Men's Ability to Detect Cyclical Changes in Women's Facial and Bodily Attractiveness

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Master's Thesis

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Abstract

Despite widespread beliefs to the contrary, recent evidence suggests that human ovulation is not completely hidden (e.g., Roberts et al., 2004). There is some evidence that men may be able to detect physical changes across the menstrual cycle (e.g., Singh & Bronstad, 2001). Second-to-fourth digit ratio (2D:4D) is a sexually dimorphic trait, said to be fixed at birth (Manning, 2002). Recent research suggests that 2D:4D may change over the menstrual cycle (Patola et al., 2006). The current study involved photographing women (faces and bodies) at the periovulatory phase and one other phase of the menstrual cycle. Measures of 2D:4D were obtained via hand scans. Ninety-three men chose the more attractive face, body, or hands from each pair of photos. Four hypotheses were tested: (a) women will be perceived as most attractive during the periovulatory phase, (b) partners will evaluate periovulatory phase photos as attractive more often than nonpartners (c) 2D:4D will be highest in the luteal phase, and (d) luteal phase or high 2D:4D hand scans will be judged as most attractive. Results indicated that overall, men found faces most attractive on the day of ovulation ($p < .01$). Makeup use affected results in that higher periovulatory preferences (PPs) were found in nonmakeup wearers, while men preferred the nonperiovulatory faces of makeup wearers. Sociosexual orientation (SO) of both men and women also affected PPs: unrestricted men showed a greater PP than restricted men, and all men showed a higher PP when evaluating restricted versus unrestricted women. Second-to-fourth digit ratio did not change over the cycle. Trends ($p < .05$) indicated that men preferred luteal phase and lower 2D:4D hand photos. These findings support the idea that men are most attracted to high estrogen faces (e.g., Smith et al., 2006). However, the sociosexuality of both men and women plays an important mediating influence on cyclical preferences, potentially due to differing mating strategies.

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Men's Ability to Detect Cyclical Changes in Women's Facial and Bodily Attractiveness

It has long been believed that ovulation in human females is a covert and concealed process (Daniels, 1983; Pawlowski, 1999; Schröder, 1993). Nevertheless, most other mammals, including primates, provide external cues of ovulation to prospective mates during the time of oestrus (Reichert, Heistermann, Hodges, Boesch, & Hohmann, 2002). It has been believed, until recently, that human females did not provide these types of overt cues to fertility. Since it may not be immediately obvious why a lack of visual evidence of ovulation is adaptive for a species, many researchers have attempted to explain why these cues to human female ovulation are not present, and this research is outlined below. From the perspective of men, it seems likely that the benefits of obtaining knowledge of a woman's current fertility status would outweigh any possible detrimental effects. Some recent research has indicated that women do exhibit cyclical changes across the menstrual cycle (including physical changes) that may be used as fertility status cues to potential mates.

The present study will seek to identify whether or not ovulation truly is a hidden event in human females, by having men evaluate the attractiveness of pictures of women in various phases of the menstrual cycle, in a forced choice paradigm. Attraction is based on many different kinds of evolved traits that signify health and fertility. Therefore, if men do find women more attractive during the ovulatory phase of the menstrual cycle, compared to other cycle phases, this would suggest that overt cues to fertility exist in women. This study will also investigate whether or not a woman's partner is better able than other men to detect changes in attractiveness over the menstrual cycle, as it seems likely that men who live in close proximity to a woman would be more likely to pick up on subtle physical differences.

Adaptive Reasons for Concealed Ovulation

A number of previous studies have attempted to explain possible adaptive benefits of concealed ovulation, both for females and males. For example, Pawlowski (1999) reviewed a number of previous studies that included explanations for female benefits of constant receptivity and concealment of ovulation. Some researchers have theorized, for example, that constant receptivity leads to greater cooperation among groups; leads to less male-male competition; increased paternal behaviour (because constant receptivity confuses paternity, and thus a male may think he's the father of the offspring, even though he may not be); and an increased possibility of deceiving males as to the paternity of offspring, which leads to decreased infanticide by males (these theories are also discussed in Burley, 1979). This latter theory may seem improbable in relation to humans. However, there is evidence that stepchildren are at a 70 to 100 times greater risk of being mistreated or murdered by a stepfather than a biological father, (Daly & Wilson, 1994; Stiffman, Schnitzer, Adam, Kruse, & Ewigman, 2002; Wilson, Daly, & Daniele, 1995), and that the qualities of the two types of killings are different (stepchildren are more likely to be beaten to death as an accidental consequence of prolonged physical violence; biological children are more likely to die by shooting or asphyxiation, with the biological father killing himself and his spouse at the same time, and this is seen as a necessity by the father and is done in sorrow), reflecting differences in motivation.

Pawlowski (1999) also delineated theories explaining that ovulation may be concealed to the woman herself as an additional guarantee that males will have no cues as to female fertility. Pawlowski suggests an alternate theory that loss of oestrus may be a by-product of the evolution of the species (to bipedalism, wherein the line of vision was altered, and genitals became hidden between the legs, and therefore sexual swelling was no longer visible), and may not have evolved for any specific purpose at all.

Manning, Scutt, Whitehouse, Leinster, and Walton (1996) outlined research suggesting that concealed ovulation also benefits women in that it enables women to engage in extra-pair copulations without detection. This could facilitate the appropriation of "good genes" from an alternate partner while still receiving paternity resources from the primary partner.

Sillen-Tullberg and Moller (1993) suggest that concealed ovulation promotes monogamy in a species (rather than vice versa, which has been proposed by others, e.g., Alexander & Noonan, 1979). Monogamy is an occurrence that is beneficial to human females, since so much time and care are expended due to an extended gestation period, and the care of young. If a woman has a committed monogamous partner, there is more chance of paternal investment from the father, and the ability to acquire adequate resources from that partner. These issues will be discussed further in the discussion of adaptive design.

Gangestad and Cousins (2001) give a full account of how concealed ovulation may have evolved to benefit women. Since the male would not know when individual females were ovulating, the mating effort benefits of copulating with multiple females would have decreased, and thus effort would have shifted to nurturing one male-female relationship, and investing in parental effort rather than mating effort. The authors also mention ovulation synchrony (when females all ovulate in unison) as a second potential push for males to concentrate on one female, as the effort of attempting to mate with multiple females in a short amount of time would be outweighed by the benefits of concentrating on one woman. However, concealed ovulation may also be a detriment to paternal investment, as males cannot be sure of paternity, since hidden ovulation also means that males cannot be sure that they were able to copulate with the female during her fertile period, and also cannot be sure that they were able to properly mate guard during this time (Gangestad & Cousins, 2001). Men who spent more time with their partner (i.e., mate-guarding) would be at an advantage in terms of greater paternity certainty. Nevertheless, women with less "attentive" mates may choose to copulate with a genetically superior male and thus benefit from her partner's failure to mate guard.

Concealed ovulation seems to primarily benefit women and offspring. However, it remains possible that men have developed adaptations to detect ovulation cues, and thus to benefit from this information.

The Menstrual Cycle

An understanding of the human female menstrual cycle is integral to understanding the research on ovulation detection. Schnatz (1985) has summarized the biological processes involved in women's menstrual cycles. The human female menstrual cycle is a neuroendocrinological process, involving the hypothalamus, pituitary, and ovary (Schnatz, 1985). The hypothalamus sends out chemical substances (such as gonadotropin-releasing hormone [GnRH], and luteinizing hormone-releasing hormone [LHRH]) to the pituitary, which stimulate or inhibit the secretion of pituitary hormones. The study of monkeys has indicated that a constant pulsatile release of GnRH to the pituitary is necessary for the normal functioning of the pituitary in synthesizing and releasing gonadotropins. The frequency of the pulse is integral in the process, with the optimum frequency being once per hour, in both humans and primates. Altering this pulse frequency alters the follicle-stimulating hormone (FSH) and luteinizing hormone (LH) levels, as well as the FSH:LH ratio. The ovulatory cycle seems to be controlled by the sensitivity of the pituitary to GnRH. The synthesis and secretion of GnRH appears to be controlled by many different factors, including catecholamines; endogenous opiates; catecholestrogens; and physiologic, pharmacologic, and environmental factors. An abnormality in any of these areas may cause difficulties or abnormalities in the menstrual cycle.

While variability exists, the menstrual cycle is often separated into four distinct phases, each of which has different levels of reproductive hormones, and within which different processes are occurring. These phases are the menstrual phase, the follicular phase, the ovulatory phase and the luteal phase. The rank order of probability of conception for the four phases of the menstrual cycle is as follows: ovulatory, then follicular, then menstrual, then luteal (Havez, 1979).

In the first phase, menstruation (days 1 to 5), the uterus sheds the endometrium, or the uterine lining. This is a layer of blood-enriched tissue, and its purpose is to successfully establish pregnancy through implantation (Lessey, 2000). If the woman does not become pregnant, this lining is shed, in the process of menstruation. This phase has low levels of all hormones (i.e., estradiol, progesterone, LH, FSH) (Carlson, 1991). Some researchers have divided the menstrual phase into the premenstrual (days 18 to 28), menstrual (days 1 to 5), and postmenstrual (days 6 to 12) phases (Chavanne & Gallup, 1998). However, many within-phase hormonal differences exist within these cycle phases, and it is most common to describe the menstrual phase as days 1 to 5.

In the second phase, follicular (days 6 to 12), FSH, LH, and estrogen begin to rise. The rise in follicle-stimulating hormone causes a number of "ripe" ovarian follicles to begin maturing. These ovarian follicles begin second stage growth (first stage growth is self-stimulatory, and independent of the menstrual cycle and pituitary gonadotropins). With the rise in LH, the follicles begin to secrete estradiol, which inhibits the pituitary secretion of FSH. The follicles also secrete other estrogens, which signal the thickening of the endometrium. With the reduction in FSH comes a slowing of the growth of the follicles (which eventually leads to the death of all but one of the follicles). The largest follicle then secretes inhibin, which further suppresses FSH secretion. The dominant follicle continues to grow, and soon becomes capable of ovulation. Once the follicle is mature, it secretes enough estradiol to trigger the release of LH. Luteinizing hormone matures the egg and weakens the wall of the ovary.

Some authors divide the follicular phase into the early (days 5 to 8) and late (days 8 to 14) follicular phases (e.g., Roberts et al., 2004). The early phase is sometimes called the postmenstrual phase, and is characterized by low levels of all hormones, with FSH being slightly elevated. The late phase corresponds to the preovulatory phase of the cycle.

The third phase of the menstrual cycle is the ovulatory phase and includes ovulation (typically between days 13 to 15). Ovulation is characterized by third stage growth, wherein the follicle wall ruptures, and the ovum is released (Schnatz, 1985). The other follicles that do not become mature experience atresia, the degeneration and reabsorption of the cells, a process that is aided by androgen, and prevented by estrogen. As discussed in Schnatz (1985), there is no known difference between the preovulatory and secondary follicles that become atretic, but evidence has indicated that the ovary that eventually produces the corpus luteum has a higher concentration of estradiol than the ovarian vein of the other ovary, which may suggest that the preovulatory follicle is selected early in the cycle.

Ovulation occurs 16 to 30 hours after the LH surge (Schnatz, 1985). The ovum travels down the fallopian tube, where it may be fertilized. Cervical mucus thickens during ovulation in an attempt to aid the capture of sperm to facilitate fertilization. During ovulation (which is the point in the cycle during which the egg is actually released, and conception is most likely to occur, providing that the timing of sexual intercourse was precise), LH, FSH, and estrogen are at increased levels, with LH and estrogen being at particularly high levels (Carlson, 1991). Some researchers (e.g., Havez, 1979) define the ovulatory phase as the days of the cycle during which conception is most likely. Given that sperm can survive for up to 72 hours in cervical mucus, 24 hours in the corpus uteri, and 48 hours in the fallopian tubes (Havez, 1979), it has been suggested that day 12 is the day when sexual intercourse leads to the highest conception likelihood. Therefore, some authors consider the preovulatory phase to range from days 10 to 14 (e.g., Havez, 1979). However, more recent evidence suggests that the day prior to ovulation (typically day 13 in a 28 day cycle) is actually the day when intercourse leads to the highest conception likelihood (Dunson, Baird, Wilcox & Weinberg, 1999; Trussell & Raymond, 1999).

The fourth phase of the menstrual cycle is the luteal phase (days 16 to 28) (e.g., Havez, 1979). Once the egg is released from the ovary, the corpus luteum (solid body formed in the ovaries) produces progesterone and estrogens. In the absence of pregnancy, the corpus luteum perishes, and levels of progesterone drop. This process occurs towards the end of the luteal phase, with the drop in progesterone signaling the beginning of menstruation, and the recurrence of the cycle. During the luteal phase, LH and FSH levels are low.

Some authors further separate the luteal phase into early, mid, and late luteal phases, as the hormone levels are significantly different throughout these different stages. In the early luteal phase (sometimes known as the postovulatory phase - days 16 to 19), estrogen, LH, and FSH all drop fairly rapidly following ovulation, while progesterone starts to rise. In the mid luteal phase (around days 20 to 25), levels of LH and FSH are low and slowly dropping, estrogen levels rise slightly, to moderate levels, and progesterone levels rise and then level out at their peak. In the late luteal phase (often associated with the "premenstrual" phase - days 26 to 28), LH and FSH are very low and slowly dropping, estrogen levels drop back down, and progesterone levels drop rapidly.

Considering the range of physiological changes that are occurring over the menstrual cycle, it does not seem implausible to think that there are other changes that are occurring around these internal events. If women's bodies are experiencing so many internal events that *are* concealed from outside observers, is it not possible that external physical changes are occurring that may be detectable? The internal changes that are occurring are all processes that are meant to aid in procreation. Since species have evolved in a way such that those who are able to attract the fittest mate are rewarded with more fit offspring, it seems likely that some form of advertisement of fertility status may have evolved to aid in that goal as well. Some studies have examined these particular questions, and this research is outlined below.

Establishing Ovulation

There are many different methods used to determine whether ovulation has occurred, or is likely to occur soon. Some of these methods include ultrasound (e.g., McArdle et al., 1983; Vermesh, Kletzsky, Davajan, & Israel, 1987), daily basal body temperature readings (e.g., Parenteau-Carreau, 1981), cervical mucus monitoring (e.g., Parenteau-Carreau, 1981), hormonal readings by saliva, urine or blood samples (e.g., Gangestad, Thornhill, & Garver, 2002; Vermesh et al., 1987), and counting methods using reported menstrual cycle information (e.g., Gangestad & Thornhill, 1998; Jöchle, 1973).

Each of these methods has advantages and disadvantages for use in research. The ultrasound method is potentially the most valid method, as it can relay the exact moment of ovulation (Guermandi et al., 2001). However, it is also the most expensive, impractical, and invasive method.

Daily basal body temperature (BBT) readings are helpful, as a rise in temperature signals a rise in the level of progesterone (Parenteau-Carreau, 1981). This rise in progesterone occurs because the corpus luteum (or ovum) that has been released secretes large amounts of progesterone in order to support pregnancy (Schnatz, 1985). However, the rise in progesterone signals that ovulation has already occurred, and thus the participant may already be in the luteal phase. Thus, this measure of ovulation confirms ovulation after the fact. This is not helpful if one plans to assess women at ovulation. Another drawback to this method is that, in order to be useful, a participant must check and record temperature readings every day at approximately the same time, which may be an inconvenience to the participant. A recent study by Guermandi et al. (2001) examined the reliabilities of various ovulation prediction methods and found that BBT is an inaccurate method of discerning ovulation, because ovulation actually occurred between 6 days before, and 4 days after, the temperature rise. However, in studies where one wishes to determine the more fertile period (especially after the fact), BBT readings may still be a fairly accurate method.

Cervical mucus monitoring can also be useful in investigating time of ovulation. There are changes in consistency and thickness of cervical mucus across the menstrual cycle, with the mucus becoming thicker during the fertile phase of the cycle (Parenteau-Carreau, 1981). This process also seems to occur in response to heightened levels of progesterone secreted by the corpus luteum (Schnatz, 1985). However, a participant must be taught how to recognize differences in consistency across the cycle, and even after being taught, many women have indicated that they could not tell the difference. Researchers have acknowledged that the differences are often subtle (Parenteau-Carreau, 1981). There are also many mitigating factors that could contribute to difficulty in distinguishing changes in cervical mucus, such as vaginal infection, or amount of time spent in water (Parenteau-Carreau, 1981). Considering that most researchers have limited time to teach participants how to monitor these changes, and that some women may be uncomfortable performing the monitoring, this method may also be rather impractical.

Direct hormonal measures obtained through saliva, blood, or urine samples are useful measures of cycle phase as well. Saliva samples are assayed in labs, with the ability to detect many different hormones (for example, testosterones, progesterone, and estrogens) (e.g., Lac, 2001). However, this method can become quite costly and impractical with high numbers of participants. Blood samples may be impractical as well, as a qualified individual must be employed to obtain the samples, and thus, again, costs can be high. Time between testing and receiving results from lab analyses may also be quite lengthy, depending on the facilities available for these analyses. However, Guermandi et al. (2001) found that blood LH levels were a reliable measure of impending ovulation, as serum LH levels rise and then peak at 16.5 hours before ovulation. Urine samples can also be obtained and then analyzed by a lab. Finally, over the counter ovulation kits are becoming an increasingly popular method to detect ovulation (e.g., Guermandi et al., 2001). Some studies have shown that ovulation kits such as Ovustick, Ovusign, First Response and Clearplan Easy (which monitor LH surges) are 97 to100% accurate in detecting ovulation (Gangestad, Thornhill, & Garver, 2002; Poran, 1994; Vermesh et al., 1987). One study found that urinary ovulation kits were 100% sensitive, and 96% accurate, especially since the kits could detect the LH surge in evening urine, even if the surge had occurred in the morning (Guermandi et al., 2001). However, again, cost may be an issue with this method, as well as the potential problem of compliance of participants.

There are numerous counting methods that have been utilized in detecting cycle phase. The most commonly used method is that of Jöchle (1973), which estimates probabilities of conception based on the participant's cycle day. Most research has used a reverse cycle day count adjusting for cycle length (using the formula $F = L - 14$; where F is the last day of the follicular phase, and L is the length of the cycle), rather than a forward cycle day count. The reverse count is more effective as most of the variation in cycle length occurs due to variation in the follicular phase, independent of cycle length (i.e., there are almost always 14 days from ovulation to first day of menstruation, regardless of the length of the cycle) (e.g. Pillsworth, Haselton, & Buss, 2004; Schnatz, 1985). The advantage to the counting method is that it is fairly easy and noninvasive. As long as the participant notes the days of menstruation, one can use one of the counting formulas to reach an approximate day of ovulation. However, the disadvantage is that it is probably the least accurate method, particularly given recent research indicating large amounts of variability in women's ovulation phases (Fehring, Schneider, & Raviele, 2006).

The Evolution of Human Attractiveness

There are many traits that humans find universally attractive in potential mates. Many of these trait preferences are likely to have evolved over time, as they served adaptive purposes. Research has shown that men and women have differing goals when evaluating potential mates (Buss & Barnes, 1986; Gangestad & Simpson, 2000; Kaplan & Lancaster, 2003; Ridley, 2003; Townsend & Wasserman, 1998). Because women are limited in their reproductive output (due to the long gestational period), and because they are more often the caretakers of the resulting offspring, women have evolved to become the more "choosy" sex (Gangestad & Simpson, 2000; Ridley, 2003). It has been suggested that women have two goals when evaluating mates: (a) to obtain a mate that is fit from a genetic standpoint (indirect benefit), and (b) to obtain a mate that is fit from a parental/provider standpoint (direct benefit) (Gangestad & Simpson, 2000; Kokko, Brooks, Jennions, & Morley, 2003). Therefore, women are looking for a man that is both rich in resources, as well as rich in "good genes". Kokko and colleagues (2003) describe direct benefits as those that increase the female's fitness and lower reproductive costs directly, such as resources, fecundity, and parental care. They describe indirect benefits as those traits that benefit females indirectly, such as passing on superior genetic material to their offspring.

Gangestad and Cousins (2001) review research indicating that many men who show low fluctuating asymmetry (a marker of genetic fitness) are attractive to women, but only as short-term mates. Thus, women would be willing to have sex with these men, but would not be willing to have long-term relationships with them. And this does not seem to be a coincidence, as men with low FA tend to have more sexual partners (and extra-pair sex), are more dishonest, and take less care of offspring (Gangestad & Cousins, 2001). Thus, these men are "good genes" men, who can pass good genetic material (indirect benefits) on to potential mates, but do not seem to be (and are not rated as) good long-term mates (direct benefits). But are these two goals mutually exclusive? Some research seems to indicate that they are (e.g., Gangestad & Cousins, 2001), and as will be discussed later, women seem to have evolved mating strategies that may increase the chances of obtaining both types of benefits for their offspring (Bröder & Hohmann, 2003; Chavanne & Gallup, 1998; Frost, 1994; Gangestad & Cousins, 2001; Penton-Voak & Perret, 2000; Rikowski & Grammer, 1999)

Of equal import in this type of research is the question of what men are looking for in a potential mate. Men have the potential to procreate many more times over the lifetime than women. This should result in a differing mating strategy. It is most adaptive for men to attract women who are healthy, fertile, and young. Women have larger gamete size then males, and as such, they experience greater initial energetic investment in offspring, through gestation (which is relatively longer in humans and nonhuman primates than most mammals of similar size) (Dufour & Sauther, 2002), and early childrearing (e.g., breastfeeding) (Kaplan & Lancaster, 2003). Men are able to mate with multiple partners because they do not incur the costs of gestation and early parental care. This leads to a greater number of sexually receptive males than there are sexually receptive females. This leads to higher instances of male-male competition (Geary, 2000). Humans are a mostly monogamous species, as has been discussed, and as such, if a man (who is physically designed to be able to reproduce many more times than a woman) is to focus his reproductive and investment effort on one female instead of many, he must be sure that the female he chooses is most likely to produce more, and healthier, offspring for him. Thus he must obtain a mate that is healthy and fertile (to ensure mating success, and health of his offspring), and she must be young, as the younger she is, the more potential offspring she can provide him with. As men also prefer women who are attractive (Buss & Barnes, 1986; Thornhill & Grammer, 1999; Townsend & Wasserman, 1998), it would be adaptive if characteristics that men consider attractive actually reflect health and fertility. Thornhill and Grammer (1999) relayed evidence that attractiveness is not only a sign of overall genetic fitness, but that it is also an adaptive feature. The authors consider the Fisherian view, which espouses the theory that reproducing with an attractive mate ensures the passing of attractive features to one's offspring, thereby giving one's offspring a higher chance of securing their *own* mate.

In a study by Townsend and Wasserman (1998), participants looked at pictures of attractive models, and listened to a description of the person. The models were described as either being successful and ambitious, or low income and not interested in high-powered careers. Participants were asked to rate each model on their desire to date/have sex with/marry them. Men were much more likely to be interested in the person, regardless of their success/ambition status, while women were more likely to take the success/ambition status into account. In a second study, participants were asked which qualities would influence whether they would want to have sex with the model. The results indicated that men and women were equally mildly interested in popularity/peer opinion, men were much less interested in commitment and status traits, and women were much less likely to choose visually inspired sexual desire than men were. These results suggest that physical attractiveness of a mate is more important to men than women.

In a similar study by Buss and Barnes (1986), married couples were asked to individually rate a wide variety of traits on a Likert scale, in terms of how attractive the trait was in a potential spouse. The items represented social, physical, personal, goal, and background attributes. The results indicated that women and men rated different attributes as being more important to them in mate selection. Women were more interested in partners that would be more likely to make good providers *and* good genetic mates, while men preferred traits that were more likely to indicate good health and good genes.

A study by Li, Kenrick, Bailey, and Linsenmeier (2002) examined whether there were differences in men's and women's "necessities and luxuries" in mating preferences. They used social exchange theory to test whether or not men and women had specific features that were necessary when evaluating potential mates, and whether there were features that they would prefer as luxuries. The results of three different studies with different methodologies found that men valued attractiveness in a partner, while women valued status. As more constrains were put on the "mating budget", the more men described attractiveness, and women described status, as the most necessary element.

Thus, because men were more likely to choose attractiveness as an important feature the more constraints were put on the "mating budget", the more important that feature was found to be in a potential mate.

Rhodes, Simmons, and Peters (2005) found that attractive women had more long-term partners than did less attractive women. Because long-term partners are more adaptive for females (having the higher reproductive costs), the finding that attractive women are more successful in obtaining long-term mates suggests that attractiveness in women is an attribute that is reproductively adaptive. This study showed the opposite finding for men: attractive men had had more short-term partners than did less attractive men.

We have now established that men are generally interested in attractive women as potential mates. But what traits do men find attractive? Are the traits that men find attractive also indicators of good genes? Is it possible that these traits have been selected through both natural and sexual selection?

Determinants of Attractiveness

There are many universal factors involved in human attraction. Included in the list of physical traits that human males find attractive in human females are low fluctuating asymmetry (FA) (e.g., Jones et al., 2001), low waist-to-hip ratio (WHR) (e.g., Singh, 1994), facial neotony (e.g., Jones, 1995), clear skin texture and lighter colour (e.g., Fink, Grammer, & Thornhill, 2001), and a body mass index (BMI) in the lower normal range (e.g., Thornhill & Grammer, 1999). There are possible evolutionary reasons for why these traits are preferred over others, and these reasons are outlined below.

Fluctuating asymmetry (FA) refers to the extent to which bilateral anthropometric features (e.g., ears, breasts, digits, eyes) differ in levels of symmetry. This asymmetry is believed to be the result of a less than optimal buffering capacity against developmental abnormalities due to parasites, ecological factors such as pollution, and stress (Møller, 1992; Parsons, 1990; Rhodes, 2006; Thornhill & Gangestad, 1993; Van Valen, 1962). Thus, symmetrical features are thought to be a sign of fitness and "superior" genes.

Human FA has been correlated with a number of different factors. For example, negative correlations have been discovered between FA and ratings of attractiveness (Gangestad, Thornhill, & Yeo, 1994; Singh, 1995; Tovée, Tasker, & Benson, 2000), violence (Furlow, Gangestad, Armijo-Prewitt, 1998; Manning & Wood, 1998), and sperm quality and ejaculate size (Manning, Scutt, & Lewis-Jones, 1998). Positive correlations have been discovered between FA and romantic jealousy (Brown & Moore, 2003), and lifetime number of partners and age of first copulation (Thornhill & Gangestad, 1994). An interesting study (Thornhill, Gangestad, & Comer, 1995), even found a negative correlation between male FA and frequency of female partner orgasm. Thus, fluctuating asymmetry appears to be a very important factor, not only in terms of whether or not one is judged to be attractive by potential mates, but also in terms of a person's sexual and reproductive health and prospects.

A few studies (e.g., Manning et al., 1996; Scutt & Manning, 1996) have shown that some measures of FA change with women's menstrual cycle phases. These studies found that FA was highest at the beginning and end of the menstrual cycle (the "infertile" phases), and lowest midcycle (the "fertile" phase), as judged by cycle day as well as ultrasound. This finding could mean that ovulation is not as concealed as once believed, as it is possible that a woman's partner may notice these subtle changes over the cycle, and the detection of these changes could potentially lead to an increased likelihood of copulation during the fertile phase.

Tovée, Tasker, and Benson (2000) used a forced choice paradigm, showing two pictures of the same woman, one that was symmetrical and another that was asymmetrical (computer software was used to alter the photos). Men preferred the symmetrical photos of the women. This study also showed that waist-to-hip ratio (WHR), and body mass index (BMI) were also important factors in the participants' choices.

In Jones and colleagues' (2001) study, participants were asked to rate photos of both sexes on attractiveness and apparent health. The results showed that there were negative correlations between FA and attractiveness, and between FA and apparent health, and positive correlations between attractiveness and apparent health, especially in regards to the photos of women. However, when the authors controlled for perceived health, the negative correlation between asymmetry and attractiveness no longer reached significance. This finding suggests that the perceived health of more symmetrical individuals may be the reason that symmetrical features are considered attractive. In a second study using a forced choice paradigm with pictures of the same people altered for symmetry, the authors found that the symmetrical faces were still considered to be healthier, but also found that the differences were more pronounced when the participants rated the opposite sex.

Waist-to-hip ratio is another important determinant of female attractiveness (Furnham, Dias, & McClelland, 1998; Singh, 1994). WHR is a measure of the waist circumference, divided by the hip circumference. WHR is a reliable measure of body fat distribution, and is an indicator of overall health (stress, nutrition, diseases, hormonal state, and phenotypic quality) (Singh, 1995). WHR has also been linked to fertility (Zaadstra et al., 1993). Zaadstra et al.'s (1993) study showed that as WHR increases above .70, fertility and conception probability decrease. A WHR between .67 and .70 is considered to be ideally attractive, and this is no accident. A WHR level within this range is also optimal for fertility (Zaadstra et al., 1993). If WHR is too low, fertility is presumably compromised, though there appears to have been little to no research conducted on the fertility issues for those with extremely low WHRs. It is possible that an extremely low WHR (e.g., .50) is so rare that it may indicate some genetic abnormality, which would affect fertility. However, there don't appear to be any published studies related to this issue.

Furnham and colleagues (1998) discussed why the WHR range of .67 to .70 is considered most attractive. When males and females are young, they have similar WHR levels. Once puberty and hormone surges begin, a woman's body begins to redistribute fat to the lower areas of the body (thighs, hips and buttocks), and thus a lower WHR level is achieved. During pregnancy, as the fetus develops and a woman's belly grows, waist circumference increases, and thus leads to higher WHRs. In menopause, a woman's WHR level again rises to higher levels. These facts indicate that female sex hormones (e.g., estrogen and progesterone) are involved in WHR differences. Thus, WHRs ranging from .67 to .70 may be considered most attractive because they signal achievement of puberty, lack of pregnancy, and premenopausal status.

Singh's (1995) study found that women with higher WHRs were rated as less attractive, less feminine, less healthy, and older. Male participants also stated that they would be less willing to engage in long-term relationships with those with higher WHRs.

Surprisingly, no differences were found between the low WHR and high WHR figures when the participants were asked about reproductive capability. So, although lower WHRs do indicate higher fertility, it is possible that the attraction of males to lower WHR women is an adaptive, evolved, innate selection mechanism for fertile women, even though males do not seem to be consciously aware of the connection between low WHR and fertility.

In their 2003 study, Hughes and Gallup found that WHR in women was positively correlated with age at first intercourse, and negatively correlated with number of sexual partners, number of extra pair copulation (EPC) partners, and number of people for whom the participant had been an EPC partner. This study gives credence to the idea that lower WHRs are considered more attractive to males.

A relevant study by Mikach and Bailey (1999) examined which traits were most salient in women with high numbers of sexual partners. They found that, contrary to their prediction, women with high numbers of past sexual partners (an average of 57.5 lifetime partners) had lower WHRs than those with low numbers of sexual partners (an average of 4.1 lifetime partners). The high-partner women also reported being more interested in casual sex, having earlier sexual experiences, an earlier loss of virginity, placing more importance on their partners' physical attractiveness, and considering themselves as being more masculine as children and as adults. The authors of this study suggest that women with high numbers of partners are more attractive as potential mates (as well as being rated as more physically attractive), and thus are able to choose more attractive mates for themselves, as well as having more offers of sexual encounters due to their overall attraction value. This is described as being an evolutionarily adaptive situation, where those with higher mate values are able to choose mates who also have higher mate values, and an attractive woman is able to pass on her own "good genes" and unrestricted sexuality to her offspring while also allowing the man's genetic tendency for physical attractiveness to be passed on as well. Thus, this study suggests a link between WHR and sociosexual orientation, which in turn creates another link between WHR and mate selection in humans.

Body mass index (BMI) has also been found to be an important factor in attractiveness (Furnham et al., 1998; Pettijohn & Jungeberg, 2004; Thornhill & Grammer, 1999). BMI is a measure of body fat, using the following formula: weight (kg) divided by height (meters) squared, or kg/m^2. Reference ranges for BMI in the medical community are as follows: below 18.5 is considered to be underweight, 18.5 to 24.9 is normal, 25.0 to 29.9 is overweight, and over 30 is obese (Health Canada, 2003). Research has shown that lower BMI is valued in cultures and times where food is abundant, and higher BMI is valued in cultures and times when food is scarce (Manning, 1995). Body fat plays an important role in the beginning of menarche at puberty, with 17% body fat being the level necessary to initiate menarche (Dhall, 1995; Klentrou & Plyley, 2003; Van Der Spuy & Jacobs, 1983). The optimal range of BMI for fertility is within the normal range (18.5 to 24.9), as women in the underweight category are at considerable risk of infertility, while those in the obese category are at risk for impaired fertility (Health Canada, 2003).

Furnham and colleagues (1998) had participants rate figures on attractiveness, willingness to engage in long- or short-term relationships, age, kindness, and fertility. Figures in the lower weight category were judged more highly on all dimensions except kindness and age, and men reacted more negatively to the heavier figures than women did. Both figures were judged equally on ratings of health, which the authors pointed out was surprising, as the thinner figures should have been judged as having more fertility problems. However, the authors did note both that the current media image of thinner women as more attractive may have coloured the opinions of the participants, and also that the participants may have been judging the figures as "normal" and "obese" rather than "underweight" and "obese", and thus their responses would correspond with the agreed upon levels of healthy weight.

Neotenous features are those features that signify youth, specifically large eyes, a small nose, full lips, a small chin, and rounder cheeks ("baby faces") (Jones, 1995; Pettijohn & Jungeburg, 2004). Jones (1995) argues that men are more attracted to more neotenous features, and that the reason for this preference is the fact that neotenous features indicate youth, and thus, higher fertility. Pettijohn and Jungeburg (2004) studied Playboy Playmates over time. Their hypothesis was that, over time and in different cultural conditions, men would prefer different face and body types. They hypothesized that in threatening times, the preference would be for more mature (thus, less neotenous) features, and in nonthreatening/optimistic times, the preference would be for neotenous faces. The results of this study supported the hypothesis to a certain extent, but found that chin size and facial thinness did not show any significant results.

Faces with blemish-free smooth skin are more attractive than faces that have blemishes (Fink, Grammer, &Thornhill, 2001; Rhodes, Hickford, & Jeffrey, 2000). Lighter-than-average skin has also been found to be more attractive in women than darker skin, a finding that holds true in cross-cultural studies as well (Aoki, 2002; Barber, 1995; Cunningham, Roberts, Barbee, Druen, & Wu, 1995). One study also correlated lighter skin tone in Black women with higher socioeconomic status, higher self-esteem, and higher probability of marriage (Udry, Bauman, & Chase, 1971). Some studies, however, have found the opposite to be true: that darker skin is indicative of higher attractiveness (e.g., Fink, Grammer, & Thornhill, 2001). Researchers have attempted to explicate the significance of skin tone and attractiveness, as well as possible evolutionary reasons for a preference. In regards to smooth, blemish-free skin, Johnston, Miles, Carter, and Macrae (2005) explained that women have lighter, smoother, and less blemished skin around ovulation, while skin is darker and more blemished around menstruation. Their study found that women had fewer blemishes at ovulation than women on the pill. Thus, acne and other blemishes may signal that women are not currently in the high fertility phase. Blemish-free skin is probably also reflective of better health.

In terms of skin colour, lighter skin is actually less adaptive than darker skin (Aoki, 2002), as darker skin is more resistant to harmful UV rays. So it seems perplexing that this trait would become a signal of attractiveness. However, Aoki's (2002) study discusses the role of sexual selection, rather than natural selection, in the evolution of light skin being more attractive. Light skin has been described as being a neotenous feature (Cunningham et al., 1995). As discussed above, neotenous features are valued, as they are signs of youthfulness. However, light skin is also a sign of femininity and sexual maturation, as females have lighter skin than do males, in general, and because estrogen is responsible for the lightening of skin at puberty. Hormones potentially alter skin tone throughout the menstrual cycle, and the lifetime, as skin becomes darker during pregnancy, menstruation, while taking oral contraceptives, and after menopause (Barber, 1995). Thus, it appears that skin colour and texture are cues to femininity, fertility and health, and thus attraction to lighter skin colour, and a smooth blemish-free texture, is logical from an evolutionary perspective, and probably not coincidental.

The findings outlined above appear to suggest that many of the traits that are considered to be attractive in human females are probably adaptive from an evolutionary perspective. It is unlikely to be a coincidence that, for a gender (i.e. males) that seeks a mate who is young, healthy, and fertile, the determinants of attractiveness also represent these features. Given that these characteristics (low FA, low WHR, facial neotony, clear skin texture and lighter colour, and BMI in the lower normal range) are important factors in attractiveness, that attractiveness is supposed to provide cues about fertility, and that fertility changes across the menstrual cycle, one might also wonder whether these physical characteristics also change across the cycle.

Attractiveness Over the Menstrual Cycle

Very little research has been undertaken to address the issue of whether or not women's physical attractiveness changes over the menstrual cycle. One study by Roberts et al. (2004) investigated whether women's faces became more attractive during the fertile phase of the menstrual cycle. A similar study by Smith et al. (2006) examined the link between hormonal levels and ratings of attractiveness, health and femininity. Finally, Johnston et al. (2005), assessed whether there were effects of menstrual cycle phase on person-construal ratings of men.

Roberts et al. (2004) took standardized digital photographs of the faces of 48 women (between 19 and 33 years old) during both the late follicular (days 8 to 14) and mid luteal (days 17 to 25) phases. Female and male raters were then asked to rate the photos for attractiveness in a forced choice task. The photos were shown both with ears and hair obscured, as well as with these features showing. This study found that both women and men were more likely to choose the late follicular photos as more attractive than the luteal photos, whether the ears and hair were obscured or not. However, the study also showed that women were much more likely than men to choose the late follicular photos as more attractive when hair and ears were not obscured. The authors assert that this suggests that women may be better able to detect subtle cyclical changes that provide cues to other women's fertility.

Roberts and colleagues (2004) did not obtain separate ratings of attractiveness from the photographed women's partners to determine whether they would be more likely to notice changes over the cycle. However, they did ask a subsample of the photographed women to choose which of their own photographs they thought was the most attractive. More than half of these women chose the follicular photograph as more attractive. The authors of the study related that this was almost equal to the results of the overall sample. They suggested that given that women were no better than others at selecting their own follicular phase photo as more attractive, long-term partners may also be no better at picking up on fertility cues than the overall population. However, this conclusion seems speculative and this is an issue that has not yet been directly tested.

In the study by Smith et al. (2006) urinary hormonal assays of estrogen and progesterone were obtained from 59 women (aged 18 to 24), and digital photos were taken of each woman's face, weekly for 4 to 6 weeks. Composite photos were then compiled from the women with the highest ($n = 10$) and lowest ($n = 10$) late follicular estrogen levels. Hair and clothing information was obscured. The women kept daily journals of menstrual cycle information, and this information was used in conjunction with the hormonal assays to determine menstrual cycle phase. Additional participants (15 females and 14 males, aged 18-25 years) were asked to rate the original photos for femininity, perceived health, and attractiveness, on Likert-type scales. Then, 11 females and 10 males rated the composite photos in a forced choice paradigm, again on femininity, perceived health, and attractiveness. The results of this study showed that, after controlling for those women who wore makeup, there was a statistically significant association between late follicular estrogen levels, and perceived health, femininity, and attractiveness, whether rated by male or female raters. When makeup was not controlled for, it was found that the women who were wearing makeup in the photos were seen as more healthy, attractive, and feminine. There was a much smaller link between progesterone levels and health and attractiveness, though these correlations were not seen in the woman who had makeup on. Overall, the results of this study suggest that faces become more attractive as estrogen increases, as judged by raters of both sexes. However, makeup appears to play a role in judgments of female attractiveness.

Johnston et al.'s (2005) study assessed how quickly men were able to categorize low-fertility or high-fertility women by sex. The target photos consisted of 10 men and 10 women. Five of the women were oral contraceptive users and five were not. All women maintained regular menstrual cycles. Each of the models had their photographs taken twice, with the women having their photos taken at both a high fertility (ovulation) and a low fertility (menstruation) phase. The authors divided the women into low and high fertility times using Jöchle's (1973) reverse counting method. Ovulation was assumed to occur on day -14, and thus high fertility was considered to be between days

-13 to -15. The low fertility period was day -1 to day 2 (menstruation). The photos were colour frontal head and shoulder photos. All models were asked to pull their hair back, keep neutral facial expressions, and women were asked to wear no makeup. Two coders were asked to identify any blemishes or irregularities in skin texture, or colour. It was noted that in all models but one, more blemishes were noted during menstruation than ovulation, contraceptive users had fewer blemishes than nonusers, and no change in blemishes was noted between photograph sessions for the male models. Twenty-seven males served as the raters in this study. The task consisted of each participant being exposed to all 40 photos (2 photos of each of 20 models), one at a time, and recording the sex of each model as quickly and accurately as possible. Each photo remained on a computer screen until the participant responded, and latency and accuracy were recorded. The results for this study determined that males had faster mean reaction times when identifying females in the low-fertility period (menstruation), rather than the high-fertility period. This finding persisted even when the models were using oral contraceptives. The authors suggested that this ability could be helpful in identifying a potential mate's future fecundity, rather than immediate fertility. This would be adaptive in that the information may represent that this is a potential mate that one could gain *future* access to, rather than necessitating immediate access. The authors also included a sample of 17 female raters in order to determine whether women were also privy to this cyclical information, and found no significant results, either with the contraceptive users or nonusers.

A previous study by the author also examined whether women's bodies change over the menstrual cycle in a way that might make them more attractive to potential mates during higher fertility periods (Patola et al., 2006). The variables measured were fluctuating asymmetry (FA), waist-to-hip ratio (WHR), body mass index (BMI), and second-to-fourth digit ratio (2D:4D). Fifty-one women (ages 18 to 40) were divided into menstrual cycle groups using prospectively collected menstrual cycle information provided by the women, and using the reverse count method. Each woman was in one of six groups, depending on which two phases of the menstrual cycle they participated in: menstrual to luteal phase (ML), luteal to menstrual phase (LM), menstrual to preovulatory phase (MP), preovulatory to menstrual phase (PM), luteal to preovulatory phase (LP), or preovulatory to luteal phase (PL). During each of two sessions, saliva samples (for use in progesterone correlation measures) and body measurements were obtained. The results of this study indicated that in the preovulatory phase, women had lower overall FA but higher digit 4 FA than in the menstrual phase; and in the menstrual phase, women had lower overall FA and digit 4 FA than in the luteal phase. WHR did not change significantly across the menstrual cycle, though a very weak trend showed that WHR was lower during the preovulatory phase. No significant results were found for BMI, however a very weak trend indicated that BMI was lower in the preovulatory versus the menstrual phase, and lower in the luteal versus the menstrual phase, which seems to be consistent with previous research stating that women eat less around ovulation, and more during menstruation (Fessler, 2003). No significant menstrual phase effects were obtained for 2D:4D, but weak trends indicated that 2D:4D was higher in the preovulatory than the menstrual phase, and higher in the luteal versus the menstrual phase. When progesterone levels were considered, it was found that as progesterone increased, BMI decreased, and 2D:4D and hand FA increased. Trends also suggested that as progesterone increased, total bodily FA, and fourth and fifth digit FA increased. The most important factor when analyzing the progesterone data seemed to be that the correlations were strongest when progesterone and estrogen were both changing in the same direction, and when testosterone was changing in the opposite direction (i.e. estrogen and progesterone both decreasing, and testosterone increasing, or vice versa). Although significant results were not found for many of the measures, there was a fairly small sample size (a range of 6 to 11 women per group), and thus more significant results may be found with a larger sample. However, taken together, the significant results and the general trends do indicate that women's bodily measures change over the menstrual cycle, and in ways that may cause them to be more attractive around ovulation.

Thus it appears that women's bodies may change over the menstrual cycle, such that they appear more attractive to potential mates around ovulation. If this is the case, then is ovulation truly a concealed event? Is it possible that women *are* displaying visual cues to fertility status that potential mates (or current mates) may be picking up on? Research has shown that women change in other ways over the menstrual cycle, and these changes may also be cues to potential mates that a woman is fertile.

Physical and Behavioural Changes Across the Menstrual Cycle

There are many changes that occur over the menstrual cycle besides the neuroendocrinological changes described earlier. It has been suggested that many of these changes occur because of evolutionary adaptations. As fertility capabilities shift across the menstrual cycle, so do ideal mate characteristics, and both behavioural and mate selection tactics. For example, olfactory and behavioural changes across fertile and nonfertile periods have been noted in both marmosets (Converse, Carlson, Ziegler, & Snowdon, 1995) and humans (Doty, Ford, Preti, & Huggins, 1975; Fessler, 2003;

Gangestad et al., 2002; Grammer, Renninger, & Fischer, 2004; Haselton, & Gangestad, 2006; Havliček, Dvořáková, Bartoš, & Flegr, 2006; Kuukasjärvi et al., 2004; Pillsworth, Haselton, & Buss, 2004; Poran, 1994; Singh & Bronstad, 2001). The human studies will be described in detail as they suggest that women may provide olfactory cues to their ovulatory status.

Poran (1994) carried out a rigorous study examining female odour changes across the menstrual cycle. Women collected odour samples from five different areas of the body (saliva, vagina, labia minor, and sweat from the underarm and loin), at five different times during the menstrual cycle. Ovulation was established by the use of an ovulation detection kit (Clearplan Easy). The first samples were taken 1 to 2 days after cessation of menstruation, the second samples were obtained 1 to 2 days before ovulation, the third samples during ovulation, the fourth samples 1 to 2 days after ovulation, and the final samples were obtained a week prior to next predicted menses. The woman's pair-bonded partner then rated these odour samples. There was a significant difference between pleasantness and cycle phase, with the ovulatory samples being rated as most attractive.

Singh and Bronstad (2001) examined whether menstrual cycle phase affected odour in 17 Caucasian women with regular menstrual cycles who were not using oral contraceptives. The women were provided with two T-shirts, along with various unscented cleaning products. They were required to wear each shirt for three days (days 13 to 15 for the follicular period, and days 20 to 22 for the luteal period), and after wearing, to store them in the freezer in a freezer bag. Bags were labeled to distinguish between follicular or luteal phase. For the attractiveness ratings, the T-shirts were thawed to room temperature. The 52 Caucasian males who rated the shirts were told that the shirts had been worn by women who differed in attractiveness (they were not told that the shirts were worn at differing points in the menstrual cycle). The males were instructed to rate the shirts on a Likert scale for intensity, pleasantness, and sexiness. The evaluators rated the still-thawed shirts on the same measures one week later, as a measure of whether or not odours dissipate over time. The results of this study indicated that the odours from the follicular phase shirts were rated as sexier than the luteal phase odours in 15 out of 21 shirt pairs. Menstrual cycle phase significantly predicted ratings of sexiness and pleasantness, but not intensity, and these results were consistent after 7 days.

In their 2004 study, Kuukasjärvi and colleagues used a similar study paradigm to that of Singh and Bronstad (2001), with a few modifications. Eighty-two women (both oral contraceptive users and nonusers) were given one T-shirt washed with unscented soap, which was to be worn for two consecutive days. Menstrual cycle phase was established based on self-report of the first day of their last menstrual period, and data was collected as to mean cycle length. Three separate dates were chosen as rating days, and the women wore the T-shirts for two consecutive days before one of the three days. The raters in this study consisted of 31 males and 12 females, who rated the shirts on each of the three rating days. T-shirts were placed into glass jars, along with a shirt that had not been worn (which served as a control). Each evaluator rated each shirt on a 10-point scale of attractiveness and intensity. Males preferred the odours of women who were currently in the ovulatory phase of the menstrual cycle. Interestingly, women also showed a trend in this direction, which suggests that women may also be able to detect cues as to another woman's fertility status. There were no significant results discovered for the ratings of odours of women who were taking oral contraceptives, and also no significant findings for ratings of intensity.

In a more recent study, Havliček and colleagues (2006) also examined body odour over the menstrual cycle. Nineteen free-cycling women with regular menstrual cycles were asked to wear cotton pads fastened to their armpits with unscented paper plaster for 24 hours. This was done during three menstrual phase periods: menstrual (days 1 to 6), follicular (days 7 to 14) and luteal (days 15 to 28) phases. This method was used for women with 28-day cycles. If cycle length differed from 28 days, the reverse count method was utilized. Once removed, the pads were put into a jar and given to experimenters. The odours were rated within one hour to control for possible effects of refrigeration. Fifty-one males acted as evaluators for this study, always rating the scents of the same women. The odours were rated on a 7-point scale for intensity, pleasantness, sexual attractiveness, and femininity. The results of this study indicated that ratings of pleasantness and attractiveness were highest during the follicular phase, and lowest in the menstrual phase. The opposite was true for ratings of intensity. The authors suggest that these findings are consistent with the belief that more intense odours are considered to be more masculine. Thus, more intense odours during the menstrual phase would be rated as less pleasant or attractive. No significant links between ratings of femininity and cycle phase were discovered.

These four studies suggest that scent changes across the cycle can be a potential cue to fertility status in women. Thus, Havliček et al. (2006) suggested that human female ovulation should be considered to be "nonadvertised", rather than concealed.

It appears that numerous behaviours change across the menstrual cycle, both in women and their partners. It has been found for example, that women eat less during ovulation (Fessler, 2003), and women's sexual desire and sexual intercourse frequency increase during ovulation (Gangestad et al., 2002; Haselton & Gangestad, 2006; Pillsworth et al., 2004; Wilcox et al., 2004). Furthermore, women show more skin, wear more sheer clothing, and tighter clothing during ovulation (Grammer et al., 2004); prefer the odours of more attractive, more symmetrical men while ovulating (Rikowski & Grammer, 1999); and prefer more masculine male faces while ovulating (Frost, 1994; Penton-Voak & Perret, 2000). Finally, women's risk-taking behaviours and risk of rape decrease during high fertility periods (Bröder & Hohmann, 2003; Chavanne & Gallup, 1998). Nevertheless, their partners become more jealous and are more likely to engage in mate-guarding tactics during ovulation (Gangestad et al., 2002; Haselton, & Gangestad, 2006). These findings are discussed in more detail below.

Fessler (2003) reviews the finding that women consume less food around the ovulatory phase of the menstrual cycle, and also outlines research indicating an increase in eating behaviours around the premenstrual (or late luteal) period. This paper suggests that the premenstrual increase in eating behaviours makes adaptive sense, as it could be explained in terms of energy costs in constructing and maintaining the endometrium, or could be an effort to increase caloric intake in case of pregnancy. However, the ovulatory drop in caloric intake is not so easily explained. The author of the 2003 study suggests that the drop in caloric intake occurs due to a shift in goal directives. The foraging goal is downgraded, while the mating goal is brought to the forefront. The woman will not squander valuable energy on foraging behaviours while the mating goal is more salient. Thus, priorities have shifted. This study indicates that not only do women's behaviours change over the menstrual cycle, but also that these changes in behaviour may have evolved due to adaptive shifts in goals over the menstrual cycle.

Grammer and colleagues (2004) studied clothing types worn in Austrian discos and examined the clothing choices based on sexual motivation (self-reported), relationship status, whether or not partners were present, and estradiol and testosterone levels. They found that sheer clothing positively correlated with motivation for sex, and also with increasing testosterone (and in some cases, estradiol) levels. Women who were at the disco unaccompanied by their partners were found to have levels of skin display that correlated positively with estradiol levels. The women involved in the study were found to understand the "rules" regarding clothing types and sexual motivation, and seemed to display skin according to sexual motivation. This finding suggests that women's behaviours do change across the menstrual cycle depending on their sexual motivation and hormonal levels.

There is a vast body of literature (e.g., Gangestad et al., 2002; Haselton & Gangestad, 2006; Pillsworth et al., 2004; Wilcox et al., 2004) that has examined whether or not women's sexual desires and sexual intercourse frequency change over the menstrual cycle. Although some have found no differences in sexual arousal over the cycle (Meuwissen & Over, 1992; Schreiner-Engel, Schiavi, Smith, & White, 1981), many have found that women are more interested in, and more frequently engage in sex during the ovulatory phase than in other phases of the menstrual cycle (e.g., Gangestad et al., 2002; Haselton & Gangestad, 2006).

Wilcox et al. (2004) considered patterns of intercourse in relation to menstrual cycle day, citing previous research that states that intercourse should be increased at times of increased fertility, and also that intercourse can, in some cases, stimulate ovulation. The study involved 68 American women who were in stable sexual relationships, and all used nonhormonal forms of birth control. The participants provided daily urine samples as well as a daily journal outlining sexual activity. Urine samples were assayed in order to determine the day of ovulation, using LH surge as the mitigating factor. The five days preceding ovulation and the day of ovulation were used as the highest fertility period. The results of this study showed that sexual activity did increase during the six-day window, with the highest frequency being on the day of ovulation itself, and the day prior to ovulation, with a decline thereafter. The authors of this study describe this increase as possibly an increase in libido in either the woman or her partner (though they did not collect data for libido state) in the six days prior to and including ovulation, or possibly an acceleration of ovulation brought on by intercourse. In regards to the latter postulation, the authors describe previous research (by Bakker & Baum, 2000) that showed that in some mammals, intercourse activated a release of gonadotropin-releasing hormone (GnRH), which thus triggers the release of the LH surge that precedes ovulation. This LH surge causes the ripe ovarian follicle to luteinize and rupture (ovulation). The authors found weak correlational evidence to suggest that acceleration of ovulation through intercourse may be a plausible explanation for the six-day increase in intercourse. However, more study is necessary to strengthen this finding.

Gangestad et al.'s (2002) study investigated whether women's sexual interests differed between two phases of the menstrual cycle, and whether male partner's behaviours changed to coincide with these interests. The two phases investigated were: within 5 days after a luteinizing hormone surge (which coincides with ovulation), and during the luteal phase. Ovulation was established using a urinary ovulation detection kit

(Ovusign), and women were asked to come in within 5 days after the LH surge. Luteal phase sessions were scheduled for at least one week after the LH surge, with the average being 10.9 days after the LH surge, and 8.1 days prior to menses. Participants were 51 American women (mean age of 19.6 years) not using hormonal contraceptives. The participants filled out questionnaires in each of the high fertility and low fertility phases. The questions related to sexual desire in general, and attraction to or fantasy about a current sexual partner or someone besides the current partner. A second questionnaire included questions regarding mate retention tactics (e.g., vigilance, spoiling, extra-pair sexual attention). The results indicated that women experienced higher rates of attraction to men other than primary partners during the fertile phase of the menstrual cycle, with greater increases occurring closer to ovulation. Although women did not feel heightened attraction to their primary partners during the fertile phase, they did report initiating more sexual encounters with them. When mate retention tactics were considered, the women reported that their partners were more vigilant closer to ovulation, and this finding was strengthened in those who reported that their relationship was not an exclusive one. The women who reported the highest level of partner vigilance were the ones who also reported the most fantasy and attraction to others besides the primary partner. Thus, male partners' heightened vigilance may have occurred in response to altered behaviour in the women. Thus this study may suggest that women's behaviours (especially towards men other than their primary partner) may change in response to changing hormonal levels and fertility status.

In their 2004 study, Pillsworth and colleagues investigated whether or not women's desire increases as a function of increased conception probability. They predicted that desire would increase in higher fertility periods, but only if the women were in committed long-term relationships. They also predicted that a shift would occur for a primary partner as opposed to extra-pair partners as ovulation approached, depending on the woman's evaluation of her partner's quality. The participants in this study were 202 American females not using hormonal contraceptives (mean age of 18.5 years). The participants completed questionnaires consisting of questions regarding assessments of their relationship, menstrual history, subjective feelings of sexiness, attractiveness and desire, extra-pair sexual desires, and in-pair sexual desires. Cycle day was calculated using the reverse count method. Only women who were in long-term relationships experienced higher levels of sexual desire during higher fertility times. The study also found significant negative correlations between satisfaction (with current relationships) and extra-pair desire, and relationship commitment and extra-pair desire. Extra-pair desire is lower when subjective feelings of relationship quality are higher, and those who were in longer relationships had higher reports of extra-pair desires during high fertility periods than those who were in shorter relationships. When in-pair desires were considered, it was found that there were positive relationships between conception probability and in-pair desires, and commitment and in-pair desires, though the latter finding was only just significant. Relationship length showed a negative relationship with in-pair desires. The results of this study seem to suggest that women's behaviour concerning extra-pair flirtations and attraction may be a cue to her fertility. It seems likely that if a woman is more attracted to those other than her primary partner during ovulation, a partner may be picking up on these feelings and possibly on behaviour such as extra-pair flirting.

Haselton and Gangestad (2006) sought to replicate the findings of this study, and to discover whether or not partners respond to these types of feelings or behaviours. The results of their study showed that women whose partners had low sexual vs. investment attractiveness were more likely to be attracted to men other than their partner when fertile. Men who are low in sexual attractiveness also show the greatest increases in jealousy and possessiveness when their partner is in the fertile phase of the menstrual cycle. However, there was a difference noted when the attractiveness of the female partner was taken into consideration. Women who were more attractive had partners who mate guarded fairly steadily across the cycle, while females who were rated as less attractive had partners who became more jealous and possessive around the fertile phase of the cycle. The study also found that men who were perceived as having a higher mate status tended to be less loving and attentive overall. Women also reported feeling more powerful and desirable than their partners during the fertile phase of the cycle, especially those whose partners were not attractive as short-term partners. Women were found to feel more attractive and sexy near ovulation, and to be more interested in going out to places where they might meet men. This finding was not moderated by relationship status. The authors of this study discovered that mate-guarding and women's reports of flirtatious behaviours were strongly positively correlated, suggesting that male partners were using women's behaviour as a cue to ovulation. The results of this study seem to provide evidence for a good genes hypothesis of human mating strategies. That is, women are more likely to be attracted to extra-pair men when ovulating, which confirms previous literature by Baker and Bellis (1995). This finding is especially strong when the woman's partner is of low sexual attractiveness. The study also suggests that women's behaviours change across the menstrual cycle, and thus ovulation may not be completely concealed.

Like the T shirt studies outlined above, Rikowski and Grammer (1999) had men and women wear T shirts for three consecutive days, while abstaining from using soaps and deodorants, smoking and drinking, and eating smelly foods. These subjects were measured for facial and bodily asymmetry, and were rated on attractiveness. The female scent raters were divided into two fertility phase groups: least fertile (days 1 to 4 and days 17 to 32), and most fertile (days 5 to 16). The participants were asked to rate the male T shirt odours on intensity, pleasantness, and sexiness (scales of 1 to 7), and were also asked to view the photos of the men and to rate the photos on attractiveness and sexiness (also on scales of 1 to 7). The results indicated that in the fertile phase, women's ratings of sexiness of body odour correlated positively with ratings of facial attractiveness, and ratings of sexiness of body odours correlated negatively with asymmetry ratings. The nonfertile phase women judged the body odours to be less pleasant and less sexy as the attractiveness of the photos increased. A nonsignificant trend also showed that the ratings of scent pleasantness and sexiness and asymmetry measures were positively correlated in nonfertile women. Rikowski and Grammer discuss these results in terms of previous research that has shown that the male hormone androstenone is less distasteful to women during ovulation.

Recent research also shows that women judge more masculine faces to be more attractive than feminine faces during fertile phases of the menstrual cycle (Penton-Voak & Perret, 2000). In this study, photographs of men and women were combined and morphed to create a 50% masculinized, a 30% masculinized, an average, a 30%

feminized, and a 50% feminized composite face. The faces were printed in colour in a magazine, along with a questionnaire. One hundred and seventy eight women responded. The results indicated that those in the high fertility phase (days 6 to 14 of the follicular phase) were more likely to choose the masculinized photos as most attractive than those in the menstrual or luteal phases. This would appear to contradict previous research (e.g., Perrett et al., 1998) that reported an overall preference for feminized faces. However, Perrett et al. do discuss the fact that masculinized faces were rated higher on perceived dominance and negative attributes that were relevant to relationships and paternal investment. Thus, it would appear that during the ovulatory phase of the menstrual cycle, women prefer more masculine male faces (which is a sign of immunocompetence, or "good genes"), while during the rest of the cycle, women prefer facial features that signify feminine characteristics (or "good parents"). Women in the high fertility phase of the cycle are also more likely to prefer the faces of darker-skinned men, as compared with women in the low fertility phases and women who are using oral contraceptives (Frost, 1994). These studies suggest that when women are in high fertility phases, they prefer the faces of men who are more typical of ideal males, and are more attracted to men who may have superior genetic characteristics.

Two studies review literature that found that women are less likely to be raped during high fertility phases of the menstrual cycle, and investigated whether this finding might be due to changes in risk-taking behaviours over the menstrual cycle (Chavanne & Gallup, 1998; Bröder & Hohmann, 2003). As discussed in these studies, it seems to be maladaptive that an occurrence that appears to have evolved to promote male fitness would be least likely at the time that is most likely to lead to conception (although a review by Gottschall and Gottschall, 2003, found that conception is more likely to occur through per-incident rape than through per-incident consensual sex). However, authors have suggested that because of the high cost of rape resulting in pregnancy (i.e., inability to exercise mate choice, lack of care by the father, possible abandonment of mother and child by a current mate, and/or reduced likelihood of attracting future mates), women unknowingly engage in less risk-taking behaviours during high fertility periods, and the research tends to support this theory.

Chavanne and Gallup (1998) recruited 300 women (ages 18 to 54, mean age 21.9) to respond to a survey that included menstrual cycle and sexual activity information, as well as a checklist of various activities (rated by others in terms of risk of making one vulnerable to rape). The authors determined cycle phase using a forward count method from the first day of the last menstruation. For the initial analyses, the data was divided into nonovulatory (days 1 to 12 and days 18 to 28) and ovulatory (days 13 to 17). For additional analyses, data was divided into menstrual (days 1 to 5), postmenstrual (days 6 to 12), ovulatory (days 13 to 17), and premenstrual (days 18 to 28). The results showed that women who were in the ovulatory phase were less likely to engage in behaviours that were deemed to be high-risk situations in relation to rape vulnerability. Women in the study who were using hormonal contraceptives did not show significant changes in their activities across the menstrual cycle, giving more credence to the findings.

Bröder and Hohmann (2003) sought to examine the same question, while controlling for potential problems with the risk-taking score, selection effects, and forward counting method of determining ovulation in the previous study. Eighty-five women (age 15 to 44 years, mean age 24.3) filled out the risk-taking checklist and first day of last menstruation, during four sessions, each of which was one week apart. Depending on when menstruation occurred during the four-week period, the forward or reverse counting method was used to establish ovulatory phase. The results of this study did support the findings of Chavanne and Gallup (1998), showing that women do engage in less risk-taking behaviours during the ovulatory phase as compared with nonfertile periods, with women using oral contraceptives not reporting any differences in activity over the menstrual cycle.

Do Men and Women Believe That They Know When Ovulation Occurs?

A relevant study examined the question of whether or not men and women believed that ovulation is concealed in human females (Small, 1996). Four hundred and twelve participants (138 males and 274 females) were asked if they knew what ovulation was, and when it occurred. Women were asked if they had regular menstrual cycles, and whether they knew when they had ovulated (if the women were using hormonal contraceptives, they were asked to remember the time before they started using contraceptives). Men in intimate long-term relationships with women who were not using hormonal contraceptives were also asked if they knew when their partner ovulated. The results of this study showed that 90% of the participants who responded to the question, thought that they knew what ovulation was. However, only 70% of these were correct regarding when in the cycle ovulation occurred. Only 67% of the overall respondents correctly identified the timing of ovulation, with women being more accurate than men. Fifty three percent of the women reported that they always or sometimes knew when they had ovulated, and 74% always or sometimes had regular menstrual cycles. Women with regular cycles were more likely to report knowing when they had ovulated, and women who correctly identified the timing of ovulation were also more likely to report knowing when they had ovulated. In regards to the males, 49% stated that they always or sometimes knew when their partner ovulated, and this claim was not related to whether or not they had correctly identified the timing of ovulation.

Small (1996) also asked participants how they "knew" that ovulation had occurred. In regards to how women knew that they had ovulated (which was not a multiple choice response), 90 women gave at least one response. The most common response was that they felt a twitch, cramp or pain (48%) (called "mittelschmerz"). The second most common response was a change in cervical mucus (30%). Physical changes were the most common types of responses. When men were asked the same question ("how do you know"), 37 men gave at least one response. The most common response was that their partner told them (46%), or that they kept track by counting backwards or forwards from their partner's menstrual period (22%). Twenty percent of the responses did mention physical changes that the men noticed in their partners. Other reasons given for "knowing" that one or one's partner had ovulated included changes in mood/emotion, an increase in sexual desire, general physical symptoms and cold-like symptoms, and changes in the smell and taste of the partner. These results suggest that many people do not believe that ovulation is completely concealed. Although men in this study did most often rely on partners to tell them when they were ovulating, some of the men did report noticing physical and behavioural changes in their partners (e.g., changes in smell, taste, and sexual desire). These anecdotal reports require further testing to determine if men do use particular cues to determine whether their partner is ovulating.

What Does It All Mean?

The research outlined above seems to suggest that ovulation may not be as unadvertised as previous research would suggest. Women's bodies do seem to change over the menstrual cycle in a predictable manner (Manning et al., 1996; Scutt & Manning, 1996), and in ways that seem to encourage the attraction of a mate at high fertility times (Roberts et al., 2004; Smith et al., 2006). Males seem to be aware of when their partner is fertile, as evidenced by changing mate-guarding tactics over the menstrual cycle (Gangestad et al., 2002), and reported awareness of changes in behaviour and mood (Small, 1996). The studies described above also suggest that men find women more attractive, both in facial appearance (Roberts et al., 2004; Smith et al., 2006), as well as smell (Kuukasjärvi et al., 2004; Pillsworth et al., 2004; Poran, 1994; Singh & Bronstad, 2001), when they are more fertile. But are men more capable of discerning these changes in their partners than in nonpartners? Are women's bodies also more attractive during ovulation? No research appears to have investigated whether or not partners would be more or less likely to notice changes in their partner over the menstrual cycle, or whether partners would be more or less likely than others to find their partner attractive during fertile phases of the menstrual cycle.

Second-to-Fourth Digit Ratio

Second-to-fourth digit ratio (2D:4D) is a sexually dimorphic trait that is calculated by dividing the length of the second digit (index finger) by the length of the fourth digit (ring finger) (e.g., Manning, 2002). Men tend to have longer fourth digits than second digits (lower 2D:4D), while women tend to have relatively shorter fourth digits than men (higher 2D:4D than males) (Manning, 2002). It is believed that testosterone in utero initiates the growth of the fourth digit in the developing fetus (Manning, 2002). Evidence suggests that digit ratios are determined in utero at about the 14th week of gestation (Fink, Neave, & Manning, 2003; Manning et al., 2000). Thus, men tend to have longer fourth digits than females. The reason that this process is believed to occur prenatally is because these sex differences are apparent at birth, and previous research reports that the differences remain relatively stable throughout puberty, and on into adulthood (Manning, 2002). Thus, 2D:4D may be a sexually selected trait, given that it provides information about gender.

A study by Manning et al. (2000) has indicated that 2D:4D is correlated with reproductive success, WHR, and incidence of marriage. The study utilized a cross-cultural sample, and the results indicated that 2D:4D was positively correlated with reproductive success in females, and negatively correlated in males. Women who were or had been married had significantly higher 2D:4D ratios than women who had never been married, while no differences were found between married and unmarried men. Large family size was related to high 2D:4D in women and low 2D:4D in men. In some of the samples, there was a negative relationship between 2D:4D and number of children in women. When combining English and Jamaican samples there was a significant negative association between right hand 2D:4D and WHR, which was increased when partialing out age effects. The authors discuss the role of 2D:4D as an indicator of underlying hormone concentration, and suggest that a preference for sex-specific 2D:4D ratios may have evolved as a way to signal the hormonal composition of one's potential mate.

A study by Manning, Bundred, and Mather (2004) linked 2D:4D ratios with measures of skin colour. They found a negative correlation between skin colour and

2D:4D ratios, indicating that women with lighter skin had higher 2D:4D ratios than women with darker skin. Estrogen is presumed to be linked to both skin colour and 2D:4D. Because lighter female skin is preferred by men, and higher 2D:4D ratios are indicative of greater femininity, higher 2D:4D may be a signal of a more attractive female mate.

Clark's (2004) study investigated relationships between women's sociosexual orientation (using the Sociosexual Orientation Inventory or SOI), 2D:4D and self-perceived attractiveness. The results of this study showed that women with lower right 2D:4D had higher SOI scores (and thus were more likely to engage in or desire casual sex). Self-perceived attractiveness was positively correlated with SOI scores, but not correlated with 2D:4D ratios. The author indicates that the link between SOI and 2D:4D suggests that high levels of testosterone are involved in both SOI and 2D:4D in that both are indicative of more masculine behaviours and traits. The lack of a link between self-perceived attractiveness and 2D:4D suggests that self-perceived attractiveness may be independent of hormonal variables. The results of this study also correspond with the results of Mikach and Bailey's (1999) study (described above), which found that women with high numbers of lifetime partners and high SOI scores described themselves as more masculine as children and as adults than those with lower SOI scores and lower numbers of lifetime partners.

Wade, Shanley, and Imm (2004) explored whether 2D:4D was related to self-perceived attractiveness, self-esteem, and body-esteem. They found that 2D:4D was positively correlated with self-perceived attractiveness. The higher the 2D:4D ratio, the higher the ratings of self-perceived attractiveness. The authors discuss these findings in terms of evolutionary theory. Since higher 2D:4D is indicative of higher levels of estrogen, and more feminine features, then other factors related to estrogen levels (such as skin colour and neotenous features) may also be present in these women. If this is the case, then it is likely that these high 2D:4D women are actually more attractive.

A study by Saino, Romano, and Innocenti (2006) examined ratings of attractiveness of male and female hands. The authors first had raters evaluate the attractiveness of 136 female and 136 male unmodified hands. Then, the authors manipulated the hands of 25 females and 25 males. The manipulations represented increased length of digit 2 or digit 4, decreased length of digit 2 or digit 4, equally increased length of both digits 2 and 4, and equally decreased length of both digits 2 and 4. These modifications were kept within the normal range. The results of this study indicate that both sexes prefer longer fingers, regardless of digit ratio. However, they did find a strict consensus between what men and women found attractive in opposite sex hands. Male hands were judged to be more attractive when they had an elongated fourth digit (i.e., a more "masculine" hand), while female hands were less attractive if they had a shortened second digit (and thus were more "masculine"). Thus it appears as though men and women consistently prefer hand features that indicate higher levels of sex-specific hormones.

Previous research by the authors has indicated that 2D:4D may change with progesterone levels across the menstrual cycle, with increases in progesterone leading to increases in 2D:4D (Patola et al., 2006). When correlations between the progesterone change and changes in 2D:4D were examined across the cycle, the most important factor when it came to these changes seemed to be whether estrogen and progesterone were both changing in the same direction (either both increasing or both decreasing), and testosterone changing in the opposite direction. Therefore, when estrogen and progesterone were increasing and testosterone was decreasing between menstrual phases (e.g., menstrual to ovulatory phases), 2D:4D increased (and thus, became more "feminine"). This finding contradicts previous beliefs that 2D:4D is fixed at birth (Manning, 2002). One recent study (Scarbrough & Johnston, 2005) found that in women, lower 2D:4D was associated with lower femininity ratings, and that women with lower 2D:4D reported a preference for more masculine long-term mates, recalled less parental bonding, had shorter intimate relationships, and had more menstrual cycle irregularities. Given the preliminary finding that 2D:4D changes across the menstrual cycle, one might wonder if this digit ratio changes in a way that affects the perception of attractiveness.

The Present Study

It seems probable that ovulation is not a completely hidden event. As the research described above indicates, women seem to become more attractive to men at times of high fertility. Therefore, it also seems plausible that a pair-bonded male may be better able to detect subtle changes in his partner's fertility status than a man to whom the woman is not pair-bonded. This would seem especially probable if the man lives with his partner, and thus has day-to-day contact with her. For a man living in close proximity to a woman to whom he is committed, and with whom conception is more likely to occur, it would be adaptive for this man to be able to establish high-fertility times. This would allow a man to properly allocate his energy towards in-pair sexual activity and/or mate guarding.

Considering the previous research outlined above that suggests that women's bodies change across the menstrual cycle, it would also be useful to determine whether or not ratings of attractiveness of body (not just face) photos differ across the menstrual cycle. No previous research appears to have utilized body photos when undertaking this type of research.

In the current study, women's head and body photos were obtained at two phases of the menstrual cycle (high and low fertility phases). Women also had their hands scanned to determine 2D:4D. Male partners and nonpartners were then asked to choose the more attractive photo of each pair of face, body, and hand photographs and scans. Second-to-fourth digit ratio was calculated for both sessions. The primary research question was whether men consider periovulatory photos more attractive than nonperiovulatory photos.

The current study tested two primary hypotheses: (1) men rate women as most attractive during the periovulatory phase of the menstrual cycle, and (2) this finding is more pronounced when men evaluate their own partners than when men evaluate unfamiliar women. Second-to-fourth digit ratio was measured, in an attempt to replicate the previous findings by the authors that 2D:4D changes as a function of phase of the menstrual cycle/differing hormone levels. The authors' previous study found that progesterone correlated positively with changes in 2D:4D (Patola et al., 2006). More robust correlations between changes in 2D:4D and progesterone were found when estrogen and progesterone changed in the same direction, and testosterone changed in the opposite direction across the cycle. Therefore, since progesterone and estrogen are both increasing, and testosterone decreasing, from the menstrual to the luteal phase (Van Goozen, Wiegant, Endert, Helmond, & Van de Poll, 1997), it is likely that the luteal phase hand scans should be rated as more attractive than the menstrual phase hands. And because progesterone and estrogen are both decreasing and testosterone increasing, from the luteal to menstrual phase (Van Goozen et al., 1997), then the menstrual phase hands should be rated as least attractive. Thus, an additional two hypotheses were proposed: (3) second-to-fourth digit ratio changes across the menstrual cycle, with 2D:4D being highest in the luteal phase and lowest in the menstrual phase; and (4) male evaluators rate the luteal phase or high 2D:4D hand scans as most attractive, and the menstrual phase scans as least attractive.

Method

Participants

The female sample whose photographs were used in the three tests consisted of 24 women, with an age range of 18 to 40 years ($M = 21.92$, $SD = 5.88$). The women were recruited to participate in a study on "person perception" from introductory psychology courses, upper-year psychology courses, courses from other disciplines within the university, bulletin board advertisements, e-mail and intra-university television monitor communication bulletins, a research conference within the university, a notice published in the university's Gender Issues Centre publication, and word of mouth. However, most of the participants were introductory psychology students. Those participants who were enrolled in introductory psychology classes or two specific upper-year courses, and who completed the screening portion of the study, received 0.5 bonus points towards their final grade. Those in the above group who completed the first testing session received 1 further bonus point, and those who completed the entire study received an additional 1.5 bonus points (for a total of 3 bonus points). The remaining participants had their names entered into a draw for one of two fifty-dollar prizes.

Seventy-three women completed the screening portion of the study, and 35 of these women met the inclusion criteria for the study. The seven inclusion criteria, and the number of women who were excluded for failing to meet one or more of the criteria, were: (a) no current use of hormonal contraceptives (n = 10), (b) no use of hormonal contraceptives within the three months prior to the screening (n = 2), (c) age between 18 and 40 years (n = 2), (d) a predictable regular menstrual cycle that ranged in length from 22 to 36 days (Fehring et al., 2006, indicated that 95% of their sample of 141 healthy women had cycle lengths within this range) (n = 22), (e) the participant was premenopausal (n = 4), (f) an absence of current and/or chronic medical disorders that could affect hormone levels (e.g., depression, polycystic ovary disease) (n = 5), and (g) no current use of medication(s) that could affect hormone levels (e.g., antidepressant medications, thyroid medications) (n = 9).

Of the 35 women who met the inclusion criteria, 29 participated in the first testing session, and 27 of those women returned for the second testing session. Those who chose not to participate in the first testing session of the study gave the following reasons for their choice: (a) no longer interested (n = 4), (b) had accrued the maximum bonus points, and were not interested in the $50 prizes ($n$ = 1), and (c) would not be in town long enough for both sessions (n = 1). Those women who participated in the first testing session but did not return for the second session gave the following reasons for their choice: (a) no longer interested in participating (n = 1), and (b) missed scheduled appointment, and would no longer be in town for the second session (n = 1). Of the 27 women who participated in both sessions, three participants' photos and data were excluded from the final analyses, due to (a) starting hormonal contraceptive use prior to the second testing session ($n = 1$), (b) withdrawing from the study after the second testing session ($n = 1$), and (c) a cycle day count indicating that the participant did not fall within the menstrual cycle phase group that she had been assigned to ($n = 1$). Therefore, the final photographs used in the study were of 24 women. These 24 women did not differ from the 11 excluded women on age, height, weight, BMI, previous contraceptive use, cycle length, menses length, age at first menstruation, or menstrual cycle regularity ($p < .05$).

Women were tested during two menstrual cycle phases: (a) the periovulatory phase ($n = 24$); and (b) either the menstrual ($n = 13$) or the luteal ($n = 11$) phase. Thus, there were four groups: (1) menstrual to periovulatory group (those who were tested first in the menstrual phase, and second in the periovulatory phase) (MP group, $n = 7$), (2) the periovulatory to menstrual group (those who were tested first in the periovulatory phase, and second in the menstrual phase) (PM group, $n = 6$), (3) the luteal to periovulatory group (those who were tested first in the luteal phase, and second in the periovulatory phase) (LP group, $n = 7$), and (4) the periovulatory to luteal group (those who were tested first in the periovulatory phase, and second in the luteal phase) (PL group, $n = 4$).

Women tested in the menstrual phase were tested on days 1 to 6 ($M = 3.69$, $SD =$ 1.89). Those tested in the luteal phase were tested on days -9 to -5 ($M = -6.18$, $SD =$ 1.83). Finally, all women were tested in the periovulatory phase on days -22 to -12 ($M =$ -16.04, $SD = 1.88$). Of the 24 women, it was possible to determine that 16 women were tested within a range of 7 days before to 5 days after the LH surge ($M = 0.75$ days after surge, $SD = 2.49$). However, for the final analyses, the women were separated into those who were tested during the ideal cycle days (Ideal group), and the overall group. The overall group means are listed above. For the Ideal group, the women tested in the periovulatory phase were tested on days -17 to -14 (M = 15.76, SD = 0.77). For the Ideal luteal group, women were tested on days -9 to -5 (M = -6.00, SD = 2.00). The women in the menstrual group were tested on the correct days, and thus there was only an Overall group for these analyses. Four women did not report a positive result on the strip, and four women used the strips and reported the positive day, but could not come in for the periovulatory session until the next cycle. It should be noted that some of the dates for the periovulatory phase were well outside of the range that is typically considered periovulatory. Therefore, as discussed later, for exploratory purposes, all 24 pairs of photos were utilized and certain analyses were later restricted to just those photo pairs that included women with more accurate cycle phase days. See the procedure section for details regarding cycle day determinations.

Of the final sample of women in the study, 8 (33.30%) reported that they were married or living with a male partner, 5 (20.80%) that they had one steady male partner whom they did not live with, 10 (41.70%) that they did not have a steady partner, and 1 (4.20%) that she had more than one steady male partner. Thirteen (54.20%) women reported that they had previously used hormonal contraceptives. When asked about menstrual cycle regularity, 1 (4.20%) woman reported that her "period was like clockwork", 20 (83.30%) that they "get their period within 2 to 3 days of when they expect it", and 3 (12.50%) that they "usually get their period, but it is irregular and unpredictable". Generally, women who indicated the latter category for menstrual cycle regularity were excluded from the study, however, the three women who were included in the study had reported average menstrual cycle and menses lengths in the screening questionnaire, and after completing the study, were found to have had normal cycles for the dates in which they were tested.

The final sample of men for the study was 93. Men were recruited from introductory psychology courses, upper-year psychology courses, e-mail bulletins, and word of mouth. The women who participated in the first phase of the study were also contacted again, and partner information was requested. Of those contacted, six women had partners whom they said might be willing to participate in the study, and 5 of the partners actually participated. The majority of the participants were introductory psychology students. Those participants who were enrolled in introductory psychology classes or two specific upper-year courses received one bonus point towards their final grade. The remaining participants had their names entered into a draw for one of two fifty-dollar prizes. Of the 120 men who indicated interest and/or were contacted for the study, 93 responded and participated. The remaining 27 did not respond after either e-mail and/or telephone contact, and were assumed to be uninterested in participation.

It should be noted that questions regarding the age and education of the male participants were inadvertently omitted from the questionnaires. However, based on appearance and university enrolment, the men likely ranged in age from 18 to 45 years. Of the 93 male participants, 89 (95.70%) reported a heterosexual orientation, 1 (1.10%) a bisexual orientation, and 2 (2.20%) a homosexual orientation. Sixty-three (67.70%) men reported being in a current romantic relationship. Finally, on the basis of their appearance, 85 (91.40%) of the men were categorized as White, 5 (5.40%) were Aboriginal, 2 (2.20%) were Asian, and 1 (1.10%) was Black.

This study received ethics clearance from the Lakehead University Research

Ethics Board.

Body, Face, and Hand Stimuli

The digital facial and body photographs of each woman were taken with a Fujifilm FinePix A350 Digital camera and tripod. The resolution for face and body photos was 5 megapixels (2592 x 1944 pixels), on the "Fine" setting. A mark on the floor indicated where the tripod was to be placed in order to assure that standardization of placement was attained, and women were asked to stand with heels against the back wall (for body photos), or to sit with a chair against the back wall (face photos). The preparation (e.g., cropping and placing) of all photographs was done by the researcher while blind to the menstrual phase status of the photographs. See the Procedure section for further details on the picture-taking process.

Body photos. The final sample of body photos consisted of 24 pairs of photos where each pair consisted of photographs of one woman taken at two different menstrual cycle phases while wearing similar or identical clothing. The photographs depicted women's bodies from the top of their shoulders to the bottom of their feet. Twelve women wore denim jeans and a white t-shirt, while the remaining 12 women wore coloured t-shirts or white t-shirts with writing or pictures on them ($n = 5$), long-sleeved shirts ($n = 4$), coloured jeans ($n = 1$), corduroy pants ($n = 2$), or black pants ($n = 3$) (and some wearing a combination of these). Nine pairs of photos depicted women who did not wear identical or highly similar attire. Thus, these photos were not used in any analyses.

All pairs of body photos (i.e., periovulatory photo and nonperiovulatory photo) were uploaded into Adobe Photoshop 7.0.1. Each of the photos was cropped around the body using the rectangular "crop tool" to approximately one-eighth of an inch (0.32 cm) (by visual inspection at full screen size) from the left- and right-most sides of the body, below the feet, and above the top of the shoulders. The photo's background was removed using the "select tool" to select the background, and then deleting. Slides that measured 8.5 by 11 inches (21.59 x 27.94 cm) in a "landscape" orientation were then created by placing both cropped photos of each woman side by side onto one slide with a white background. Photos were enlarged so that the bodies were 7.5 inches (19.05 cm) tall with the appropriately proportioned width. A vertical line guide was place in the middle of each body, and if the body was not straight, it was rotated until it matched the midline. The left-hand photo was always the first session photo and the right-hand photo was always the second session photo, in an attempt to ensure that the menstrual cycle phases of the photos were counterbalanced on the left and right sides of the screen. A black 'A' was placed under the left photo, and a black 'B' was placed under the right photo. After all slides were created, they were uploaded into Microsoft PowerPoint to generate a slideshow. Two examples of the body slides are shown in Figure 1. See the Procedure section for further details on the taking of the body photographs.

Face photos. The final facial stimuli consisted of 24 photograph pairs. Each pair of photos included two photos of the same woman from two different menstrual cycle phases. The women had a neutral facial expression and wore either minimal or no make-up in order to ensure uniformity across the pictures. Photos depicted each woman's head from the top of the shoulders to the top of the head.

All photos were uploaded into Adobe Photoshop 7.0.1. The oval-shaped "crop tool" was used to crop the faces so that just the face was showing (i.e., with the hair cropped out), similar to the process outlined in Rhodes et al. (2005). Hair was cropped

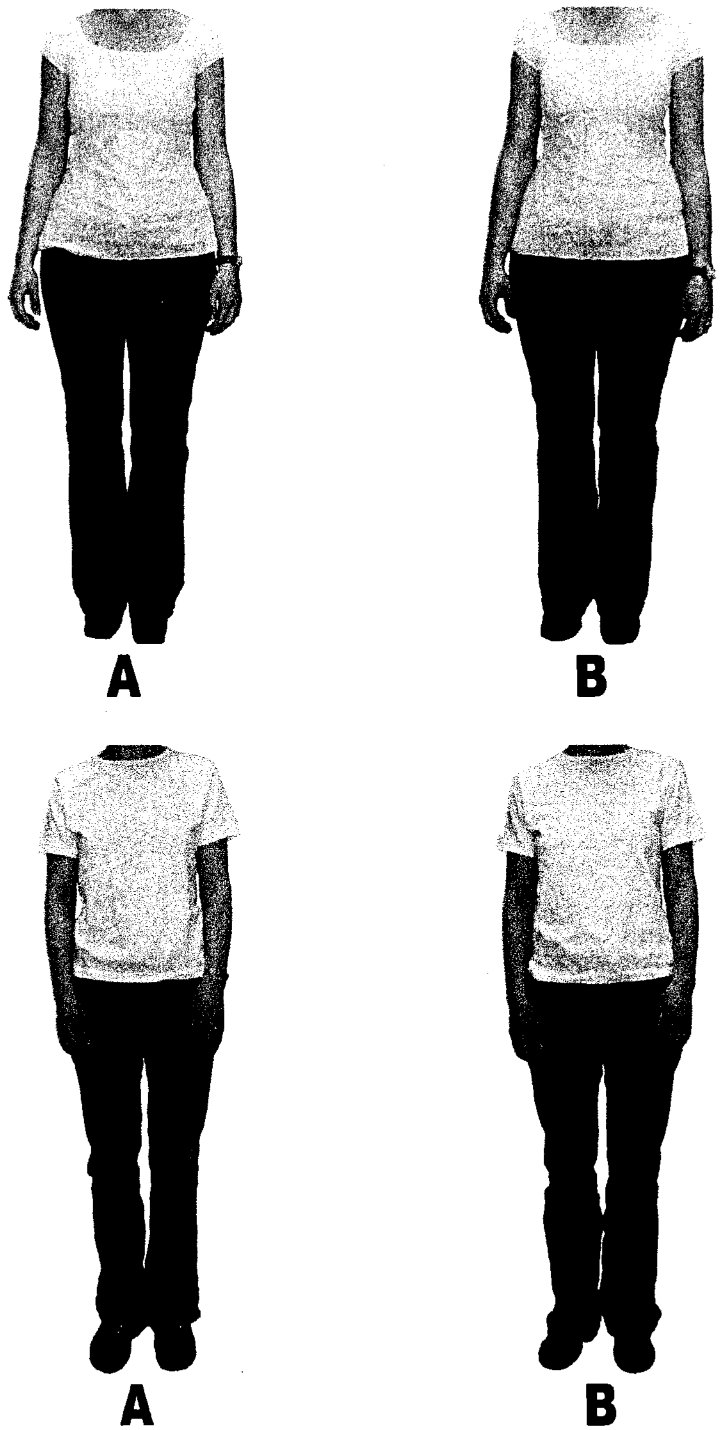

Figure 1. Examples of body slides used in the Body Preference Test. The top slide represents a participant who was photographed in the luteal (left) and periovulatory (right) phases. The bottom slide represents a participant who was photographed in the menstrual (left) and periovulatory (right) phases.

out of the photos to remove the potential influence of differing hairstyles for the two sessions, and to ensure that it was the facial features themselves (and not extraneous variables) that were being rated. The oval was placed just under the lowest part of the chin, just outside each ear, and at the top of the forehead. After cropping, the background of each photo was removed, including any extra hair that may still have been within the oval of the photo. This was accomplished by using the "select tool" to select the background, and then deleting it. Slides were then created, with both photos from each woman being placed side by side onto one slide. The background for the face slides was black. Photos were enlarged to 7.5 inches (19.05 cm) tall, with the appropriately proportioned width. To ensure vertical rotation of the face, a vertical line guide was placed over the midline of each face, and the face was rotated until it was straight. In addition, if there were unavoidable differences between the photos that could not be removed without distorting the photo (e.g., a strand of hair on the face in one photo), they were duplicated on the second photo, using the "select tool", and then a "cut" and "paste" technique. A white 'A' was placed under the left-hand photo, and a white 'B' was placed under the right-hand photo. After all slides were created, they were uploaded into Microsoft PowerPoint to generate a slideshow. Two examples of the face photos are shown in Figure 2. See the Procedure section for further details on the taking of the facial photographs.

Hand scans The final hand stimuli consisted of 24 pairs of female hand photographs that had been obtained at two different menstrual cycle phases. The hands were scanned at 200 pixels per inch (ppi) on an HP Scanjet 4070 scanner, with both hands placed palms down on the scanner screen simultaneously. The scanned photos

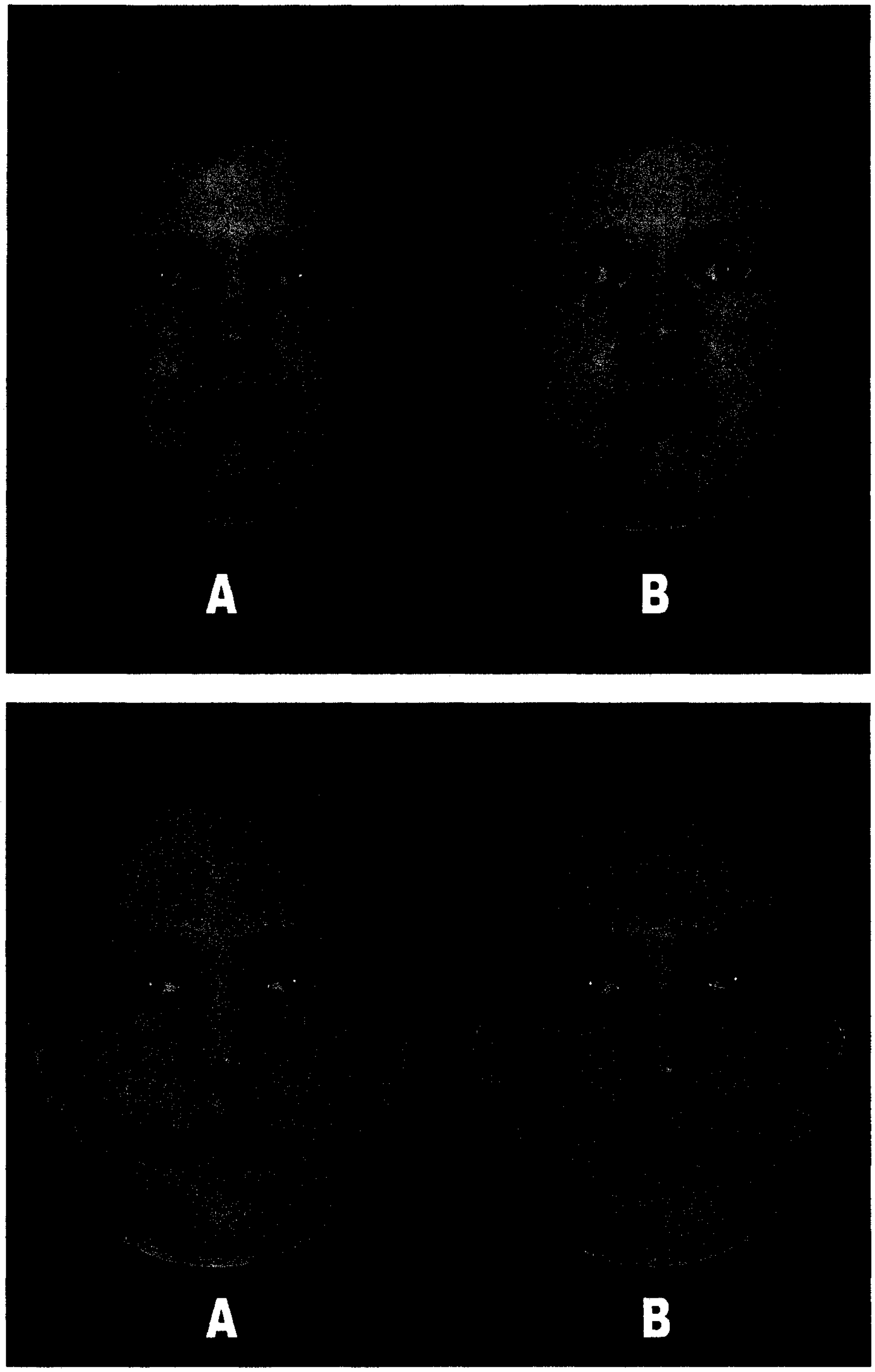

Figure 2. Examples of face slides used in the Face Preference Test. The top slide represents a participant who was photographed in the menstrual (left) and periovulatory (right) phases. The bottom slide represents a participant who was photographed in the periovulatory (left) and menstrual (right) phases.

were uploaded into Adobe Photoshop 7.0.1., and the background was removed from each scan using the "select tool" to select the background, and then deleting it. Flaws were removed from the hand slides (e.g., shadows or humidity lines around fingers) using the "eraser tool". Slides were then created by placing each pair of hand photos vertically onto the slide. The photos were placed above and below each other rather than side by side to allow for better placement on the slides. First session scans were always on the top, and second session scans were always on the bottom in order to counterbalance menstrual cycle phase placement. The background for the hand slides was black. Hand scans were enlarged or reduced to approximately 3.75 inches (9.53 cm) high, with the appropriately proportioned width. A white 'A' was placed to the left of the top photo, and a white 'B' was placed to the left of the bottom photo. After all slides were created, they were uploaded into Microsoft PowerPoint to generate a slideshow. Two pairs of photos depicted hand pairs that did not include the same accessories on each hand. Thus, these photos were not used in any analyses. This was thought to be especially important because the accessories in question were rings, and rings may confer information regarding marital status. Two examples of the hand slides are shown in Figure 3. See the Procedure section for further details on how the hand scans were obtained.

Measures

The female participants in the study completed three self-report measures: a Screening Questionnaire (SQ), a First Session Questionnaire (FSQ), and a Second Session Questionnaire (SSQ). The male participants in the study completed one self-report measure: the Experimental Session Questionnaire (ESQ).

Screening Questionnaire. The Screening Questionnaire (SQ) (see Appendix A)

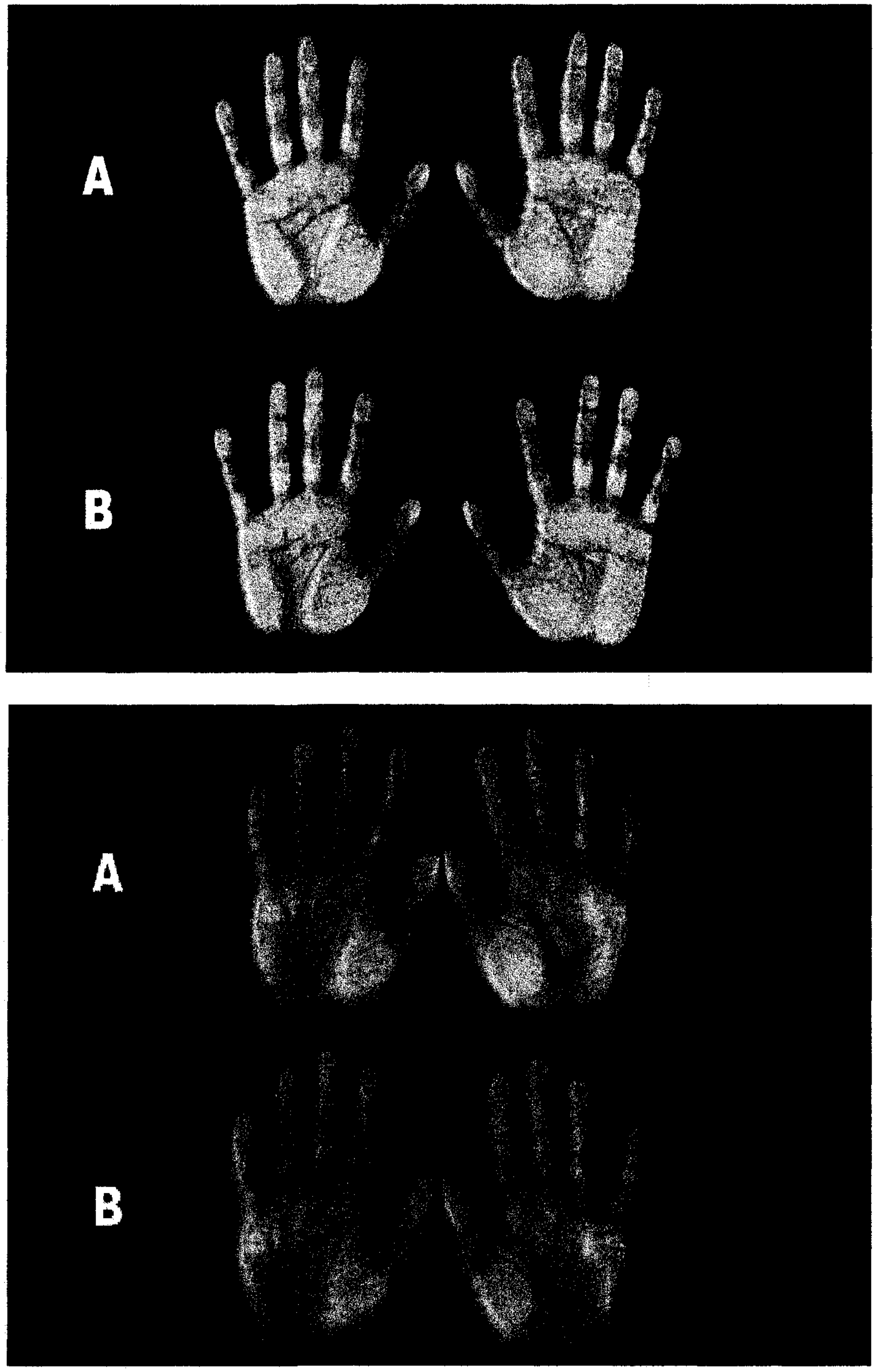

Figure 3. Examples of hand slides used in the Hand Preference Test. The top slide represents a participant who was photographed in the periovulatory (top) and menstrual (bottom) phases. The bottom slide represents a participant who was photographed in the menstrual (top) and periovulatory (bottom) phases.

was utilized to select potential female study participants to determine whether they met the inclusion criteria for the study (see above). The questionnaire included sections on demographic information, medications, reproductive and menstrual cycle information, medical information, and relationship information.

First Session Questionnaire. The First Session Questionnaire (FSQ) (see Appendix B) included Simpson and Gangestad's (1991) Sociosexual Orientation Inventory (SOI), additional questions regarding sexual history and attitudes, and relationship questions. The SOI is a measure used to determine an individual's willingness to engage in uncommitted sexual relationships. It has adequate validity and reliability (Simpson & Gangestad, 1991). The FSQ also included a separate form with a request for a woman's partner's contact information (name, phone number and e-mail address), in order to contact the men for Stage 4 of the study.

Second Session Questionnaire. The Second Session Questionnaire (SSQ) (see Appendix C) was identical to the FSQ, with the elimination of the request for partner information.

Experimental Session Questionnaire. The Experimental Session Questionnaire (ESQ) (see Appendix D) also consisted of Simpson and Gangestad's (1991) SOI, additional questions regarding sexual history and attitudes, relationship items, and questions about the desire for children. Additional items include some of the questions regarding ovulation detection that were used in Small's (1996) study. These were used to determine whether men believe that they are capable of detecting when a woman is ovulating.

Digit measurements. In order to calculate 2D:4D (second digit length divided by fourth digit length), the length of digits two and four were measured twice on both right and left hands from hand scans. The palms of the hands were scanned using an HP Scanjet 4070 scanner. Test-retest reliabilities for each digit and for each session ranged from .99 to 1.0 ($p < .001$). Measurements were made from the tip of the middle of each finger to the basal crease (to 0.1 mm) (e.g., Manning et al., 2000; Romano, Leoni & Saino, 2006; Voracek & Dressler, 2006). The digit lengths were measured on the scanned images, using Adobe Photoshop 7.0.1. Once in Photoshop, each hand was cropped to exact hand size (lowest point of the palm, highest point on the longest digit, outer edges on left and right sides). Once cropped, each photo was enlarged to 12 inches in height. After enlarging the photo, the second and fourth digits were measured twice in an alternating pattern as described above, using Photoshop's "measure tool". This tool allows for placement of two points, which can later be moved for greater accuracy, and then provides a measurement of the distance between points A and B. The photos were enlarged because the measure tool only allows for measures in mm to one decimal place, rather than the standard two decimal places that previous 2D:4D research has utilized (e.g., Manning et al., 2000, Scarbrough & Johnson, 2005). A previous study found that measuring digit length to one decimal place from hand scans was reliable (Romano, Leoni & Saino, 2006). Thus, the present method of enlarging the photos prior to measuring the digits should lead to even greater accuracy for the digit (and therefore, the 2D:4D) measures. However, because the photos were enlarged, the resulting finger length measures are imprecise as actual stand-alone measures (and are therefore not presented here). The 2D:4D measures, which were the focus of the study, are nevertheless, accurate. Previous research has indicated that test-retest reliabilities of digit length and resultant 2D:4D measures are as high as $rs = .81$ to .89 (Manning et al., 1998).

Measures of hormonal status. Female participants were asked to use luteinizing hormone (LH) detection strips in order to obtain a more accurate indication of their time of ovulation. The "no-name" brand LH strips were purchased from a bulk medical supply source. As described earlier, similar ovulation predictor strips are 97 to 100% accurate in detecting ovulation (Gangestad, Thornhill, & Garver, 2002; Poran, 1994; Vermesh et al., 1987), and one study found that urinary LH surge kits were as accurate at detecting ovulation as transvaginal ultrasonography (Guida et al., 1999). This method has previously been used in menstrual cycle studies, such as Gangestad and colleagues (2002). The timing and occurrence of ovulation was established using the urinary LH surge detection strips. The participants were asked to start using the strips on day –18 of the menstrual cycle (calculated using self-reported cycle length and expected next menses date), and were instructed to continue using the strips until they got a positive result. The women were instructed to use the strips at the same time every day, and to test after 2:00 p.m., as the luteinizing hormone surge usually occurs between 6:00 a.m. and 12:00 p.m., and thus needs time to build to measurable levels in the urine (see Cano & Tarin, 1998). The women collected their urine in a paper cup, dipped the detection strip into the urine, held the strip in the urine for 5 seconds, and then removed the strip and placed it on a clean flat surface. The strips showed one line for a negative result, and 2 for a positive result. Participants were told that the two purple lines should be approximately the same colour and darkness, as a lighter second line most likely indicates an evaporation line. When the strip displayed two lines, this result indicated that the luteinizing hormone surge had occurred, and that ovulation would follow within the next 24 to 48 hours.

Body Preference Test. The Body Preference Test (BPT) consisted of 24 slides of pairs of bodies that were presented for an unlimited amount of time on a computer monitor using Microsoft PowerPoint. Participants viewed each pair of photos and were asked to choose the photograph that they considered "most attractive". A statement at the beginning of the test instructed participants to view each set of photos, to indicate on the sheet provided whether they found 'A' or 'B' more attractive, not to skip any of the slides, and to try not to take any differences in clothing or accessories in the photos into account when making their decision. The instruction slide also gave the opportunity to ask questions before beginning the task. After choosing the more attractive photo from each pair, and marking his response on the provided sheet, the participant pressed the spacebar on the computer keyboard to access the next set of photo pairs. Each slide contained two photographs of the same woman with one photograph taken in the periovulatory phase and the other taken in either the menstrual or luteal phase. As the focus of the test was to determine whether men show preference for periovulatory phase photos, each slide response was scored as a 0 or 1 to indicate preference for periovulatory phase bodies. A score was calculated to indicate each man's preference for periovulatory bodies, with higher scores indicating a greater preference for periovulatory bodies.

Face Preference Test. The FPT was identical to the BPT except for the inclusion of face as opposed to body slides. An instruction slide also appeared before the set of face photos asking participants to view each set of photos, to indicate on the sheet provided whether they found 'A' or 'B' more attractive, not to skip any of the slides, and to try not to take any differences in accessories in the photos into account when making their decision. The instruction slide also gave the opportunity to ask questions before beginning the task. The test included 24 slides. Scores reflected a man's preference for faces in the periovulatory phase.

Hand Preference Test. The HPT was identical to the BPT and the FPT except for the inclusion of hand as opposed to body and face slides. The instruction slide was identical to that used for the FPT. The test consisted of 24 slides. Higher scores reflected a greater preference for the periovulatory hand scans. Separate scores were also calculated to reflect preference for luteal phase hands, as well as a preference for higher (less androgenized) 2D:4D hands.

Procedure

There were four stages in the current study: Stage 1 (Screening), Stage 2 (First Session and Instructions), Stage 3 (Second Session), and Stage 4 (Experimental Session).

Participants were asked to attend Stages 2 and 3 during two different phases of their menstrual cycle. One session took place during the periovulatory phase, and the other during one of two other menstrual cycle phases: menstrual or luteal. Testing days were determined using self-reported menstrual cycle information (first day of last menstruation, average cycle length, and expected start day of next menses); Jöchle's (1973) reverse counting method, adjusted for cycle length; and use of the LH strips. The participants were informed that the strips were indicators of body hormone levels, but were not informed as to which specific hormones the strips were measuring until the debriefing session. Twelve women had a session scheduled during expected menstruation (days 1 to 5), and thirteen women had a session scheduled during the expected luteal phase (days -5 to -9, [5 to 9 days prior to their expected first day of next menses]).

All participants had one session scheduled during the periovulatory phase. For 14 women, the periovulatory phase was defined as days -15 to -17, relying on the participant's reported cycle length and next expected first day of menses (Count group). These fourteen women were asked to attend a session on one of those days. These women also used the ovulation detector strips, and were asked to contact the experimenter when the detector indicated that the LH surge had occurred. Ten of the 14 women provided this information. While the LH surge date was not used to schedule a testing session, it was used as a post hoc method of checking accuracy of the reverse counting method. In fact, the mean testing date of these women ($M =$ -15.62, $SD = .77$) was 1.17 ($SD = 1.47$) days after the LH surge. In the remaining eleven women, periovulatory phase was defined based on the ovulation detection kit results, which, as discussed previously, are 97% to 100% accurate (Gangestad et al., 2002; Poran, 1994; Vermesh et al., 1987) (LH Positive group). These women were asked to contact the experimenter as soon as the detection strip indicated a positive result (and thus, an LH surge). An appointment was then scheduled to take place preferably within the next two days ($n = 8$). One of these women could not come in to the lab until 5 days after the LH surge, one came in one week prior to the surge (because she would be out of town during the next week), and one woman did not get a positive result on the strips. Testing day was defined in relation to the LH positive test: day 0 (the day of the positive result), +1 (the day after the positive result), +2, etc. While the women whose sessions were scheduled based on the LH strips were tested close to the exact moment of ovulation, the women whose sessions were scheduled using the reverse count method were likely tested during a broader range of days in the periovulatory phase. Previous literature has indicated that days -17 to -15 indicate the most fertile days of the cycle (e.g., Barrett & Marshall, 1969; Dunson, Weinberg, Baird, Kesner, & Wilcox, 2001).

A one-way ANOVA was performed in order to determine whether there were significant differences between the periovulatory session day attended between the Count (n = 13, M = -15.62, SD = 0.77) and the LH Positive (n = 11, M = -16.55, SD = 2.62) groups. The ANOVA was not significant, $F(1, 22) = 1.50$, $p = .23$, which suggests that the mean day of attendance for the periovulatory session did not differ between the two groups. This gives further evidence that the reverse-count method is a reasonably reliable and valid method of determining day of ovulation.

To control for testing order effects, women attended the sessions in one of four orders: (a) menstrual then periovulatory phase (n = 7); (b) periovulatory then menstrual phase (n = 6); (c) luteal then periovulatory phase (n = 7); or (d) periovulatory then luteal phase (n = 4). This means that some of the participants received the ovulation detection strips and instruction sheet before arriving for their first session.

Stage 1: Screening. Participants were asked to take part in the Screening phase of a study that was examining person perception. They were told that participation was voluntary, that they could withdraw at any time without penalty, and that all data would remain confidential. Consent forms were completed with name and contact information, and these forms were later removed to protect confidentiality. Participants received Consent Form A (see Appendix E), and a Screening Questionnaire, and were asked to read and sign the consent form, complete the questionnaire, and return them to a marked box. At the end of the Screening Questionnaire was Debriefing Form A (see Appendix F), which participants were instructed to detach from the Questionnaire to keep for their records. Women who met the inclusion criteria (see above) for the study were selected to participate and were contacted by telephone or e-mail. When contacted, the procedures were explained, participants were able to ask questions, and dates and times for their appointments were set up. Some of the participants were asked to use the ovulation detection strips, and those participants did not have their periovulatory phase session scheduled until the LH surge was detected, and thus these individuals did not know one of their appointment times right away. The participants were requested to wear denim jeans and a white t-shirt to the sessions; no make-up, or the same make-up for each session; and to wear their hair pulled back off of the face. Participants were provided with an instruction sheet that outlined this information (see Appendix G).

Stage 2: First Session and Instructions. Each of the participants met in an individual session with the experimenter, and was asked to read and sign Consent Form B (see Appendix H) if they wished to participate. Participants completed the First Session Questionnaire, as well as a separate page requesting male partner information.

The women then had their photos taken using a Fujifilm FinePix A350 Digital camera and tripod. As the women were photographed on two separate occasions, they were asked to attend both sessions wearing the same denim jeans and white t-shirt, their hair pulled back from their face, and no make-up (or the same make-up for both sessions). White t-shirts were provided for those women who did not have them, if they were willing to wear the provided shirts, and hair ties were provided for those who did not have their hair pulled back from their face. Photos were taken of both the face (with a neutral expression) and body. Three photos were taken of each shot (head and body) in order to ensure that the best quality photo could be chosen (e.g., in case of closed eyes, blurriness). For the body photos, the women were asked to stand with their legs straight, and arms straight at their sides, and photos were taken from just below the feet to the top of the shoulders, against a white background. For the face photos, women were asked to sit in a provided chair, and photos of the face were taken from the top of the shoulders up, with a neutral expression, and a white background. Participants' hands were then scanned palms down on the HP Scanjet 4070 scanner. Both hands were scanned at one time. Previous studies have shown that using scanned hand images is a valid and reliable method for measuring 2D:4D compared with alternative methods, such as direct measurement with vernier callipers (e.g., Voracek & Dressler, 2006). Participants were instructed to place their hands on the screen, and not to press down, in an effort to control for factors such as colour and size differences that may occur through pressure. Again, three scans were taken for each participant, to allow for a better choice of a quality image. The participants who were in the menstrual or luteal phase of the cycle were then provided with an instruction sheet (see Appendix I), and a urinary ovulation detector kit (5 strips each). Each of these participants were asked to use one strip daily starting on day –18, determined by the average reported length of her menstrual cycle (e.g., for a 28 day cycle, the participant was instructed to start using the strips on the 11^{th} day of her cycle), until the LH surge had occurred (the ovulation detection strip showed a positive result). These participants were asked to then contact the experimenter, and to come in for their second session within two days of receiving a positive result from the ovulation detection kit. All participants were also asked to contact the experimenter to report the first day of next menses, in order to verify the cycle phase information for each session.

Stage 3: Second Session. The second session was identical to the first, with the elimination of Consent Form B, the ovulation detection kits, and information; and participants completed the Second Session Questionnaire. After this session, participants were debriefed, provided with Debriefing Form B (see Appendix J), and had an opportunity to ask questions.

Stage 4: Experimental Session. Male participants were contacted for the photo-viewing portion of the study. These participants consisted of partners of the female participants who had already participated in the first portion of the study ($n = 5$), as well as nonpartners recruited from Introductory Psychology courses (as additional participants were required) ($n = 88$). These men were contacted via telephone or e-mail, using the contact information provided by them (during class, word of mouth or e-mail recruitment) or their partners who participated in the First Session. When contacted, these men were asked to attend an experimental session for a study examining person perception, which consisted of viewing photos of women, choosing the most attractive of the photos; and answering questions regarding relationships, sexual history, and reproductive issues. Participants who attended the experimental session were provided with Consent Form C (see Appendix K), and were asked to read and sign the document before participating.

Participants first had a digital photo taken of their face (with a neutral expression), using the same Fujifilm FinePix A350 Digital camera and tripod that was used for the first and second stages. These photos may be used in subsequent studies, if consent was given for such, and if the studies receive ethics clearance.

The male participants then completed the photo judgment tasks as described above, in the following order: Body Preference Test, Face Preference Test, and then Hand Preference Test. After the photo judgments, the participants were asked to complete the Experimental Session Questionnaire.

Once the questionnaire was complete, each participant was shown a sheet of photo "fingernails" (small photos) and asked to indicate (point out) which (if any) of the women was his current partner. A separate form for the experimenter indicated which picture number the participant chose, and later the information was used to identify which two participant numbers belonged together as partners.

Once the experimental sessions were completed, each male participant was provided with Debriefing Form C (see Appendix L). They were given an opportunity to ask questions, and were reminded that they could receive a summary of the results of the study by e-mail, if they chose.

Data Reduction and Analyses

As described above, the female participants in the study were categorized into four menstrual cycle phase groups: menstrual-periovulatory (MP group), periovulatory-menstrual (PM group), luteal-periovulatory (LP group), and periovulatory-luteal (PL group). The women were further categorized based on whether their periovulatory session was scheduled according to a positive result on the LH strip (LH group), or based on the reverse count method (Count group).

Data were separated into two different groups in order to: a) maximize sample size, and b) ensure accuracy of menstrual cycle phase. Thus, women were divided into those who were in the correct cycle phase ($n = 21$), as per the parameters for the study (menstrual = days 1 to 6; periovulatory = days -17 to -15 [reverse count] or days +1 to +2 [LH positive]; luteal = days -9 to –5) (Ideal group); and a subset that included the Ideal group as well as those who were very close to the above parameters, and were likely still in the correct phase ($n = 3$) (Overall group, $n = 24$). One of these latter three women was tested on day -22, one on day -20, and one on day -12 (strip days -7, -5, and +5, respectively). Separate analyses were carried out for both the total group of women ($n = 24$), as well as the total minus the three women who did not fit into the study parameters ($n = 21$). For the women in the Ideal group, the mean periovulatory day on which they were tested was -15.76 ($SD = 0.77$, $n = 21$). For the Ideal subset of the Count group, the mean periovulatory day on which they were tested was -15.62 ($SD = 0.77$, $n = 13$). For the Ideal subset of the LH positive group, the mean periovulatory day on which they were tested was -16.00 ($SD = 0.76$, $n = 8$).

Prior to the analyses, the photo slides were categorized according to whether or not they were ideal photos. Photos were deemed to be ideal if the participant was wearing the same clothing, accessories, and makeup, and had a similar pose for both sessions. Then, data from those who had ideal photos were categorized as the Ideal group, whereas data from those who had less ideal photos were placed into the Overall group. Data from both the Ideal group and the Overall group were analyzed independently (rather than removing the Overall group data from the analyses altogether), in an attempt to retain power. Thus, separate analyses were carried out for each group, though greater focus will be placed on the Ideal group results.

The main analyses used to test each hypothesis were as follows: <u>Hypothesis 1: Men find women most attractive during the periovulatory phase of the menstrual cycle.</u> First, two sets of scores were calculated for each male participant: (a) periovulatory body preference scores (a percentage score converted from a score out of 24 for the Overall group, and out of 15 for the Ideal group), and (b) a periovulatory face preference score (a percentage score converted from a score out of 24 for the Overall group, and out of 21 for the Ideal group). Separate one-sample *t* tests were carried out for the men's periovulatory body and face preference scores. The percentage of periovulatory photos chosen as more attractive was compared with 50, as 50% would be the amount of periovulatory photos one would expect to be chosen by chance alone. Two additional one-sample *t* tests were carried out for both face and body scores to evaluate men's preference scores when evaluating slides of women who were (a) in the PM or MP groups (only those women who had one session in the menstrual phase), and (b) in the LP or PL group (only those women who had one session in the luteal phase). The latter *t* tests were done to determine whether or not there were differences in preferences when the periovulatory photos were compared only with luteal photos, or only with menstrual photos. This ensures that a high or low preference for one of the latter phases does not obfuscate the relationship.

<u>Hypothesis 2: Men choose their own partners' periovulatory photos as more attractive than do men evaluating unfamiliar women.</u> Because the sample of males who had partners in the study was very small ($n = 5$), the planned analyses could not be undertaken due to low power. In order to conduct an exploratory test of the hypothesis, the following analyses were completed. First, a score out of 2 was calculated for each partner ($n = 5$) to reflect his periovulatory preferences (PPs) when rating his partner's photos (there was a face slide and a body slide for each woman, hence the score out of 2). This number was then converted to a percentage (partner periovulatory preference score) (face and body scores were combined to maximize power). Second, nonpartner periovulatory preference scores were calculated for the remaining men ($n = 88$) based on their scores for the slides containing the 5 women with partners (5 women with 2 slides

each resulted in a score out of 10 for these men). This score was then converted to a percentage (nonpartner periovulatory preference score). Once the two percentage scores were calculated, an independent-samples *t* test was carried out to evaluate whether partner periovulatory preference scores were higher than nonpartner periovulatory preference scores, which would indicate that male partners are more likely to choose their partner's periovulatory photo as most attractive than men who were rating the same women, but who were not familiar with them. Because the partner's percentage scores could only be 0, 50, or 100, the assumption of equal variances was violated, and thus a test using "equal variances not assumed" was utilized. Once this was completed, an independent-samples *t* test was again carried out, comparing only the responses for the women in the LP or PL group (only women in a luteal phase) ($n = 2$), and another was conducted comparing only the responses for the women in the MP or PM group (only women in a menstrual phase) ($n = 3$). These comparisons did not violate the assumption of equal variances, and thus were carried out in the standard manner.

Hypothesis 3: Second-to-fourth digit ratio will change across the menstrual cycle, with 2D:4D being highest in the luteal phase and lowest in the menstrual phase. Two groups of analyses were performed to examine this hypothesis. The first step was to carry out one-way within-subjects ANOVAs, with the within-subjects factor being session (first, second), the between-subjects factor being group, and the dependent variable being 2D:4D. This ANOVA was completed to compare the MP versus PM groups on three dependent variables: right, left, and mean 2D:4D scores. For the LP and PL groups, one-way within-subjects ANOVAs were utilized with the same dependent and independent variables. ANOVAs were performed rather than MANOVAs since the 2D:4D measures were too highly intercorrelated (i.e., multicollinearity and singularity).

The second set of analyses used to evaluate this hypothesis were independent-samples *t* tests, to evaluate whether there were significant differences between menstrual and luteal phase 2D:4D difference scores. Difference scores were calculated using the following formulas: (a) for menstrual difference scores: menstrual 2D:4D - periovulatory 2D:4D, and (b) for luteal difference scores: luteal 2D:4D - periovulatory 2D:4D. These scores were calculated in this manner (rather than by session number) so that the information provided by the score would be instructive. For example, if the 2D:4D difference score for a MP group participant was -0.03, this would tell us that the periovulatory 2D:4D was higher than the menstrual 2D:4D. Because the hypothesis states that luteal phase 2D:4D will be highest, and menstrual lowest, comparing menstrual to periovulatory and luteal to periovulatory change scores is the most direct test of changes in 2D:4D between these phases. Three *t* tests were performed, one each using right, left, and mean 2D:4D scores.

Hypothesis 4: Male raters consider luteal phase (or higher 2D:4D phase) hand photos most attractive, and the menstrual phase (or lower 2D:4D phase) hand photos least attractive. First, each female participant's 2D:4D scores were examined for each session, in order to ascertain for which session each woman had the highest 2D:4D. Then, two scores were calculated for each male participant: (a) number of luteal hand scans chosen (out of a possible 11, then converted to a percentage score), and (b) number of high 2D:4D hand scans chosen (out of a possible 24, then converted to a percentage score). In order to examine these hypotheses, two types of analyses were performed. A one-sample *t* test was performed to determine whether the percentage of luteal hand scores preferred differed significantly from 50 (since 50% is what we would expect someone to choose just by chance). Then, to test the second portion of the hypothesis, another one-sample *t* test was performed, this time assessing whether the high 2D:4D hand preference scores differed from 50%.

For all main analyses, a significance level of $\alpha \leq .01$ was chosen in order to control for the number of analyses undertaken. A significance level of $\alpha \leq .05$ was considered to be a trend.

Results

Data Screening

The data were first assessed for accuracy of data entry and outliers. Outliers were assessed as a function of groups used in the analyses. Men's face and body periovulatory preference scores were assessed, with total scores, scores for menstrual photos, and scores for luteal photos examined independently. Difference scores for menstrual and luteal phase 2D:4D were also examined independently, as well as being examined as a function of group (MP, PM, LP, PL). Both luteal phase hand preference scores and high 2D:4D hand preference scores were also examined. Distributions of raw scores were explored in order to determine whether or not any outliers were present, and none were found, based on the standards recommended by Tabachnik and Fidell (2001) (i.e., $|z| \geq 3.29$).

Assessing univariate assumptions. Data were assessed to ensure that univariate assumptions were met. Skewness and kurtosis were examined using the following formulas: skewness divided by the standard error of skewness < 3; kurtosis divided by the standard error of kurtosis < 3 (Tabachnik & Fidell, 2001). Visual inspection of histograms was also utilized as a confirmation of normality. Values were all within the acceptable range, and all distributions were reasonably normally distributed.

MANOVA analyses were considered in assessing the hypothesis that 2D:4D is highest in the luteal phase and lowest in the menstrual phase. The variables for such analysis would be right, left, and mean (mean = right + left / 2) 2D:4D. Because mean 2D:4D is composed of the right and left 2D:4D measures (which are already highly correlated), the variables were found to be significantly multicollinear and singular (Pearson correlation analyses reported *r*s of .531 to .951, $p < .01$), and thus ANOVAs were chosen for these analyses instead.

Examination of Group Equivalency

Groups compared in the analyses were examined to ensure group equivalency on relevant demographic and hormonal variables (i.e., age, weight, height, BMI, length of menstrual cycle, length of menses, age at first menstruation, and relationship status). Group membership for the women in the study was based on random assignment to the menstrual cycle groups. One-way ANOVAs were performed for the first seven variables, and Chi square tests were used to examine group equivalency in relationship status. These analyses were used to compare the PM group with the MP group (see Table 1), and the LP group with the PL group (see Table 2). In addition, the menstrual phase group (MP and PM), was compared with the luteal phase group (LP and PL) (see Table 3). As noted in Tables 1 to 3, no group differences were discovered for any of these analyses.

Descriptive Data

Table 4 indicates the means (and standard deviations), or frequencies (and percentages) of variables relating to menstrual cycle (cycle length, menses length, and

Table 1

Assessing Group Equivalency For the Menstrual-Periovulatory and Periovulatory-Menstrual Groups: Means and Standard Deviations or Raw Frequency and Percentages of Specific Attributes

Variable	Menstrual-Periovulatory $n = 7$	Periovulatory-Menstrual $n = 6$
	Means (Standard Deviations)	
Age	21.86 (4.06)	20.50 (1.52)
Weight (kg)	58.51 (9.20)	63.49 (10.22)
Height (cm)	165.10 (7.03)	167.22 (5.43)
BMI (kg/m^2)	17.68 (2.40)	18.95 (2.76)
Cycle length (days)	28.86 (1.46)	28.42 (3.75)
Length of menses (days)	4.93 (1.43)	4.83 (0.93)
Age at menarche (years)	12.57 (1.72)	12.33 (1.21)
	Raw Frequency (Percentage)	
Relationship Status		
Partner	3 (42.9)	4 (66.7)
No partner	4 (57.1)	2 (33.3)

$^t p < .05$. $^* p < .01$. $^{**} p < .001$.

Table 2

Assessing Group Equivalency For the Luteal-Periovulatory and Periovulatory-Luteal Groups: Means and Standard Deviations or Raw Frequency and Percentages of Specific Attributes

Variable	Luteal-Periovulatory $n = 4$	Periovulatory-Luteal $n = 4$
	Means (Standard Deviations)	
Age	19.50 (1.73)	29.25 (11.35)
Weight (kg)	63.98 (11.93)	80.68 (29.60)
Height (cm)	167.32 (9.06)	162.60 (11.86)
BMI (kg/m^2)	19.05 (2.70)	24.49 (7.57)
Cycle length (days)	29.38 (3.90)	29.13 (1.31)
Length of menses (days)	5.50 (1.08)	4.13 (.85)
Age at menarche (years)	12.50 (0.71)	12.75 (0.96)
	Raw Frequency (Percentage)	
Relationship Status		
Partner	2 (50.0)	4 (100.00)
No partner	2 (50.0)	0 (0.00)

$^t p < .05$. $^*p < .01$. $^{**}p < .001$.

Table 3

Assessing Group Equivalency For the Menstrual (MP and PM) and Luteal (LP and PL) Groups: Means and Standard Deviations or Raw Frequency and Percentages of Specific Attributes

Variable	Menstrual $n = 13$	Luteal $n = 8$
	Means (Standard Deviations)	
Age	21.23 (3.11)	24.38 (9.15)
Weight (kg)	60.80 (9.62)	72.33 (22.72)
Height (cm)	166.07 (6.18)	164.96 (10.09)
BMI (kg/m^2)	18.27 (2.55)	21.77 (6.01)
Cycle length (days)	28.65 (2.64)	29.25 (2.70)
Length of menses (days)	4.88 (1.88)	4.81 (1.16)
Age at menarche (years)	12.46 (1.45)	12.63 (0.79)
	Raw Frequency (Percentage)	
Relationship Status		
Partner	7 (53.8)	6 (75.0)
No partner	6 (46.2)	2 (25.0)

$^{t}p < .05$. $^{*}p < .01$. $^{**}p < .001$.

Table 4

Means and Standard Deviations or Raw Frequencies and Percentages of Specific Attributes as a Function of Menstrual Phase Group

	Means (Standard Deviations)				
	M-P (*n* = 7)	P-M (*n* = 6)	L-P (*n* = 4)	P-L (*n* = 4)	Overall (*n* = 21)
Length of mens. cycle (days)	28.86 (1.46)	28.42 (3.75)	29.38 (3.90)	29.13 (1.31)	28.88 (2.61)
Length of menses (days)	4.93 (1.43)	4.83 (0.93)	5.50 (1.08)	4.13 (.85)	4.86 (1.14)
Age at first menstruation (years)	12.57 (1.72)	12.33 (1.21)	12.50 (0.71)	12.75 (.98)	12.52 (1.22)
	Raw Frequency (Percentage)				
Relationship Status					
Partner	3 (42.9)	4 (66.7)	2 (50.0)	4 (100.0)	13 (61.9)
No partner	4 (57.1)	2 (33.3)	2 (50.0)	0 (0.0)	8 (38.1)

(Table 4 continues

(Table 4 continued)

	Raw Frequency (Percentage)				
	M-P ($n = 7$)	P-M ($n = 6$)	L-P ($n = 4$)	P-L ($n = 4$)	Overall ($n = 21$)
Hormonal Contraceptive Status					
Never User	4 (57.1)	1 (16.7)	1 (25.0)	2 (50.0)	10 (47.6)
Previous User	3 (42.9)	5 (83.3)	3 (75.0)	2 (50.0)	11(52.4)
Menstrual Cycle Regularity					
"Get period, but unpredictable and irregular"	0 (0.0)	1 (16.7)	0 (0.0)	2 (50.0)	3 (14.3)
"Get period within 2 to 3 days of when expected"	7 (100.0)	4 (66.7)	4 (100.0)	2 (50.0)	17 (81.0)
"Period is like clockwork"	0 (0.0)	1 (16.7)	0 (0.0)	0 (0.0)	1 (4.8)

$^{t}p < .05$. $^{*}p < .01$. $^{**}p < .001$.

age at first menarche), relationship status, hormonal contraceptive use, and menstrual cycle regularity, as a function of menstrual phase group, and overall.

Main Analyses

In terms of the periovulatory preference (PP) scores (%), separate analyses were conducted for the heterosexual male sample ($n = 89$), as well as a sample consisting of nonheterosexual men ($n = 3$) (see Table 5 for means and standard deviations). One-way ANOVAs were carried out in order to determine whether the two samples (heterosexual versus nonheterosexual) differed in their preferences. A significant difference was found for the luteal body preferences, $F(1, 90) = 6.57, p < .01$, indicating that the heterosexual only group (M = 48.64, SD = 16.64) was more likely to prefer the periovulatory photos than the nonheterosexual group (M = 23.81, SD = 8.25), when comparing the periovulatory with the luteal body photos. Because the results for the heterosexual men are of more consequence to the study, and that a difference in preferences was found between the two groups in spite of a small sample in one group, all results reported here will be based only on the heterosexual sample. However, it is interesting to note that overall, nonheterosexual men showed a higher preference for periovulatory photos than did the heterosexual sample, except in regards to the luteal (and total) body photos.

Similarly, when analyzing luteal and high 2D:4D preferences, separate analyses were carried out for both the heterosexual sample, and the nonheterosexual sample. Given that the results did not differ between the two groups, only the results for the heterosexual sample will be reported here.

Hypothesis 1: Men evaluate women as most attractive during the periovulatory phase of the menstrual cycle. One-sample t tests were carried out to determine which cycle phase photos

Table 5

Means and Standard Deviations for Men's Periovulatory Preference Scores (Percentages) for Body and Face Photos by Menstrual Cycle Phase: Heterosexual Sample and Nonheterosexual Sample

	Mean (Standard Deviation)	
	Group	
	Heterosexual ($n = 90$)	Nonheterosexual ($n = 3$)
Total Body Photos	49.06 (12.56)	44.44 (3.85)
Menstrual Body Photos	49.44 (17.97)	62.50 (12.50)
Luteal Body Photos *	48.64 (16.64)	23.81 (8.25)
Total Face Photos	45.91 (10.73)	50.79 (5.50)
Menstrual Face Photos	44.60 (13.13)	51.28 (4.44)
Luteal Face Photos	48.17 (17.53)	50.00 (12.50)

Note. Scores above 50% indicate that men showed a preference for the photos taken in the periovulatory phase; scores below 50% indicate that they showed a preference for photos taken in the nonperiovulatory phase.

$^{t}p < .05$. $^{*}p < .01$. $^{**}p < .001$.

were preferred. The *t* tests were performed for: total body photos, total face photos, menstrual body photos, luteal body photos, menstrual face photos, luteal face photos. The middle column in Table 5 shows the PP scores (%) for the heterosexual sample of male participants. Scores of 50% indicate no preference for periovulatory or nonperiovulatory photos, scores above 50% suggest a preference for periovulatory photos, while scores below 50% suggest a preference for nonperiovulatory photos. Examination of the means in Table 5 (all below 50%) indicates no preference for the periovulatory photos with this group of photos.

One-sample *t* tests for the heterosexual PP scores are presented in Table 6. The men did not show a preference for the body photos at any particular cycle phase. However, a significant preference was found for the total face photo group, such that the facial PP score, 45.91%, was significantly lower than 50%, $t(88) = -3.60$, $p < .001$. This indicates that men preferred the nonperiovulatory faces. Further analyses revealed an even stronger nonperiovulatory facial preference when the menstrual phase photos were examined. The PP score of 44.60% indicates that men preferred the menstrual phase face photos over the periovulatory face photos, $t(88) = -3.88$, $p < .001$.

The results of these analyses indicate that, although most of the analyses did not reach statistical significance, there was still a consistent preference for nonperiovulatory photos, when rating both face and body photos. However, the two significant findings indicate that men preferred the nonperiovulatory face photos over the periovulatory face photos, and also that they preferred the menstrual face photos over the periovulatory face photos. This is contrary to the hypothesized relationship between these variables.

Hypothesis 2: Men evaluating their own partners will be more likely to choose periovulatory photos as most attractive than will be men rating unfamiliar women. An

Table 6

Results for One-Sample *t* Tests Examining Men's Periovulatory Preference Scores for Body and Face Photos

Preference Scores	*df*	*t*	*d*	95% CI
Total Body Photos	88	-0.70	.07	-3.58 to 1.71
Menstrual Body Photos	88	-0.30	.03	-4.35 to 3.22
Luteal Body Photos	88	-0.77	.08	-4.87 to 2.14
Total Face Photos**	88	-3.60	.38	-6.35 to -1.83
Menstrual Face Photos**	88	-3.88	.41	-8.17 to -2.64
Luteal Face Photos	88	-0.98	.10	-5.52 to 1.87

$^{t}p < .05$. $^{*}p < .01$. $^{**}p < .001$.

independent-samples *t* test was performed to determine whether male partners were more likely to choose their partner's periovulatory photos as most attractive, as compared with men who were rating these same women, but who were unfamiliar with them. An overall analysis was completed, comparing the PP scores for the partners ($M = 50.00$, $SD = 50.00$, $n = 5$) and nonpartners ($M = 54.32$, $SD = 14.21$, $n = 88$). Due to significant Levene's tests for equality of variances ($p < .01$), the results for "equal variances not assumed" were utilized. While the direction of the means actually suggested a greater periovulatory preference for the nonpartners, no group differences were found, $t(4.04) = -.19$, $p = .857$. When the analysis was repeated using only slides of women with one photo in the menstrual phase ($n = 3$), the partners ($M = 44.44$, $SD = 25.46$, $n = 3$) and nonpartners ($M = 54.92$, $SD = 20.24$, $n = 88$) did not differ, $t(89) = -.88$, $p = .383$. The same occurred when only results for the slides of women in one of the luteal groups ($n = 2$) were analyzed, where partners' ($M = 37.50$, $SD = 17.68$, $n = 2$) and nonpartners' ($M = 53.41$, $SD = 22.80$, $n = 88$) scores did not significantly differ, $t(88) = -.98$, $p = .33$. Therefore, although means for the partners and the nonpartners consistently indicated that the nonpartners were more likely to choose the periovulatory photos as most attractive (which is contrary to the hypothesized direction), none of these results achieved statistical significance.

<u>Hypothesis 3: Second-to-fourth digit ratio will change across the menstrual cycle, with 2D:4D being highest in the luteal phase and lowest in the menstrual phase.</u> The first set of analyses carried out to test this hypothesis were one-way within-subjects ANOVAs (for the MP versus PM comparisons and the LP and PL comparisons). The top half of Table 7 lists the means and standard deviations for the left, right, and mean 2D:4D measures as a function of menstrual cycle group and session, as well as overall. The bottom half of the table presents

Table 7

Means and Standard Deviations of Right, Left, and Mean 2D:4D as a Function of Group (Menstrual-Periovulatory [MP], Periovulatory-Menstrual [PM], Luteal-Periovulatory [LP], and Periovulatory-Luteal [PL]), and Session (First and Second)

	Mean (Standard Deviation)			
	Group			
	MP ($n = 7$)		PM ($n = 6$)	
	Session		Session	
Variable	1st	2nd	1st	2nd
Mean 2D:4D	.975 (.028)	.976 (.026)	.948 (.033)	.948 (.029)
Left 2D:4D	.976 (.031)	.974 (.027)	.955 (.041)	.953 (.037)
Right 2D:4D	.974 (.026)	.977 (.027)	.942 (.027)	.942 (.026)

Means of the 2 sessions

Variable	MP ($n = 7$)	PM ($n = 6$)
Mean 2D:4D	.975 (.027)	.948 (.031)
Left 2D:4D	.975 (.029)	.954 (.039)
Right 2D:4D	.976 (.026)	.942 (.026)

(Table 7 continues)

(Table 7 continued)

	Mean (Standard Deviation)					
	Group					
	LP (n = 4)		PL (n = 4)		Overall ($n = 21$)	
	Session		Session		Session	
Variable	1st	2nd	1st	2nd	1st	2nd
Mean 2D:4D	.959 (.006)	.954 (.015)	.969 (.029)	.961 (.020)	.963 (.028)	.961 (.025)
Left 2D:4D	.963 (.026)	.958 (.028)	.963 (.030)	.955 (.024)	.965 (.032)	.961 (.029)
Right 2D:4D	.955 (.017)	.950 (.024)	.975 (.029)	.968 (.017)	.961 (.028)	.960 (.027)

Means of the 2 sessions

Variable	LP (n = 4)	PL (n = 4)	Overall
Mean 2D:4D	.956 (.010)	.965 (.024)	.962 (.026)
Left 2D:4D	.960 (.025)	.959 (.027)	.963 (.030)
Right 2D:4D	.953 (.021)	.971 (.022)	.961 (.027)

the same means collapsed across session. It should be noted that the mean 2D:4Ds for this sample of women are considerably lower than the 2D:4Ds of similar samples drawn from the same population of women (e.g., Oinonen, Jarva, & Mazmanian, 2008). Proposed explanations for this finding will be outlined in the discussion.

For the first set of ANOVAs, the MP group ($n = 7$) was compared with the PM group ($n = 6$). The within-subjects factor was session (first, second), the between-subjects factor was group, and the dependent variables were right, left, and mean 2D:4D. Table 8 outlines the results of these three analyses. As the table indicates, there were no significant main effects for session, and no session x group interactions for either right, left, or mean 2D:4D. However, for right 2D:4D, there was a trend for a main effect of group, $F(1, 11) = 5.60$, $p < .05$, partial $\eta^2 = .34$. An examination of the means for right 2D:4D for the two groups (see table 7) indicates that the MP group had a higher mean right 2D:4D ($M = .98$, $SD = .03$) than the PM group ($M = .95$, $SD = .94$). Thus, although the women were randomly assigned to menstrual cycle groups, the measures of 2D:4D differed according to whether the women were in the MP group or the PM group.

The second set of ANOVAs compared the 2D:4D of those in the LP group ($n = 4$) with those in the PL group ($n = 4$). Again, the within-subjects factor was session (first, second), the between-subjects factor was group, and the dependent variables were right, left, and mean 2D:4D. The LP versus PL comparison (see Table 9), showed no significant interaction between session and group, and no significant main effects of group or session. Thus, 2D:4D did not change across the cycle.

The final set of analyses carried out for this hypothesis were independent-samples *t* tests comparing the menstrual and luteal phase right, left, and mean 2D:4D difference

Table 8

One-Way Repeated Measures Analysis of Variance (ANOVA) Table for the Between- and Within-Subjects Results of 2D:4D for the MP and PM Groups

Variables	*df*	*F*	Partial η^2	*P*
Right 2D:4D		Between Subjects		
Group (G) [t]	1	5.60	.34	.04
S within-group error	11	(1.34)		
		Within Subjects		
Session (S)	1	0.39	.03	.55
S x G	1	0.39	.03	.55
Error	11	(3.38)		

(Table 8 continues)

(Table 8 continued)

Variables	*df*	*F*	Partial η^2	*P*
Left 2D:4D		Between Subjects		
Group (G)	1	1.21	.10	.29
S within-group error	11	(2.31)		
		Within Subjects		
Session (S)	1	0.44	.04	.52
S x G	1	0.00	.00	.96
Error	11	(3.50)		
Mean 2D:4D		Between Subjects		
Group (G)	1	2.98	.21	.11
S within-group error	11	(1.63)		
		Within Subjects		
Session (S)	1	0.00	.00	.98
S x G	1	0.17	.02	.69
Error	11	(2.24)		

Note. Values enclosed in parentheses represent mean square errors. *S* = subjects.

[t] $p < .05$. *$p < .01$. **$p < .001$.

Table 9

One-Way Repeated Measures Analysis of Variance (ANOVA) Table for the Between- and Within-Subjects Results of 2D:4D for the LP and PL Groups

Variables	*df*	*F*	Partial η^2	*P*
Right 2D:4D		Between Subjects		
Group (G)	1	1.54	.20	.26
S within-group error	6	(9.15)		
		Within Subjects		
Session (S)	1	1.60	.21	.25
S x G	1	0.06	.01	.81
Error	6	(9.79)		

(Table 9 continues)

(Table 9 continued)

Variables	*df*	*F*	Partial η^2	*P*
Left 2D:4D		Between Subjects		
Group (G)	1	0.01	.00	.95
S within-group error	6	(1.36)		
		Within Subjects		
Session (S) ^{t}	1	1.60	.21	.25
S x G	1	0.06	.01	.81
Error	6	(9.79)		
Mean 2D:4D		Between Subjects		
Group (G)	1	0.45	.07	.53
S within-group error	6	(6.81)		
		Within Subjects		
Session (S)*	1	2.42	.29	.17
S x G	1	0.10	.02	.77
Error	6	(6.46)		

Note. Values enclosed in parentheses represent mean square errors. *S* = subjects.

$^t p < .05$. $^*p < .01$. $^{**}p < .001$.

scores. See Table 10 for the means and standard deviations of the right, left, and mean 2D:4D difference scores as a function of group. Table 11 shows the results of the *t* tests. As the table indicates, none of the *t* tests indicated significant group differences. This suggests that there were no significant differences in 2D:4D change scores between the menstrual and periovulatory phase or between the luteal and periovulatory phase for either right, left, or mean 2D:4D.

Hypothesis 4: Male raters will evaluate the luteal phase (or higher 2D:4D phase) hand photos as more attractive, and the menstrual phase (or lower 2D:4D phase) hand photos as least attractive. The first set of analyses employed for this hypothesis were one-sample *t* tests comparing the luteal hand preference scores (%) with 50, as 50% is the preference score expected merely by chance. Next, one-sample *t* tests were used to compare the high 2D:4D hand preference scores (%) with 50%. A one-way ANOVA indicated that there were no significant differences between the preferences of the heterosexual and nonheterosexual samples, and thus only the results of the heterosexual sample of men will be reported. The trend for mean luteal hand preference scores (53.61%), $t(88) = 2.23$, $p = .028$, $d = .24$, indicates that men preferred the luteal hand photos over periovulatory hand photos. The trend for the mean high 2D:4D hand preference scores (47.26%), $t(88) = -2.43$, $p = .017$, $d = .26$, indicates that men preferred the lower 2D:4D hand photos over higher 2D:4D hand photos. Thus, although the results were not significant, strong trends suggest that men prefer luteal hand photos (which supports the hypothesis), as well as preferring lower 2D:4D hand photos (which is contrary to the hypothesis). This is surprising since it was hypothesized that men would prefer luteal hand photos due to the hypothesis that 2D:4D is higher in the luteal phase.

Table 10

Means and Standard Deviations of Right, Left, and Mean 2D:4D Difference Scores as a Function of Menstrual Cycle Phase

	Mean (Standard Deviation)		
	Group		
Difference Score	Menstrual (*n* = 13)	Luteal (*n* = 8)	Overall (*n* = 21)
Right 2D:4D	-.0015 (.0080)	-.0012 (.0146)	-.0014 (.0106)
Left 2D:4D	.0000 (.0082)	-.0013 (.0146)	-.0005 (.0107)
Mean 2D:4D	-.0012 (.0071)	-.0025 (.0141)	-.0017 (.0100)

Note: Difference scores for each group were calculated using the formula: Nonperiovulatory 2D:4D – Periovulatory 2D:4D. Thus, positive scores indicate higher 2D:4D in the nonperiovulatory phase, while negative scores indicate a higher 2D:4D in the periovulatory phase.

Table 11

Results for Independent-Sample *t* Tests Examining Whether Menstrual Phase 2D:4D Difference Scores Differ from Luteal Phase 2D:4D Difference Scores

Difference Scores	*df*	*t*	*d*	95% CI
Right 2D:4D	19	-.06	.03	-.01 to .01
Left 2D:4D	19	0.25	.11	-.01 to .01
Mean 2D:4D	9.22[a]	0.25	.16	-.01 to .01

[a] Due to significant Levene's test, degrees of freedom were calculated with "equal variances not assumed"

[t] $p < .05$. *$p < .01$. **$p < .001$.

Supplementary Analyses

Facial Periovulatory Preferences By Cycle Day

In order to further explore the above-reported preference for menstrual faces and the absence of a preference for periovulatory faces, analyses were performed to determine whether men's PP scores differed depending on the cycle day on which the women attended their sessions. Table 12 shows the means and standard deviations of the facial PP scores as a function of cycle day for the menstrual and luteal phases. Table 13 shows the means and standard deviations of the facial PP scores as a function of cycle day for the periovulatory phase using reverse count, and the periovulatory phase using days from the LH positive test. Figure 4 indicates the PP scores for the face photos as a function of cycle day, for the menstrual and luteal cycle phases. Figure 5 presents PP scores for the face photos as a function of cycle day for the periovulatory cycle phase, using both reverse count (top of figure) and LH positive cycle days (bottom of figure).

Menstrual phase cycle days. As indicated in Figure 4, cycle day for the menstrual face photos did not provide strong evidence to contradict the above results indicating a preference for menstrual over periovulatory face photos. Faces of women photographed on days 1, 2, 3, and 5 of the menstrual phase were preferred over periovulatory faces. However, when women were photographed on cycle day 6, men preferred the periovulatory photos. This may not be surprising given that when a woman is on day 6 of the cycle, she is usually not considered to be in the menstrual phase (e.g., Chavanne & Gallup, 1998; Macrae, Alnwick, Milne, & Schloerscheidt, 2002; Penton-Voak & Perrett, 2000). In fact, day 6 was only included post hoc in order to increase sample size and power. A one-way within-subjects ANOVA was carried out to determine whether the

Table 12

Means and Standard Deviations for Periovulatory Preference Scores as a Function of Cycle Day for the Menstrual Phase and the Luteal Phase

Cycle Phase and Day	Mean (SD) ($n = 93$)	Preference
Menstrual Phase		
Cycle Day 1 (1 slide) [t]	42.47 (32.09)	Menstrual [t]
Cycle Day 2 (2 slides) **	39.25 (31.15)	Menstrual
Cycle Day 3 (3 slides) [t]	44.80 (25.77)	Menstrual [t]
Cycle Day 5 (3 slides) **	37.63 (21.55)	Menstrual
Cycle Day 6 (3 slides) [t]	56.37 (26.00)	Periovulatory
Luteal Phase		
Cycle Day -9 (3 slides) *	41.22 (28.82)	Luteal
Cycle Day –7 (1 slide) *	36.56 (48.42)	Luteal
Cycle Day –6 (1 slide)	53.76 (50.13)	None
Cycle Day –5 (6 slides)	50.72 (19.49)	None

[t] $p < .05$. *$p < .01$. **$p < .001$.

Table 13

Means and Standard Deviations of Facial Periovulatory Preference Scores as a Function of Cycle Day for the Periovulatory (Reverse Count and LH Positive) Phase

Cycle Phase and Day	Mean (SD) ($n = 93$)	Preference
Periovulatory - Reverse Count		
Cycle Day -22 (1 slide) *	36.56 (48.42)	Nonperiovulatory
Cycle Day -20 (1 slide) *	36.56 (48.42)	Nonperiovulatory
Cycle Day -17 (3 slides) **	34.77 (18.98)	Nonperiovulatory
Cycle Day -16 (11 slides) **	44.67 (15.14)	Nonperiovulatory
Cycle Day -15 (6 slides) *	56.81 (20.74)	Periovulatory
Cycle Day -14 (1 slide) [t]	38.71 (48.97)	Nonperiovulatory [t]
Cycle Day -12 (1 slide)	53.76 (50.13)	None
Periovulatory - LH Positive		
Strip Positive Day -7 (1 slide) *	36.56 (48.42)	Nonperiovulatory
Strip Positive Day -5 (1 slide) *	36.56 (48.42)	Nonperiovulatory
Strip Positive Day -2 (1 slide) **	26.88 (44.57)	Nonperiovulatory
Strip Positive Day -1 (1 slide) *	36.56 (48.42)	Nonperiovulatory
Strip Positive Day 0 (3 slides) **	34.77 (18.98)	Nonperiovulatory
Strip Positive Day +1 (6 slides)	47.85 (20.45)	None
Strip Positive Day +2 (3 slides) [t]	55.56 (27.07)	Periovulatory [t]
Strip Positive Day +3 (1 slide) *	34.41 (47.76)	Nonperiovulatory
Strip Positive Day +5 (1 slide)	53.76 (50.13)	None

[t] $p < .05$. *$p < .01$. **$p < .001$.

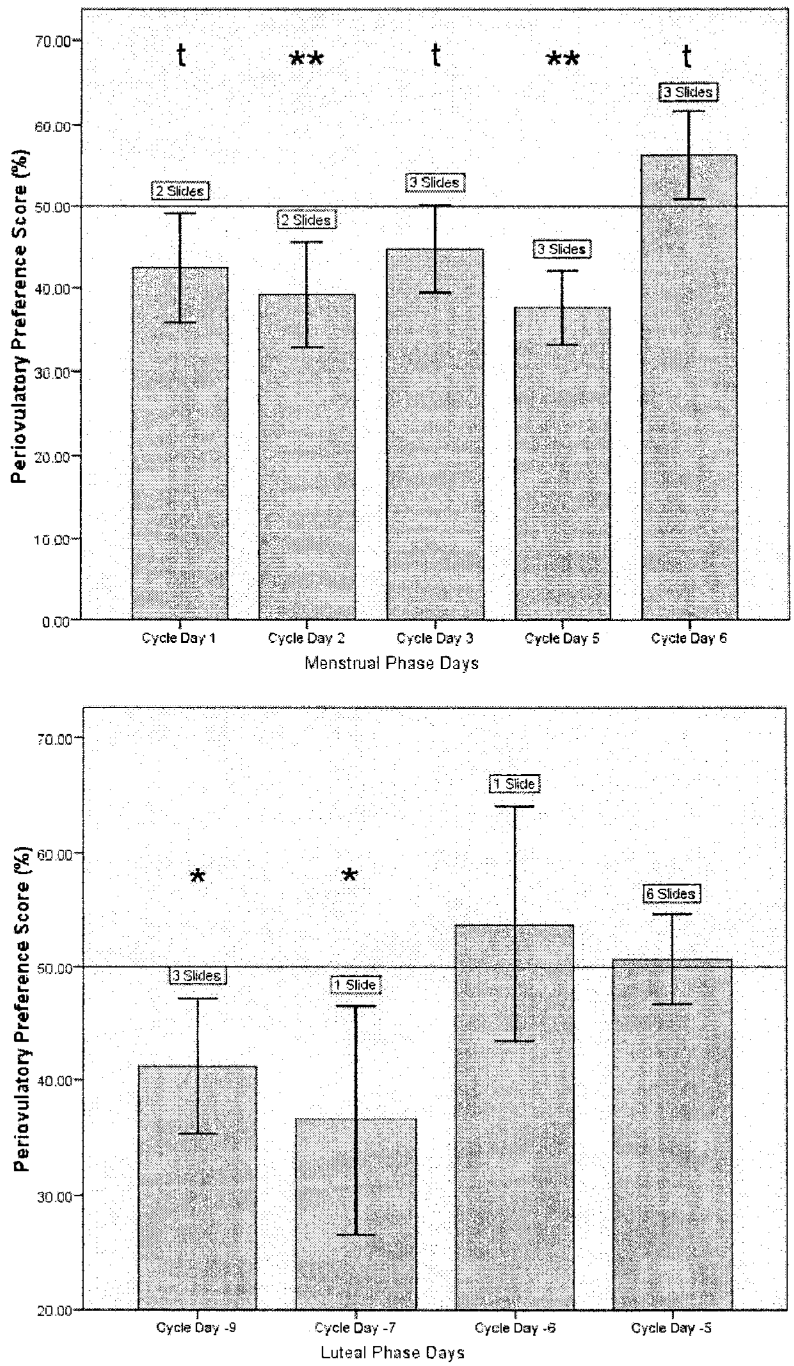

Figure 4. Mean periovulatory face preference scores (%) by cycle day for the menstrual (top) and luteal (bottom) phases. Error bars represent the standard error of the mean. A menstrual phase face preference was found for women tested on days 2 to 5 of the menstrual phase. A luteal phase face preference was found for women tested on days -9 and -7 of the luteal phase.

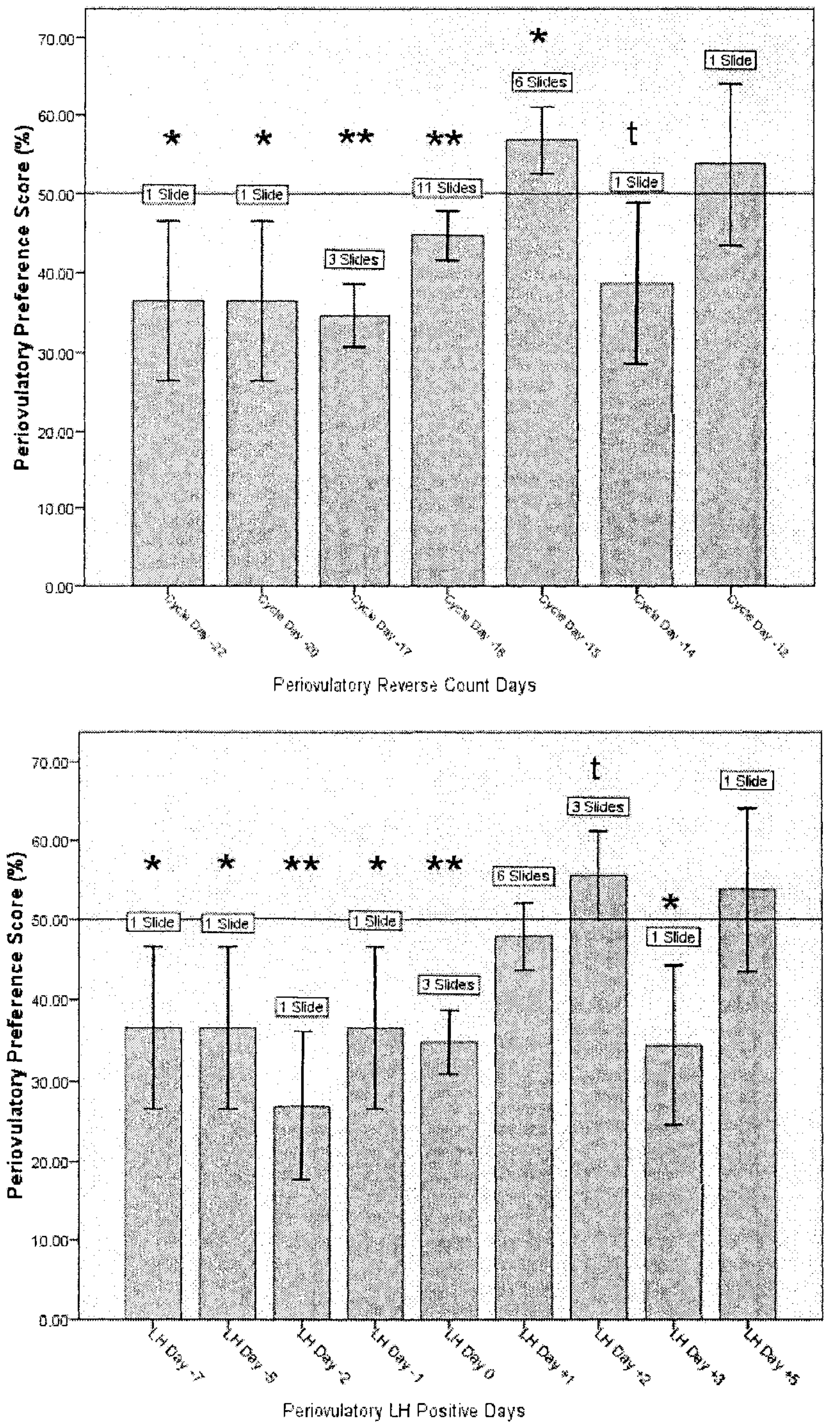

Figure 5. Mean periovulatory face preference scores (%) as a function of cycle day for both periovulatory reverse count (top) and LH positive (bottom) cycle days. Error bars represent the standard error of the mean. The only days on which a periovulatory preference was found include day -15 (p = .002) and a trend for LH day +2 (p = .051).

results for each of the cycle days differed significantly from each other. As Mauchley's test of sphericity was significant ($p = .02$), the Huynh-Feldt correction was utilized, because $\varepsilon > 0.75$ (see Quintana & Maxwell, 1994). The results indicated an overall effect of cycle day, $F(3.80, 334.20) = 6.80$, $p < .001$. Pairwise comparisons were carried out for each of the cycle day pairs. There were significantly lower PPs for menstrual phase days 2 and 5 when compared with day 6 ($ps < .001$), and there were trends suggesting that scores on days 1 and 3 were significantly lower than day 6 ($ps < .05$). One-sample *t* tests were also carried out to determine whether preference scores for each of the cycle days were significantly different from 50% (what one would expect merely by chance). As indicated in Table 12 and Figure 4, scores for cycle days 2 and 5 were significantly below 50% ($p < .001$), while there were trends for days 1 (< 50%) and 6 (> 50%) ($ps < .05$). There was also a weak trend for day 3 (< 50%) ($p = .06$).

Luteal phase cycle days. As shown in Figure 4, the first two cycle days for the luteal phase (days -9 and -7) both had PP scores indicating that men preferred the luteal phase face photos over the periovulatory photos, while the opposite was found for the latter two days (days -6 and -5). However, only the preference scores for days -9 and -7 were significant (see Table 12 and Figure 4). A one-way repeated-measures ANOVA was again utilized, and as the sphericity assumption was violated, the Huynh-Feldt correction was again used. The ANOVA showed a significant effect for cycle day, $F(2.52, 225.26) = 3.88$, $p < .01$). Pairwise comparisons comparing each pair of luteal cycle days showed a trend indicating that preference scores on days -9 and -5 differed. One-sample *t* tests indicated that only scores on days -9 and -7 were significantly different (i.e., lower) than 50% ($p < .01$).

Periovulatory: reverse count cycle days. As indicated in the top of Table 13 and Figure 5, PP scores differed quite considerably depending on which periovulatory cycle day the women were tested on. When evaluating photos of women who were on the days prior to the most likely day of ovulation (i.e., day -15), the men preferred the nonperiovulatory photos. However, when evaluating photos of women on the likely day of ovulation (day -15), men preferred the periovulatory face photos. Then, for the likely day after ovulation (day -14), men showed a trend towards preferring the nonperiovulatory photos. A one-way within-subjects ANOVA was conducted comparing the scores for each periovulatory reverse count cycle day with each of the other periovulatory reverse count days. Again, the Huynh-Feldt correction was used, and indicated that the results were significant, $F(4.30, 395.80) = 4.96$, $p < .001$). Pairwise comparisons indicated that scores for days -17 and -16 were significantly lower than scores for day -15 ($p < .001$), that scores for day -22 were significantly lower than scores for day -15 ($p < .01$), and that scores for day -17 were significantly lower than scores for day -16 ($p < .01$). Trends also indicated that scores for days -20 and -14 were lower than scores for day -15, and that scores for day -17 were lower than scores for day -12 ($p < .05$). One-sample t tests involved examining whether PP scores differed from 50%. Mean scores on days -17 ($p < .001$), -16 ($p < .001$), -20 ($p < .01$), and -22 ($p < .01$) were significantly lower than 50%, indicating a nonperiovulatory preference. However, there was a preference for the periovulatory face when photos were taken on day -15 ($p < .01$).

Periovulatory: LH positive cycle days. The bottom panel of Table 13 and Figure 5 shows a similar pattern for the periovulatory LH positive cycle days as was seen with the reverse count method. On every day except the expected day of ovulation (day +2) and 3 days after the expected day of ovulation (day +5), the mean scores suggest that men preferred the nonperiovulatory face photos. A one-way ANOVA was conducted, and again, the Huynh-Feldt correction was utilized. The results indicated an effect of cycle day, $F(6.89, 634.11) = 5.47, p < .001$. Pairwise comparisons indicated that scores for LH positive days -2 and 0 were significantly lower than those of LH positive day +2, and also that scores for LH positive day 0 were significantly lower than those of LH positive day +1 ($p < .001$). There were also significant results indicating differences between the results for LH positive days +1 and +5 (higher scores) when compared with day -2 (lower scores) ($p < .01$). Trends were also discovered indicating lower scores for days -7 and +3 in comparison with day +2 ($p < .05$). One-sample *t* tests comparing the PP scores with the chance level of 50% for each cycle day, indicated a nonperiovulatory preference on days -2 and 0, $p < .001$, and on days -7, -5, -1 and +3, $p < .01$. There was a trend indicating a periovulatory preference for LH positive day +2 at the $p < .05$ level.

Figure 6 shows the periovulatory preference scores for the three cycle days with highest conception likelihood (Dunson et al., 1999; Trussell & Raymond, 1999). In the top panel, the reverse count days used were the two days prior to ovulation (days -17 and -16), and the day of ovulation (day -15). The bottom panel of the figure shows scores as a function of days from the LH positive test (days 0, +1, +2). It is important to note that the scores are lowest two days prior to ovulation, higher the day before, and highest on the presumed day of ovulation. This finding is valuable in determining *why* other studies have found a periovulatory attractiveness preference. It is possible that men find women attractive during the periovulatory phase due to either highest conception probability, or differences in circulating hormone levels throughout the menstrual cycle. If men found

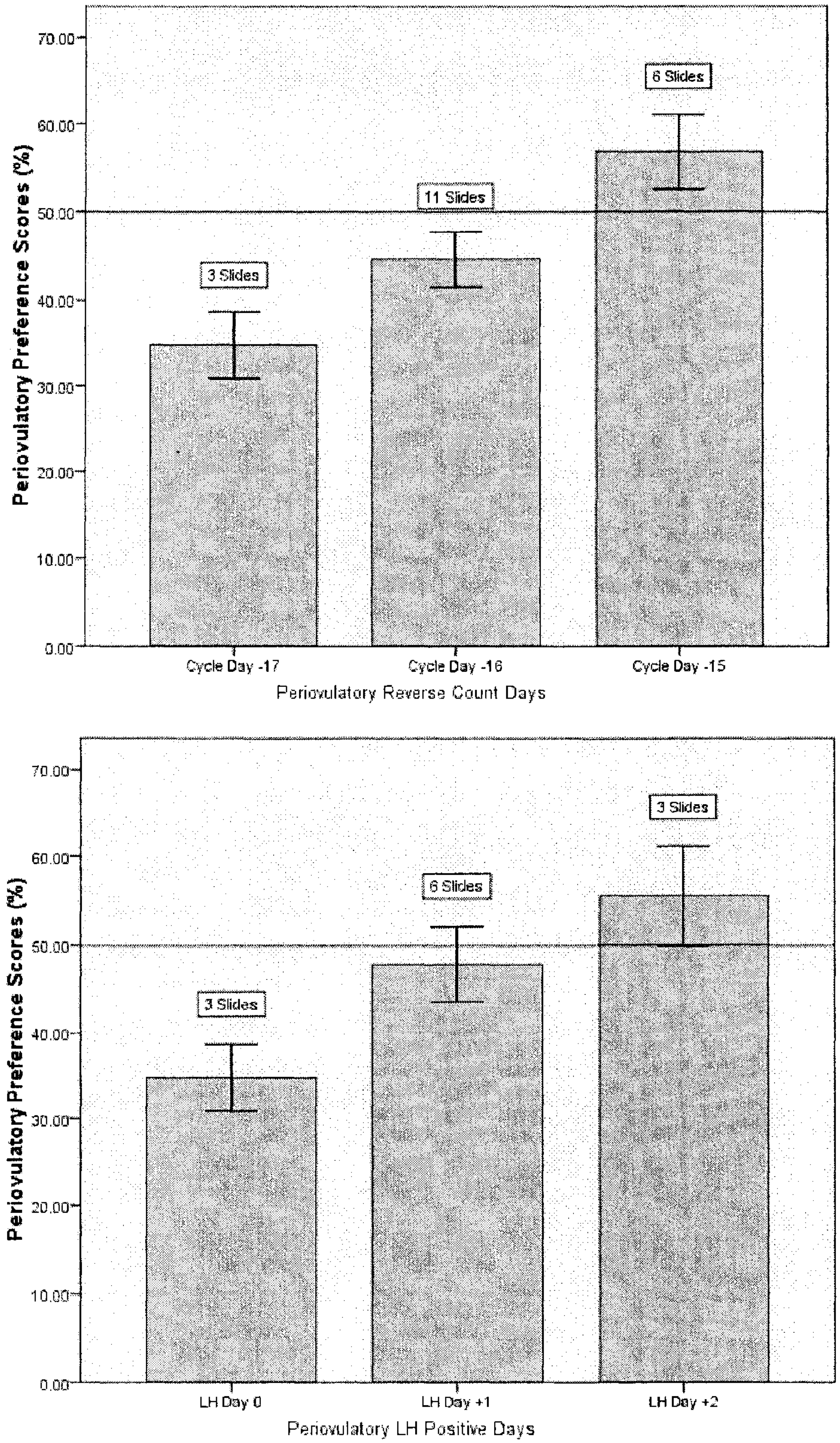

Figure 6. Periovulatory facial preference scores for the 3 cycle days with the highest conception probability, for both the reverse count (top) and LH positive (bottom) cycle days. A periovulatory preference was found only on day -15 (reverse count) and +2 (LH positive).

women most attractive during the preovulatory period (days -17 and -16 or days 0 and +1), this would provide evidence for the "highest conception probability" theory, while the finding that women are most attractive on the day of ovulation indicates that this attractiveness effect may be more a by-product of differing hormone levels in the body (e.g., high estradiol). This issue will be discussed further in the Discussion section.

Periovulatory Preference Scores for Faces and Bodies After the Removal of Cycle Day 6

Cycle day 6 is not typically considered part of the menstrual phase in menstrual cycle research (e.g., Chavanne & Gallup, 1998; Macrae et al., 2002) given that hormone levels may already be starting to rise on this day. For this reason, and because the results by cycle day (see Figure 4) indicate that the day 6 results are different from those on days 1 to 5, analyses for face and body preference were conducted again, with the removal of cycle day 6 from the analyses. As expected, the mean PP face score ($M = 44.56$, $SD = 11.41$) was again significantly lower than 50%, $t(92) = -4.60$, $p < .001$. Furthermore, when cycle day 6 was removed from the menstrual phase, men were more likely to prefer nonperiovulatory face photos (44.56%) than when cycle day 6 photos were used alone ($M = 56.27$, $SD = 26.00$), $t(92) = 4.08$, $p < .001$. This suggests that a woman's attractiveness or men's preferences may differ between day 6 and days 1 to 5.

The *t* test for the menstrual face photos only was also repeated with the removal of cycle day 6 slides. The PP score ($M = 40.86$, $SD = 13.45$) was significantly lower than 50%, $t(92) = -6.56$, $p < .001$. Furthermore, a paired-samples *t* test showed that the new PP score was significantly lower than the score for cycle day 6 slides only ($M = 67.20$, $SD = 34.18$), $t(92) = -7.13$, $p < .001$, indicating that men were more likely to choose the menstrual photos as more attractive than the periovulatory photos when looking at days 1 to 5 as opposed to day 6 alone.

When the analyses for the body PP scores were repeated with cycle day 6 removed, the men were less likely to prefer the periovulatory photos ($M = 51.31$, $SD = 13.32$), as compared with the PP scores for women on day 6 only ($M = 56.27$, $SD = 18.38$). However, the new score did not differ significantly from 50%, $t(92) = .95$, $p = .35$. A paired-samples *t* test comparing the new mean for the scores when cycle day 6 was not included with the mean for the scores for cycle day 6 only, was significant, $t(92) = -2.05$, $p < .001$, and the score for cycle day 6 only was significantly higher than 50%, thus there was a PP on day 6, but not for days 1 to 5.

Preference Differences Between High and Low SOI Men

Analyses were undertaken to determine whether there were differences in PPs between men with high or low scores on the Sociosexual Orientation Inventory. As described earlier, SOI scores represent the degree to which one requires closeness, commitment and emotional involvement prior to engaging in sex with a partner (Simpson & Gangestad, 1991). High SOI scores indicate that one does not require this closeness and commitment prior to engaging in sex, while low scores indicate a higher need for closeness and commitment. Those with high SOI scores are referred to as "unrestricted", while those with low scores are referred to as "restricted". First, SOI scores were calculated using the following formula from Oinonen, Klemencic and Mazmanian (2008), which was adapted from Simpson and Gangestad (1991): SOI = (5 [no. of partners in the past year] + 1 [no. of partners foreseen in the next 5 years] + 5 [no. of one-night stands] + 2 [attitudes toward engaging in casual uncommitted sex]).

Next, men were divided into low and high SOI groups, using approximately the bottom and top 33% of scores as cut-offs. Then, to examine more extreme groups, the bottom and top 10% of responses were used to create low and high SOI groups. Table 14 indicates the means and standard deviations of the PP scores for each of the preference tests, as a function of low or high SOI (using both sets of cut-offs).

One-way ANOVAs were utilized to determine whether the low and high SOI men differed significantly on PP scores for each of the face and body preference tests. For the less stringent cut-off (bottom and top 33%), a trend was found for the luteal face photos, $F(1, 51) = 0.59$, $p < .05$. The high SOI men were more likely to choose the periovulatory faces as more attractive ($M = 51.92$, $SD = 17.92$), than the low SOI men ($M = 42.13$, $SD = 17.04$). When the more stringent cut-off (bottom and top 10%) was applied, the face PP scores differed significantly between low and high SOI men, $F(1, 14) = 12.06$, $p < .01$. With the more extreme SOI groups, high SOI men showed a strong (though not significant) preference for periovulatory over luteal face photos (62.50%), $t(7) = 2.00$, $p = .086$. On the other hand, the low SOI men showed a strong trend for a preference for the luteal over the periovulatory photos (PP score = 34.83%), $t(7) = -3.04$, $p = .019$. An independent-samples t test indicated that the difference between the high and low SOI PPs was significant, $t(14) = 3.47$, $p < .01$.

Although most of the group differences in Table 14 failed to reach significance, it is interesting to note some consistent patterns in the low and high SOI group preferences. For the body photos, high SOI men generally had higher PP scores (i.e., were more likely to prefer periovulatory bodies than low SOI men). When the total face photos were taken

Table 14

Means and Standard Deviations for Men's Periovulatory Preference Scores (%) for Body and Face Judgments, as a Function of Low or High Sociosexual Orientation Inventory Groups

	Mean (Standard Deviation)			
	Bottom and Top 33%		Bottom and Top 10%	
	Low SOI	High SOI	Low SOI	High SOI
Stimuli	(n = 27)	(n = 26)	(n = 8)	(n = 8)
Total Body Photos	46.42 (12.19)	49.23 (14.49)	46.67 (13.80)	53.33 (14.25)
Menstrual Body Photos	44.44 (17.79)	50.00 (19.36)	43.75 (20.04)	50.00 (17.68)
Luteal Body Photos	48.68 (16.46)	48.35 (20.23)	50.00 (18.70)	57.14 (24.15)
Total Face Photos	45.33 (12.49)	48.35 (11.64)	41.67 (11.59)	48.81 (11.02)
Menstrual Face Photos	47.29 (12.20)	46.15 (15.23)	46.15 (11.63)	40.38 (14.09)
Luteal Face Photos	42.13 (17.04) ^{t}	51.92 (17.92) ^{t}	34.38 (14.56)*	62.50 (17.68)*

^{t} $p < .05$. *$p < .01$. **$p < .001$.

into account, both SOI groups were more likely to choose nonperiovulatory photos as more attractive, but the high SOI men were slightly more likely to choose periovulatory photos than the low SOI men. When the more extreme SOI groups were used (i.e., bottom and top 10%), this difference became more apparent. The one exception to this pattern involved the menstrual face photos. Although both groups were more likely to choose the menstrual faces as more attractive, the high SOI men were even more likely to prefer menstrual faces. This difference was even more apparent in the more stringent SOI groups.

These results are interesting, as they suggest that, overall, high SOI men are more likely than low SOI men to choose periovulatory photos as more attractive. However, the one exception is when menstrual face photos are evaluated, where high SOI men are actually more likely to choose menstrual face photos as most attractive (although this is not significant). These findings suggest that the menstrual face preference is strongest in high SOI men. The pattern of the means also suggests that high SOI men show the following phase preferences for women's faces: menstrual > periovulatory > luteal. On the other hand, low SOI men show a different pattern of face preferences: luteal > menstrual > periovulatory. Also of note is the fact that one of the strongest preferences found in the study was the low SOI men's preference for luteal phase face photos over periovulatory photos (34.38%). These patterns will be discussed further in the Discussion section.

Preference Differences as a Function of Women's SOI.

Paired-sample *t* tests were carried out to determine whether or not there were differences in PP scores when men were rating low or high SOI women's faces. SOI scores were calculated for the women using the same formula as for the men. Then, women were separated into low and high SOI using the top and bottom seven women (approximately the bottom and top 30%). The high SOI group consisted of 4 luteal slides and 3 menstrual slides, and the low SOI group consisted of 4 menstrual slides and 3 luteal slides. Thus, the groups were similar. A paired-samples *t* test indicated that the PP scores for the photos of the high SOI ($M = 41.47$, $SD = 17.88$) and low SOI ($M = 49.16$, $SD = 17.04$) women were significantly different, $t(92) = -3.19$, $p < .01$. Men were more likely to prefer the periovulatory photos when looking at the photos of low SOI women than when looking at high SOI women, although men still did not prefer the periovulatory photos at higher-than-chance levels, $t(92) = -0.48$, $p = .63$. When the body photos were assessed, a paired-samples *t* test was performed on the top four high and low SOI women's photos (fewer body photos were used, as there were fewer ideal photos of the bodies). The high SOI group consisted of 1 luteal slide and 3 menstrual slides, and the low SOI group consisted of 2 luteal slides and 2 menstrual slides. The results again indicated significant differences between the scores for high ($M = 49.19$, $SD = 24.02$) and low ($M = 76.61$, $SD = 16.40$) SOI women, $t(92) = -9.67$, $p < .001$. Men were much more likely to prefer the periovulatory body photos when looking at the low SOI women than when looking at high SOI women. These results also indicate that when viewing photos of low SOI women, men evaluate periovulatory photos as significantly more attractive than nonperiovulatory photos, $t(92) = 15.64$, $p < .001$, while there is no PP when men view photos of high SOI women.

Preference Scores as a Function of the SOI of Both Men and Women

Next, analyses were conducted in order to determine whether there were differences in preferences: (a) between low and high SOI men's evaluations of low SOI women, and (b) between low and high SOI men's evaluations of high SOI women. Table 15 indicates the means and standard deviations for PP scores for each group (low or high SOI men), when they rated the faces and bodies of both low and high SOI women. Figures 7 and 8 provide graphical representations of the means for both the face and body PP scores. One-way ANOVAs were conducted for each, with the independent variable being the SOI group of the women (low or high) and the dependent variable being SOI group of the men (low or high). The only noteworthy result (other than those previously discussed) was a trend suggesting a difference between high ($M = 84.38$, $SD = 12.94$) and low ($M = 68.75$, $SD = 11.57$) SOI men when rating low SOI women's bodies, $F(1, 14) = 6.48$, $p = .025$. This trend suggests that high SOI men are more likely than low SOI men to choose periovulatory photos as most attractive when looking at low SOI women's bodies. However, both male SOI groups showed a significant preference for the periovulatory bodies: for the high SOI group, $M = 84.38$, $SD = 12.94$, $t(7) = 7.51$, $p < .001$, and for the low SOI group, $M = 68.75$, $SD = 11.57$, $t(7) = 4.58$, $p < .01$. It is of interest to note that both low and high SOI men shared this PP when evaluating the bodies of low SOI women. On every other analysis, low SOI men consistently preferred nonperiovulatory photos, while high SOI men showed no preference.

Preference Differences According to Whether or Not Male Raters Had a Partner

A one-way ANOVA was carried out to determine whether the scores of men who had a partner ($n = 63$) differed significantly from the scores of men who did not have a partner ($n = 30$). The one-way ANOVAs were carried out for each of the preference tests. Two trends were found. First, the total body PP score mean for men who had a partner

Table 15

Means and Standard Deviations for Men's Periovulatory Preference Scores (%) for Faces and Bodies, for Both Low and High Sociosexual Orientation Men When Evaluating Both Low and High Sociosexual Orientation Women

	Mean (Standard Deviation)	
	Group	
	Low SOI Men (n = 8)	High SOI Men (n = 8)
Faces		
Low SOI Women (n = 7)	41.07 (20.82)	51.79 (22.83)
High SOI Women (n = 7)	39.29 (23.84)	51.79 (16.97)
Bodies		
Low SOI Women (n = 7) ^{t}	68.75 (11.57)	84.38 (12.94)
High SOI Women (n = 7)	43.75 (29.12)	50.00 (23.15)

$^{t}p < .05$. $^{*}p < .01$. $^{**}p < .001$

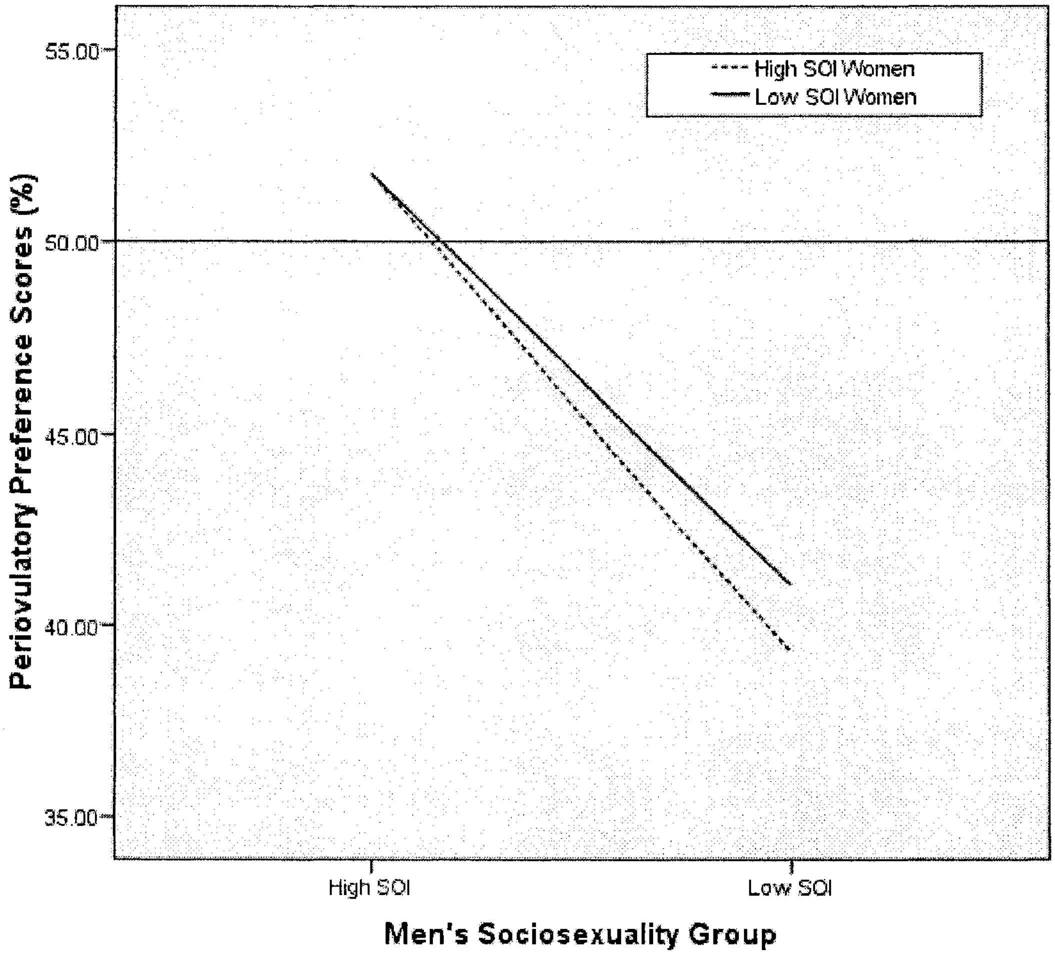

Figure 7. Periovulatory preference scores obtained from high and low SOI men when evaluating high and low SOI women's faces. High SOI men showed no preference between high and low SOI women's faces, while low SOI men preferred the periovulatory faces of low SOI women more than those of high SOI women (though not significantly). High SOI men were more likely to prefer periovulatory faces than low SOI men.

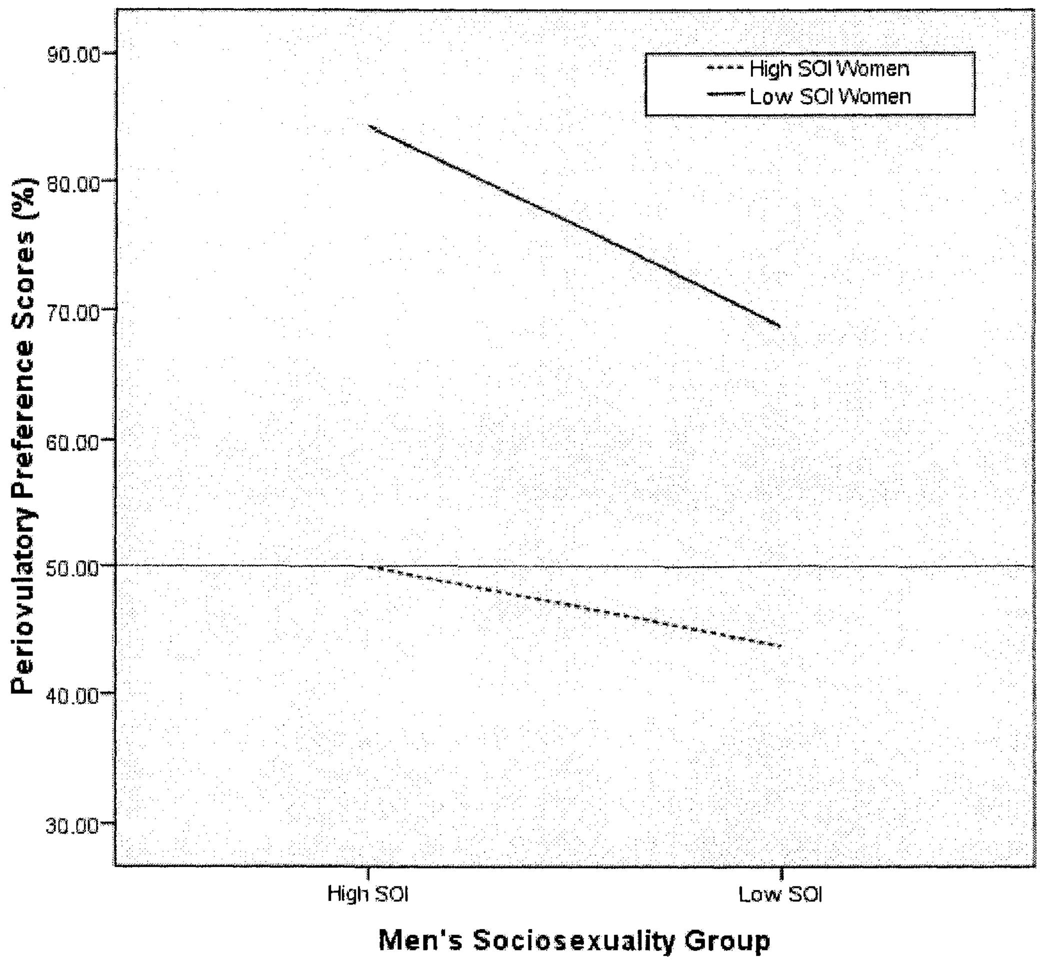

Figure 8. Periovulatory preference scores obtained from high and low SOI men when evaluating high and low SOI women's bodies. High SOI men significantly preferred the periovulatory bodies of low SOI women over those of high SOI women (p = .004), and low SOI men showed a trend in the same direction (p = .050). High SOI men were more likely to prefer periovulatory bodies than were low SOI men, when evaluating both high and low SOI women's bodies.

$SD = 13.02$), $F(1, 91) = 6.28$, $p < .05$, indicating that the partnered men were more likely ($M = 51.11$, $SD = 11.48$) was higher than for men who did not have a partner ($M = 44.44$, to choose the periovulatory body photos as more attractive when compared with the nonpartnered men. Second, further analysis of this finding using the menstrual body photos found that the partnered men judged the periovulatory photos more attractive ($M = 52.38$, $SD = 17.08$), than the nonpartnered men ($M = 44.17$, $SD = 18.49$), $F(1, 91) = 4.46$, $p < .05$. Although none of the other analyses were significant, the same pattern was seen with each of the preference tests: partnered men were more likely than nonpartnered men to choose the periovulatory photos as more attractive, however, all groups still preferred the nonperiovulatory photos over the periovulatory photos.

Differences in Preferences When Women Were or Were Not Wearing Makeup

Paired-samples *t* tests were conducted to determine whether or not there were differences in PPs when men evaluated women wearing and not wearing makeup. Women were considered to be wearing makeup if they had checked off at least one of nine makeup choices when they were asked what (if any) makeup they were wearing on that day (this was asked during both sessions). Two women indicated that they had worn makeup during one session, but not in the other, and thus were not used in these analyses. The means and standard deviations of the total face preference scores for the groups are as follows: women wearing makeup, ($n = 12$) ($M = 41.40$, $SD = 13.76$), and women not wearing makeup ($n = 7$) ($M = 50.08$, $SD = 18.68$). A paired-samples *t* test indicated that there was a significant difference in PP scores when makeup was taken into account, $t(92) = -3.68$, $p < .001$. When women wore makeup, men were more likely to choose the nonperiovulatory faces as more attractive. Further paired-samples *t* tests were carried out for both the menstrual phase only photos (makeup: 8 slides, $M = 42.34$, $SD = 16.18$; no makeup: 6 slides, $M = 49.03$, $SD = 21.17$) and the luteal phase only photos (makeup: $n = 4$, $M = 39.52$, $SD = 24.82$; no makeup: $n = 2$, $M = 52.69$, $SD = 34.86$). There was a group differences for the luteal face photos, $t(92) = -3.17$, $p < .01$, and there was a trend for the menstrual face photos, $t(92) = -2.44$, $p < .05$. The analyses indicate that when men were viewing photos of women who were wearing makeup as opposed to women not wearing makeup, they were more likely to choose nonperiovulatory photos as more attractive. However, when viewing photos of women who were not wearing makeup, they were more likely to choose periovulatory photos as more attractive, when compared with their PP scores for women with makeup. Further one-sample *t* tests were conducted to determine whether or not any of the PP scores were significantly different from 50%. For the analyses in which women were wearing makeup (for the total, luteal, and menstrual groups), men showed a preference for the nonperiovulatory photos. The results for each group were as follows: total, $t(92) = -6.03$, $p < .001$; luteal, $t(92) = -4.07$, $p < .001$; menstrual, $t(92) = -4.57$, $p < .001$. However, when the women were not wearing makeup, no significant results were found (i.e., the men showed no preference for faces in any particular phase).

Do Men Know (And Think They Know) When Ovulation Occurs?

A study by Small (1996) attempted to determine whether or not men and women believed that ovulation was concealed. The participants were asked if they thought they knew when ovulation occurred, at what point they thought ovulation occurred, and, if they were men in intimate relationships, whether they thought that they knew when their partner ovulated. The current study posed these same questions to the male participants, in an attempt to replicate the previous study's findings. Table 16 indicates the results for the questions posed to the men in the current study. Small's (1995) results indicated that 90% of those who responded (both men and women) believed that they knew what ovulation was. In the current study, almost all of the men (96.7%) believed that they know what ovulation means. In the current study, 21.1 % of the men indicated that they knew when in the cycle ovulation occurred, and 48.9% thought that they knew. However, only 8.3% of the respondents correctly identified ovulation, choosing the correct menstrual cycle phase. Respondents in Small's (1995) study were considerably more likely to choose the correct menstrual cycle portion (67%). Thus, the current study found evidence suggesting that men believe that ovulation may not be concealed, however, when asked to pinpoint when in the cycle ovulation occurs, the vast majority of men were incorrect.

Discussion

Summary of the Findings

The first hypothesis for this study was that men would show a periovulatory preference (PP) for women's faces and bodies. Contrary to this hypothesis, a menstrual face preference was discovered, particularly when the periovulatory photos were compared with those taken on days 1 to 5 (mean PP = 44.56%). When makeup status was examined, however, it was found that the menstrual preference only existed when the women were wearing makeup (mean PP = 42.34%). A luteal preference was also found when evaluating this group (mean PP = 39.52%). There was no preference for any phase when the women were not wearing makeup (mean PP = 49.03% for menses slides, 52.69% for luteal slides). However, when the preferences were examined as a function of

Table 16

Frequencies and Percentages for Men's Responses to Questions Regarding Ovulation

Question Posed	Raw Frequency (Percentage)
"Do you know what "ovulation" means?"	
Yes	87 (96.70)
No	3 (3.30)
"Do you know during which portion of the menstrual cycle ovulation occurs?"	
Yes	19 (21.10)
No	27 (30.00)
I think so	44 (48.90)
"Please check the box that indicates the approximate time in the menstrual cycle during which you believe ovulation occurs:"	
During the menstrual period	10 (11.90)
One week after the menstrual period	13 (15.50)
One week before the menstrual period	33 (39.30)
Right after the menstrual period	9 (10.70)
Middle of the menstrual cycle	7 (8.30)
Right before the menstrual period	12 (14.30)

cycle day, a PP was discovered for the day of ovulation, for both the reverse count (mean PP = 56.81%, day -15) and the LH positive count (mean PP = 55.56%, LH positive day +2) methods, and this finding was independent of SOI status, makeup use, and the phase that the periovulatory photos were compared to. This result provides strong support for the hypothesis, indicating that men do have a PP for faces, but only on the day of ovulation. When the sociosexual orientation of both the men and the women was taken into account, SOI group differences in the PP were also discovered. Men with high SOI showed a clear PP (mean PP = 62.50%) when comparing periovulatory with luteal face photos, while low SOI men showed a clear luteal preference (mean PP = 34.38%). In addition, a general SOI-dependent facial preference pattern was discovered for the men: (a) high SOI men showed a preference for menstrual > periovulatory > luteal faces, and (b) low SOI men preferred luteal > menstrual > periovulatory faces. When the SOI of the women was taken into account, a greater PP existed when men were evaluating the faces of low SOI women (mean PP = 49.16%) than when rating the faces of high SOI women (mean PP = 41.47%), though only the score for high SOI women was significantly lower than 50%. For the body preference analyses, again, a strong PP was found when men evaluated the bodies of low SOI women (mean PP = 76.61%), and the PP score was significantly higher than for men evaluating the bodies of high SOI women (mean PP = 49.19%). When the sociosexuality of both the women and the men was examined concurrently, a strong trend indicated that high SOI men (mean PP = 84.38%) showed a greater PP than low SOI men (mean PP = 68.75%) when evaluating the bodies of low SOI women. Both groups of men showed an overall PP when evaluating the bodies of low SOI women (mean PP = 76.61%). This suggests that the degree of preference for periovulatory bodies is dependent on the SOI of the men and the women. Thus, there is support for hypothesis one, but it is conditional. Men show a facial PP when evaluating women on the day of ovulation and when the SOI of the men is high. Men show a bodily PP when evaluating low SOI women, and this PP is stronger for high SOI men. Other factors such as wearing makeup and having a partner also affect PPs.

The second hypothesis was not supported. When men rate their own partner's photos, they are not more likely to prefer periovulatory photos than are men who rate the same women but who are unfamiliar with them. Although these findings failed to reach significance, the direction of the means indicated that the nonpartners were actually more likely to show a PP than were the partners of these women. When analyses were carried out to determine whether there were overall PP differences between men with partners and those without partners, it was discovered that partnered men showed higher body PPs ($M = 51.11\%$) than did the nonpartnered men ($M = 44.44\%$). Thus, the partnership status of a man may affect his PPs when evaluating women's bodies.

The third hypothesis did not receive support. Analyses comparing 2D:4D measurements over the cycle found that 2D:4D did not differ significantly over the menstrual cycle. This was true for all three measures of 2D:4D (left, right, and mean).

The fourth hypothesis regarding hand preferences received partial support. In support of the hypothesis, a trend indicated that men preferred the luteal hand photos ($p = .028$). Contrary to the hypothesis, a strong trend also indicated that men preferred lower 2D:4D hand photos ($p = .017$).

Discussion of Results

A conditional preference for periovulatory faces. Contrary to the hypothesis, when overall face photos were evaluated, men consistently preferred nonperiovulatory faces, and more specifically, menstrual faces, over periovulatory faces. When cycle day 6 was removed from analyses (because it is not generally considered to be part of the menstrual phase, and because differences were found in the current study between days 1 to 5 and day 6), men were even more likely to prefer menstrual faces. However, when the cycle day that women were photographed on, and when sociosexuality of the male evaluators and of the female models were considered, PPs were discovered. For cycle day, scores indicated that when women were photographed on the presumed day of ovulation (day -15 reverse count, and/or LH positive day +2 methods), there was a significant PP. In terms of sociosexuality, high SOI men showed a PP when comparing periovulatory and luteal photos, while low SOI men showed a luteal preference. The sociosexuality findings will be explicated and discussed further later.

The finding of the current study that overall, men preferred nonperiovulatory or menstrual faces, is contrary to previous research by Roberts et al. (2004), which indicated that the masked faces of women (masked = obscuring ears and hair) in the follicular (periovulatory) phase were rated as more attractive by men than were the faces of women in the luteal phase. The present study did not find this preference for the entire periovulatory phase, except when the men's responses were differentially analyzed according to whether the men had high or low SOI scores (high SOI men showed a PP, while low SOI men showed a luteal preference). However, men showed a significant PP on day -15 (the day of probable ovulation and thus the probable day of highest estrogen levels) (Carlson, 1991; Wilcox et al., 1995). This still differs from Roberts et al., given that they found the follicular phase preference for days 8 to 14 as a whole. Differences in findings between the current study and Roberts et al. may be due to one or more methodological differences between the two studies. First, for Roberts et al., women were required to remove cosmetics prior to being photographed. In the current study it was requested that women not wear makeup, but makeup was allowed with the request that the amount and appearance be consistent between the two sessions. Results according to makeup use will be discussed later, but it is worth noting that the menstrual face preference was only found in women wearing makeup. Second, Roberts et al. did not photograph women during the menstrual phase, and thus results are only reported for comparisons of the luteal versus periovulatory phases. One problem with not including all phases of the menstrual cycle is the fact that preferences across the cycle may differ depending on the levels of circulating hormones across the cycle. Thus, in order to obtain a more accurate picture of what hormonal influences may be at work for the preference ratings, all cycle phases should be included. A third difference between the current study and Roberts et al. is that different days were used to quantify menstrual cycle phases. In Roberts et al., for the follicular phase, women were photographed on days 8 to 14, and for the luteal phase, days 17 to 25. Although it was not explicitly stated, it is assumed that the experimenters used a forward count method to determine cycle day, as the cycle days were expressed as positive rather than negative numbers. As has been discussed in previous research (e.g., Pillsworth et al., 2004), forward count is only a reliable method of determining cycle day when the women's cycles range from 28 to 30 days. As Roberts et al. only reported that the women's cycles were "*ca.* 28 days in length", it is difficult to know whether or not the forward count method was the best method for determining cycle length. The current study utilized the reverse count method, and the parameters for cycle day included a range of 3 days for the periovulatory phase, and 5 days for the luteal phase. The study by Roberts et al. allowed for 7 days for the periovulatory phase, and 9 days for the luteal phase. Thus, given our findings of differences between menstrual, periovulatory, and luteal phases, it is possible that responses differ according to which days the women are photographed on. However, our finding of a PP only on the day of ovulation would suggest that a narrower definition of phases would be more likely to result in a PP. Although relevant information was not provided, it is possible that Roberts et al. utilized women with lower SOI and/or men with higher SOI than those in the current study, as the current study found PPs when men were rating low SOI women, or when high SOI men were evaluating the women. Another difference between this and the previous study was a difference in the photograph methods. Roberts et al. utilized 2 types of photos: (a) full head shots, which included hairstyle and clothing, with clothing differing across sessions (i.e., the colour of shirt that the participant wears may affect how good they look), (b) masked face photos, with ears and hair obscured. The current study utilized photos that were standardized in regards to clothing, and when masking photos, ears were left in the photos. Thus, with all of these facts taken together, it is possible that differences in results between the two studies may be due to one or all of the reasons outlined above.

The finding in the current study of a significant PP on the day of ovulation is consistent with Smith et al.'s (2006) reported positive correlations between estrogen levels and ratings of attractiveness, health and femininity. Smith et al. also found trends indicating correlations between high progesterone and higher ratings of attractiveness and perceived health. As the 2005 study was concerned with attractiveness in relation to circulating hormone levels, the experimenters did not photograph women in the menstrual phase (when levels of estrogen and progesterone are both low). It should be noted that in the Smith et al. study, when comparing photos, evaluators were comparing composite faces, one made up of the 10 women with highest late-follicular estrogen levels, and one made up of the 10 women with the lowest late-follicular estrogen levels. Thus, the raters were comparing composites made up of two different groups of people. Therefore, it is possible that women in the higher estrogen group were more attractive overall than were women in the lower estrogen group for reasons unrelated to estrogen. In contrast, the present study paradigm of men comparing the same women at two different points in the cycle controls for factors like between-subject differences in attractiveness, and thus the evaluators examine photos that (presumably) have no differences between them except the phase of cycle. Therefore, the current method should be a more accurate way of determining whether or not there are attractiveness differences across the menstrual cycle and/or with hormone levels. In the present study, when women were photographed on the highest estrogen day, men preferred periovulatory over nonperiovulatory photos. This is further evidence that there is an overarching preference for high estrogen faces, and that this preference trumps the finding of a menstrual face preference that was found when all periovulatory days were considered together. This is consistent with the findings of Smith and colleagues. If women are considered more or less attractive in the periovulatory phase depending on the cycle phase days that they are photographed on, this suggests that differing hormone levels may be the underlying cause of the differences between this and previous studies, given the use of different cycle testing days. Therefore, future research in this area should test for possible differences in attraction based on the exact day of cycle and/or hormone levels, rather than using widely defined menstrual cycle phases.

In spite of the PP on the day of ovulation, an overall preference for menstrual faces (when not separated by makeup use, SOI or cycle day) was found. While additional analyses indicated that this effect was only found in women wearing makeup, it is possible that the latter finding is only correlational. Thus, it is worth exploring possible explanations for a menses face preference. Three explanations are provided. First, women may look more feminine during menstruation. A recent study by Johnston et al. (2005) found that men were faster at categorizing women not wearing makeup as women (rather than men) when the women were photographed during menstruation. A recent study (Fink et al., 2005) also discovered that many "masculine" facial features correspond to low 2D:4D measures, while many "feminine" facial features correspond to high 2D:4D measures. The findings of Burriss, Little and Nelson (2007) correspond with those of Fink et al. (2005), finding that women with high 2D:4D had more feminine facial characteristics. These findings may be noteworthy as, anecdotally, many of the male participants in the present study indicated that they had found that many of the women looked rather masculine. Thus, if low 2D:4D women do indeed have more masculine features, it is possible that this tendency for men to make faster male/female categorizations when women are in the menstrual phase would become salient for the current study, considering the lower-than-average mean 2D:4D of the women. If the women were perceived as masculine, the "attractiveness" task may have become one of choosing the more feminine face. Thus, future research could examine femininity ratings of photos of women, as low or high feminine women might evoke different strategies in men during forced-choice attractiveness paradigms.

The second potential explanation for the menstrual face preference is that men may not be sensitive to markers of peak fertility, but rather to markers of long-term fecundity (e.g., Johnston et al., 2005). Because the appearance of the face changes more during menstruation than during either the periovulatory or luteal phases (e.g., flaws, colour, and clarity of the skin), menstrual face changes may be more obvious, and thus may be a better overall signal of fecundity, since the changes between the faces of periovulatory and luteal phase women may be more difficult to detect. Johnston et al. (2005) suggested that it would be beneficial for men to be sensitive to markers of peak fertility only if they would also most likely have access to the woman during that time. Furthermore, the menses face signals low hormone levels and lack of pregnancy. Thus, it is possible that men would have evolved to prefer the lowest hormone face as it would indicate that the woman is not pregnant.

The final explanation for the menstrual face preference finding is the possibility that human females may have evolved to hide, rather than advertise, fertility status at high-fertility times of the cycle, especially if certain traits or cues are widely available to potential mates. A recent study by Provost, Quinsey, and Troje (2008) found that men preferred the gaits of luteal phase women over those of periovulatory women. They propose that the reason for this is because gait is something that can be seen from relatively far distances; it is widely advertised, and thus may attract the attention of unfit mates. Therefore, it may be beneficial to be able to protect oneself during high fertility times by having a more appealing gait during low-fertility times. Previous research has indicated that women engage in fewer high-risk behaviours (e.g., parking in a dark corner of an underground garage) during high-fertility times (Bröder & Hohmann, 2003; Chavanne & Gallup, 1998), and that this potentially protects women against sexual assault at times when the chances of conception (and thus costs) are high. Thus, it is possible that cyclical changes in facial attractiveness (which are also easily viewed by others at relatively far distances) may also have evolved such that women's faces are more appealing during low-fertility (low-risk) times, rather than during high-fertility (high-risk) times. Provost et al. proposed that faces may be more likely to advertise fertility status, and thus be more attractive during periovulation, because the cues are not as easily accessible as gait. However, this theory was based on the results of the Roberts et al. (2004) study of a PP. The present finding of a menses face preference would seem to contradict this proposal. Therefore, it is possible that widely advertised cues (like gait, bodies [which will be discussed below], and faces) hide fertility cues, whereas less widely advertised cues like smell (e.g., Havlíček et al., 2006; Kuukasjärvi et al., 2004; Singh & Bronstad, 2001), which necessitate that a potential mate is closer (and thus may be easily detected by current partners or those whom women allow to get close to them) advertise fertility. This last explanation appears most likely given the evidence that other behaviours and traits seem to have evolved in order to protect women at high-fertility times.

One potential explanation for the finding of a PP only on the day of ovulation is that it reflects an evolved preference for high-estrogen faces when men are evaluating women. Past evolutionary theories about cyclical changes have seemed to imply that it is beneficial for a woman to be more attractive during the most fertile phase of the cycle, as being attractive at this time would lead to a higher probability of conception. This was not found for all women in the current study; instead, an overall PP was only found on the day of ovulation. Findings from previous research suggest that being most attractive on the day of ovulation is actually a detriment, rather than a benefit, in terms of conception probability. Research has shown that the day prior to ovulation is the day on which sexual intercourse is most likely to lead to conception (Dunson et al., 1999; Trussell & Raymond, 1999), and also that conceiving on the day of ovulation has the highest risk of pregnancy loss of any day in the fertile window (around 50%) (Wilcox, Weinberg, & Baird, 1995). Thus, in order for a periovulatory attractiveness increase to be beneficial in terms of conception probability, the woman should be most attractive on the day prior to ovulation. This was not the case.

While the findings suggest that attractiveness has evolved in association with high estrogen levels, it is not clear how this would have been adaptive to women (or offspring). This high-estrogen preference seems to occur regardless of (a) whether or not women wear makeup, (b) the SOI of the women, and (c) the SOI of the men; as it was found for the entire sample of men rating all slides of women. One potential explanation for the ovulation-day preference is a possible adaptation to hide peak fertility. Given that women report greter EPC desire and fantasy during peak fertility (Gangestad et al., 2002; Gangestad et al., 2005; Pillsworth et al., 2004) and less commitment to their partner during the later folicular phase (Jones et al., 2005), it would be adaptive for men to be able to identify when women are at peak fertility. Furthermore, the fact that women report that their primary partners engage in more mate retention tactics near the ovulatory phase (Gangestad et al., 2002) suggests that men are capable of detecting ovulation; and that they use this information to decrease their likelihood of being cuckolded. However, our finding that women appear to be most attractive on the day of ovulation, when peak fertility has already passed, suggests the possibility that the peak in attractiveness may actually be a female adaptation to hide peak fertility from their partners. Women may use this peak in attractiveness to mate with their partner on the day of ovulation, after an EPC with a more attractive man the night before. However, it is necessary to replicate the finding of peak attractiveness at ovulation before the latter hypothesis is explored further. The PP scores for day -15 were based on slides where the periovulatory phase was compared to either the luteal or menstrual comparison slides. Thus, the findings indicate that men find women's faces more attractive on the day of ovulation than during either the menstrual or luteal phases.

One strength of the present study, as discussed above, was the use of photos from all phases of the menstrual cycle. As there are differing hormonal fluctuations as well as differing levels of conception probability throughout the cycle, it is imperative that all phases of the cycle be studied, rather than focusing on just one or two. Also, because there are most likely a number of factors related to fluctuations in attractiveness over the cycle, it is important to gather evidence that includes, or attempts to control for, potentially misleading information (e.g., makeup use and sociosexual orientation). Another strength in the current study was the analysis of preference scores by cycle day. These analyses led to the discovery that although preference scores differed significantly across menstrual cycle phases, there were also significant fluctuations depending on the day of the cycle on which the women were photographed. This is important information, which should lead to greater precision in future studies of this kind. One limitation to the study was the relatively small sample size of women. It was difficult to obtain a large sample of mostly young women who fit the inclusion criteria, especially those who had partners, were willing to come in for two sessions, answer very personal questions, have their photos taken knowing they were going to be viewed by others, and who were willing to perform the urinary hormone testing. Including greater incentives for participation, or advertising in a greater capacity might bolster the number of women willing to participate. Another limitation was the fact that menstrual faces were not compared with luteal faces. As some of the results were contrary to previous research, and contrary to what was expected, future studies should ensure that comparisons are made between numerous cycle phases (or cycle days). Although response latency was not measured in this study, the experimenter was cognizant of the fact that response times for the evaluation of the photos varied widely between participants. Some of the participants took as little as 10 minutes to rate all 75 of the photo slides, while others took as long as 45 minutes (average of 8 to 36 seconds per slide). Because there was such a vast difference between the response times, it is possible that different processes were at work for different evaluators during the evaluation phase of the study, which might have affected the responses obtained (e.g., "gut reaction" versus attention to detail). Thus future research might utilize analyses of response latency to determine which processes may be at work when men evaluate the attractiveness of women.

A conditional preference for periovulatory bodies. No significant phase preferences were discovered for the comparisons of all body photos across menstrual phases. However, when sociosexuality was taken into account, it was found that men showed a greater PP when evaluating the bodies of low than high SOI women, and high SOI men were more likely than low SOI men to show a PP for the bodies of low SOI women. A more detailed explanation of differences in PPs according to SOI status of men and women will be discussed below.

One of the strengths in regards to the analysis involving ratings of body photos was the fact that this was the first study (to the authors' knowledge) that has examined preferences for body photos over the menstrual cycle. The body photos were also carefully standardized in regards to posture and lighting, thus making it more difficult for evaluators to base their decisions on anything but the potential differences in appearance over the cycle phases. A potential limitation in the body analyses was the display of the body slides on a computer screen, when life-size display of the photos (perhaps through use of a projector) may lead to stronger effects. This method could also be used to determine how close men have to be to a woman to notice small cyclical changes, thus testing the hypothesis that women's bodies have evolved the ability to mask ovulation in characteristics that are widely advertised (e.g., Provost et al., 2007). Also, as an anecdote, some of the male participants stated that they could not make proper attractiveness comparisons because the body photos did not have the female participants' heads showing. It is possible, then, that men do not (and potentially can not) make attractiveness attributions without considering both facial and body cues together. Some of the participants also stated that they could not make a decision because the body photos looked too similar. Although photo similarity was the desired condition, it suggests that some of the respondents may have resorted to guessing when they did not have a preference. A final limitation for these bodily ratings was the small number of women whose slides were usable ($n = 15$).

Makeup wearers: Periovulatory faces are less attractive than menstrual or luteal *faces*. Differences in PPs were discovered when makeup use was taken into consideration, indicating that when women were wearing makeup in the photos, men were significantly more likely to prefer the nonperiovulatory photos, regardless of cycle phase, while when women were not wearing makeup, men were more likely to exhibit a PP (though not at higher-than-chance levels [50.08%]).

This finding is somewhat consistent with that of Roberts et al. (2004), who found that men had a preference for periovulatory over luteal photos when comparing photos of women whom were not wearing makeup. Roberts and colleagues utilized two samples of men. While one sample showed a clear preference for the follicular phase for both masked and unmasked photos, the other did not (preference score = 50.6%) for the masked images. The results are also consistent with those of Smith et al. (2006), who found a significant association between estrogen and attractiveness, healthiness, and femininity only when the photographed women were not wearing makeup. Taken together, these findings suggest that PPs may be most apparent when women are not wearing makeup. The results of the current study indicated that the greatest difference in preferences between evaluations of makeup and non-makeup wearers was found when comparing the luteal phase photos. When evaluating makeup wearers, the luteal phase photos were chosen as more attractive ($M = 39.52$, $SD = 24.82$), and when evaluating women not wearing makeup, the periovulatory photos were chosen as more attractive ($M = 52.69$, $SD = 34.86$). It should be noted, however, that the sample sizes for each group were small, and therefore, with larger sample size, it is possible that significant effects might be found. Thus, the results from the current study provide further evidence for the finding that menstrual cycle face preferences are affected by whether or not women wear makeup.

There are three possible explanations for these findings. The first possible explanation is that women who wear makeup actually show different menstrual cycle attractiveness patterns, regardless of whether or not they are wearing makeup. Thus, it is possible that those women are actually least attractive during the periovulatory phase. However, given that the bodies of these women did not show such a pattern (in fact, higher PPs were discovered for the bodies of women who were wearing makeup: makeup wearers, $M = 52.69$; no makeup, $M = 41.17$, $p < .001$), it suggests that it is the makeup that is responsible for the observed preferences. The second explanation is one outlined by Smith et al. (2006), stating that makeup may be intentionally used by women to mask decreases in attractiveness over the cycle, and thus to remain equally attractive over the cycle. This would unintentionally conceal ovulation, in that the "less attractive" faces of less fertile phases would become more attractive than if the woman was not wearing makeup. This appears to be the most plausible explanation, given evidence that women wearing makeup are perceived as more attractive (Smith et al., 2006). This may also explain the popularity of cosmetics among women. However, there is a third possibility. It could also be beneficial for women to use cosmetics to hide ovulation for the reasons given in the introduction of this paper: concealing ovulation can be beneficial to women as it can protect against sexual assault at times of high conception risk, it can confuse paternity and allow extra-pair copulation without detection, and it promotes paternal investment, monogamy, and cooperation among groups (Manning et al., 1996; Pawlowski, 1999; Sillen-Tullberg & Moller, 1993). Thus it appears that makeup plays an important role in attractiveness evaluations by men, and that the use of makeup may (a) make women more attractive overall, and/or (b) may confuse fertility status, either intentionally, or unintentionally.

Sociosexuality: A factor in periovulatory preferences. When the SOI of male evaluators was examined, high SOI men preferred periovulatory over luteal faces, while low SOI men preferred luteal over periovulatory faces. For all other preference tests, there was a nonsignificant pattern whereby high SOI men were more likely than low SOI men to show a PP. Patterns for each group indicated that SOI status of men may affect PPs differentially. That is, high SOI men show a pattern of preference for menstrual > periovulatory > luteal photos, while the pattern for low SOI men is luteal > menstrual > periovulatory photos.

When the SOI status of the women in the photos was taken into account, men were significantly more likely to prefer periovulatory faces when evaluating low rather than high SOI women, though they did not show a significant PP. In regards to the body photos, men were again significantly more likely to show a PP when evaluating low rather than high SOI women, and they were also significantly more likely to show a PP (mean PP greater than 50%).

When the SOI scores of both the men and the women were taken into account, a strong trend ($p = .023$) indicated that high SOI men were more likely than low SOI men to show a PP when evaluating the bodies of low SOI women (mean PP = 84.38% for the high SOI men, and mean PP = 68.75% for low SOI men), and both groups were more likely to show a PP when evaluating low SOI women's bodies, suggesting that body PP may depend on the SOI status of both the men and women.

For SOI overall then, high SOI in men tends to correlate with greater PPs for faces and bodies, while low SOI correlates with greater nonperiovulatory preferences. Low SOI in women tends to correlate with greater PP scores, while high SOI tends to correlate with greater nonperiovulatory preference scores. When the SOI of both men and women are taken into consideration, high SOI men are more likely than low SOI men to prefer periovulatory faces of low SOI women. Low and high SOI men are both more likely to prefer the periovulatory bodies of low SOI women than high SOI women, and high SOI men are more likely than low SOI men to show a PP for all women.

One explanation for the differences between low and high SOI men when rating low and high SOI women is a difference in mating strategy. According to Simpson and Gangestad (1992), like attracts like. That is, men who possess adaptive traits (like physical attractiveness or considerable resources) may have an easier time attracting mates without having to contribute long-term paternal investment, and thus adopt a more unrestricted sociosexual orientation. Thus, high SOI men should also seek out unrestricted women (those who would not require commitment or investment in a sexual relationship) with whom to pursue a sexual relationship. Men who do not possess adaptive traits, however, would likely have to adopt a more restricted sociosexual orientation, in order to provide long-term paternal investment in place of those adaptive traits (i.e., indirect benefits) that they are lacking. Thus, for these men, seeking a similarly restricted female partner is more beneficial (Simpson & Gangestad, 1992).

So, in these terms, high SOI men, who have more partners, and require and provide less commitment and emotional bonding in their relationships, may need to be more attuned to fertility cues than low SOI men. Because they prefer short-term over long-term relationships, knowing the fertility status of a potential mate (or at least being more attracted to a woman at more fertile times) should lead to a greater likelihood of conception resulting from these short-term relationships. This would be especially beneficial when dealing with similarly unrestricted women (who may be more willing to have sex with them on a short-term basis than would restricted women). For low SOI men, however, who require and provide higher levels of commitment and bonding prior to a sexual relationship, being attuned to signs of overall, rather than short-term fecundity may be more beneficial. Because restricted men are providing paternal investment, the greatest benefit to them would be to ensure that their potential mate (with whom they would presumably be forming a long-term bond, at the cost of having higher numbers of short-term partners), will be able to provide them with more, and higher quality, offspring.

Of particular interest in terms of male SOI status are the different menstrual cycle preference patterns for low and high SOI men. Low SOI men preferred luteal photos overall (significant for faces, but not for bodies). The luteal phase represents the phase with the highest levels of progesterone. Progesterone levels are also high during pregnancy. Thus, one could speculate that that low SOI men, who desire higher levels of bonding and commitment, who are most likely looking for long-term relationships, and who may be more likely to offer and provide paternal investment in a relationship, may have evolved a preference for women whose hormone levels are more indicative of pregnancy. On first read, this suggestion may seem counterintuitive as evolutionary psychology theories generally suggest that men should prefer nonpregnant highly fertile women. However, in the past, women spent most of their fertile years pregnant or lactating, with very few menstrual cycles occurring between pregnancies. Thus, for men who utilize a restricted strategy (low SOI), it would be adaptive to find women attractive when they are pregnant. Attraction to the luteal phase is also adaptive, as women who do not ovulate and thus are not fertile, do not experience a true luteal phase. Thus, the attractiveness of the luteal phase may be due to the fact that it signifies that one is generally currently fertile. Such attraction during pregnancy and the luteal phase would maintain the relationship and increase the likelihood of offspring survival and fitness due to the direct benefits provided by two parents (e.g., food, shelter, safety). The relationship maintenance component would decrease the likelihood of infidelity by the female partner, and thus decrease the likelihood of cuckoldry (i.e., the man providing for another man's child). In contrast, high SOI men show an overall preference for menstrual photos, although this preference is fairly weak. The menstrual phase represents the phase with the lowest levels of both progesterone and estrogen. High SOI men are thus most attracted to women whose hormone levels do not indicate either high fertility or pregnancy. If the primary strategy for these men includes sex without commitment, it would be most adaptive to ensure that the woman is not already pregnant. The best indicators that a woman is not pregnant are low estrogen and progesterone levels, as in the menstrual phase. Thus, the high SOI men's main strategy may involve initiating sex with nonpregnant women. Given that these men will be less confident than low SOI men about offspring's paternity, knowing that the woman was not already pregnant when sex occurred would increase paternity certainty. Thus, it is possible that high and low SOI men have evolved different preferences for women over the cycle, due to their differing goals and mating strategies.

The mating strategies and goals for low and high SOI women may be similar to those of low and high SOI men. That is, women who are attractive, young, and fertile, or those with more resources, would not have to invest in long-term bonded partnerships in order to attain a mate, and thus would be more likely to adopt a more unrestricted sociosexual orientation, while women who do not possess these attributes would more likely adopt a restricted sociosexual orientation (e.g., Simpson & Gangestad, 1992) (though this would seem to conflict with the findings of Rhodes et al., 2005, who found that attractive women were more successful at attaining long-term mates). But are restricted women somehow advertising fertility status in a way that unrestricted women are not? As was found when all men rated either restricted or unrestricted women, men were more likely to prefer the periovulatory faces and bodies of restricted women. A recent study (Boothroyd, Jones, Burt, DeBruine & Perrett, 2008) found that men and women were able to correctly determine the sociosexual orientation of other men and women simply by viewing photos. Unrestricted men and women were also rated as more attractive than restricted men and women. It is possible then, that men recognize women as restricted or unrestricted in photos, and thus pay attention to different cues for each, depending on what mating strategy would have to be adopted.

The other possibility is that restricted women may advertise their fertility status more than unrestricted women. Because unrestricted women have more partners, it is less important for them to advertise fertility status than it would be for restricted women who prefer fewer (and more long-term) partners. Thus, restricted women (who are presumably less attractive, and less "genetically fit") may display greater differences in attractiveness over the cycle, such as greater differences in fluctuating asymmetry (e.g., Manning et al., 1996; Scutt & Manning, 1996), skin colour or clarity, or other signals of fertility status and health. Unrestricted women, who are more attractive (and presumably more "genetically fit") may undergo fewer changes in attractiveness over the cycle, due to better overall health, and thus do not advertise fertility status. A recent study by Oinonen and colleagues (2008) found that unrestricted women were most interested in uncommitted sex when they were least likely to conceive, while restricted women were most interested in uncommitted sex when they were most likely to conceive.

Two studies seem to be somewhat consistent with our finding that restricted women show more change across the menstrual cycle. Here we found that men perceived more cyclicity in restricted women's attractiveness across the menstrual cycle. Given that sex differences in SOI scores suggest that women are more restricted than men (Simpson & Gangestad, 1991), our findings suggest that more "feminine" (i.e. more restricted) women show more change across the menstrual cycle. Similarly, it has been found that more feminine women show a greater shift in male facial preferences across the menstrual cycle (Johnston, Hagel, Franklin, Fink, & Grammer, 2001). Of potential relevance is another finding indicating that "feminine" women show more of a difference in the type of partner they would like for a ST versus a LT mate (Scarbrough & Johnston, 2005). Thus, more "feminine" women may show more menstrual cyclicity in behavioural, psychological, and physical variables related to mate preferences and mate attraction. If that is the case, given the low mean 2D4D of the women in our study, it would be expected that our findings would be even more robust when using a more feminine sample. Thus it is possible that men pick up on different cues that women exhibit based on both sociosexual orientation, as well as current fertility status. Taken together, the findings of this and previous studies seem to suggest that women with differing sociosexuality orientations may exhibit differences in both overall attractiveness, as well as cyclical changes in attractiveness, and that men notice these differences and alter their preferences based on the mating strategy required of the situation.

It is also important to account for the interaction between the sociosexuality of the male evaluators and the female models. Men in both SOI groups preferred periovulatory over luteal body photos for the restricted women, though unrestricted men showed a greater PP than restricted men. Again, it is possible that restricted women advertise their fertility phase (or have greater changes in traits that signal fertility) over the cycle, and these changes may become more apparent when the whole body is in view (e.g., for fluctuating asymmetry), whereas high SOI women may not advertise, or may show fewer advertisements. The periovulatory and the luteal phases are the two phases that are least alike in terms of conception probability, and thus there may be greater differences between these two phases than in others. Unrestricted men may be more likely to notice changes than restricted men because restricted men may be more likely to notice cues to overall fertility rather than peak fertility (e.g., Johnston et al., 2005). For the face analyses, unrestricted men showed no preferences for either restricted or unrestricted women ($M = 51.79$ for both low and high SOI women's faces), but were more likely to prefer periovulatory photos than were restricted men. The potential reasons for this were discussed earlier. Restricted men were more likely to prefer periovulatory photos when rating restricted ($M = 68.75$) rather than unrestricted ($M = 43.75$) women's bodies. This may be because it is more beneficial for restricted men to attain restricted women, given their similar strategies. Because sociosexuality is apparent when viewing photos, restricted men may pay more attention when viewing photos of restricted women.

As this was (to the authors' knowledge) the first study testing attractiveness over the menstrual cycle in terms of both the evaluators' and models' sociosexual orientation, further research is needed before any of these explanations can be verified.

Relationship status: A factor in periovulatory preferences. Trends indicated that men who had a partner were more likely to prefer periovulatory bodies as more attractive, especially when comparing them with menstrual bodies. None of the other analyses provided significant results, though a similar pattern was noted, whereby partnered men were more likely than nonpartnered men to find periovulatory faces and bodies more attractive.

Recent research has suggested that there is a bias for men and women to reduce thoughts of attractive others when engaged in a committed long-term relationship (Gonzaga, Haselton, Smurda, Davies & Poore, 2008). Our finding that men in relationships are better than nonpartnered men at noticing that women in the periovulatory phase are more attractive than women in nonperiovulatory phases (which, as indicated by the present findings, may depend on a number of factors such as SOI status, and whether or not the woman is wearing makeup), seems to contradict previous findings suggesting that those in relationships suppress attractiveness cues in others. However, the study by Gonzaga et al. (2008) did find that the results of their study depended on love rather than sexual attraction feelings. That is, in a condition where the participants were asked to remember love feelings for their partner, they found higher levels of suppressing thoughts of attractive alternatives. When the participants were in the sexual attraction condition, the same was not found. The present study did not quantify relationship status for the men (i.e., determining the commitment level, love, or exclusivity of the relationships). Thus it is possible that men in this study had nonexclusive relationships, or relationships to which they were not wholly committed.

One explanation for the findings of the current study could again be that men who are not partnered are looking for cues as to long-term or overall fertility, rather than peak fertility. Add to that the fact that if partnered men are evaluating others in terms of extra-pair copulations (EPCs, or sex outside of the primary partnership), it would be beneficial, in evolutionary terms, for the partnered men to be able to recognize peak fertility, rather than long-term fertility. More research into this area is required to test any of these proposed explanations.

No differences in periovulatory preferences between a woman's partner and unfamiliar men. There was no support for the hypothesis that men would be more likely to prefer periovulatory photos when evaluating their own partners, than would be men rating the same women but who were unfamiliar with them. However, it should be noted that the sample size for the partners was very small ($n = 5$), and thus it was impossible to test this hypothesis in a powerful way. The means for the analyses did suggest that nonpartners were more likely to show a PP than were partners, however, again, the results were not significant, and the sample size was very small.

As this was the first study (to the authors' knowledge) to examine the relative abilities of partners and nonpartners in detecting cyclical changes in attractiveness, it is suggested that future research in this area should also take into account the responses of partners versus nonpartners in order to determine whether or not there are differences between the two groups.

There are logical explanations for either partners or nonpartners being better able to detect cyclical changes in attractiveness over the cycle. For the partners, it may be beneficial to find one's mate most attractive at high-fertility times, as higher attraction may increase the likelihood of initiating sexual contact, and thus increase the likelihood of conception. It may also be possible that partners, because they are more familiar with their mate, may be better able to detect smaller changes across the cycle than would a man who is not familiar with her. These were the hypotheses advanced by the authors. On the other hand, because a partner would have fairly frequent access to the woman, it may be that partners are *less* likely to pay attention to and notice cyclical changes. If a man already has access (i.e., the woman is his partner), he has a higher chance of intercourse on days of high fertility than a strange man would. Thus, there might not be much of a need for the partner to notice cyclical changes. The reverse may be true for the nonpartners. Because they do not currently have access to the woman, it may be beneficial to pick up on cues of fertility status, in order to be more aware of high-fertility times in potential mates. It could also be true that because they are not familiar with the woman, they may not notice small changes in fertility status, because they have no baseline for comparison. Finally, there may be no differences at all between the abilities of partners and nonpartners in detecting cyclical changes in attractiveness. After all, in strictly evolutionary terms, whatever traits (or phases) men may have evolved to prefer, it is probably more of a universal, overarching preference, rather than a preference that only shows itself when one is either coupled with a woman or not. Obviously more research into this area will be required in order to determine which (if any) of these explanations has merit.

One strength for this portion of the study was the fact that this was (to the authors' knowledge) the first study to attempt to determine whether partners or nonpartners are more likely to show a PP over the menstrual cycle. An obvious limitation for the test of this hypothesis was the small sample size, and the resulting difficulties in carrying out appropriate and accurate analyses. Again, it was difficult to obtain participants for this portion of the study, even more so than for the female participants. Because the female sample mostly consisted of university students, many of the women reported having partners who did not reside in the area. Many of those who completed the screening questionnaire were young university-enrolled women, and those who did have partners frequently reported the current use of hormonal birth control as well. One other issue was the fact that many partners may not have wanted to participate due to low incentives.

Second-to-fourth digit ratio does not change across the menstrual cycle. Results for the 2D:4D comparisons indicated that there is no change in second-to-fourth digit ratio over the menstrual cycle, whether looking at right, left, or mean 2D:4D. This was contrary to the hypothesis, which proposed that 2D:4D would be highest in the luteal phase, and lowest in the menstrual phase.

The results for this study are contrary to previous research by the authors (Patola et al., 2006), that found significant positive correlations between changes in progesterone and changes in 2D:4D over the cycle. The results indicated that changes in 2D:4D were most likely to occur when progesterone and estrogen levels were changing in the same direction (i.e., both increasing or both decreasing), and testosterone levels were changing in the opposite direction. Thus, in the current study, 2D:4D should have been highest in the luteal phase. Comparisons between menstrual, luteal, and preovulatory phases in the previous study did not reveal any significant findings, however, weak trends indicated that 2D:4D was higher in the preovulatory phase than in the menstrual phase, and higher in the luteal phase than in the menstrual phase. The current study did not replicate any of these findings.

A recent study by Mayhew, Gillam, McDonald, and Ebling (2007) found significant differences in 2D:4D over the menstrual cycle, indicating that (in the left hand only) 2D:4D tended to be significantly higher at mid-cycle than in any other phase. The results of this study were based on the ratios of 13 women aged 18 to 21 who were not using oral contraceptives, and the digit measures were acquired by measuring finger lengths from photocopies, using digital callipers to .01 mm. The menstrual cycle was separated into seven phases of four days' duration, starting from day 1 of the cycle. Each woman's hands were photocopied during each of the seven phases, for two cycles (8 weeks). The current study utilized a larger sample ($n = 21$), with a wider age range (18 to 40 years), and digital hand scans were measured with the "measure tool" in Adobe Photoshop. Each woman's hands were scanned during the periovulatory, and one other phase of the cycle. Thus it is possible that differences between the study by Mayhew et al. (2007) and the current study may have occurred due to sample or methodology differences.

The present finding of no change in 2D:4D across the cycle is consistent with research suggesting that 2D:4D does not correlate with adult hormone levels. One recent meta-analysis by Honeköpp, Bartholdt, Beier, and Liebert (2007) presented the results of all research to date that had examined correlations between adult circulating sex hormones and 2D:4D. The final study included 10 different papers reporting on 15 samples (plus the inclusion of two of their own samples), (total of 332 female and 850 male participants). However, there was no report of whether or not the women who participated in the studies were using hormonal contraceptives. Only 5 of the studies reported significant correlates between 2D:4D levels, and these studies all involved only men, and were either wholly or partly comprised of atypical samples (i.e., infertile men with probable severely compromised testicular functioning). When the atypical men were removed from the results, in all but one case, the results no longer remained significant. Thus, this meta-analysis supports the current study's result of no significant changes in 2D:4D over the menstrual cycle as it suggests that 2D:4D is not related to adult circulating hormone levels.

It appears, then, that 2D:4D may be set at birth, as has previously been suggested in the literature (e.g., Manning, 2002), rather than being affected by, or depending on, adult levels of circulating hormones. However, more research should investigate whether or not 2D:4D changes across the cycle in women who are not using hormonal contraceptives, as the three studies listed here (the present study included) have found differing results.

It should be noted again that the women in the current study had lower overall 2D:4D ratios than many others studies have reported, including a study using a similar sample of women from the same university (Oinonen et al., 2008). One partial explanation for this result may be that when 2D:4D measurements are obtained from photocopies (and therefore, possibly hand scans), the resulting 2D:4D measures tend to be lower than from direct finger measurement (Manning, Fink, Neave & Caswell, 2005). The explanation proposed for this phenomenon postulates that differences in fat pads at the tips of the fingers most likely cause light to reflect differently when the fingers are placed onto the screen, and thus distort the lengths of the fingers when three-dimensional real fingers are transformed to two-dimensional photocopies. However, the 2005 study found differences in mean 2D:4D in women of only about .001 to .006, whereas in this study, the difference between mean 2D:4D and that of the similar sample from Oinonen et al.'s (2008) study was approximately .03. Thus the results of the study by Manning et al. (2005) would not seem to fully account for the lower mean 2D:4D found in this study as compared with the similar sample. It is possible that there are differences between women who would agree to participate in this type of research, as compared with those who would not. For example, women with low 2D:4D have been found to have higher SOI scores than women with high 2D:4D (Clark, 2004). Women with high SOI scores are more willing to engage in sex with a partner with lower levels of commitment, bonding or emotional attachment, report more lifetime partners, and describe themselves as more masculine (both as children and during adulthood) than do those with low scores (Mikach & Bailey, 1999). Clark (2004) has indicated that the link between high SOI and low 2D:4D suggests that high levels of testosterone are involved in each, in that both high SOI and low 2D:4D are indicative of more masculine behaviours. A recent very large study (comprising 225,116 participants via a BBC Internet survey) (Manning & Quinton, 2007) indicated that there is a negative correlation between 2D:4D and self-perceived general, body and face attractiveness ratings for both men and women. Thus, the lower the 2D:4D score, the more likely a woman is to rate herself as attractive. It is conceivable, then, that women with low 2D:4D may have higher levels of confidence, especially in terms of attractiveness. Thus, it is possible that the lower 2D:4D of the women in our study was due to the fact that lower 2D:4D women tend to have a higher

SOI; and rate themselves as more attractive than higher 2D:4D women. The higher self-rated attractiveness and high SOI of low 2D:4D women might have made them feel more comfortable participating in research requiring them to answer personal questions about sexual history, have photos taken of their faces and bodies for future comparisons by members of the opposite sex, and use urinary hormone tests. Since no 2D:4D measures were obtained for women who did not take part in the study, there was no way for the authors to test this hypothesis.

One strength of this part of the study was the randomization of women into cycle phase groups, as well as the attempt to control for time effects by having women randomly placed into either periovulatory or nonperiovulatory groups for the first session. One potential limitation of the present study was that each woman was tested at only two points in the menstrual cycle. A methodology similar to that of Mayhew et al. (2007) may be more appropriate in this line of research. Because of Mayhew et al.'s (2007) more rigorous study design (which allowed for comparisons of each woman's 2D:4D measures at seven different points across the cycle), it is possible that their results are most reliable and valid.

A preference for luteal phase and lower 2D:4D hands. Although the results for the hand preference tests were not significant, trends indicated that men preferred both luteal phase (p = .028) and lower 2D:4D (p = .017) hand photos. The first finding is consistent with the hypothesis, and the second finding is contrary to the hypothesis. It is surprising that the men preferred the luteal phase hands, as it was only hypothesized that men would prefer the luteal hands because the luteal phase was expected to have the highest 2D:4D measures. This was not the case, as no differences were found between cycle phases for 2D:4D. What was even more surprising was that the men actually showed a trend for preferring lower 2D:4D hands. Lower 2D:4D indicates higher testosterone exposure in utero, and more "masculine" sex role identity (e.g., Csathó et al., 2003), and low 2D:4D in women has been found to correlate with lower reproductive success (e.g., less likely to marry, fewer children) (Manning et al., 2005), lower self-perceived attractiveness (Wade et al., 2004), and darker skin colour (which, because skin pigment is sexually dimorphic, has been found to be less attractive in females) (Manning, Bundred & Mather, 2004). Thus, it is somewhat surprising that lower 2D:4D hands were preferred. It is worth noting again that our sample had lower 2D:4D than women in studies with similar populations.

The present results are contrary to the findings of Saino et al. (2006), who found no significant correlations between 2D:4D and attractiveness of male or female hands, as evaluated by both male and female participants. However, the 2005 study did find that men "avoided" female right hands that had been manipulated to look more masculine by shortening the second digit (2D) (and thus would have a lower 2D:4D). This is opposite to the trend found in the current study, as our findings suggest that men prefer lower over higher 2D:4D.

However, our findings make sense within the context of Fink, Manning, Neave and Grammer's (2004) discovery that 2D:4D was significantly positively correlated with facial asymmetry in women. Thus, women with low 2D:4D had lower levels of facial asymmetry. Because symmetry is universally considered a component of attractiveness, and because symmetry is potentially a sign of superior fitness and genetic quality (e.g., Møller, 1992; Parsons, 1990; Rhodes, 2006; Thornhill & Gangestad, 1993; Van Valen, 1962), the results of this study seem to imply that women with lower 2D:4D may be more attractive than those with higher 2D:4D, as lower 2D:4D would indicate lower facial asymmetry. Thus, in terms of the research on facial symmetry, it makes sense for men to prefer lower 2D:4D hands.

The present study was the first to examine whether hands differ in attractiveness across the menstrual cycle. One limitation was the fact that many of the participants indicated after testing that: (a) they did not find hands attractive, and thus had a difficult time completing the task (so there may have been a higher probability of guessing), and (b) that they could not see differences between hands, and therefore relied on other factors in making their decisions (e.g., colour or "how hard it looked like they were pressing"). Thus it is possible that the hand results represent chance findings or Type I error. Because of the reports from participants and the experimenters' own questions about the validity of the hand preference task, it is difficult to say with any certainty whether the majority of the responses on this preference test have any kind of practical validity.

Difference between men's beliefs about their knowledge and their actual knowledge about ovulation. The vast majority of men in this study reported that they knew what "ovulation" meant (96.70%). Over half of the men also indicated that they knew when in the cycle ovulation occurred. However, when asked to choose the correct phase of the cycle during which ovulation occurs (out of a multiple-choice list), less than 10% chose the correct phase. This is in stark contrast to Small's (1996) study, which revealed that 67% of the sample chose the correct cycle portion. One of the differences between the 1996 study and the current study, however, is that Small included both men and women respondents. As one might expect women to be more accurate at choosing the precise moment of ovulation (and indeed Small did indicate that more women in the sample were correct, though did not provide a breakdown of data by sex), it is possible that this explains part of the difference. However, the sample for Small's (1996) study were all in undergraduate anthropology or human sexuality courses (and thus might have gained knowledge about the topic from their coursework), and were also only given four choices as to the timing of ovulation, while the current study used six. Another potential explanation of the findings is potential differences in sex education teachings for the different geographical locations of this and the previous study. It is probable that one or some combination of these factors is responsible for the variability in responses between the two studies. However, it is interesting to note that few men in the current study knew when ovulation occurs. It is not clear how representative the findings are of ovulation knowledge in the general population. Similar research should be conducted elsewhere to ascertain whether this is an accurate reflection of men's poor understanding of conception-related processes, as this could have potential consequences on later conception rates. In addition, it is possible that different wording (i.e., when is a woman most fertile or most likely to conceive?) might lead to different results. It would also be beneficial to include women in future studies, for the same reasons.

Strengths of the Current Study

This study was the first (to the authors' knowledge) to (a) test ratings of attractiveness comparing the periovulatory with the two other major menstrual cycle phases, (b) test periovulatory preferences for bodies, (c) test hand attractiveness over the menstrual cycle, (d) separate ratings of periovulatory preference according to cycle day,

(e) use luteinizing hormone detection strips to assess the reliability and validity of the reverse count method of ovulation quantification, (f) assess PP scores according to potential sociosexual factors, and (g) attempt to determine differences in PP between partners and nonpartners. Thus, future research should attempt to determine whether these results can be replicated.

The study design for the current study was fairly rigorous, in that the design included: (a) randomly assigning women to menstrual cycle and LH detection strip groups, (b) controlling for potential confounding factors (e.g., effects of wearing different clothing), (c) using reliable and valid methods for detecting ovulation (including a hormonal measure), and (d) standardization of photo-taking and hand scan procedures, and photo evaluations. The authors also attempted to replicate many findings from similar studies, and had men and women complete questionnaires with many different types of questions included (and thus gained a greater understanding of other potential factors involved in the PP). Time and order effects were also controlled for. Thus, the current study was very conscientiously and rigorously carried out, and examined many factors previously overlooked, thus expanding our current knowledge of the factors involved in cyclical changes in attractiveness.

Limitations of the Current Study

The most obvious limitation of the current study is the small sample size of women, although the effect sizes for most results were still reasonably high. In comparison with similar studies, Roberts et al. (2004), utilized a sample of 48 women, while the results for Smith et al.'s (2006) study were based on two composite photos comprised of 10 women each. As was outlined earlier, attempting to recruit women who both fit the criteria for, and are willing to participate in, this type of research is very difficult. However, the sample size for the men was acceptably high. One potential limitation was the possible incorrect usage of the urinary luteinizing hormone detection strips. As the differences in colour or shading of the two lines may have been difficult to read, false positive or negative results are possible. As the women used the LH strips on their own at home, it is impossible to know whether the results given were reliable. However, use of the reverse count method in conjunction with the LH strips suggested that the positive LH results occurred two days before the participant's expected day of ovulation (as would be expected). Another potential limitation was the fact that limited demographic information was collected on the men in the study, as well as the fact that the sample (of both men and women) was predominantly White. Therefore, it is difficult to determine whether a more heterogeneous multicultural sample would provide different results than the current sample.

Future Research

Future research in this area should retain the current study's model of examining the relative attractiveness of faces and bodies across the three major menstrual phases. However it would be useful to compare the menstrual with the luteal phase. It would be especially informative to have women photographed at many different points in the cycle, and then to have men compare all of the photos, as this method would provide more precise results. However, this method may be unrealistic in terms of the added time required of participants as well as the specificity of the testing dates. This would likely reduce the willingness of women to participate (which is already an issue for this type of research). As makeup appears to be a confounding factor when it comes to changes in attractiveness over the cycle, future research should ensure that women do not use cosmetics during the photography portions of the study. The alternative, as in the present study, is to examine the two groups of participants separately. It would also be helpful to have male participants complete separate attractiveness and femininity ratings (on a Likert-type scale) of each of the photos used in the study, as an alternative way of determining whether there are differences between these ratings, and as a way of ascertaining whether menstrual faces are seen as more feminine. Future research should also employ the use of response times when men are carrying out the comparison tests, in order to determine whether there are differences between those men who are slower or faster when making their decisions. When the men are evaluating body photos, it would be beneficial to project the slides onto a large screen, in order to make the slides as close to life-size as possible. This may reveal differences in the comparisons that were not noticeable when the photos were displayed at such a small size. The study by Smith et al. (2006) incorporated a Likert-type scale when comparing the different faces, in order to determine how strongly the participants felt about their choices (and thus may have been better at detecting when participants were truly sure one was more attractive than the other, or whether they were just randomly guessing). Composite photos for each phase might also lead to more robust findings (i.e., create a composite of all menstrual photos, one of all periovulatory photos, and one of all luteal photos). Further studies in this area should also utilize nonuniversity samples, as well as examining whether there are differences based on socioeconomic status, as more variation may occur based on these parameters as well.

The preference results for faces and bodies when day 6 is removed suggest that

(a) when conducting menstrual cycle research, especially research conducted on attractiveness over the cycle, it may be inappropriate to categorize day 6 within the menstrual phase, and (b) previous studies that have categorized cycle day 6 within the menstrual phase may have reached incorrect conclusions, based on a cycle day that seems to have differing processes at work than the previous 5 days, at least in terms of attractiveness.

Future studies examining 2D:4D across the menstrual cycle should obtain 2D:4D measures from all phases of the menstrual cycle. This would increase power (given that each woman would then be a participant in all groups, rather than one or two), and would provide a more valid picture of whether or not 2D:4D does change across the cycle. Because Manning et al. (2005) found that 2D:4D obtained from photocopies generally yielded lower ratios then those obtained from direct measures, 2D:4D may be better measured from direct measures, in order to be comparable with the results of other studies, though it should be noted that with scans and photocopies more time can be taken in measurement, and thus may lead to increased validity. The results of the hand preference tests may be unreliable given that numerous participants stated that they did not find hands attractive or that finding differences between the hands was too difficult. Therefore, it is not clear whether changes in attractiveness of women's hands can be obtained from this form of test. Despite some trends (i.e., men prefer luteal and lower 2D:4D hands) it appears that cyclical changes in the attractiveness of women's faces and bodies are more apparent than cyclical changes in the attractiveness of hands.

In order to attempt to recruit more female participants (and partners), future research should use widespread advertising. Also it appears important to offer appealing incentives for participation.

Conclusion

The findings of the present study indicate that men show a facial PP on the day of ovulation (day of highest estrogen), and this preference is independent of SOI of either men or women, independent of the cycle phase with which they are comparing periovulatory photos, and independent of whether or not the women are wearing makeup. Thus, men seem to show a fairly robust preference for high-estrogen faces. This seems to negate the prior conception-likelihood theory of attractiveness, and instead points to a hormonal explanation (i.e., high estrogen = high attractiveness). However, makeup use and SOI status of both men and women affect evaluations of attractiveness. In women wearing makeup, nonperiovulatory faces are considered most attractive, while when women are not wearing makeup, there is not preference for any phase. When SOI is considered, high SOI men are more likely to show PPs than low SOI men (for faces and bodies – though all but luteal face findings were nonsignificant); men are more likely to show PPs when evaluating low SOI rather than high SOI women's faces and bodies; and both high and low SOI men show a significant PP when evaluating low SOI women (faces and bodies). The current study found no significant changes in 2D:4D over the menstrual cycle. Our analyses showed strong trends indicating that men preferred both luteal and lower 2D:4D hand photos. Our findings also suggest that men believe that they know when ovulation occurs, but when asked to indicate where in the cycle it occurs, the vast majority of men are incorrect. Thus, some of the findings from the current study seem to suggest that ovulation is not concealed in human females, however, the stronger finding seems to be that there are many mediating factors involved in cyclical attractiveness evaluations, including makeup use by women, and SOI status of both men and women (and thus differing mating strategies). That is, periovulatory preferences appear to be conditional.

References

Alexander, R. D., & Noonan, K. M. (1979). Concealment of ovulation, parental care, and human social evolution. In N. A. Chagnon, & W. G. Irons, (Eds.), *Evolutionary Biology and Human Social Behavior.* (pp. 436-436). Scituate: North Duxbury Press.

Aoki, K. (2002). Sexual selection as a cause of human skin colour variation: Darwin's hypothesis revisited. *Annals of Human Biology, 29(6),* 589-608.

Baker, R. R., & Bellis, M. A. (1995). *Human sperm competition: Copulation, masturbation, and infidelity.* New York, NY: Chapman & Hall.

Bakker, J., & Baum, M. J. (2000). Neuroendocrine regulation of GnRH release in induced ovulators. *Frontiers in Neuroendocrinology, 21(3),* 220-262(43).

Barber, N. (1995). The evolutionary psychology of physical attractiveness: Sexual selection and human morphology. *Ethology and Sociobiology, 16,* 395-424.

Barrett, J. C., & Marshall, J. (1969). The risk of conception on different days of the menstrual cycle. *Population Studies, 23,* 455-461.

Boothroyd, L. G., Jones, B. C., Burt, D. M., DeBruine, L. M., & Perrett, D. I. (2008). Facial correlates of sociosexuality. *Evolution and Human Behavior, 29,* 211-218.

Bröder, A., & Hohmann, N. (2003). Variations in risk-taking behavior over the menstrual cycle: An improved replication. *Evolution and Human Behavior, 24,* 391-398.

Brown, W. M., & Moore, C. (2003). Fluctuating asymmetry and romantic jealousy. *Evolution and Human Behavior, 24,* 113-117.

Burley, N. (1979). The evolution of concealed ovulation. *American Naturalist, 114,* 835-858.

Burriss, R. P., Little, A. C., & Nelson, E. C. (2007). 2D:4D and sexually dimorphic facial characteristics. *Archives of Sexual Behavior, 36, 377-384.*

Buss, D. M., & Barnes, M. (1986). Preferences in human mate selection. *Journal of Personality and Social Psychology, 50(3),* 559-570.

Cano, A., & Tarin, J. J. (1998). Two distinct two-step ranks of progesterone stimulation after three different levels of oestrogen priming. Effect on induction of luteinizing hormone surges in young and climacteric women. *Human Reproduction, 13(4),* 852-858.

Carlson, N. R. (ed.). (1991). *Physiology of Behavior.* (4th ed.). Toronto: Allyn & Bacon.

Chavanne, T. J., & Gallup, G. G., Jr. (1998). Variation in risk taking behavior among female college students as a function of the menstrual cycle. *Evolution and Human Behavior, 19,* 27-32.

Clark, A. P. (2004). Self-perceived attractiveness and masculinization predict women's sociosexuality. *Evolution and Human Behavior, 25,* 113-124.

Converse, L.J., Carlson, A. A., Ziegler, T. E., & Snowdon, C. T. (1995). Communication of ovulatory state to mates by female pygmy marmosets, *Cebuella pygmaea. Animal Behaviour, 49,* 615-621.

Csathó, Á., Osváth, A., Bicsák, É., Karádi, K., Manning, J., & Kállai, J. (2002). Sex role identity related to the ratio of second to fourth digit length in women. *Biological Psychology, 62,* 147-156.

Cunningham, M. R., Roberts, A. R., Barbee, A. P., Druen, P. B., & Wu, C. H. (1995). "Their ideas of beauty are, on the whole, the same as ours": Consistency and variability in the cross-cultural perception of female physical attractiveness.

Journal of Personality and Social Psychology, 68(2), 261-279.

Daly, M., & Wilson, M. I. (1994). Some differential attributes of lethal assaults on small children by stepfathers versus genetic fathers. *Ethology and Sociobiology, 15,* 207-217.

Daniels, D. (1983). The evolution of concealed ovulation and self-deception. *Ethology and Sociobiology, 4(2),* 69-87.

Dhall, A. (1995). Adolescence: myths and misconceptions. *Health Millions, 21(3),* 35-38.

Doty, R. L., Ford, M., Preti, G., & Huggins, G. R. (1975). Changes in the intensity and pleasantness of human vaginal odors during the menstrual cycle. *Science, 190(4221),* 1316-1318.

Dufour, D. L., & Sauther, M. L. (2002). Comparative and evolutionary dimensions of the energetics of human pregnancy and lactation. *American Journal of Human Biology, 14(5),* 584-602.

Dunson, D. B., Baird, D. D., Wilcox, A. J., & Weinberg, C. R. (1999). Day-specific probabilities of clinical pregnancy based on two studies with imperfect measures of ovulation. *Human Reproduction, 14(7),* 1835-1839.

Dunson, D. B., Weinberg, C. R., Baird, D. D., Kesner, J. S., & Wilcox, A. J. (2001). Assessing human fertility using several markers of fertility. *Statistics in Medicine, 20(6),* 965-978.

Fehring, R. J., Schneider, M., & Raviele, K. (2006). Variability in the phases of the menstrual cycle. *Journal of Obstetric, Gynecologic, & Neonatal Nursing, 35(3),* 376-384.

Fessler, D. M. T. (2003). No time to eat: An adaptationist account of periovulatory behavioral changes. *The Quarterly Review of Biology, 78(1),* 3-21.

Fink, B., Grammer, K., Mitteroecker, P., Gunz, P., Schaefer, K., Bookstein, F. L., Manning, J. T. (2005). Second to fourth digit ratio and face shape. *Proceedings of the Royal Society of London B: Biological Sciences, 272(1576),* 1995-2001.

Fink, B., Grammer, K., & Thornhill, R. (2001). Human (Homo sapiens) facial attractiveness in relation to skin texture and color. *Journal of Comparative Psychology, 115(1),* 92-99.

Fink, B., Manning, J. T., Neave, N., & Grammer, K. (2004). Second to fourth digit ratio and facial asymmetry. *Evolution and Human Behavior, 25,* 125-132.

Fink, B., Neave, N., & Manning, J. T. (2003). Second to fourth digit ratio, body mass index, waist-to-hip ratio, and waist-to-chest ratio: Their relationships in heterosexual men and women. *Annals in Human Biology, 30(6),* 728-738.

Frost, P. (1994). Preference for darker faces in photographs at different phases of the menstrual cycle: Preliminary assessment of evidence for a hormonal relationship. *Perceptual & Motor Skills, 79,* 507-514.

Furlow, B., Gangestad, S. W., & Armijo-Prewitt, T. (1998). Developmental stability and human violence. *Proceedings of the Royal Society of London B: Biological Sciences, 265,* 1-6.

Furnham, A., Dias, M., & McClelland, A. (1998). The role of body weight, waist-to-hip ratio, and breast size in judgments of female attractiveness. *Sex Roles, 39,* 311-325.

Gangestad, S. W., & Cousins, A. J. (2001). Adaptive design, female mate preferences, and shifts across the menstrual cycle. *Annual Review of Sex Research, 12,* 145-

185.

Gangestad, S. W., & Simpson, J. A. (2000). The evolution of human mating: Trade-offs and strategic pluralism. *Behavioral and Brain Sciences, 23,* 573-644.

Gangestad, S. W., & Thornhill, R. (1998). Menstrual cycle variation in women's preferences for the scent of symmetrical men. *Proceedings of the Royal Society of London B: Biological Sciences, 265,* 927-933.

Gangestad, S. W., Thornhill, R., & Garver, C. E. (2002). Changes in women's sexual interests and their partners' mate-retention tactics across the menstrual cycle: Evidence for shifting conflicts of interest. *Proceedings of the Royal Society of London B: Biological Sciences, 269,* 975-982.

Gangestad, S. W., Thornhill, R., & Yeo, R. A. (1994). Facial attractiveness, developmental stability, and fluctuating asymmetry. *Ethology and Sociobiology, 15,* 73-85.

Geary, D. C. (2000). Evolution and proximate expression of human paternal investment. *Psychological Bulletin, 126(1),* 55-77.

Gonzaga, G. C., Haselton, M. G., Smurda, J., Davies, M., & Poore, J. C. (2008). Love, desire, and the suppression of thoughts of romantic alternatives. *Evolution of Human Behavior, 29(2),* 19-126.

Gottschall, J. A., & Gottschall, T. A. (2003). Are per-incident rape pregnancy rates higher than per-incident consensual pregnancy rates? *Human Nature, 14(1),* 1-20.

Grammer, K., Renninger, L., & Fischer, B. (2004). Disco clothing, female sexual motivation, and relationship status: Is she dressed to impress? *The Journal of Sex Research, 41,* 66-74.

Guermandi, E., Vegetti, W., Bianchi, M. M., Uglietti, A., Ragni, G., & Crosignani, P. (2001). Reliability of ovulation tests in infertile women. *Obstetrics & Gynecology, 97(1),* 92-96.

Guida, M., Tommaselli, G. A., Palomba, S., Pellicano, M., Moccia, G., Di Carlo, C., & Nappi, C. (1999). Efficacy of methods for determining ovulation in a natural family planning program. *Fertility and Sterility, 72(5),* 900-904.

Haselton, M. G., & Gangestad, S. W. (2006). Conditional expression of women's desires and men's mate guarding across the ovulatory cycle. *Hormones & Behavior, 49(4),* 509-518.

Havez, E. S. E. (ed.). (1979). *Human ovulation: Mechanisms, prediction, detection and induction.* (Volume 3). New York, NY: North-Holland Publishing Company.

Havliček, J., Dvořáková, R., Bartoš, L., & Flegr, J. (2006). Non-advertized does not mean concealed: Body odour changes across the human menstrual cycle. *Ethology, 112,* 81-90.

Health Canada. (2003). *Canadian Guidelines for Body Weight Classification in Adults.* Retrieved June 12, 2006, from http://www.hc-sc.gc.ca/fn-an/nutrition/weights-poids/guide-ld-adult/bmi_chart_java-graph_imc_java_e.html.

Hönekopp, J., Bartholdt, L., Beier, L., & Liebert, A. (2007). Second to fourth digit length ratio (2D:4D) and adult sex hormone levels: New data and a meta-analytic review. *Psychoneuroendocrinology, 32,* 313-321.

Hughes S. M., & Gallup, G. G. (2003). Sex differences in morphological predictors of sexual behavior: Shoulder to hip and waist to hip ratios. *Evolution and Human Behavior, 24,* 173-178.

Jöchle, W. (1973). Coitus-induced ovulation. *Contraception, 7,* 523-564.

Johnston, V., Hagel, R., Franklin, M., Fink, B., & Grammer, K. (2001). Male facial attractiveness: Evidence for hormone-mediated adaptive design. *Evolution and Human Behavior, 22(4),* 251-267.

Johnston, L., Miles, L., Carter, C., & Macrae C. N. (2005). Menstrual influences on person perception: Male sensitivity to fluctuating female fertility. *Social Cognition, 23(3),* 279-290.

Jones, D. (1995). Sexual selection, physical attractiveness, and facial neoteny: Cross-cultural evidence and implications. *Current Anthropology, 36(5),* 723-748.

Jones, B. C., Little, A. C., Penton-Voak, I. S., Tiddeman, B. P., Burt, D. M., & Perrett, D. I. (2001). Facial symmetry and judgements of apparent health: Support for a "good genes" explanation of the attractiveness-symmetry relationship. *Evolution and Human Behavior, 22,* 417-429.

Kaplan, H. S., & Lancaster, J. B. (2003). An evolutionary and ecological analysis of human fertility, mating patterns, and parental investment. In K. W. Wachter, & R. A. Bulatao (Eds.), *Offspring: Fertility Behavior in Biodemographic Perspective* (pp. 170-223). National Research Council: Washington, D.C.: National Academies Press.

Klentrou, C., & Plyley, M. (2003). Onset of puberty, menstrual frequency, and body fat in elite rhythmic gymnasts compared with normal controls. *British Journal of Sports Medicine, 37(6),* 490-494.

Kokko, H., Brooks, R., Jennions, M. D., & Morley, J. (2003). The evolution of mate choice and mating biases. *Proceedings of the Royal Society of London B:*

Biological Sciences, 270, 653-664.

Kuukasjärvi, S., Eriksson, C. J. P., Koskela, E., Mappes, T., Nissinen, K., & Rantala, M. J. (2004). Attractiveness of women's body odours over the menstrual cycle: the role of oral contraceptives and receiver sex. *Behavioral Ecology, 15,* 579-584.

Lac, G. (2001). Saliva assays in clinical and research biology. *Pathologie Biologie, 49,* 660-667.

Lessey, B. A. (2000). The role of the endometrium during embryo implantation. *Human Reproduction, 6,* 39-50.

Li, N. P., Kenrick, D. T., Bailey, J. M., & Linsenmeier J. A. W. (2002). The necessities and luxuries of mate preferences: Testing the tradeoffs. *Journal of Personality and Social Psychology, 82(6),* 947-955.

Macrae, C. N., Alnwick, K. A., Milne, A. B., & Schloerscheidt, A. M. (2002). Person perception across the menstrual cycle: Hormonal influences on social-cognitive functioning. *Psychological Science, 13(6),* 532-536.

Manning, J. T. (1995). Fluctuating asymmetry and body weight in men and women: Implications for sexual selection. *Ethology and Sociobiology, 16,* 145-153.

Manning, J. T. (2002). *Digit ratio: A pointer to fertility, behavior, and health.* Piscataway, NJ: Rutgers University Press.

Manning, J. T., Barley, L., Walton, J., Lewis-Jones, D. I., Trivers, R. L., Singh, D., Thornhill, R., Rhode, P., Bereczkei, T., Henzi, P., Soler, M., & Szwed A. (2000). The 2nd:4th digit ratio, sexual dimorphism, population differences, and reproductive success: evidence for sexually antagonistic genes? *Evolution and Human Behavior, 21,* 163-183.

Manning, J. T., Bundred, P. E., & Mather F. M. (2004). Second to fourth digit ratio, sexual selection, and skin colour. *Evolution and Human Behavior, 25,* 38-50.

Manning, J. T., Fink, B., Neave, N., & Caswell, N. (2005). Photocopies yield lower digit ratios (2D:4D) than direct measurements. *Archives of Sexual Behavior, 34(3),* 329-333.

Manning, J. T., & Quinton, S. (2007). Association of digit ratio (2D:4D) with self-reported attractiveness in men and women. *Journal of Individual Differences, 28(2),* 73-77.

Manning, J. T., Scutt, D., & Lewis-Jones, D. I. (1998). Developmental stability, ejaculate size, and sperm quality in men. *Evolution and Human Behavior, 19,* 273-282.

Manning, J. T., Scutt, D., Whitehouse, G. H., Leinster, S. J., & Walton, J. M. (1996). Asymmetry and the menstrual cycle in women. *Ethology and Sociobiology, 17,* 129-143.

Manning, J. T., & Wood, D. (1998). Fluctuating asymmetry and aggression in boys. *Human Nature, 9,* 53-65.

Mayhew, T. M., Gillam, L., McDonald, R., Ebling, F. J. P. (2007). Human 2D (index) and 4D (ring) digit lengths: Their variation and relationships during the menstrual cycle. *Journal of Anatomy, 211,* 630-638.

McArdle, C. R., Seibel, M., Weinstein, F., Hann, L. E., Nickerson, C., & Taymor, M. L. (1983). Induction of ovulation monitored by ultrasound. *Radiology, 148(3),* 809-812.

Meuwissen, I., & Over, R. (1992). Sexual arousal across phases of the human menstrual cycle. *Archives of Sexual Behavior, 21(2),* 101-119.

Mikach, S. M., & Bailey, J. M. (1999). What distinguishes women with unusually high numbers of sex partners? *Evolution and Human Behavior, 20,* 141-150.

Møller, A. P. (1992). Parasites differentially increase the degree of fluctuating asymmetry in secondary sexual characters. *Journal of Evolutionary Biology, 5,* 691-699.

Oinonen, K. A., Jarva, J. A., & Mazmanian, D. (2008). Pre-existing hormonal differences between oral contraceptive users and nonusers? Evidence from digit ratio, age of menarche, and sociosexual orientation. In G. A. Conti (Ed.), *Progress in Biological PsychologyResearch,* (pp. 95-116). Hauppauge, NY:Nova Science Publishers, Inc.

Oinonen, K. A., Klememcic, N., & Mazmanian, D. (2008). The periovulatory sociosexuality tactic shift (PSTS): Activational hormonal mechanisms in two female sexual strategies. In G. A. Conti (Ed.), *Progress in Biological PsychologyResearch,* (pp. 139-158). Hauppauge, NY:Nova Science Publishers, Inc.

Parenteau-Carreau, S. (1981). The sympto-thermal methods. *International Journal of Fertility, 26(3),* 170-181.

Parsons, P. A. (1990). Fluctuating asymmetry: An epigenetic measure of stress. *Biological Reviews, 65,* 131-145.

Patola, J., Oinonen, K., & Mazmanian, D. (2006, June). *Anthropometric fluctuation as a function of phase of the menstrual cycle in women.* Poster session presented at the annual convention of the Canadian Psychological Association, Calgary, Alberta.

Pawlowski, B. (1999). Loss of oestrus and concealed ovulation in human evolution: The case against the sexual-selection hypothesis. *Current Anthropology, 40(3),* 257-276.

Penton-Voak I. S., & Perret, D. I. (2000). Female preference for male faces changes cyclically: Further evidence. *Evolution and Human Behavior, 21,* 39-48.

Perrett, D. I., Lee, K. J., Penton-Voak, I., Rowland, D., Yoshikawa, S., Burt, D. M., Henzi, S. P., Castles, D. L., & Akamatsu, S. (1998). Effects of sexual dimorphism on facial attractiveness. *Nature, 394(6696),* 826-827.

Pettijohn II, T. F., & Jungeberg, B. J. (2004). Playboy playmate curves: changes in facial and body feature preferences across social and economic conditions. *Personality and Social Psychology Bulletin, 3,* 1186-1197.

Pillsworth, E. G., Haselton, M. G., & Buss, D. M. (2004). Ovulatory shifts in female sexual desire. *The Journal of Sex Research, 41(1),* 55-65.

Poran, N. S. (1994). Cyclic attractivity of human female odors. *Advances in the Biosciences, 93,* 555-560.

Provost, M. P., Quinsey, V. L., & Troje, N. F. (2007) (in press). Differences in gait across the menstrual cycle and their attractiveness to men. [Electronic version]. *Archives of Sexual Behavior, 2007, September 13, Epub ahead of print.*

Quintana, S. M., & Maxwell, S. E. (1994). A Monte Carlo comparison of seven ε-adjustment procedures in repeated measures designs with small sample sizes. *Journal of Educational Statistics, 19,* 57– 71.

Reichert, K. E., Heistermann, M., Hodges, J. K., Boesch, C., & Hohmann, G. (2002). What females tell males about their reproductive status: Are morphological and behavioral cues reliable signals of ovulation in bonobos (*Pan paniscus*)?

Ethology, 108, 583-600.

Rhodes, G. (2006). The evolutionary psychology of facial beauty. *Annual Review of Psychology, 57,* 199-226.

Rhodes, G., Hickford, C., & Jeffrey, L. (2000). Sex-typicality and attractiveness: Are supermale and superfemale faces super-attractive? *British Journal of Psychology, 91(1),* 125-140.

Rhodes, G., Simmons, L. W., & Peters, M. (2005). Attractiveness and sexual behavior: Does attractiveness enhance mating success? *Evolution and Human Behavior, 26,* 186-201.

Ridley, M. (2003). *The Red Queen: Sex and the Evolution of Human Nature.* New York, NY: Penguin Putnam.

Rikowski, A., & Grammer, K. (1999). Human body odour, symmetry and attractiveness. *Proceedings of the Royal Society of London B: Biological Sciences, 266,* 869-874.

Roberts, S. C., Havlicek, G., Flegr, J., Hruskova, M., Little, A. C., Jones, B. C., Perrett, D. I., & Petrie, M. (2004). Female facial attractiveness increases during the fertile phase of the menstrual cycle. *Proceedings of the Royal Society of London B: Biological Sciences, 271(Suppl. 5),* S270-S272.

Romano, M., Leoni, B., & Saino, N. (2006). Examination marks of male university students positively correlate with finger length ratios (2D:4D). *Biological Psychology, 71,* 175-182.

Saino, N., Romano, M., & Innocenti, P. (2006). Length of index and ring fingers differentially influence sexual attractiveness of men's and women's hands.

Behavioral Ecology and Sociobiology, 60, 447-454.

Scarbrough, P. S., & Johnston, V. S. (2005). Individual differences in women's facial preferences as a function of digit ratio and mental rotation ability. *Evolution and Human Behavior, 26,* 509-526.

Schnatz, P. T. (1985). Neuroendocrinology and the ovulation cycle - Advances and review. *Advances in Psychosomatic Medicine, 12,* 4-24.

Schreiner-Engel, P., Schiavi, R. C., Smith, H., & White, D. (1981). Sexual arousability and the menstrual cycle. *Psychosomatic Medicine, 43(3),* 199-214.

Schröder, I. (1993). Concealed ovulation and clandestine copulation: A female contribution to human evolution. *Ethology and Sociobiology, 14,* 381-389.

Scutt, D., & Manning, J. T. (1996). Symmetry and ovulation in women. *Human Reproduction, 11,* 2477-2480.

Sillen-Tullberg, B., & Moller, A. P. (1993). The relationship between concealed ovulation and mating systems in arthropoid primates: A phylogenetic analysis. *American Naturalist, 141(1),* 1-25.

Simpson, J. A., & Gangestad, S. W. (1991). Individual differences in sociosexuality: Evidence for convergent and discriminant validity. *Journal of Personality and Social Psychology, 60,* 870-883.

Simpson, J. A., & Gangestad, S. W. (1992). Sociosexuality and romantic partner choice. *Journal of Personality, 60(1),* 31-51.

Singh, D. (1994). Is thin really beautiful and good? Relationship between waist-to-hip ratio (WHR) and female attractiveness. *Personality and Individual Differences, 16,* 123-132.

Singh, D. (1995). Female health, attractiveness, and desirability for relationships: Role of breast asymmetry and waist-to-hip ratio. *Ethology and Sociobiology, 16,* 465-481.

Singh D., & Bronstad, P. M. (2001). Female body odour is a potential cue to ovulation. *Proceedings of the Royal Society of London B: Biological Sciences, 268,* 797-801.

Small, M. F. (1996). "Revealed" ovulation in humans? *Journal of Human Evolution, 30,* 483-488.

Smith, M. J. L., Perrett, D. I., Jones, B. C., Cornwell, R. E., Moore, F. R., Feinberg, D. R., Boothroyd, L G., Durrani, S. J., Stirrat, M. R., Whiten, S., Pitman, R. M., & Hillier S. G. (2006). Facial appearance is a cue to oestrogen levels in women. *Proceedings of the Royal Society of London B: Biological Sciences, 273(1583),* 135-140.

Stiffman, M. N., Schnitzer, P. G., Adam, P. A., Kruse, R. L., & Ewigman, B. G. (2002). Household composition and risk of fatal child maltreatment. *Pediatrics, 109(4),* 615-621.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics* (4^{th} Ed.). Toronto, ON: Allyn and Bacon.

Thornhill, R. S., & Gangestad, S. W. (1993). Human facial beauty: Averageness, symmetry, and parasite resistance. *Human Nature, 4,* 237-269.

Thornhill, R., & Gangestad, S. W. (1994). Human fluctuating asymmetry and sexual behavior. *Psychological Science, 5,* 297-302.

Thornhill, R., Gangestad, S. W., & Comer, R. (1995). Human female orgasm and mate fluctuating asymmetry. *Animal Behavior, 50,* 1601-1615.

Thornhill R., & Grammer, K. (1999). The body and face of woman: One ornament that signals quality? *Evolution and Human Behavior, 20,* 105-120.

Tovée, M. J., Tasker, K., & Benson, P. J. (2000). Is symmetry a visual cue to attractiveness in the human female body? *Evolution and Human Behavior, 21,* 191-200.

Townsend, J. M., & Wasserman, T. (1998). Sexual attractiveness: Sex differences in assessment and criteria. *Evolution and Human Behavior, 19,* 171-191.

Trussell, J., & Raymond, E. G. (1999). Statistical evidence about the mechanism of action of the Yuzpe regimen of emergency contraception. *Obstetrics & Gynecology, 93(5),* 872-876.

Udry, J. R., Bauman, K. E., & Chase, C. (1971). Skin color, status, and mate selection. *American Journal of Sociology, 76(4),* 722-733.

Van Der Spuy, Z. M., & Jacobs, H. S. (1983). Weight reduction, fertility and contraception. *International Planned Parenthood Federation Medical Bulletin, 17,* 2-4.

Van Goozen, S. H. M., Wiegant, V. M., Endert, E., Helmond, F. A., & Van de Poll, N. E. (1997). Psychoendocrinological assessment of the menstrual cycle: The relationship between hormones, sexuality, and mood. *Archives of Sexual Behavior, 26(4),* 359-382.

Van Valen, L. (1962). A study of fluctuating asymmetry. *Evolution, 16,* 125-142.

Vermesh, M., Kletzsky, O. A., Davajan, V., & Israel, R. (1987). Monitoring techniques to predict and detect ovulation. *Fertility and Sterility, 47(2),* 259-264.

Voracek, M., & Dressler, S. G. (2006). High (feminized) digit ratio (2D:4D) in Danish men: a question of measurement method? *Human Reproduction, 21(5),* 1329-1331.

Wade, T. J., Shanley, A., & Imm, M. (2004). Second to fourth digit ratio s and individual differences in women's self-perceived attractiveness, self-esteem, and body-esteem. *Personality and Individual Differences, 37,* 799-804.

Wilcox, A. J., Baird, D. D., Dunson, D. B., McConnaughey, D. R., Kesner, J. S., & Weinberg, C. R. (2004). On the frequency of intercourse around ovulation: Evidence for biological influences. *Human Reproduction, 19(7),* 1539-1543.

Wilcox, A. J., Weinberg, C. R., & Baird, D. D. (1995). Timing of sexual intercourse in relation to ovulation: Effects on the probability of conception, survival of the pregnancy, and sex of the baby. *The New England Journal of Medicine, 333(23),* 1517-1521.

Wilson, M., Daly, M., & Daniele, A. (1995). Familicide: The killing of spouse and children. *Aggressive Behavior, 21(4),* 275-291.

Zaadstra, B.M., Seidell, J. C., Van Noord, P. A., te Velde, E. R., Habbema, J. D., Vrieswijk, B., & Karbaat, J. (1993). Fat and female fecundity: Prospective effect of body fat distribution on conception rates. *British Medical Journal, 306,* 484-487.

Appendix A

Subject Number______________

Screening Questionnaire

1) Age:___________

2) Sex (Circle your answer): Male Female

3) Today's Date:____
Day of week (e.g., Monday) Day of month (e.g., 5^{th}) Month (e.g., May)

4) Height: ___________ (feet & inches) or ___________(cm)

5) Weight:__________ (pounds) or _________(kg)

6) Education: _______ years

7) Are you currently taking any type of hormonal contraceptive (e.g., oral contraceptives, the Pill, Depo Provera, hormonal patch, Implanon implant, NuvaRing)?
(Circle your answer) YES NO

8) If you are **not** currently taking oral contraceptives, have you ever taken oral contraceptives before? (Circle your answer) YES NO

9) If you have **previously used a hormonal contraceptive** but are not using one right now, how many years and months has it been since you last used the hormonal contraceptive (e.g., oral contraceptives)?
_________years and _________months

10) What is the average length of your menstrual cycle right now (i.e., how many days are there from the first day of one period to the first day of your next period: most people range between 25 and 35 days)?___________

11) What is your average length of menstruation (i.e. how many days does your period last)?______________

12) How old were you when you first started menstruating? _________ years

13) Which statement best describes your menstrual cycle right now? (Put an 'X' beside your response)

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

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

October

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

November

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

December

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

January

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

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

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

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

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

17) Do you think that you have started to go through menopause? YES NO MAYBE

18) Are you currently pregnant? YES NO MAYBE

19) Check the box that best describes your current romantic situation:
[ ] married or living with male partner [ ] one steady male partner but living apart
[ ] no steady partner [ ] more than one steady male partner
[ ] other: [ ] same sex partner
[ ] married or living with same sex partner

20) If you are currently in a steady relationship, how long have you and your partner been together (in years and months)? ________ years and ________ months

21) If you are currently living with a male partner, how long have you been living together (in years and months)? ________ years and ________ months

22) If you are currently living with a male partner, do you think he would be interested/available for contact and participation in this study? YES NO

23) Please list any medications that you are currently taking:

____

____

____

24) Please list any medical disorders that you have been diagnosed with:

____

____

____

25) Have you ever broken either of your hands or any of your fingers? YES NO

Appendix B

Subject Number:_______________

First Session Questionnaire

1) How many times have you had sex in the past two days? __________

2) How many times have you had sex in the past month? __________

3) With how many different partners have you had sex in your lifetime? __________

4) With how many different partners have you had sex within the past year? __________

5) If there was nothing to inhibit you (e.g., no threat of contracting AIDS, VD, or herpes, no fear of unwanted pregnancy, your partner(s) willingly consented, etc.), with how many different partners (whom you currently know) would you enjoy having sex? __________

6) How many different partners do you foresee yourself having sex with during the next five years? _________

7) With how many different partners have you had sex on one and only one occasion?

____

8) How frequently do you think about sex?

1	2	3	4	5	6	7	8	9
virtually never								*almost all the time*

9) How often do (did) you fantasize about having sex with someone other than your current (most recent) dating partner?

1	2	3	4	5	6	7	8
never							*at least once a day*

10) "Sex without love is OK". How do you feel about this statement?

1	2	3	4	5	6	7	8	9
strongly disagree								*strongly agree*

11) "I can imagine myself being comfortable and enjoying casual sex with different partners". How do you feel about this statement?

1	2	3	4	5	6	7	8	9
strongly disagree								*strongly agree*

12) "I would have to be closely attached to someone (both emotionally and psychologically) before I could feel comfortable and fully enjoy having sex with him." How do you feel about this statement?

1	2	3	4	5	6	7	8	9
strongly disagree								*strongly agree*

13) Imagine that you leave this session today and walk down the hall. As you are walking, you notice an extremely attractive man walking towards you. He appears to fit your idea of an ideal man. If the man expressed an interest in you and was willing, how likely would you be to have a one-night stand with him tonight?

1	2	3	4	5	6	7	8	9	10
Very unlikely									*Extremely likely*

14) Are you currently menstruating? YES NO

15) Are you currently taking hormonal contraceptives? YES NO

16) If you are currently menstruating, how many days have you been bleeding? __________ days

17) If you are not currently menstruating, how many days has it been since you started your last period? _________ days

18) How attractive do you feel today, compared with how attractive you normally feel?

1	2	3	4	5	6	7
I feel much less attractive than I normally do						*I feel much more attractive than I normally do*

19) How physically attractive do you feel your partner is to you?

1	2	3	4	5	6	7
unattractive			*somewhat attractive*			*very attractive*

20) How physically attractive do you think other women would say your partner is?

1	2	3	4	5	6	7
unattractive			*somewhat attractive*			*very attractive*

21) How important is it to you that your partner be physically attractive?

1	2	3	4	5	6	7
unimportant			*somewhat important*			*very important*

22) a) Are you a parent? YES NO

b) If yes, how many children do you have? ________ How many biological children do you have? _______

23) Do you want to have children during your lifetime? YES NO UNSURE

24) How strong is your desire for children?

1	2	3	4	5	6	7
No desire whatsoever						*very strong desire*

25) Ideally, how many children would you like to have in total? _________

26) How important is it that you have at least one child in your lifetime?

1	2	3	4	5	6	7
not at all important						*extremely important*

27) For you, what would be the ideal age to start having children? ___________

28) Does your partner want to have children someday? YES NO UNSURE

29) How important is it to you whether your partner wants children?

1	2	3	4	5	6	7
unimportant			*somewhat important*			*very important*

30) Some women notice physical changes or mood changes in themselves across their menstrual cycle. To what extent do you experience predictable mood or bodily changes within your menstrual cycle?

1	2	3	4	5
not at all	*a little*	*moderately*	*quite a bit*	*extremely*

31) If you are wearing makeup today, please indicate which of these types of makeup you are wearing:

[ ] foundation
[ ] blush
[ ] cover-up
[ ] bronzer/tanner
[ ] lipstick/gloss/liner
[ ] eye shadow
[ ] mascara
[ ] eyeliner
[ ] other

32) Within the past two weeks, please indicate if you have done any of the following:

[ ] applied self-tanner
[ ] tanned outside
[ ] attended tanning sessions

Request for Partner's Information

If you have a partner that you believe would be willing to participate in this study, please fill out this form. We may contact him/her to participate. Those participants who are not Psychology 1100 students will have their names entered into a draw for two $50.00 prizes.

Your First Name (please print): ____________________

Partner's First Name (please print): ________________________

Partner's Phone Number: ________________________

Partner's E-Mail Address: ____

Appendix C

Subject Number:______________

Second Session Questionnaire

1) How many times have you had sex in the past two days? __________

2) How many times have you had sex in the past month? __________

3) With how many different partners have you had sex in your lifetime? __________

4) With how many different partners have you had sex within the past year? __________

5) If there was nothing to inhibit you (e.g., no threat of contracting AIDS, VD, or herpes, no fear of unwanted pregnancy, your partner(s) willingly consented, etc.), with how many different partners (whom you currently know) would you enjoy having sex? _________

6) How many different partners do you foresee yourself having sex with during the next five years? ________

7) With how many different partners have you had sex on one and only one occasion?

____

8) How frequently do you think about sex?

1	2	3	4	5	6	7	8	9
virtually never								*almost all the time*

9) How often do (did) you fantasize about having sex with someone other than your current (most recent) dating partner?

1	2	3	4	5	6	7	8
never							*at least once a day*

10) "Sex without love is OK". How do you feel about this statement?

1	2	3	4	5	6	7	8	9
strongly disagree								*strongly agree*

11) "I can imagine myself being comfortable and enjoying casual sex with different partners". How do you feel about this statement?

1	2	3	4	5	6	7	8	9
strongly disagree								*strongly agree*

12) "I would have to be closely attached to someone (both emotionally and psychologically) before I could feel comfortable and fully enjoy having sex with him." How do you feel about this statement?

1 2 3 4 5 6 7 8 9

strongly disagree *strongly agree*

13) Imagine that you leave this session today and walk down the hall. As you are walking, you notice an extremely attractive man walking towards you. He appears to fit your idea of an ideal man. If the man expressed an interest in you and was willing, how likely would you be to have a one-night stand with him tonight?

1 2 3 4 5 6 7 8 9 10

Very unlikely *Extremely likely*

14) Are you currently menstruating? YES NO

15) Are you currently taking hormonal contraceptives? YES NO

16) If you are currently menstruating, how many days have you been bleeding? __________ days

17) If you are not currently menstruating, how many days has it been since you started your last period? _________ days

18) How attractive do you feel today, compared with how attractive you normally feel?

1 2 3 4 5 6 7

I feel much less attractive than I normally do *I feel much more attractive than I normally do*

19) How physically attractive do you feel your partner is to you?

1 2 3 4 5 6 7

unattractive *somewhat attractive* *very attractive*

20) How physically attractive do you think other women would say your partner is?

1 2 3 4 5 6 7

unattractive *somewhat attractive* *very attractive*

21) How important is it to you that your partner be physically attractive?

1 2 3 4 5 6 7

unimportant *somewhat important* *very important*

22) a) Are you a parent? YES NO

b) If yes, how many children do you have? ________ How many biological children do you have? _______

23) Do you want to have children during your lifetime? YES NO UNSURE

24) How strong is your desire for children?

1	2	3	4	5	6	7
No desire whatsoever						*very strong desire*

25) Ideally, how many children would you like to have in total? _________

26) How important is it that you have at least one child in your lifetime?

1	2	3	4	5	6	7
not at all important						*extremely important*

27) For you, what would be the ideal age to start having children? _______________

28) Does your partner want to have children someday? YES NO UNSURE

29) How important is it to you whether your partner wants children?

1	2	3	4	5	6	7
unimportant			*somewhat important*			*very important*

30) Some women notice physical changes or mood changes in themselves across their menstrual cycle. To what extent do you experience predictable mood or bodily changes within your menstrual cycle?

1	2	3	4	5
not at all	*a little*	*moderately*	*quite a bit*	*extremely*

31) If you are wearing makeup today, please indicate which of these types of makeup you are wearing:

[ ] foundation
[ ] blush
[ ] cover-up
[ ] bronzer/tanner
[ ] lipstick/gloss/liner
[ ] eye shadow
[ ] mascara
[ ] eyeliner
[ ] other

32) Within the past two weeks, please indicate if you have done any of the following:

[ ] applied self-tanner
[ ] tanned outside
[ ] attended tanning sessions

Appendix D

Subject Number:______________

Experimental Session Questionnaire

1) Please check the box which best describes your sexual orientation:
   [ ] Heterosexual [ ] Bisexual [ ] Homosexual

2) How many times have you had sex in the past two days? __________

3) How many times have you had sex in the past month? __________

4) With how many different partners have you had sex in your lifetime? __________

5) With how many different partners have you had sex within the past year? _________

6) If there was nothing to inhibit you (e.g., no threat of contracting AIDS, VD, or herpes, no fear of unwanted pregnancy, your partner(s) willingly consented, etc.), with how many different partners (whom you currently know) would you enjoy having sex? _________

6) How many different partners do you foresee yourself having sex with during the next five years? ________

7) With how many different partners have you had sex on one and only one occasion?

____

8) How frequently do you think about sex?

1	2	3	4	5	6	7	8	9
virtually never								*almost all the time*

9) How often do (did) you fantasize about having sex with someone other than your current (most recent) dating partner?

1	2	3	4	5	6	7	8
never							*at least once a day*

10) "Sex without love is OK". How do you feel about this statement?

1	2	3	4	5	6	7	8	9
strongly disagree								*strongly agree*

11) "I can imagine myself being comfortable and enjoying casual sex with different partners". How do you feel about this statement?

1	2	3	4	5	6	7	8	9
strongly disagree								*strongly agree*

12) "I would have to be closely attached to someone (both emotionally and psychologically) before I could feel comfortable and fully enjoy having sex with her." How do you feel about this statement?

1	2	3	4	5	6	7	8	9
strongly disagree								*strongly agree*

13) How attractive do you think you are, compared with other men your age?

1	2	3	4	5	6	7	8	9	10
not at all attractive									*extremely attractive*

14) If you have a partner, how physically attractive do you feel your partner is to you?

1	2	3	4	5	6	7
unattractive			*somewhat attractive*			*very attractive*

15) If you have a partner, how physically attractive do you think other men would say your partner is?

1	2	3	4	5	6	7
unattractive			*somewhat attractive*			*very attractive*

16) How important is it to you that your partner be physically attractive?

1	2	3	4	5	6	7
unimportant			*somewhat important*			*very important*

17) a) Are you a parent? YES NO

b) If yes, how many children do you have? ________ How many biological children do you have? _______

18) Do you want to have children during your lifetime? YES NO UNSURE

19) How strong is your desire for children?

1	2	3	4	5	6	7
No desire whatsoever						*very strong desire*

20) Ideally, how many children would you like to have in total? _________

21) How important is it that you have at least one child in your lifetime?

1	2	3	4	5	6	7
not at all important						*extremely important*

22) For you, when would be the ideal age to start having children? ______________

23) Does your partner want to have children someday? YES NO UNSURE

24) How important is it to you whether your partner wants children?

1	2	3	4	5	6	7
unimportant			*somewhat important*			*very important*

25) Do you know what "ovulation" means? YES NO

26) Do you know during which portion of the menstrual cycle ovulation occurs?
YES NO THINK SO

27) Please check the box that indicates the approximate time in the menstrual cycle during which you believe ovulation occurs:
[ ] During the menstrual period
[ ] One week after the menstrual period
[ ] One week before the menstrual period
[ ] Right after the menstrual period
[ ] Middle of the menstrual cycle
[ ] Right before the menstrual period

27) Do you usually know when your partner is ovulating? YES NO

28) If yes, how do you know when she is ovulating? (Please write down any responses that you can think of)

____
____
____
____
____
____
____
____
____
____
____
____
____
____
____
____

Appendix E

CONSENT FORM A

This study is being conducted by Jennifer Patola under the supervision of Dr. K. Oinonen of the Department of Psychology at Lakehead University. The purpose of the study is to examine person perception. This screening questionnaire will be used to select subjects for the next stage of our study. Individuals who are selected to participate in the next stages of the study will receive up to 3 bonus points towards their final mark for participating (if they are Psychology 1100 students).

Your participation in this screening process will involve the completion of a short questionnaire that will take approximately 10 minutes. The questionnaire includes personal questions about topics such as: demographic information, health information, reproductive history, and relationship information.

Participation in this experiment is voluntary and you may withdraw at any time without explanation and without penalty. All records of your participation will be kept in strict confidence and any reports of the study will not identify you as a participant. As per university requirements, all data will be stored for seven years by Dr. K. Oinonen at Lakehead University and remain completely confidential. Individuals who meet specific criteria will be asked to participate in the next phase of the study. Therefore, we have asked for your name, telephone number, and e-mail address on this form (please do not detach the form). Once we have determined who will be asked to participate in the next phase, this sheet will be removed from your questionnaire and your information will remain confidential. There will be no way that your name can be connected to your responses. There are no known physical or psychological risks associated with participating in this study.

I have read and understood the consent form, and I agree to participate in this study under these conditions.

Name (please print): ________________________ Phone Number: ________________

Signed:______________________________ E-mail Address: ______________________

Date:_______________________

If you have any questions or concerns regarding this study please contact Jennifer Patola (343-8186) or the supervisor of this study, Dr. Oinonen (343-8096).

Appendix F

DEBRIEFING FORM A

Thank you for participating in this study. The data you have contributed will be used to investigate the effects of menstrual cycle phase on facial and bodily ratings by men. Portions of this research constitute a Masters Thesis by Jennifer Patola. We are particularly interested in determining whether women are judged to be more attractive during fertile phases of their menstrual cycle, particularly when being rated by their partners, as compared to ratings by strangers. Previous research suggests that women are rated as more attractive during fertile phases (e.g., Roberts et al., 2004; Smith et al., 2006).

Please be assured that all of your responses are coded to conceal your identity on the questionnaires, that all data will remain confidential, and that photos and identifying information will be kept separate. Below are listed some related references that might be of interest to those who would like further information on the effects of hormones and menstrual cycle phase on ratings of attractiveness. If you have indicated an interest in receiving information about the results of this study, a summary will be sent to you at the end of this study.

Roberts, S.C., Havlicek, J., Flegr, J., Hruskova, M., Little, A.C., Jones, B.C., Perrett, D.I., & Petre, M. (2004). Female facial attractiveness during the fertile phase of the menstrual cycle. *Proceedings of the Royal Society of London, B: Biological Sciences (Suppl.), 271,* S270-S272.

Smith, M.J.L., Perrett, D.I., Jones, B.C., Cornwell, R.E., Moore, F.R., Feinberg, D.R., Boothroyd, L.G., Durrani, S.J., Stirrat, M.R., Whiten, S., Pitman, R.M., Hillier, S.G. (2006). Facial appearance is a cue to oestrogen levels in women. *Proceedings of the Royal Society of London B: Biological Sciences, 273,* 135-140.

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Appendix G

Instructions for First and Second Sessions

Please come to both of your sessions wearing the same denim jeans and a white T shirt. If you do not have a plain white T shirt, some will be available for use during the session. Please do not wear makeup to your sessions, or if you absolutely have to, try to ensure that the same makeup is worn for both sessions. Please wear hair back and off of the face (e.g., in a ponytail, bangs held back with a hairband, etc.). If hair is not away from the face, you will be asked to put it back with hair elastics (new), or ties (unused). Below are allotted areas for you to write down your session appointments, keeping track on this form may help you remember the time and place. Please contact Jen Patola at 343-8186 or jmpatola@lakeheadu.ca if you have any questions.

Session 1 Date: ___________________

Session 1 Time: ___________________

Session 2 Date: ___________________

Session 2 Time: __________________

Location: ______________________________

Appendix H

CONSENT FORM B

This study is being conducted by Jennifer Patola under the supervision of Dr. K. Oinonen of the Department of Psychology at Lakehead University. The purpose of the study is to examine person perception.

The study consists of two phases that will all take place at Lakehead University during 35 days and will last approximately 30 minutes each. The two sessions will be scheduled approximately 10 to 14 days apart. During each session you will be asked to: complete a questionnaire, have a digital photo taken of your head and body, have your hands scanned, and possibly be provided with hormonal urine strips, and instructions regarding their use. The questionnaire includes personal questions about topics such as: reproductive information, and sexual and relationship information. During a final phase of this study, the photographs will be shown to your partner and/or other men for a study on person perception. At the end of the second session, Psychology 1100 students will receive up to 3 bonus points towards their final mark.

Participation in this experiment is voluntary and you may withdraw at any time without explanation and without penalty. All records of your participation will be kept in strict confidence and any reports of the study will not identify you as a participant. As per university requirements, all data will be stored for seven years by Dr. K. Oinonen at Lakehead University and remain confidential, and any identifying information will be kept separate from your photos. There are no known physical or psychological risks associated with participating in this study.

I have read and understood the consent form, and I agree to participate in this study under these conditions.

Name (please print): ______________________________

Signed:______________________________

Date: ______________________

[ ] Please check this box if you also consent to the use of your photos and information in any future similar studies.

[ ] Please check this box if you agree to provide your consent for the researchers to use your photos as an example in any publications or presentations.

[ ] If you are interested in receiving an e-mailed summary of the results of this study, please check this box, and provide your e-mail address: ______________________

If you have any questions or concerns regarding this study please contact Jennifer Patola (343-8186) or the supervisor of this study, Dr. Oinonen (343-8096).

Appendix I

Instructions for Use of Hormone Detection Strips

* Begin using the hormone strips on the __________ day after your period.

Step 1

Collect urine in one of the paper cups provided. Open the strip package when ready to use.

Step 2

Immerse the strip in the urine, with the arrow pointing down towards the urine. Do not immerse past the MAX line. Take the strip out after 5 seconds and lay the strip flat on a clean, dry, nonabsorbent surface. Do not immerse for longer than 7 seconds.

Step 3

Wait for coloured bands to appear (40 seconds to 10 minutes). Either one band or two bands will appear.

Step 4

Once a test result shows 2 coloured bands, please contact the experimenter that day (Jen Patola 343-8186, or jmpatola@lakeheadu.ca). An appointment for your next session will be made. Preferably for the one of the following two days, or if that is not convenient, within the next 4 days.

Please follow these instructions: testing should not occur in the morning. Best results will occur after 2 p.m. Please test at the same time every day (so before beginning to test, think about what time of day would be the best for you in terms of being able to consistently test at the same time). If you run out of strips before you see two lines, please contact the experimenter, and more strips will be provided to you (preferably giving the experimenter enough notice to allow us to get you some more strips without missing a day of testing). Keep the unused strips away from moisture and direct sunlight.

Thank you for your participation. If you have any questions or concerns, please contact the experimenter at the phone number or e-mail address listed above.

Appendix J

DEBRIEFING FORM B

Thank you for participating in the screening phase of our study. Portions of this research constitute a Masters Thesis by Jennifer Patola. If you are selected to participate in the second part of the study, you will be contacted by the researcher, Jennifer Patola, in the next few months. Participants in the next phase of the study will receive up to 3 bonus points towards their final mark (if they are psychology 1100 students).

Please be assured that once participants have been selected for the study, the consent forms will be removed from the questionnaires and there will be no way to identify your responses. All of your responses will be coded to conceal your identity on the questionnaires and all data will remain confidential.

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Appendix K

CONSENT FORM C

This study is being conducted by Jennifer Patola under the supervision of Dr. K. Oinonen of the Department of Psychology at Lakehead University. The purpose of the study is to examine person perception.

The study consists of one session that will take place at Lakehead University and will last approximately 1 hour. During the session, you will be asked to: have a digital photo of your head/face taken, complete a questionnaire; and look at and evaluate head, body, and hand photos of various women. The questionnaire includes personal questions about sexual and relationship information. At the end of the session, Psychology 1100 students will receive one bonus point towards their final mark, and those who are not in Psychology 1100 will have their name entered into a draw for two $50 prizes.

Participation in this experiment is voluntary and you may withdraw at any time without explanation and without penalty. All records of your participation will be kept in strict confidence and any reports of the study will not identify you as a participant. As per university requirements, all data will be stored for at least seven years by Dr. K. Oinonen at Lakehead University and remain confidential, and any identifying information will be kept separate from your photos. There are no known physical or psychological risks associated with participating in this study.

I have read and understood the consent form, and I agree to participate in this study under these conditions.

Name (please print): ______________________________

Signed:______________________________

Date: ______________________

[ ] Please check this box if you also consent to the use of your photos and/or information in any future similar studies.

[ ] If you are interested in receiving an e-mail summary of the results of the study, please check this box and provide your e-mail address: ________________________

If you have any questions or concerns regarding this study please contact Jennifer Patola (343-8186) or the supervisor of this study, Dr. Oinonen (343-8096).

Appendix L

DEBRIEFING FORM C

Thank you for participating in this study. The data you have contributed will be used to investigate the effects of menstrual cycle phase on attractiveness ratings by male partners and nonpartners. Portions of this research constitute a Masters Thesis by Jennifer Patola. We are particularly interested in determining whether women are judged to be more attractive during fertile phases of their menstrual cycle, particularly when being rated by their partners, as compared to ratings by strangers. Previous research suggests that women are rated as more attractive during fertile phases (e.g., Roberts et al., 2004; Smith et al., 2006).

Please be assured that all of your responses are coded to conceal your identity on the questionnaires, that all data will remain confidential, and that photos and identifying information will be kept separate. Below are listed some related references that might be of interest to those who would like further information on the effects of hormones and menstrual cycle phase on ratings of attractiveness. If you have indicated an interest in receiving information about the results of this study, a summary will be sent to you at the end of this study.

Roberts, S.C., Havlicek, J., Flegr, J., Hruskova, M., Little, A.C., Jones, B.C., Perrett, D.I., & Petre, M. (2004). Female facial attractiveness during the fertile phase of the menstrual cycle. *Proceedings of the Royal Society of London, B: Biological Sciences (Suppl.), 271,* S270-S272.

Smith, M.J.L., Perrett, D.I., Jones, B.C., Cornwell, R.E., Moore, F.R., Feinberg, D.R., Boothroyd, L.G., Durrani, S.J., Stirrat, M.R., Whiten, S., Pitman, R.M., Hillier, S.G. (2006). Facial appearance is a cue to oestrogen levels in women. *Proceedings of the Royal Society of London B: Biological Sciences, 273,* 135-140.

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