THE ROLE OF TESTOSTERONE AND ESTRADIOL IN WOMEN'S PREFERENCES AND MATING STRATEGIES ACROSS THE MENSTRUAL CYCLE: A HORMONAL PERSPECTIVE

A Dissertation

by

JENNIE YING-CHEN CHEN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2011

Major Subject: Psychology

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ABSTRACT

The Role of Testosterone and Estradiol in Women's Preferences and Mating Strategies across the Menstrual Cycle: A Hormonal Perspective. (December 2011)

Jennie Ying-Chen Chen, B.A., The University of Texas; M.S., Texas A&M University

Chair of Advisory Committee: Dr. William S. Rholes

This dissertation project investigated fluctuations in estradiol and testosterone across the human menstrual cycle. During the part of the cycle when women are most fertile, women show stronger preferences for men with more masculine faces, and these preference changes may be related to changes in hormone levels during ovulation. The present study investigated preferences changes among women for higher testosterone men over the menstrual cycle as estradiol and testosterone in those women fluctuated. 32 women participated in this 5-week long study tracking their estradiol and testosterone levels and preferences for masculine men. Women with higher levels of estradiol preferred men who had higher levels of testosterone than women who had lower levels of estradiol. During ovulation, women were more like to find high testosterone men more attractive than other parts of the menstrual cycle. In addition to ratings of men, several other psychological tests were administered and examined for changes as a function of state and trait levels of hormones.

DEDICATION

This dissertation is dedicated to my late mentor, Dr. Devendra Singh. Thank you for exposing me to research, encouraging me to pursue my other interests, bringing me into his family, feeding me fantastic Indian food, and for teaching me about what is important in life. I hope to pass on the tradition and passion for figs, the ultimate super food.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Rholes, and my committee members, Dr. Simpson, Dr. Alexander, and Dr. Alvard, for their guidance and support throughout the course of this research. I would also like to thank Dr. Devendra Singh and Dr. Ludy Benjamin for their constant support and encouragement.

Thanks also go to my friends and colleagues and the department faculty and staff for making my time at Texas A&M University a great learning experience. I would also like to extend my gratitude to Dr. Marisol Perez sharing her laboratory space and time, and I would like to thank Dr. Stephen Balfour for his incredible support and mentorship in teaching. I would also like to thank my undergraduate research assistants for their dedication and work in collecting the data.

Finally, thanks to parents and siblings for seeing me through my graduate career. And lastly, thanks to my communities, mentors, canine sports partners, and significant other for providing support and encouragement.

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1. INTRODUCTION

The field of evolutionary psychology supports many of the same concepts as biological evolution (Buss, 1995). Humans are an evolved species that has developed adaptations to solve challenges to our survival and reproduction. In addition to biological adaptations that have enabled us to survive and reproduce, scientists have also proposed that humans have mental mechanisms that have also evolved to assist in survival and reproduction (Buss, 1995). These mental mechanisms are holdovers from past challenges and currently affect our preferences, behaviors, and emotions (Buss, 1995).

While these current social and cultural situations contribute to a substantial portion of the variance in current behaviors, instinct and innate preferences also play a role in human behavior (Buss, 1999). One multifaceted area of research in social psychology and evolutionary psychology are romantic and sexual relationships. From attraction to commitment to dissolution of relationship bonds, the science of relationships has been has garnered much attention in evolutionary psychology. One of the key questions addressed in this field concerns mate selection - what personal qualities and what circumstances affect the perception of an individual as a good mate.

Physical attractiveness is a much desired mate attribute for both men and women. Characteristics that are attractive in women are feminine facial features, large eyes, high

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cheekbones, low waist to hip ratio, youth, and smooth skin (Symons, 1995).

Characteristics that are attractive in men are angular jaws, broad eyebrows, symmetrical features, and waist to hip ratio of 0.90 (Singh, 1995). Attractiveness characteristics are not only different between the sexes, but they are also different when seeking a long-term or short-term relationships (Buss, 1999; Li & Kenrick, 2006). According to evolutionary theory, the rules of attraction and mating are not arbitrary; rather they follow from complex and functional procedures (Singh, 1995; Symons, 1995, Johnston, Hagel, Franklin, Fink, & Grammer, 2001). Humans find certain physical traits attractive because attractiveness is theorized to be a signal to mate value (Singh, 1995; Johnston et al., 2001).

Symmetry in many species including humans is a variable that plays a role in physical attractiveness (Frederick & Gallup, 2007). Symmetry refers to how physically aligned bilateral features are set (Gangestad & Thornhill, 1998). Symmetry is thought to be a signal to allostatic load or otherwise referred to as developmental stability (Thornhill & Gangestad, 1993). Allostatic load is the physiological consequences of chronic stress and a chronic activation of the stress system. Allostatic load is often referred to as the cumulative effect of wear and tear on an organism due to stress. (Frederick & Gallup, 2007; Thornhill & Gangestad, 1993). It is conceptualized that the higher the allostatic load a person endures, the lower developmental stability the person has and the less stress a person can endure.

Fluctuating asymmetry (FA) is defined as deviations from symmetry that is a marker of developmental stability (Thornhill & Gangestad, 2006). Fluctuating

asymmetry has been theorized to be an indicator of allostatic load (Thornhill & Gangestad, 1993). Theoretically, lower levels of allostatic load or stresses (i.e., due to illness, disease, etc) during development should be associated with the development of more symmetrical features (Thornhill & Gangestad, 1993). Higher allostatic load or other problems during development should lead to less symmetrical development of the body, resulting in a less physically attractive individual. This is a phenotypic marker of genotypic quality as individuals who had lower FA had better coping systems to environmental stress. In natural environments, males of many species with more symmetrical features have higher reproductive success as measured by the number of offspring. (Koshi et al., 2007; Gallup, Frederick, & Pipitone, 2008). Developmental stability is desirable as it shows that the individual can withstand harsh environmental stress.

These effects have also been found in humans. Men who have more symmetrical features are judged to smell better to women and have been reported to give more and better orgasms (Thornhill & Gangestad, 1999). More symmetrical men are judged to be more attractive as short term mates (Thornhill & Gangestad, 1993, 1999; Fink, Neave, Manning, & Grammer, 2006). During ovulation, women tend to prefer the scent of men who are more symmetrical (Penton-Voak et al, 1999). There has also been some evidence that symmetrical features have been related to health outcomes (Milnea et al., 2003; Al-Elisa, Egan, & Wassersug, 2004).

Secondary sex characteristics in both men and women are characteristics that are attractive to the opposite sex (Symons, 1995; Singh, 1995). Secondary sex

characteristics are thought to be a marker of hormone profile that is linked to viability in men and in women. In men, these characteristics are strong angular jaws, broad eyebrows, and a less curvaceous body type (Symons, 1995). Secondary sex characteristics have been thought to be an honest signal as they might actually advertise hormone profile. Men who are more masculine actually do have higher levels of testosterone (Penton-Voak & Chen, 2004), and they do behave in such a fashion that reflects the higher testosterone levels (Book, Starzyk, & Quinsey, 2001; Boothroyd, Jones, Burt, DeBruine, & Perrett, 2008).

In women, secondary sex characteristics are low waist to hip ratio, higher cheekbones, fuller lips, and softer jaw lines. These characteristic have been hypothesized to be a product of estrogen, however, there have been no empirical studies to support the relation between secondary facial characteristics and hormones in women (Boothroyd, Jones, Burt, & Perrett, 2007).

The traits in women that men find attractive center around markers of fertility and behavioral characteristics that may be indicative of sexual exclusivity (Buss & Schmitt, 1993). Traits such as youth and low waist to hip ratio in women are attractive as they are markers of fertile hormone profile and fertility (Singh, 1995, 2004). For men to be drawn to characteristics in women that signal fertility (Singh, 1995, 2004; Buss, 1999) is an advantageous preference as it increases the chances of inseminating a fertile female.

Behavioral cues to sexual exclusivity are also important for long-term mate selection. Such cues include the appearance of sexual exclusivity to one's partner and

fidelity. Without attention to such cues men may be investing too many resources and too much time and effort pursuing females who would engage in extra-pair copulations with other men (Buss & Schmitt, 1993; Shackelford & Goetz, 2007). This concept of possibly caring for someone else's child is called "paternity uncertainty" (Buss, Larsen, Westen, & Semmelroth, 1992). Males, without the advances of genetic testing, can never be certain that their offspring are genetically theirs. An error on the male's investment may result in him providing for another man's child for many years while his own fitness is compromised (Alcock, 1993).

For the majority of men, physical attractiveness among women is rated as one of the most important characteristics in both long-term and short-term relationships (Li & Kenrick, 2006; Buunk, Dijkstra, Fechenhauer, & Kenrick, 2002). This supports the idea that the ultimate goal in both long-term and short-term mating in males is to ensure the survival of their genes (Buss & Schmitt, 1993; Daly & Wilson, 1988; Freeman, 1993). Using a long-term strategy is geared more towards high investment into ensuring survival and success of the offspring while short-term strategy focuses on the improving the quantity of offspring produced.

However, these male preferences for are not generalizable to women. The qualities that women look for in their mates are not based so much on proxies to fertility and physical appearance, but more genetic quality, resources, and behavioral traits (Li & Kenrick, 2006). Women typically look for men with good financial prospects, social status, ambition, love and commitment cues, positive interactions with children, dependability, stability, kindness, with physical attractiveness being preferred (Daly &

Wilson, 1988). Evolutionarily, these traits with the exception of physical attractiveness are cues to a man's ability and willingness to invest in his children (Buss, 1999). Women are drawn to these cues because it may be a critical mistake to bear children with men who do not have these traits. Men without good financial resources will not be able to provide for his young. Men who do not display love and commitment cues will be less likely to invest time and energy into his children (Van anders, Hamilton, & Watson, 2007).

Due to evolutionary pressures, women developed different sets of preferences in desired mates. Challenges that women faced included securing resources and food, obtaining the superior genes from a superior mate, securing protection for herself and her offspring, finding a suitable long-term mate, and caring for her young. Since these challenges were multifaceted, it would be plausible that women might seek these needs from different types of men.

The evolutionary literature (Penton-Voak & Chen, 2004) indicates that men who show high parental investment in children and men who produce genetically viable offspring are often not the same. Genetic viability is theorized to be associated with masculine appearance and traits and negatively associated with parental investment (Gangestad & Cousins, 2001). It is conceptualized that attractiveness in men for short-term relationships is tied to the genetic benefits of that man. From the perspective of strategic pluralism women should prefer to have long-term relationships with high parental investors and short-term relationships with more masculine appearing men (with masculinity being a signal of genetic quality). In order to be productive, short-

term mating should ideally take place when the probability of conception is greatest, and it appears that nature may have provided women with behavioral and emotional tendencies that would facilitate such behavior.

In evolutionary psychology, many of the changes studied in women's behaviors and preferences occur during the ovulation period (Haselton & Gangestad, 2006; Johnston, Hagel, Franklin, Fink, & Grammer, 2001; Johnston & Franklin, 1993; Pillsworth & Haselton, 2006). This is because during the high risk periods of ovulation, men should concentrate more on mating efforts during this time, and women should be more discerning on partner's mate quality (Gangestad & Simpson, 2000).

The body of research examining women's behavioral changes throughout the menstrual cycle has been fast growing. Much of the first research addressed women's increase in sexual signaling (Grammer, 1996). It was first shown that during ovulation, women engaged more in behaviors that were more sexually attractive to men, with the idea that it would facilitate reproduction by encouraging sexual behavior during high risk of conception periods of time (Grammer, 1996).

Early studies focused on women's sexual behavior during ovulation, mostly on sexual interest (Alexander & Sherwin, 1993). Diary studies have shown that females tend to report more sexual interest and think about sex (including more interest in erotic literature and masturbation) during ovulatory phases of the menstrual cycle (Alexander & Sherwin, 1993; Schreiner-Engel, 1981; Stanislaw & Rice, 1988; Zillmann, 1995; Slob et al. 1996).

Stanislaw and Rice (1998), for instance, found that sexual desire fluctuates during the menstrual cycle. Stainslaw and Rice found that women reported greater sexual desire during ovulation than when not ovulating. This effect has been replicated (Alexander & Sherwin, 1993; Schreiner-Engel, 1981; Zillmann, 1995; Slob et al. 1996) and supports the idea that humans have evolved mental mechanisms that helped facilitate successful mating and conception, much like other mammalian species. Even though humans do engage in sexual behavior across the menstrual cycle, humans are also designed with mechanisms that may encourage sex behavior even more during periods of high risk fertility. In a study by Brown, Calibuso, and Roedl (2011) found that women, even those who were not currently sexually active, experienced increased libido just prior to ovulation.

The early psychologically focused studies began to examine women's preference changes across the menstrual cycle as opposed to sex drive and sex behavior only. Many of the early studies utilized computer generated stimuli that differed in masculinity and femininity (Johnston & Franklin, 1993). Women are more likely to find masculine men more attractive during ovulation (Johnston et al, 2001; Penton-Voak et al., 1999). Johnston and Franklin (1993), for example, utilized a technique that involves masculinizing or feminizing photographs of faces. Participants were shown computer composite facial images that metamorphized from being highly masculine to highly feminine. Using this technique, the attractiveness and symmetry of each face remained the same, thus controlling for most other facial attractiveness factors. Women indicated which faces were more attractive, both when they were ovulating and when they were

not ovulating. The results revealed that women preferred more masculine men, but only during ovulation.

Penton-Voak et al. (1999) asked women to rate men's attractiveness as both short-term and long-term partners. They found that ovulation had a significant effect on the types of men that women found most attractive. Ovulating women preferred masculine men as short-term partners, but ovulation had no effect on preferences for long-term partners.

Other research has shown that masculine appearing men also tend to be less investing in relationships, less faithful as relationship partners, and more aggressive (Thornhill & Gangestad, 1999). Such men are not typically preferred as long-term relationship partners due to these negative traits and behaviors. However, women tend to prefer more masculine men during ovulation, particularly as short-term mates (Penton-Voak et al., 1999). These findings also support the notion that women may prefer different types of men at different points of the menstrual cycle and that different men may serve different reproductive functions for women (Gangestad & Simpson, 2000).

Baker and Bellis (1995) found that women are more likely to engage in extra-pair copulations (EPCs) during ovulation. This phenomenon does not imply that all women tend to engage in extra-pair copulations during ovulation. However, it does imply that if women engage in EPCs, they should be more likely to do so during ovulation than at other times of the menstrual cycle. Because of the negative consequences that may

accompany extra-pair copulations, there may be a functional reason why women engage in EPCs during high risk-of- pregnancy periods.

Overall, the research shoes that women tend to favor a certain set of male characteristics during ovulation as opposed to non-ovulatory phases of the menstrual cycle such as more masculine facial features (Johnston, Hagel, Franklin, Fink, & Grammer, 2001; Penton-Voak & Perret, 2001), men with lower levels of fluctuating asymmetry (Gangestad & Thornhill, 1998, Rikowski & Grammer, 1999), masculine behavior in men (Gangestad, Garver-Apgar, Simpson, & Cousins, 2007), and creative men (Haselton & Miller, 2006). Puts (2005) found that ovulating women preferred lower vocal pitch in males to be more attractive as short-term mates. The lower pitch is theorized to be a marker of higher testosterone levels.

Morrison, Clark, Grawleski, Campbell, and Penton-Voak (2010) found that women's probability of conception was associated with perceived attractiveness of videos of flirtatious men. They found that the higher the risk of conception, the women found flirtatious men in videos to be more attractive. Not only do women's sexual and preferences change across the menstrual cycle, their sexual signaling and mate acquisition tactics also change. Women who were near ovulation tended to engage in self-ornamentation (Haselton, Mortezaie, Pillsworth, Bleske-Rrechek, & Frederick, 2007), and they wore more revealing clothing (Durante et al., 2008). In Haselton et al. (2007), raters viewed photographs of women and assessed the self-ornamentation levels in each photo. The photos that were rater higher in self-ornamentation were close to ovulation as opposed to photos of women who were in the ovulatory phase. Durante

(2008) found that women tended to depict preferred clothing during ovulation to be more revealing.

Pillsworth (2004) found that during ovulation, women were more likely to wear more revealing clothing. When asked to draw a typical outfit, women during ovulation would draw pictures of skimpier clothing as compared to when they were not ovulating. This is evidence that women were engaging in advertising their sexual receptiveness, though they probably were not consciously aware of their behavior changes.

Grammer (1996) found that women tend to wear more revealing clothing during ovulation. Studying women who were attending a dance club, the researchers took photographs of women and observed their behavior in the bar. Women who were ovulating wore more revealing clothing and tighter skirts and they touched men more than did women who were not ovulating.

In a study by Provost et al. (2008), it was also found that in addition to wearing more revealing clothing, women's walk tended to also change during ovulation. It is unclear whether or not this is conscious, however women tend to sway their hips more during ovulation as compared to non-ovulation. This may also be related to exaggerating hip sway to attract more attention to the hips as a method of sexual signaling.

It has also been demonstrated that these subtle behavioral and preference cues in women during ovulation are not completely concealed from men. Haselton et al. (2007) also found that women are labeled as more attractive during ovulation than when not ovulating strictly from photographs. Having photographs of 30 women during ovulation

and during non-fertile phases of the menstrual cycle, judges found that ovulating pictures of the women were more attractive than pictures of the same woman taken during non-fertile phases.

Men have been shown to detect and prefer the scent of ovulating women (Gildersleeve et al., 2010; Havlicek et al., 2006; Kuukasjarvi et al., 2004; Singh & Bronstad, 2001) and to engage in mate guarding behaviors when their partners are ovulating (Gangestad et al., 2002; Haselton & Gangestad, 2006). Miller et al. (2007) showed that female lap dancers earn larger tips during ovulatory phases of their menstrual cycle as opposed to other phases. It would be logical to propose that the male receivers of the lap dances are either willing to pay more for a lap dance from an ovulating woman or that they find ovulating women to be more attractive and tip more. Miller and Maner (2010) found that when men were exposed to the scent of ovulating women, they became sexually primed and were more willing to make risky decisions.

Other research focusing on brain activation when viewing erotic films indicated that women's brains reacted differently during parts of the menstrual cycle (Zhu, Wang, Parkinson, Cai, Gai, & Hu, 2010). The right inferior frontal gyrus, right lateral occipital cortex, and left postcentral gyrus, and bilateral superior parietal lobeule activation was different between the ovulatory and the non-ovulatory subjects. It must also be noted that this particular study found the opposite, and that the authors attribute the down-regulation of sexual arousal during ovulation as the demographic of women were actively avoiding pregnancy.

While determining exactly which brain parts play an active role in mate preference and mating strategies across the menstrual cycle still has not been demonstrated, the evidence it fairly clear that it does occur during ovulation. When using LH strips to confirm ovulation, it was found that self-reported women's sexual desire was elevated during ovulation (Brown, Calibuso, & Roedl, 2011).

The current evidence does lead us in the general direction that it is the corresponding changes in hormone levels during ovulation that influences mate preferences and mating strategies. Studies testing whether or not these mate preferences are more heavily influenced by ovulation or hormones have not been conducted.

The directions of these findings are not always in the same direction, nor are the findings very clear. Some of the more recent studies have found that there was no change in women's physical but not intention displays of fertility during ovulation (Bleske et al., 2011), but other studies did show a significant change in waist-to-hip ratio across the menstrual cycle (Kirchengast & Gartner, 2002). These inconsistencies in the area of research could be due to the design of the studies and differences in those relationships were not examined. Specifically, many of the studies do not examine mating strategies deployed by the women or variables in the subjects' current relationships.

Past research has shown that masculine appearing men also tend to be less investing in relationships, less faithful as relationship partners, and more aggressive (Thornhill & Gangestad, 1999). Such men are not typically preferred as long-term relationship partners due to these negative traits and behaviors. However, women tend

to prefer more masculine men during ovulation, particularly as short-term mates (Penton-Voak et al., 1999). These findings also support the notion that women may prefer different types of men at different points of the menstrual cycle and that different men may serve different reproductive functions for women (Gangestad & Simpson, 2000).

As previously discussed, past research confirms that women tend to behave differently during ovulation. In general, women tend to have greater sexual desire and engage in more sexual signaling when ovulating. These findings support the premise that women might unconsciously engage in behavior that may facilitate certain mating opportunities. However, given that women tend to engage in extra-pair copulations when the risk of pregnancy is greatest (Carter, 1985), there must be some benefits for engaging in such potentially costly behaviors. The negative consequences of extra-pair copulations may result in the loss of resources, tarnished reputations, physical retaliation by aggrieved romantic partners, and/or loss of social support from friends and family (Buss & Schmitt, 1993).

Sexual Strategies Theory (SST) (Buss & Schmitt, 1993) explained why men and women different in mating strategies. The mating and child-rearing pressure between men and women are different due to inherent biological design. Women carry the majority of the physical and time investment in child-bearing and rearing; while men can invest a relatively minimal amount to cause conception. Because of these differences, men and women should have different preferences and criteria when selecting mates.

In women, child-bearing and child-rearing challenges also different. Women must find men with high genetic viability or superiority for child-bearing, and women must also find men who exhibit traits that are amendable for child-rearing. Because the solution to these challenges is not always in the same man, women may employ different mating strategies during strategic phases of the menstrual cycle.

Strategic pluralism is a mating strategy used by women that involves having a primary partner and also a short term extra-pair partner. Women prefer a less masculine primary partner during low-risk of conception periods. This has been called strategic pluralism because two different mating strategies are practiced simultaneously (Gangestad & Simpson, 2000).

Specifically, it has been proposed that the two general types of men that most women prefer as mates are one that are highly masculine and those that are less masculine. This can be linked to the two types of mates that women sought: (1) mates that might be "good parents," and (2) mates that might have "good genes" that might be passed on to offspring (Gangestad, 1993). The term "good parent" is used to describe men who are both able and willing to be good providers and, thus, more likely to invest time, resources, and effort in parenting – and these men were less masculine (Haselton & Gangestad, 2006). The term "good genes" is used to describe men who have the attributes or cues signaling good genes (ie., symmetrical features, highly masculine appearance), but are also more likely to be aggressive, sexualize other women, and invest less in relationships and offspring. These "good genes" or markers of masculinity

may also be passed on to the woman's male offspring. These "sexy sons" would also have higher reproductive success (Penton-Voak & Perrett, 2000).

In order to obtain the benefits of both types of men, women may engage in strategic pluralistic mating. That is, they may selectively engage in both short-term mating and long-term mating, depending on current conditions most notably ovulation. Thus, while in a primary relationship with a "good parent" mate, a woman might for example engage in a selective extra-pair relationship with a man who possesses indicators of "good genes" only when she is fertile. Such an extra-pair relationship is usually characterized as being short-term in duration and primarily sexual in nature. During non-fertile periods of the menstrual cycle, the women typically do not prefer their extra-pair partner, but prefer their primary partner. While the consequences of this strategy are modest (Anderson, 2006), the evidence showing that the preference change has been relatively consistent so far. The timing of the benefits from these trade-offs in long-term and short-term relationships would be optimized (Sheib, 2001). Specifically, the advantages of a short-term or extra-pair relationship would be pursued during the time in which the risk of conception is the highest.

Sustaining multiple sexual relationships, however, may often not be feasible and it also carries with it consequences should either partner discover the other. For the male partners, this is especially risky as the chance of paternity uncertainty is higher. Not only is it time consuming for both men and women to have multiple mates; extra-pair involvements also reduce the amount time that a woman can invest with a "good parent" mate. Moreover, extra-pair relationships carry risks and consequences if extra-pair

relationships that are secretive are exposed. Nevertheless, by selectively engaging in extra-pair mating with a mate who may have "good genes", a woman can potentially receive the benefits of both mates.

According to Strategic Pluralism, therefore, the benefit for a woman to mate with a "good genes" man is to obtain the superior genes for her children. Because the window of time in which a woman can become pregnant each month is small, a woman's preference for a "good genes" male should be evident during the ovulatory phase of her menstrual cycle.

Researchers started making predictions that the flucations that occurred during ovulation were actually tied to hormone levels in women (Roney & Simmons, 2008). They theorized that as hormone levels changed, so did behaviors that were evolutionary advantageous. Estradiol should be correlated with fertility, so as fertility increases, so should behaviors that increase the likelihood of conception. Women with higher levels of estradiol should be interested in sex, be open to casual sex, prefer men with higher quality genes, and engage in more sexual signaling.

Another study investigating women's preferences for symmetry during ovulation found that the preferences were predicted by lower levels of progesterone and higher levels of estradiol (Garver-Apgar, Gangestad, & Thornhill, 2008). However, the levels of progesterone and estradiol were estimated; they were not directly measured. In Morrison, Clark, Cralweski, Campbell, & Penton-Voak (2010), it was found that women were more attracted to flirtatious facial movements in men during ovulation. But like

the previous study, no actual hormone levels were measured. Instead, hormone levels were estimated using hormone data from Wilcox (2001).

As stated before, the current body of research in female menstrual cycle changes has begun to incorporate biological data. Recently, hormonal measurements have been incorporated into the field of menstrual cycle effects. Several studies have shown that state level amounts of hormones were related to preferences for masculinity (Roney & Simmons, 2008; Welling, Jones, DeBruine, Conway, Law Smith, Little, Fienberg, Sharp, & Aldujaili, 2007). Welling et al. (2007), showed that when women have increased levels of salivary testosterone, they also show an increased attraction to masculine faces.

In Roney and Simmons's 2008 study, estradiol levels were assayed via saliva samples in women once during the study. Then the women completed a number of measures including rating pictures of male faces. Roney and Simmons found that as estradiol levels in the women increased, their preference for masculine faces increased. Additionally, when estradiol levels were regressed onto days of the menstrual cycle, a clear picture of estradiol increase during ovulation mirrored the increase in preference to masculine faces (Roney & Simmons, 2008).

In 2009, Lukaszewski and Roney published an additional study examining the estimated hormone's prediction on women's mate preferences for dominant personality traits in men. With this design, Lukasewski and Roney did not examine actual hormone levels, rather hormones levels were estimated by estimating which phase of the menstrual cycle the women were in, and then estimating the levels of hormones that were typical for that particular phase. Even with the rough double estimation method of

this design, the results indicated that estrogen was a significant predictor of preference for dominance, but not with lutenizing hormone, follicular stimulating hormone, testosterone, and prolactin.

Past studies have also shown that testosterone has been related to sexuality in women. Testosterone has often been used as a supplement or replacement therapy for treatment for females suffering from sexual dysfunction (van Anders, et al, 2005). Brown, Calibuso, & Roedl (2011) found that women self reported increased sexual behavior just prior to ovulation. Ovulation in this study was confirmed with lutenizing hormone (LH) strips. In a study looking at number of sex partners, it was found that in both men and women, higher testosterone levels were correlated with having more sexual partners (van Anders at al, 2007).

Other studies have also demonstrated that testosterone might also affect one's physical features. It is hypothesized that testosterone has masculinzing effects on men not only in their face, but also physically and behaviorally. Penton-Voak and Chen (2004) found that of men who actually look more masculine actually have higher levels of testosterone. Using facial averages of known testosterone levels of men, they found there to be noticeable differences in testosterone the faces of men. The mathematical average of high testosterone faces were rated to be more masculine as compared to the mathematical average of low testosterone faces. This is evidence that testosterone during facial development may actually play a role in facial features. This is also evidence that there is facial masculinity can also be an honest signal to genetic quality and behaviors (Penton-Voak & Chen, 2004).

The evidence linking hormone levels to changes in women's mating preferences and relationship behaviors is currently lacking. The two proposed theories to explain this area of research are strategic pluralism, also known as the mixed-mating theory (Gangestad & Thornhill, 2008), and the between-cycle theory (Lukaszewski & Roney, 2009). The mixed-mating theory proposes that mental mechanisms in women increases their preference for more masculine men during days of higher risk of conception and only for short-term relationships, and a preference for less masculine men as primary partners throughout other phases of the menstrual cycle. The explanation here is that the advantages of infidelity are functional during ovulation, and only with men who are genetically superior to their current primary partners. Thusly, preference for genetically superior partners should only occur during ovulation.

The between-cycle theory (Lukaszewski & Roney, 2009) proposes that preference shifts for more dominant males should occur not only during different phases of the menstrual cycle but also between menstrual cycles. Specifically, preferences for more dominant males should be stronger during cycles that are more fertile than cycles that are less fertile. The theory postulates that given ancestral environments, some cycles were more fertile than others, and that estrogen levels are an index of cycle fertility, with higher estrogen levels during higher fertility cycles. Thus, brain mechanism that shifts preference for dominance does not occur only during ovulation, but it shifts during cycles with higher levels of estrogen.

These two different theoretical approaches to this area of research can be conceptualized as trait hormone effects and state hormone effects. Although these two

theoretical approaches do make different predictions, they are not mutually exclusive. Rather these two theories can function interdependently. Trait hormone levels refer to the typical level of hormones in a woman's body summed across phases of the menstrual cycle while state hormone levels refer to the current level of hormones in a woman's body. While fluctuations in hormone levels are expected on a day to day basis, it is predicted that hormone levels are relatively stable.

While this research in this area is not novel, there are still many questions left unanswered. Overall, the findings are relatively consistent, but there are still mixed results in some studies investigating factors that might influence cycle changes (Harris, 2011, Bleske- Rechek, Harris, Denkinger, Webb, Erickson, & Nelson, 2011). Currently, the majority of studies that do examine menstrual cycle and hormone fluctuations in women tend to use a between subject single sample design with estimated cycle phases and estimated hormone levels. Without a within subject design, the mixed-mating theory versus the between cycle theory cannot be tested. Previous studies have not examined trait and state effects of hormone fluctuations across the menstrual cycles.

To find support for the between-cycle (trait hormone levels) or the mixed-mating model, this study examined the relation between fluctuations of estradiol and testosterone during the menstrual cycle and preference for photographs of men with higher levels of testosterone. This study will test the relation between women's hormone levels and two different characteristics of the male faces used as stimuli. The results of this study will give a more clear picture of hormones might affect women's mating strategies and mate preferences.

It is important that these questions in this area of research are resolved as hormones are the facilitators of the menstrual cycle. It is logical to think that if hormones facilitate the reproductive organs in the human body, it might also modulate the correlated mating preferences and behaviors.

The evolutionary theory underlying these predictions about the association of women's hormones and men's facial masculinity and testosterone levels, the theory of strategic pluralism, asserts two things. The first, as discussed above, is that women selectively seek sexual relationships with men with "good genes" as revealed by their appearance. The second is that women should be more psychologically oriented toward short-term mating strategies during ovulation. Psychological factors that are predicted to change with fluctuations in estradiol and testosterone during the more fertile period of our participants' cycles include: motives, sociosexuality, commitment to current dating partner (all women participating in the study will be involved in a dating relationship of at least 3 months duration), satisfaction with current dating relationship, perceptions of the availability of alternative relationship partners, and closeness to current partners, and desire to become a parent.

The predictions for this study were that baseline levels (trait levels) and changes (state levels) in estradiol and testosterone will independently predict that: a) women's sexual motives that focus more on the sex act itself and less on emotional and relationship factors, b) women's approval of engaging in sexual intercourse outside of a committed relationship will increase, c) women will report being less committed to and less satisfied with their current dating relationship, d) women will perceive greater

availability of alternative relationship partners, e) women will express less interest in becoming a parent, and f) women will report being less close to their dating partners.

With regard to perceptions and ratings of men's faces, it is hypothesized that higher levels of testosterone and estradiol independently should be related to preference for more masculine men and men with higher levels of testosterone. Women with higher baseline levels of testosterone and estradiol as well as women who experience an increase of testosterone and estradaiol should predict a preference for masculine men and men with higher levels of testosterone. Higher levels of testosterone and estradiol are predicted to occur during ovulation.

This study employed a longitudinal design tracking women's hormone levels, preference for testosterone in men, mating preferences, and current relationship quality variables over five weeks.

2. METHOD

2.1 Participants

For part one of the study, 40 women were recruited from the Introductory Psychology Subject Pool. Eight women were excluded from the final analyses due to incompletion of the study (two) or lack of ovulatory period of the women (four) or use of hormonal medication (two). Thirty-two subjects were used in the final analyses. All participants were involved in an exclusive heterosexual dating relationship of at least three months duration. The women were not taking any hormonal or steroidal medications including birth control during the duration of the studybg. Women were compensated with five credit hours of research.

The mean age of the women was 18.33 years (SD = 0.60). The ethnicities of the women are 82.2% Caucasian, 11% Hispanic, 2.6 % Asian, 2.6% African American, and 1.6% identified themselves as other. The average length of time in their respective relationships was 15.35 months (SD = 11.55). The criteria for participation in the study were that the women could not be on any type of hormonal medication, and they had to currently be in a relationship for a minimum of three months at the start of the study.

2.2 Materials

Data was gathered on menstrual cycle information, and dating history. Scales and inventories used included the Sociosexuality Orientation Inventory (SOI; Simpson & Gangestad, 1992), Perceived Relationship Quality Components Measure (PROC; Fletcher et al., 2000), the Aron Inclusion of Others in Self Scale (Aron et al., 1992), the

Best Alternative Partner Index (Simpson, 1987), long-term and short term dating preferences (Shackleford, Schmitt, & Buss, 2005), an abbreviated Desire for Children Scale (Rholes, Simpson, Blakely, Lanigan, & Allen, 1997), Sexual desire scale (Beck, Bozman, & Qualtrough, 1991), and an abbreviated AMORE sexual motives scale (Hill & Preston, 1996).

The Sociosexuality Orientation Inventory (SOI; Simpson & Gangestad, 1992) measured attitudes towards casual sex. The Perceived Relationship Quality Components Measure (PROC; Fletcher et al., 2000), measured reported current relationship quality and relationship closeness. The Best Alternative Partner Index (Simpson, 1987) measured to what extent the participants feel that they have viable access to alternative partners. The abbreviated Desire for Children Scale (Rholes, et. al, 1997) measured the participants' desire for children. A subset of questions from the Desire for Children scale was used to measure desire to become a parent. The abbreviated AMORE sexual motives scale (Hill & Preston, 1996) measured changes in sexual desire and sexual motivation respectively. The two subscales of the AMORE sexual motives scales included are the pleasure factor and the experiencing my partner's power factor. The other subscales were omitted from the study.

Items on the Sociosexuality Orientation Inventory (SOI; Simpson & Gangestad, 1992) ($\alpha = .575$) included "With how many different dating partners do you foresee yourself having during your lifetime?" and "With how many different partners have you had sex within the past year?" The Perceived Relationship Quality Components Measure (PROC; Fletcher et al., 2000) ($\alpha = .894$) included items like "How do you feel about

your relationship today?" and "How emotionally intimate is your relationship today?" The Best Alternative Partner Index (Simpson, 1987) (α = .722) included items such as "How do your alternatives compare to your relationship with your partner?" and "If you weren't dating your current partner, would you do ok – would you find another appealing person to date?" The abbreviated Desire for Children Scale (Rholes, et. al, 1997) (α = .873) included items like "I have a strong desire to have children." and I could be quite happy without having children." The abbreviated AMORE sexual motives scale (Hill & Preston, 1996) (α = .728) included items such as "How much do you fantasize about sex?" and "How often do you experience sexual desire?"

Additional materials required include microscope slides, microscope slip covers, and plastic screw-top vials. Testosterone and estradiol kits from Salimetrics were used to assay the saliva samples. Photographs of men from Penton-Voak and Chen (2005) were used as stimuli in part one this study. Testosterone levels of the men pictured were measured and were used in the data analysis.

2.3 Procedure

2.3.1 Part One

This study used a within subject design tracking 32 undergraduate women for five weeks and collecting five saliva samples from each woman over the five weeks for testosterone and estradiol assay. In order to assess ovulation, women provided additional saliva samples during their predicted ovulation dates (using the reverse counting method) to be examined for salivary ferning.

The women also completed scales and measures five times throughout the five weeks about their own sexual motives, socio-sexual orientation, commitment to current partners, satisfaction with current partners, subjective estimates of the availability of other relationship partners, closeness to current partner and the desire to become a parent.

During these five laboratory sessions, women also rated pictures of men that they did not know for masculinity, attractiveness, preference for long-term relationship, and preference for short-term relationship. These pictures were used in Penton-Voak and Chen (2004). Standardized black and white pictures of men were presented to the women individually, and each woman rated the pictures on attractiveness, masculinity, desirability for a short term relationship, and desirability for a long term relationship. The men pictured had their testosterone levels assayed at the time of the photograph was taken.

All the laboratory sessions were the same with the exception of the informed consent in the first sessions, and the debriefing in the last session. Each laboratory session was scheduled approximately one week apart. At these lab sessions, the women also collected saliva samples for estrodial and testosterone assays and to confirm ovulation.

Lab session 1: Upon completing the informed consent, the women completed questionnaires, inventories, and rate photographs on Survey Monkey.com privately on a desktop computer. They also provided a saliva sample for testosterone and estradiol assay. Women were asked to complete a short survey to assess their hormonal and

steroidal medical history and to assess their menstrual cycles. Women were asked questions about the regularity of their menstrual cycle, the number of days in their typical menstrual cycle, the date of their last 2 menses, and to predict the date of their next to menses.

Lab sessions 2-4: The women completed questionnaires, inventories, and rated photographs of male stimuli on Survey Monkey.com privately on desktop computer. They also provided a saliva sample for testosterone and estradiol assay.

Lab session 5: The women completed questionnaires, inventories, and rated photographs on Survey Monkey.com privately on desktop computer. They also provided a saliva sample for testosterone and estradiol assay. They were also debriefed upon completion of the study.

During the predicted ovulation days, the women took home slides on which to collect saliva. These saliva samples were analyzed for salivary ferning to confirm ovulation.

2.3.2 Menstrual Cycle Confirmation

Using the menstrual cycle data, researchers tried to approximate the date of the ovulation. This method of approximation was combined with the salivary ferning method was used to confirm ovulation in the women. Each female participant indicated (on a four-month calendar) the days of her last 2 menstruations and then estimated the timing of her next two menstruations. Each female participant provided information on her menstrual cycle length, regularity, typical days of menstruation, and any use of hormonal products or medication.

The menstrual cycle information was used to estimate when each female would most likely be ovulating during the study, using the reverse counting method (RCM) otherwise known as the Calendar Method (Fehring, 2005). The RCM estimates ovulation by counting backwards 14 days from a woman's last menstruation in order to estimate the next ovulation**.** A window of time (5-10 days) for each female was then identified. Specifically, each woman's ovulation dates for the next two months were estimated. This method permits one to obtain better estimates of the 5-10 day window when each woman might be ovulating.

During these 5-10 days, each female participant was instructed to provide a saliva sample each morning immediately after waking so that ovulation could be confirmed (salivary ferning method). Each morning, each participant recorded the time of collection and then collected the saliva on a microscope slide. Using a finger, each participant was instructed to swipe non-foamy saliva from under the tongue and apply it to the microscope slide. A cover slip is then placed over the saliva, which will be allowed to dry. This protocol will be followed during the targeted 5-10 days of the diary period. Using the combination of the two methods will better assess the women's ovulation.

2.3.2.1 Estimating Ovulation

Researchers examined each woman's slides and determined when each she was ovulating according to the Salivary Ferning method (Guida, et al, 1993). Inter-rater reliability for all the raters and slides was found to be Kappa = 0.936, $p < .0.001$, 95% CI (0.880, 0.992). Four days prior to ovulation and two days after, increases in minerals

and estrogen present in each woman's saliva were detectable. Dried saliva samples have a fern pattern due the minerals, catecolestrongens, and estrogens during ovulation. The ovulation window of all 32 women was confirmed using the Salivary Ferning method. The mean number of ovulatory days out of the 5-10 day window for women was 2.44 days. The mean number of days per cycle was 28.10 days. The session that was chronologically closest to the date of ovulation was designated the ovulatory session.

2.3.3 Reordering Sessions

Though the women in the study had fairly regular menstrual cycles, women were not on the same phase of the menstrual cycle at the same time. Thus, laboratory sessions for each couple were renumbered according to each woman's specific menstrual cycle date. In particular, the week of ovulation was renumbered to be session three, with the follicular phases being session one and two, and the luteal phases being session four and five. This reordering process ensured that sessions one and two corresponded to pre-ovulatory days, session three corresponded to the ovulatory window, and session four and five corresponded to the post-ovulatory days. Thus, the description of session was relative to each woman's own menstrual cycle, not the day in which the participant completed a laboratory session.

2.3.4 Data Set-up for Hierarchical Linear Modeling (HLM)

The models in this dissertation were tested in hierarchical linear modeling (HLM). HLM was chosen for this particular data set due to the method of the study design. Using HLM, the repeated measure components and the testosterone level of men that were rated in the study could be tested in these models. The testosterone levels in

level one could be designated as independent variables. Without the HLM, the nesting capabilities and ability to model independent variables that are not tied to the subjects is limited.

This data set is unique because it was analyzed using both a 3 level method and a 2 level method within Hierarchical Linear Modeling (HLM). Dependent variables are always at level 1 of each model, so the models have to be changed depending on which dependent variables was being tested.

2.3.5 3 Level Models and 2 Level Models

For predictions testing women's ratings of men, the data was organized into a 3 level-method. A 3 level model was used because the ratings of the men served as individual observations. (See Figure 1). With this set up, the testosterone levels of the men pictured could be incorporated into the model as an independent variable. For predictions testing changes in women's relationship variables, the data was organized into a 2 level model. Relationship variables included comittment, satisfaction, available alternatives, desire to become a parent, and relationship closeness.

Using a 2 level method, women's preference changes over the five sessions serves as level 1, and the women's individual and relationship variables served as level 2 measures. When using a 3 level method, the women's ratings of men and the men's testosterone levels would serve as level 1 measures, and women's preference changes over the five sessions serves as level 2, and the women's relationship variables would serve as level 3 measures. Relationship variables included comittment, satisfaction, available alternatives, desire to become a parent, and relationship closeness.

Using the 3-level method would allow for analysis of the testosterone levels of the men who are rated. The independent variable at level 1 would be the testosterone level of the men, and the independent variable at level 2 would be the phase of the menstrual cycle or hormone level in the women.

The independent variable in the two level models was cycle state. Dependent variables included estradiol levels, testosterone levels, commitment, satisfaction, available alternatives, desire to become a parent, and relationship closeness. Independent variables in the three level model included cycle state. Dependent variables in the three level models included state estradiol, testosterone, ratings of attractiveness, ratings of masculinity, and preference for long-term and short-term relationship with the men pictured.

2.3.6 Testing Models and Predictions

The predictions (quadratic models) were tested using Hierarchical Linear Modeling 7.0 by setting up the following equations:

For two level models testing state hormone effects :

Level 1 :

Outcome Variable = B1(women's relationship variables) + B2(women's state hormone levels) + r

Level 2 :

B1 = Y10 + Y11(relationship variables) + error term

B2 = Y2

Relationship variables included comittment, satisfaction, available alternatives, desire to become a parent, and relationship closeness.

For three level models testing state hormone effects:

Level 1:

Outcome Variable = B1(testosterone level of the men being rated) +B2(women's state hormone levels) + r

Level 2:

B1 = Y10+ Y11 (women's state hormone levels) + error term

B2 = Y20

Level 3 :

Y1 = G10 + G11 (relationship variables) + error term

Y2 = G20

Relationship variables included comittment, satisfaction, available alternatives, desire to become a parent, and relationship closeness.

For two level models testing trait hormone effects:

Level 1 :

Outcome Variable = B1(women's relationship variables) + B2(women's trait hormone) + r

Level 2 :

B1 = Y10

B2 = Y2

Relationship variables included comittment, satisfaction, available alternatives, desire to become a parent, and relationship closeness.

For three level models testing trait hormone effects:

Level 1:

Outcome Variable = B1(testosterone level of the men being rated) + r

Level 2:

B1 = Y10+ Y11 (women's trait hormone levels) + error term

B2 = Y20

Level 3 :

Y1 = G10

Y2 = G20

Results with 8000 degrees of freedom were tested in the three level model. Results with 160 degrees of freedom were tested in the two level model.

3. RESULTS

3.1. Descriptive Statistics

Descriptive statistics were run on level-1, level-2 variables, and level-3 variables. (see Table 1). Means and standard deviations for these items are all based on a 7-point Likert scale.

3.2. Cycle Predictions

Cycle state, specifically the ovulatory phased as compared to non-ovulatory phases, significantly predicted a preference for short-term relationships, $t(8000) = -2.819$, $p = 0.006$, long-term relationship preference for testosterone in men, $t(8000) = -3.412$, $p = 0.003$. This indicated that during ovulation, women were more likely to rate higher testosterone men as preferable during for short-term and long-term relationships. During ovulation, women did find the higher testosterone men more attractive, $t(8000) = -3.480$, $p = 0.002$. Specifically, women rated men with higher levels of testosterone as preferable during ovulation as long-term partners, short-term partners, and on attractiveness. Women's rating of masculinity in men as a function of the men's testosterone levels did not change across the menstrual cycle states, $t(8000) = 1.528$, $p = 0.137$. The prediction that women who are ovulating rated men higher in masculinity independent of testosterone levels was not significant, $t(8000) = -1.750$, $p = 0.080$.

It was predicted that testosterone and estradiol should peak during ovulation. Across the menstrual cycle, testosterone did not rise and fall as predicted, $t(160) = 1.153$,

p = 0.249. Across the menstrual cycle, estradiol did not rise or fall as predicted, t(160) = 0.144, p = 0.886.

Sexual desire in women did not significantly change across the menstrual cycle, t(160) = -0.228, p = 0.820. Specifically, women's self report on frequency and strength of sexual desire from the AMORE scale did not change across the menstrual cycle. Sociosexuality did significantly change across the menstrual cycle, t(160) = -1.976, p = 0.050, being highest during ovulation. Relationship satisfaction in women did not significantly change across the menstrual cycle, t(160) = -0.089, p = 0.929. Change in perceptions of available alternative partners across the menstrual cycle was not significant, t(160) = -1.779, p = 0.078. Closeness of current partner across the menstrual cycle did not significantly change, t(160) = -0.772, p = 0.442. Desire to become a parent across the menstrual cycle did not significantly change, t(160) = 0.866, p = 0.388. Interest in short-term relationships across the menstrual cycle did significantly change t(160) = 2.341, p = .021, being highest during ovulation.

3.3. State Versus Trait

For both testosterone and estradiol, state and trait measures were tested. State measures indicate that the specific measured amount of hormone was tested. In other words, the subject's state levels of hormone was used in the analyses. Trait measures indicate that the average measured amount of hormone was tested. In other words, the subject's average levels of measured hormone was used in the analyses.

It is important to make the distinction between state and trait levels of hormones. According to this framework, state levels of hormones should affect preferences

throughout the menstrual cycle. Specifically, the state changes of hormones should affect changes in preferences. Trait levels of hormones should be tied to the base rate or baseline levels preferences and mating strategies. Women with differing trait levels of hormones should have different preferences and mating strategies independent of hormone fluctuations.

3.4. State Estradiol Predictions

Women with higher state levels of estradiol did not rate higher testosterone men as more masculine, $t(8000) = 0.226$, $p = 0.823$ or to be more attractive, $t(8000) = -0.305$, $p = 0.763$. Women with higher levels of state estradiol did rate men with higher levels of testosterone to be more attractive for long-term relationships, $t(8000) = -3.576$, $p < 0.001$ and short-term relationships, $t(8000) = -3.900$, $p < 0.001$. In other words, women with higher levels of state estradiol found higher levels of testosterone to be preferable for long-term and short term relationships.

State estradiol levels significantly predicted higher masculinity ratings in men independent of their testosterone levels, $t(8000) = 2.855$, $p = 0.008$. Women with higher levels of state estradiol rated men higher in masculinity as compared to women with lower levels of estradiol.

Sexual desire in women did not significantly change as a function of current estradiol levels, $t(160) = 0.350$, $p = 0.727$. Sociosexuality did significantly change as a function of current estradiol levels, $t(160) = -2.069$, $p = 0.041$. Sociosexuality did increase significantly as state estradiol levels increased. Relationship satisfaction in women did not significantly change as a function of current estradiol levels, $t(160) =$ -

0.779 p = 0.437. Change in perceptions of available alternative partners did not significantly change as a function of state estradiol levels, t(160) = 0.302, p = 0.763. Closeness of current partner significantly changed as a function of current estradiol levels, t(160) = 6.578, p <0.001. Closeness to current partner significantly dropped as state estradiol levels in the women decreased. Desire to become a parent did not significantly change as a function of current estradiol levels, t(160) = 1.003, p = 0.318. Interest in short-term relationships did not significantly change as a function of current estradiol levels, t(160) = 1.040, p =.300.

3.5. Trait Estradiol Predictions

The prediction that trait estradiol in women predicted a high masculinity rating in men was not significant, t(8000) = -1.186, p = 0.240. Specifically, trait estradiol levels in women did not affect their masculinity ratings. All other findings related to trait estradiol were non-significant.

3.6. State Testosterone Predictions

State levels of testosterone levels in women did not significantly predict the women's ratings of attractiveness in high testosterone men, t(8000) = -1.476, p=0.140, and it did not predict masculinity ratings of the high testosterone men, t(8000) = -0.532, p = 0.595. The state levels of testosterone did significantly predict long-term relationship preference, t(8000) = 2.201, p = 0.028. Women with higher state levels of testosterone did rate men with higher levels of testosterone to be significantly more attractive for long-term relationships. State levels of testosterone in women was not significant for short-term relationship preference in men, t(8000) = 1.784, p = 0.074.

Women with higher state levels of testosterone did not significantly rate higher testosterone men as more masculine, $t(8000) = -0.653$ $p = 0.518$ or to be more attractive, $t(8000) = -0.139$, $p = 0.890$. Women with higher levels of state testosterone did not rate men with higher levels of testosterone to be significantly more attractive for long-term relationships, $t(8000) = 1.197$, $p = 0.241$, and short-term relationships was also not significant, $t(8000) = 1.210$, $p = 0.236$. These findings indicated that women did not rate higher level testosterone men to be more masculine, attractive, or preferable for long-term or short-term relationships. Higher state testosterone levels in women did not significantly predict a higher masculinity rating in men independent from the men's testosterone levels, $t(8000) = 0.960$, $p = 0.347$.

Sexual desire in women did not significantly change as a function of current testosterone, $t(160) = 0.407$, $p = 0.685$. Sociosexuality did not significantly change as a function of current testosterone, $t(160) = -1.178$, $p = 0.241$. Relationship satisfaction in women did not significantly change as a function of current testosterone, $t(160) = 0.408$, $p = 0.684$. Closeness of current partner did not significantly change for testosterone, $t(160) = 0.513$, $p = 0.609$. Desire to become a parent did not significantly change as a function of current testosterone, $t(160) = 0.589$, $p = 0.557$. Interest in short-term relationships did not significantly change as a function of current testosterone, $t(160) = .681$, $p = 0.497$. There were no significant changes in sexual desire, sociosexuality, relationship satisfaction, perception of available alternative partners, closeness of current partner, desire to become a parent, and interest in short-term relationships as state levels of testosterone changed. Change in perceptions of available alternative partners did

significantly change as a function of state testosterone, $t(160) = -2.438$, $p = 0.016$. This finding indicated that higher levels of testosterone were tied to the perception of more available alternative partners.

3.7. Trait Testosterone Predictions

The prediction that higher levels of trait testosterone in women predicted a higher masculinity rating in men independent of the men's testosterone level was not significant, $t(8000) = -0.532$, $p = 0.600$. There were no significant results involving trait testosterone. (See Table 2 for state and trait findings).

4. DISCUSSION

4.1 Cycle Predictions

Cycle state, specifically the ovulatory phase as compared to non-ovulatory phases, significantly predicted a preference for short-term relationships and long-term relationship with higher testosterone men. Women also found these men to be more attractive during ovulation than other phases of the menstrual cycle, but not more masculine. It was predicted that women would find higher testosterone men preferable as a short-term mate during the ovulatory phase of the menstrual cycle, but past research does not show that women find these same men preferable for a long-term relationship. The long-term preference during ovulation is inconsistent with past findings. The literature in this area shows that women prefer more masculine men for short-term relationships during the most fertile period of the ovulatory cycle. Since high testosterone men were not perceived to be more masculine, there should be no advantage for them in terms of their desirability for short-term relationship partners. Higher testosterone men were, however, perceived to be more attractive. General attractiveness should be related to women's preferences for both long- and short-term relationships. For that reason, women may have preferred higher testosterone men for both types of relationships.

The women's rating of masculinity of men as a function of the men's testosterone levels did not change across the menstrual cycle states nor did the women rate the men higher in masculinity overall during ovulation as compared to other phases of the menstrual cycle. While past research has shown that women preferred masculine

men for short-term relationships during ovulation, past research has not shown that women's perception of masculinity necessarily changes. More research on this specific finding should be conducted to tease out the perception of masculinity and the preference for masculinity.

It was predicted that testosterone and estradiol should peak during ovulation. However, those results were not consistent with these predictions. This might be because of the relatively few number of research participants as compared to other studies (Alliende, 2002, Zillmann, Schweitzer, & Mundorf, 1995, Wilcox et al., 2001). Additionally, given that the majority of subjects in were likely experiencing a major life transition, the transition to college, the subjects' menstrual cycle could have been affected by stress or changing environments. Another possible explanation for these findings will be discussed below in the section of the discussion regarding weaknesses of this study.

This study did not find that self-reported sexual desire, relationship satisfaction, perception of available alternative partners, closeness to current partner, and desire to become a parent did not change across the menstrual cycle. It was predicted that sexual desire and available alternative partners should increase during ovulation, and closeness to current partner, relationship satisfaction, and desire to become a parent should decrease during ovulation. The lack significant results in this data set can be attributed to the small sample size. If the findings are not due to statistical error, then they would seem to indicate that cycle phase does not have an effect on feelings toward the current partner, even though they may affect feelings toward an extra-pair relationship. That is

to say, the effect on cycle phase may be limited to increasing the attractiveness of certain types of men for extra-pair relationships without that effect being mediated by a change in feelings about an existing partner.

This study did find that sociosexuality (interest in non-committed-sexual relationships) and interest in short-term relationships did significantly increase during ovulation. This finding is consistent with past research, and it may indicate that these attitudes are more malleable than the previous items, perhaps because they focus on the possibility of a relationship with an extra-pair partner rather than an existing partner.

4.2 State Estradiol Predictions

The data indicated that women with higher levels of state estradiol found men with higher levels of testosterone to be preferable for long-term and short term relationships, but they were not necessarily rated more masculine or more attractive. These findings are somewhat contradictory to each other. This finding does not appear to be a function of attractiveness ratings. Thus, the factors that mediate this effect are not readily apparent. That is to say, there are no findings within the current data set that help explain this effect.

Women with higher levels of state estradiol rated men higher in masculinity regardless of the man's testosterone levels as compared to women with lower levels of estradiol. This finding is a novel as past research has only examined preference for masculinity as estradiol changes in women but not differences in masculinity ratings as estradiol changes in women.

Sexual desire, relationship satisfaction, perception of available alternative partners, relationship satisfaction, desire to become a parent, and interest in short-term relationships did not change as estradiol in the women changed. Sociosexuality and closeness to current partner did change as estradiol changed with an increase in sociosexuality and decrease in closeness. The increase in sociosexuality scores is consistent with an increased interest in an extra-pair sexual relationship.

4.3 Trait Estradiol Predictions

Trait estradiol levels in women did not affect their masculinity ratings. All other findings related to trait estradiol were non-significant. It has been theorized that women with higher levels of trait estradiol should have higher baseline levels of preference for masculinity and short-term mating interests (Lukaszewski & Roney, 2009), but no study to date has reported such findings.

4.4. State Testosterone Predictions

State levels of testosterone levels in women did not significantly predict the women's ratings of attractiveness in high testosterone men, predict masculinity ratings of high testosterone men, or predict short-term or long-tem relationship preference for high testosterone men. These findings are inconsistent with the study predictions; however, it may be due to the within subject design. It is unlikely that women's perceptions or preference for high testosterone men would change enough in the same woman to be statistically significant with this sample size. State levels of testosterone did predict long-term relationship preference for higher testosterone men.

There were no significant changes in sexual desire, sociosexuality, relationship satisfaction, perception of available alternative partners, closeness of current partner, desire to become a parent, and interest in short-term relationships as state levels of testosterone in the women among higher versus lower testosterone women. Change in perceptions of available alternative partners did significantly change across women as a state testosterone levels changed. This finding indicated that higher levels of testosterone were tied to the perception of more available alternative partners, which has not been previously shown.

4.5. Trait Testosterone Predictions

The prediction that higher levels of trait testosterone in women predicted a higher masculinity rating in men independent of the men's testosterone level was not significant. This might also be attributed to the high variation of testosterone levels. Testosterone levels can be affect by social and psychological influences. Because only five independent samples were used to calculate the trait testosterone levels, outlier samples might have skewed accurate trait testosterone levels. Trait testosterone was not significantly related to any of the other dependent variables assessed in this study.

The conclusions of these results may indicate that estradiol and testoeterone play different roles in women's mating preference. It appears that state and trait estradiol and testosterone do not change the perception of attractiveness or masculinity in men. There is also some evidence that estradiol and testosterone might change attitudes surrounding mating including attitudes towards short-term relationships and sociosexuality. Interestingly, trait levels of hormones did not predict as well in this study

as cycle phase and state hormone levels variables. Previous studies have not shown that women's mating strategies and goals change across the menstrual cycle. Previous studies have only shown that preferences for certain types of men do change, but mating goals in the women have not been examined.

This study aimed to find support for theoretical questions that had not been examined in a single study. The first question is whether preferences changes in women occur as a function of the menstrual cycle or are these changes driven by fluctuating hormones independent of the menstrual cycle. State effects of hormones have not been examined in this line of research. Specifically, are current levels of hormones related to preference changes? Independent of phase of the menstrual cycle, are there changes in behavior and preferences as current levels of hormones fluctuate?

The second question addressed deals with trait effects of the hormones. If there is a relation between hormones and relationship preferences, there should be differences in women who have differing trait levels of the said hormones. This question has not been tested in previous studies.

The results of this study attempted to show a more holistic picture of how estradiol and testosterone influence women's mating strategies and relationship perceptions across the menstrual cycle. While the significant findings did support what other researchers have found, not all predictions were statistically significant. As a whole, the results did not show that either state or trait levels of testosterone or estradiol affected ratings of attractiveness and masculinity. However, it did appear that estradiol

levels were tied to women's preference for long-term relationships and short-term relationships, but testosterone levels were not.

Inconsistent with previous research was that women often preferred high testosterone men for short-term and long-term relationships. Past research typically shows that women only prefer more masculine men during ovulation only and typically only for short term relationships. While past research has shown that women should differentiate significantly in terms of short-term and long-term relationship preference, this study did not find a difference in this particular data set. Also inconsistent with past research (Wilcox et. al, 2001, Alliende, 2002, Zillmann et al., 1995), hormone levels in the women did not fluctuate across the menstrual cycle as they should typically. The lack of consistently significant results in this study may be due to a number of reasons outlined in the limitations section of the discussion below.

The scope of predictions in this dissertation is large in comparison to the types of studies in this area. While other studies have found effects in when examining a narrow scope of predictions, this study found supportive effects for the previously mentioned theories, but not all findings were statistically significant.

The strengths and limitations of this study are outlined below. A strength of this study over the past studies is the longitudinal design. There are currently no published studies to date in the area of menstrual cycle, hormones, and changes in preferences that utilize this type of longitudinal design and repeated measures.

Another strength of this study is that it examined both estradiol and testosterone in a single study, and this study did measure the actual amounts of aforementioned

hormones. Previous studies (Lukaszewski & Roney, 2009; Roney & Simmons, 2008; Welling, et. al, 2007) typically examine only one hormone, and many times the phase of the menstrual cycle and hormone levels are estimated instead of measured empirically.

Currently, many researchers use the assumption that most women's hormone levels rise and fall according to a normal menstrual cycle. Additionally, the menstrual cycles for those women, for the most part, are merely estimated in each of the studies using the reverse counting method or a modified reverse counting method. Once the phase of the menstrual cycle for each of the women is estimated, then an estimated hormone level is assigned to the woman according to mean values from previously established mean levels (Alliende, 2002, Zillmann, et al., 1995, Wilcox et al., 2001,).

This method has multiple issues as it estimates the data as twice: once is the day of the menstrual cycle for the women, and the other is the actual hormone level of women. The amount of error that is inherent in estimating a woman's menstrual cycle using the reverse counting method is compounded with the error of estimating a woman's hormone level using archival data.

Given the methodology of this particular study, it is possible to test the effects of state and trait levels of estradiol and testosterone whereas other studies cannot. The majority of other studies in this area only attempt to examine state levels of hormones in relation to differences in women's dating and relationship preferences via a single sample, empirically or estimated.

This study is important because it does address the previously mentioned issues: state versus trait effects, longitudinal designs, and lack of hormone measurement in this

area of research. The importance of these findings is that there seems to be state hormone, trait hormone, and cycle effects.

4.6. Limitations

While the design of this study attempted to address some of the unanswered questions in previous research, this study also had limitations. Factors that can affect hormone level readings can be environmental stressors, sexual behavior, exposure to estrogens in the food supply, time of day that the sample was collected, and even the method of collection.

It has recently been shown that saliva assays for hormones are severely affected by the use of sugar-free chewing gum (Van Anders, 2010). Until recently, almost all studies utilizing saliva were collected with sugar-free gum as opposed to passive drool. This current study also utilized sugar-free gum to facilitate saliva flow, so a certain degree of additional error in the results may exist.

While previous studies (Alliende, 2002; Wilcox et al., 2001; Zillmann et al., 1995) showed that utilizing large number of subjects will typically even out the noise, variability, and inaccuracy of estimating hormone levels, but for relatively small sample sizes, the results could be highly incorrect. Although pre-hoc tests indicated that 32 subjects with the repeated measures and longitudinal design was adequate, the hormone levels of 32 women across a single menstrual cycle might have deviated too much from normal fluctuations.

5. CONCLUSIONS

In conclusion, there is some evidence that hormones, specifically estradiol, might be connected to women's behavior in relationships and mating preferences. These findings support an evolutionary perspective of mating on several aspects. Hormones may affect preferences and behaviors in ways that facilitate mating behaviors, particularly with mating behaviors that pass along higher quality genes.

While this dissertation did not statistically confirm all the predictions in this dissertation, this study has been the most comprehensive one in this area. This study is the only of the few to measure actual levels of testosterone and estradiol in women, and this is only one to date that measured these levels in women longitudinally in the area of mating. Given that this methodology of this investigation is vastly different from previous studies, it brings a more holistic view of hormones' influences on our behavior.

More data is this area of research should be collected. Specifically, an additional study with a larger number of women, more frequent samplings of hormones, more frequent samplings of women's preferences, and a longer longitudinal period would likely clear up some of the mixed significant findings. Additionally, because the previous research in this area that measured actual levels of hormones was rather small, the effect size in the a priori power test might have been overestimated. Future studies using this paradigm could collect larger samples of women and underestimate the effect size in power tests.

In respect to changes in mating approaches, future studies should more thoroughly investigate changes in mating strategies. This study only sampled a few

items related to relationship and sexual attitudes. Future investigations should also examine behavioral changes tied to those relationship and sexual attitudes.

To further the area of research, tests of the relation between estrogen levels and attractiveness in women should be conducted. If estrogens are responsible for women's mating preferences and behavioral changes for masculine men during ovulation, women with higher trait estrogen levels should engage in these behaviors throughout the menstrual cycle more so than women with lower levels of estrogen. Because estrogen is also responsible for physical cues to fertility such as secondary sex characteristics, women with higher levels of estrogens should appear more attractive to men regardless of phase of the menstrual cycle more so than women with lower levels of estrogens. These types of tests will provide information on the between-cycle perspective and the strategic pluralism perspective in women's mating preferences.

Future studies should also examine other hormones, specifically oxytocin. In Theodoridou, Rowe, Rogers, and Penton-Voak (2011), trending evidence suggests that ratings of attractiveness in masculine men might be affected by oxytocin. Specifically, men's and women's ratings of attractiveness in masculine men appeared linked to the exposure of intranasal oxytocin. The theorized reason for these shifts is that oxytocin might minimize the negative aspects of higher testosterone men during ovulation, and thus maximizing the possible benefits of a possible short-term relationship.

Because hormones are an integral part of the female menstrual cycle, it is imperative that hormones related to mating, childbirth, and bonding are tested when examining changes in female mating strategies.

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APPENDIX

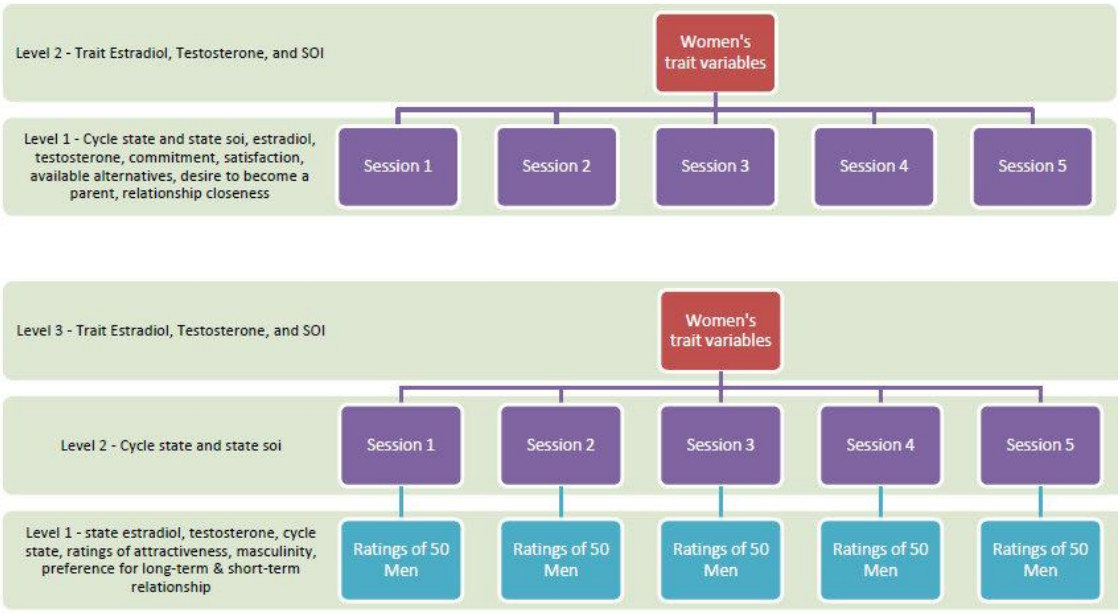

Figure 1. Two level and three level models.

Table 1. Women's Descriptives Statistics

Variable	Mean	Standard Deviation
Estradiol	29.92	137.33
Testosterone	86.30	77.38
Attractiveness Ratings	2.45	1.51
Masculinity Ratings	3.26	1.78
Preference for short-term relationship	1.85	1.31
Preference for long-term relationship	1.75	1.27
Masculinity Ratings by an independent group of non-ovulating women	3.44	0.88
Relationship Satisfaction	6.03	1.20
Sexual Desire	27.16	4.07
Relationship Closeness	6.07	1.01
Availability of Alternative Partners	11.96	1.32
Desire to become a Parent	25.19	4.14

Table 2. State and Trait Effects

Effect	t	df	p value	
State Estradiol				
Higher ratings of high testosterone men as more masculine				
Higher ratings of high testosterone men as more attractive	-0.305	8000	0.763	
Higher ratings of high testosterone men as long-term partners	-3.576	8000	0.001	*
Higher ratings of high testosterone men as short-term partners	-3.900	8000	0.001	*
Predicted higher masculinity ratings in men	2.855	8000	0.008	*
Sexual Desire	0.350	160	0.727	
Sociosexuality	-2.069	160	0.041	*
Relationship Satisfaction	-0.779	160	0.437	
Availability of alternative partners	0.302	160	0.763	
Closeness to current partner	6.578	160	0.001	*
Desire to become a parent	1.003	160	0.318	
Interest in short-term relationships	1.040	160	0.300	
Trait Estradiol				
Higher ratings of masculinity of men	-1.186	8000	0.240	
State Testosterone				
women's attractiveness rating of high testosterone men by cycle ratings	-1.476	8000	0.140	
women's masculinity ratings of high testosterone men by cycle ratings	-0.532	8000	0.595	
Higher ratings of high testosterone men as more masculine	0.653	8000	0.518	
Higher ratings of high testosterone men as more attractive	0.139	8000	0.890	
Higher ratings of high testosterone men as long-term partners	1.197	8000	0.241	
Higher ratings of high testosterone men as short-term partners	1.210	8000	0.236	
Predicted higher masculinity ratings in men	0.960	8000	0.347	
Sexual Desire	0.407	160	0.685	
Sociosexuality	-1.178	160	0.241	
Relationship Satisfaction	0.408	160	0.684	
Availability of alternative partners	-2.438	160	0.016	*

Closeness to current partner	0.513	160	0.609	
Desire to become a parent	0.589	160	0.557	
Interest in short-term relationships	0.681	160	0.497	
Trait Testosterone				
Higher ratings of masculinity of men	-0.532	8000	0.600	
Cycle Effects				
Predicted short-term relationship preference in high testosterone men	-2.819	8000	0.006	*
Predicted long-term relationship preference in high testosterone men	-3.412	8000	0.003	*
Higher testosterone men were rated as more attractive	-3.480	8000	0.002	*
Ratings of masculinity was higher for higher testosterone men	1.528	160	0.137	
Women who were ovulating rated men higher in masculinity	-1.750	160	0.080	
Testosterone levels fluctuated as predicted	1.153	160	0.249	
Estradiol levels fluctuated as predicted	0.144	150	0.886	
Sexual Desire	-0.228	160	0.820	
Sociosexuality	-1.976	160	0.050	*
Relationship Satisfaction	-0.089	160	0.929	
Availability of alternative partners	-1.779	160	0.078	
Closeness to current partner	-0.772	160	0.442	
Desire to become a parent	0.866	160	0.388	
Interest in short-term relationships	2.341	160	0.021	*

VITA

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