.00	5.24
3	6.42	3.77
4	5.63	5.53
5	6.00	4.58

Note. No significant differences.

Table 2
Caloric Compensation's Effect on PMS Symptomatology

Compensation	Mean	SD
2	24.22	5.97
3	21.00	2.74
4	22.38	4.98
5	23.67	5.77

Note. No significant differences.

Table 3
Caloric Compensation's Effect on Overestimation of PMS Symptomatology

Compensation	Mean	SD
2	4.44	9.34
3	6.57	9.58
4	8.62	11.75
5	18.33	8.08

Note. Women who ate *much more than usual (5)* overestimated their state PMS symptomatology much more than women who ate the usual or less than usual, p=.22.

Table 4
Caloric Compensation's Effect on Cognition

Compensation	Mean	SD
2	.33	.71
3	.52	.93
4	.38	1.06
5	1	1.73

Note. No significant differences.

Table 5
Caloric Compensation Effect on Aggression

Compensation	Mean	SD
2	27.74	21.71
3	33.57	23.87
4	30.65	15.69
5	36.57	36.33

Note. No significant differences.

Appendix B: Variables of Interest

Depletion Manipulation Check
Mark the following that apply to you:

_____ 1. I feel mentally depleted today.
_____ 2. I feel energized today.
_____ 3. I feel tired today.
_____ 4. I got plenty of good-quality sleep last night.

17-item Daily Symptom Report (DSR) adapted for a one-time administration in the lab:

Please rate your experience of the following in the last couple days, including today, based on the following scale:
0- not present at all;
1-minimal, only slightly apparent to you
2-moderate, aware of symptom but does not affect daily routine
3-a lot, continuously bothered by symptom and/or symptom interferes with daily activity
4-severe, symptom is overwhelming and/or unable to carry out daily activity

1. Irritability
2. Mood swing
3. Nervous tension
4. Anxiety
5. Depression
6. Feeling out of control
7. Poor coordination
8. Confusion
9. Insomnia,
10. Crying
11. Fatigue
12. Food cravings
13. Breast tenderness,
14. Swelling
15. Cramps
16. Aches
17. Headache

Positive and Negative Affect Schedule in short form (Watson, Clark, Tellegen, 1988; Thompson, E.R., 2007)

Original directions: Thinking about your usual self, using the following scale, to what extent do you generally feel:
1-Never
2-Rarely
3-Sometimes
4-Often
5-Always

Adapted directions: Indicate to what extent do you feel this way right now.
1- Very slightly or not at all
2- A little
3- Moderately
4- Quite a bit
5- Extremely

1. Upset
2. Hostile
3. Alert
4. Ashamed
5. Inspired
6. Nervous
7. Determined
8. Attentive
9. Afraid
10. Active

Cognitive Reflection Test (Frederick, 2005)
These three questions tap into intuitive and heuristical thinking (using mental shortcuts) and also

its opposite critical thinking.

Please answer the following questions:

A bat and a ball together cost 110 cents. The bat costs 100 cents more than the ball. How much does the ball cost? (impulsive answer: 10 cents; correct answer: 5 cents).

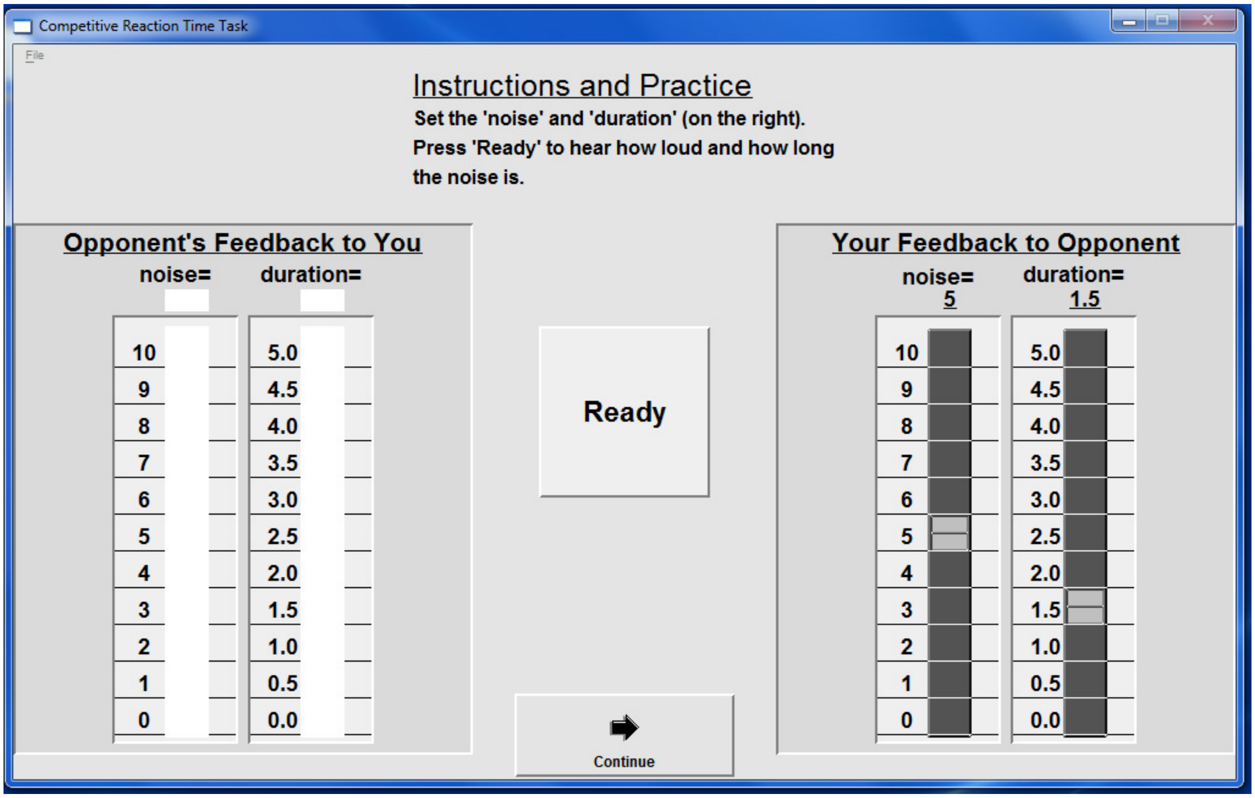
If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? (impulsive answer: 100 min; correct answer: 5 min).

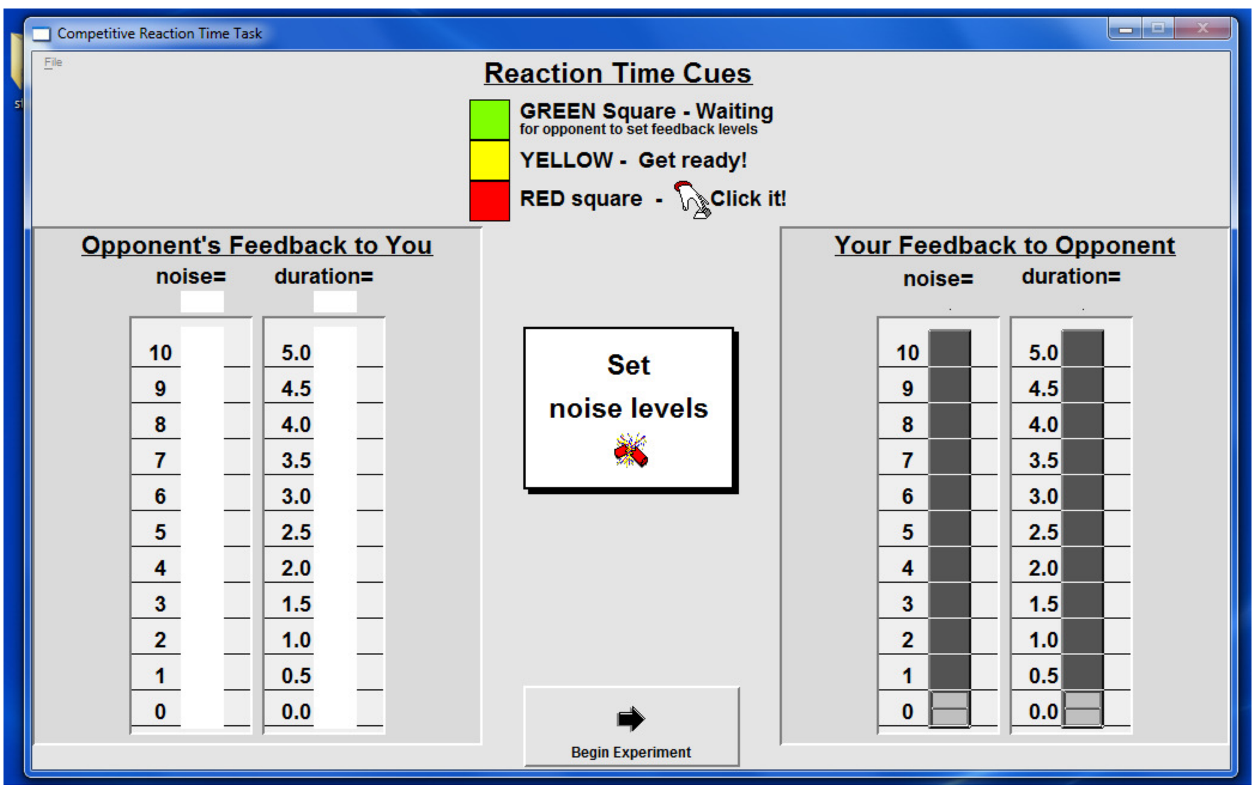
In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? (impulsive answer: 24 days; correct answer: 47 days).

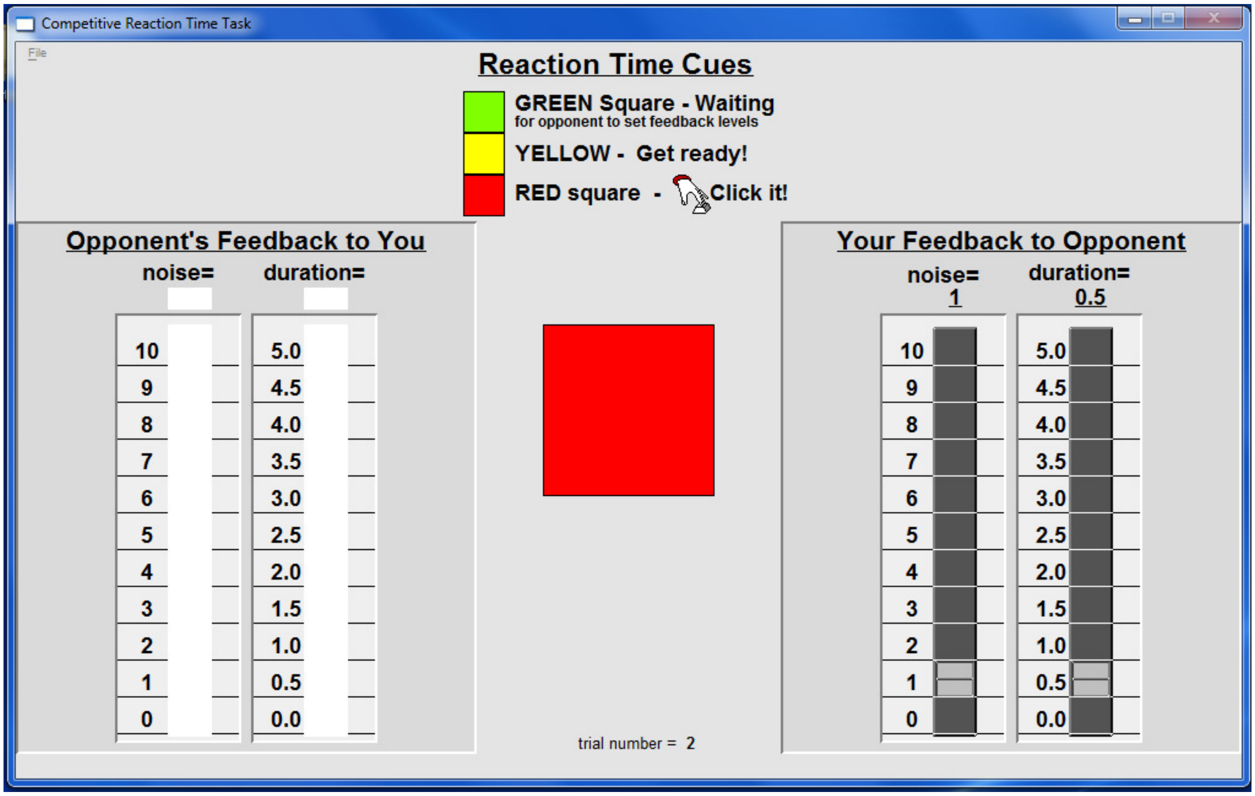
Caloric Compensation

Please rate the description of yesterday's meals, snacks, drinks, etc on the following scale:
1-Much less than I usually eat
2-A little less than I usually eat
3-What I usually eat
4-A little more than I usually eat
5-Much more than I usually eat

Noise Blast Task






Competitive Reaction Time Task
File
Reaction Time Cues
GREEN Square - Waiting
for opponent to set feedback levels
YELLOW - Get ready!
RED square - Click it!
Opponent's Feedback to You
noise=
duration=
10 9 8 7 6 5 4 3 2 1 0
5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
Your Feedback to Opponent
noise=
1
duration=
0.5
10 9 8 7 6 5 4 3 2 1 0
5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
trial number = 2