2003

Effects of hormones on symmetry detection and perceptions of facial attractiveness /Oinonen, Kirsten. --

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Running head: HORMONES, SYMMETRY, AND FACIAL ATTRACTIVENESS

The Effects of Hormones on Symmetry Detection and Perceptions of Facial Attractiveness

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Doctoral Dissertation

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Date: May, 2003

0-612-85019-6

Abstract

Research on the perception of facial attractiveness suggests hormonal involvement in mate selection mechanisms. Facial symmetry is one of four factors that is reliably associated with facial attractiveness, and there is evidence that people with symmetrical bodies and faces have adaptive characteristics (e.g., higher fertility, physical fitness, psychological health, and the potential to provide sexual pleasure). During the preovulatory phase of their menstrual cycle when conception is most likely, women's bodies are more symmetrical, and women show a visual preference for males with darker skin and more masculine facial features, as well as an olfactory preference for males with more symmetrical bodies. Previous research has not examined whether women also show a preovulatory phase advantage in the visual detection of facial symmetry. In the present study, 45 women performed symmetry detection tests and rated the attractiveness of male faces that varied in symmetry level (low, normal, high, and perfect) at two of three phases in their menstrual cycle (menstrual, preovulatory, luteal). Although there was no evidence to support the hypotheses that women are better at detecting, and show a preference for, symmetrical male faces during the preovulatory phase, there was evidence of an activational effect of hormones on facial symmetry detection and mate selection. The ability to detect facial symmetry was highest in the menstrual phase of the cycle and women rated all faces as sexier during the preovulatory phase, compared to the rest of the cycle. The findings were interpreted in the context of asymmetric hemispheric activation and evolutionary mate selection theory. Also noteworthy was a dose-effect association between alcohol consumption and decreased visuoperceptual learning. The present findings provide strong support for a role of gonadal steroids in modulating both perceptual abilities and mate selection criteria.

Acknowledgements

I would like to thank my advisor, Dr. Dwight Mazmanian, for his guidance, expertise, and kind mentorship. His ability to see the silver lining amidst any apparent setback always helped to put things in perspective and restore motivation. Thanks to Dr. Josephine Tan, Dr. Charles Netley, and Dr. Ian Newhouse of Lakehead University for their helpful comments and suggestions on the proposal and final thesis. Thanks to Dr. Elizabeth Hampson of the University of Western Ontario for sharing her many ideas and suggestions regarding the final thesis. Thanks to the four HBA and MA students who helped with the data collection: Sarah Morrison, Nora Klemencic, Joy Creese, and Janelle Jarva. Finally, thanks to Russ for all his love and encouragement. Portions of this work were funded by a Lakehead University internal NSERC grant awarded to Dr. Dwight Mazmanian. Scholarship funding was provided from an NSERC Postgraduate Scholarship - PGSB and a SSHRC Doctoral Fellowship.

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Facial attractiveness can have a large influence on one's choice of a mate (Walster, Aronson, Abrahams, & Rottmann, 1966). Overall physical attractiveness depends more on facial attractiveness than on bodily attractiveness (Berscheid, 1981), and people with more attractive faces are more likely to marry, marry at a younger age, and have children (Kalick, Zebrowitz, Langlois, & Johnson, 1998). It has been suggested that the effect of facial attractiveness on mate choice evolved because the face provides important cues as to the physical health, or the genes, of the prospective mate (e.g., Cunningham, Roberts, Barbee, Druen, & Wu, 1995). However, regardless of whether or not facial attractiveness provides "honest" cues about physical health in today's relatively healthy society (e.g., Kalick et al., 1998), facial attractiveness remains an adaptive quality to the individual, as noted above. Furthermore, the ability to perceive and attract individuals with an attractive face must also have been adaptive to the perceiver in the past. The fact that specific, reliable, and consistent preferences of facial attractiveness have been identified suggests that evolutionary forces have shaped the way our perceptual systems perceive or judge facial attractiveness, and that specific neurochemicals or areas in the brain may be involved in the perception or detection of attractiveness. Interestingly, recent research suggests that hormones may play a role in the perception of facial attractiveness (e.g., Frost, 1994; Johnston & Wang, 1991; Penton-Voak, Perrett, Castles, Kobayashi, Burt, Murray, & Minimisawa, 1999).

In order to examine the role of hormones in the perception of facial attractiveness, three areas of research will be reviewed: (a) the reliability and consistency of facial attractiveness ratings across individuals, times, ages, and cultures; (b) the importance of four factors involved in the perception of facial attractiveness (averageness, non-average sexually dimorphic features, the left side of the face, and symmetry); (c) evidence of hormonal involvement in the selection and attracting of a mate; and (d) the effects of hormones on brain structure and function. Finally, the rationale for the following hypothesis will be more specifically outlined: Women have evolved such that their hormone levels just prior to ovulation, when they are most likely to conceive, optimize their ability to detect facial symmetry in a potential mate, and therefore, to choose a mate with the best genetic material.

Ratings of Facial Attractiveness are Stable and Reliable

Ratings of facial attractiveness are quite stable and reliable across cultures, raters, time, and age. These four areas of research suggest that, contrary to the common belief that beauty is in the eye of the beholder, the perception of facial attractiveness is more objective than subjective. Furthermore, research on newborns suggests that certain perceptual mechanisms that are involved in attractiveness perception, are either innate or are acquired very early in life.

Cross-cultural studies have demonstrated consistency across cultures in ratings of facial attractiveness. Cunningham and colleagues (1995) found that the mean correlation between Asians', Hispanics', and Whites' ratings of Asian, Hispanic, Black, and White women was .93, and that Taiwanese ratings correlated at .91 with these ratings. A study by Jones and Hill (1993) found somewhat lower cross-cultural agreement on attractiveness. The following average correlations between attractiveness ratings were obtained: .64 (within members of Western culture), .42 (within the Ache and Hiwi Indian populations), and .13 (cross-culturally). As subjects were required to place the photographs in order from least to most attractive, as opposed to rating each picture individually, the lower cross-cultural agreement in this study may have been a function of the methodological differences.

The high interrater reliability of within-culture attractiveness ratings also suggests a common representation of attractiveness. In studies by Langlois and Roggman (1990), interrater reliability coefficient alphas ranged from .90 for 23 male raters to .98 for 46 female raters. In another study, the average reliabilities were .87 for male faces and .90 for female faces (Zebrowitz, Olson, & Hoffman, 1993). In two experiments by Rhodes, Sumich, and Byatt (1999), the coefficient alphas for five different types of ratings, including attractiveness and mate appeal, ranged from .91 to .98. Furthermore, young adults in their 20s and 30s agreed with adults in their 60s and 70s regarding the attractiveness of older adult faces (Johnson & Pittenger, 1984). Test-retest reliability of facial attractiveness ratings are also high (e.g., Hansell, Sparacino, & Ranchi, 1982).

Two studies by Slater and colleagues (1998) suggest that the preference for attractive faces is present soon after birth. The researchers found that when newborn infants (14-151 hours old) were shown pairs of pictures of female faces, they looked longer at the pictures that had been judged <u>attractive</u> by adults, than at the faces that had been judged <u>unattractive</u> by adults. This study suggests that the perceptual mechanisms used by adults in the judgement of facial attractiveness are quite similar to those used by infants. Furthermore, the findings suggest that the perceptual mechanism that detects and responds to faces is either innate or rapidly learned soon after birth.

The cross-cultural, interrater reliability, test-retest, and newborn research suggests that judgements of facial attractiveness are relatively consistent across time, people, ages, and cultures. The newborn studies suggest that the cognitive mechanisms responsible for the perception of attractiveness are either innate or acquired very early in life.

Four Components of Facial Attractiveness

The research on facial attractiveness suggests that there are four components that are positively associated with the perception of an attractive face: averageness, non-average sexually dimorphic features, an attractive left side of face, and symmetry. Support for the importance of each of these four factors is reviewed below. While the research on facial symmetry has the most relevance here, the research on the other three factors is also important as it provides further evidence that evolutionary pressures have shaped our facial attractiveness ideals.

Average Faces are Attractive

As reviewed by Langlois and Roggman (1990), the theory of natural selection predicts that average values or population mean values of characteristics should be preferred by conspecifics as they signal a decreased likelihood of carrying harmful genetic mutations. Average features signal genetic diversity as they are most likely to occur in individuals with high protein heterozygosity while individuals with features on either extreme of the average would have greater homozygosity (Gangestad, Thornhill, & Yeo, 1994). Since individuals with high protein heterozygosity have more proteins to which parasites must adapt, these individuals would be more resistant to parasites and should be preferred as mates (Thornhill & Gangestad, 1993). Cognitive theory and developmental theory also suggest that the average values of facial features may be preferred over extreme values. If humans form facial prototypes based on previously seen faces, one might predict that an attractive face may be judged attractive simply because it best fits the existing prototype of the average face.

Research on average faces has taken two forms. One method has been to determine if there is a preference for the photometric average of faces (e.g., Langlois & Roggman, 1990). This approach involves averaging many faces together such that the mathematical mean configuration of the facial features results. In this approach, the resulting face represents a face with facial features in mean relative positions, not necessarily a face with facial features of average size. A preference for the composite face or a positive correlation between attractiveness and the number of faces making up the photometric composite is taken as evidence for a preference for an average facial configuration. The second method has been to determine if there is a preference for facial features of average size, the metric mean of the population (e.g., Cunningham, Barbee, & Pike, 1990). This approach has involved examining deviations of facial feature size from the population mean and correlating these deviations with attractiveness ratings. With rare exceptions (e.g., Cunningham, Barbee, & Pike, 1990; Cunningham et al., 1995), the research indicates that an average facial configuration is considered attractive while facial features of average size are not as highly correlated with attractiveness.

Langlois and colleagues were the first to propose that the mathematical average of faces in a population is perceived as attractive (Langlois & Roggman, 1990; Langlois, Roggman, & Musselman, 1994; Langlois, Roggman, Musselman, & Acton, 1991). They found that the attractiveness of the composites increased with the number of faces making up the composite (Langlois & Roggman, 1990; Langlois et al., 1991). Langlois and Roggman used a set of 32 faces to create composites made up of 2, 4, 8, 16, and 32 faces each. Each composite represented the average facial shape and features for all faces included. Three findings emerged. First, almost all individual faces were rated as less attractive than their composites. Second, there was a strong linear trend of increasing attractiveness as more faces were entered into the composite.

Third, the 32-face and 16-face composites were rated as significantly more attractive than the individual faces making up the composites. These findings were consistent for three sets of male and three sets of female young adult faces. The authors argued that their results were in line with evolutionary pressures that would favour facial features that are close to the mean of the population, and with cognitive processes that involve prototypical category members.

Several authors have argued that artifacts of the averaging process may account for the above finding that average faces are judged more attractive (e.g., Alley & Cunningham, 1991; Johnston & Oliver-Rodriguez, 1997). The reduction of blemishes, the enhancement of facial symmetry, and the use of different horizontal and vertical scaling factors (e.g., matching location of eye pupils and middle of the lip line across all faces) may be alternative explanations for the finding that attractiveness increases as more faces are added to the composite. By changing the vertical and/or horizontal scaling of the individual faces to facilitate the averaging process, crucial aspects or proportions of the individual faces may have been altered such that the composite face no longer represented the average face (Johnston & Oliver-Rodriguez).

In response to these criticisms and misunderstandings about their original study, Langlois, Roggman, and Musselman (1994) conducted another study. They attempted to address the following four alternative explanations for their finding that averageness is attractive: (1) The composite appears younger and is therefore perceived as more attractive. Although the composite was indeed perceived as being younger than the individual faces, Langlois and colleagues argued that this is not a valid argument since they did not find a significant relationship between perceived youthfulness and attractiveness for the individual faces. (2) The composite is more symmetrical and is therefore more attractive. The authors argued that this explanation was not valid since perfectly symmetrical faces made using the mirror imaging technique were not rated as more attractive than the original faces. However, as discussed below, there appears to be some flaws in the procedure used to create the symmetrical faces. (3) The composite is more familiar and is therefore more attractive. Langlois and colleagues agreed with this explanation as they suggest that average faces are perceived as attractive because they fit the prototype for an average face and should be perceived as familiar. When they tested this hypothesis, averaged faces were judged to be significantly more familiar than individual faces and the correlation between familiarity and attractiveness of faces was strong and positive for both male ($r = .73$) and female faces ($r = .77$). (4) The averaging process gets rid of blemishes, smooths, blurs, and distorts the image. In order to address this explanation for averageness being preferred, the authors created averaged faces using only one person's face. They took 16 different photographs of the person and combined these photos with their mirror images to produce a 32-face composite of one face. The thirty-two one-person composites were compared to the 32-person composite. The 32-person composite was rated as significantly more attractive than the 32 one-person composites. This suggested that the averaging process cannot account for the preference for the average face. Despite the fact that some researchers continue to argue that enhanced symmetry and the reduction in blemishes could account for the attractiveness of the composites (e.g., Johnston & Oliver-Rodriguez, 1997), Langlois, Roggman, and Musselman maintain their position that averaged faces are perceived as attractive because they best fit a face prototype that represents the mean of a population of faces..

However, a study by Rhodes and Tremewan (1996) provides further evidence that blending artifacts do not account for findings that average faces are attractive. Average faces were still attractive when the blending artifacts were removed through the use of line drawings. The line drawings of faces were more attractive when the features were closer to the average size. Furthermore, another study indicated that the increase in symmetry created by the averaging process cannot account entirely for the finding that average faces are attractive (Rhodes, Sumich, & Byatt, 1999).

Examination of the preference for average size facial features indicates that nose size is the only feature for which there is any evidence that it is preferred at average size in both males and females. Cunningham, Barbee, and Pike (1990) looked at the attractiveness of average-size features in men and found that only noses were most attractive when they were of average size. Cunningham and colleagues (1995) found that in women, only 2 of approximately 27 facial features were most attractive at the average value in their sample: vertical position of the eyes and nose tip width. It may be of significance that the majority of pictures used in this study were of highly attractive women who had participated in an international beauty contest. The average size of this sample's facial features may not be in line with the average of the general population. However, another study reported within the same paper used photos of college students as stimuli, and the authors did not find that any of the facial features were judged most attractive when they were at the average value of the sample. It is noteworthy that none of these studies systematically varied the size of various facial features while keeping all other variables constant.

Jones and Hill (1993) found weak support for the theory that average size features play a role in attractiveness. Two methods were used to determine how each face differed from the average face in each sample (i.e., pattern variability index, a Euclidean Distance matrix index). Using both methods, the results suggested that only when the Ache Indians rated faces drawn from their own population was there a significant negative correlation between attractiveness and the deviation from the average (range from -.26 to -.43). While the correlations for the Brazilians and the U.S. Americans were in the predicted direction, they were not significant. However, when the correlations for all populations were pooled, there was a significant relationship between attractiveness and averageness with the effect for the female faces being slightly stronger than for the male faces.

Grammer and Thornhill (1994) found that attractiveness was positively correlated with averageness in women, but negatively correlated with averageness in men. Female 4-face, 8-face, and 16-face composites were rated as more attractive than the individual females faces, but the individual male faces were rated as more attractive than the composite male faces. A second method of determining averageness involved calculating how much the size of facial features and the vertical and horizontal distance between facial features differs from the sample mean. When measures of fluctuating asymmetry were partialled out of the men's ratings of female faces, female facial averageness did not correlate significantly with attractiveness. When the level of symmetry was controlled in the male faces, there was a significant negative relationship between facial averageness and attractiveness. These findings suggest that photometric averageness is attractive in female, but not male, faces, and that metric averageness is not attractive in either female or male faces.

In summary, the research suggests that photometric average faces, faces made by combining a number of faces together, are attractive. The research does not provide strong support for the theory that metric average faces, faces with features of the average population size, are attractive. However, average facial feature size does seem to have a positive effect on the attractiveness of female faces (e.g., Jones & Hill, 1993). Averageness also appears to be considered attractive because it is more familiar. Cognitive mechanisms that perceive facial averageness as attractive likely developed because averageness reflects heterozygosity and therefore, parasite resistance. The inconsistency in the research suggests that other factors are involved in attractiveness and that while an average facial appearance may be considered attractive, it is not necessarily ideally attractive.

Specific Sex-Typical Non-Average Facial Features are Attractive

Evolutionary theory predicts that specific non-average sex-typical facial features will be judged attractive in male and female faces. Non-average sex-typical traits may advertise fertility and parasite resistance, as well as providing obvious gender clues. In women, shorter lower face proportions and fuller lips may serve as reliable indicators of high fertility resulting from high estrogen and low androgen exposure at puberty. In men, large testosterone-associated secondary sex traits may advertise parasite resistance (e.g., a large jaw), particularly since jaw and cheekbone size appear to be related to facial symmetry (Scheib, Gangestad, & Thornhill, 1999). These features may signal an increased resistance to disease due to the ability to survive such a large susceptibility to disease during the period of reduced immunocompetence associated with the high levels of sex hormones (Grammer & Thornhill, 1994). Grammer and Thornhill have also suggested that highly estrogenized female features (e.g., prominent cheekbones) similarly reflect enhanced immunocompetence. This theory predicts that secondary sex traits in men (i.e., cheekbones, jaw size, and chin size) and secondary sex traits in women (i.e., cheekbones) should be preferred at a greater-than-average size while features not influenced by testosterone (e.g., nose and eyes) should be preferred at average size. One might also hypothesize that the same features that differentiate males from females may be involved in the perception of attractiveness of male and female faces. Therefore, for any features that differ significantly between the average male and female, one would predict that opposite extreme sizes of that feature will be preferred on male and female faces (e.g., a smaller than average jaw for females and a larger than average jaw for males).

Studies examining preferences for non-average facial features in women have yielded surprisingly consistent results. The research indicates that the following facial feature characteristics are perceived as more attractive in women: (a) a shorter than average lower face (e.g., Cunningham et al., 1995; Johnston & Franklin, 1993; Johnston & Oliver-Rodgriguez, 1997; Jones & Hill, 1993; Perrett, May, & Yoshikawa, 1994), (b) a larger than average distance between the eyes and hair (e.g., Johnston & Franklin, 1993), (c) fuller lips (e.g., Johnston & Franklin, 1993; Johnston & Oliver-Rodgriguez, 1997), (d) a narrower mouth (e.g., Johnston & Franklin, 1993), (e) wider eyes than average (e.g., Cunningham et al., 1995; Johnston & Oliver-Rodgriguez, 1997; Jones & Hill, 1993; Perrett, May, & Yoshikawa, 1994), (f) a small nose area (e.g., Cunningham et al., 1995), (g) a narrow chin (e.g., Johnston & Oliver-Rodgriguez, 1997), (h) prominent cheekbones (e.g., Grammer & Thornhill, 1994; Perrett, May, & Yoshikawa, 1994), (i) a narrow face (e.g., Cunningham et al., 1995; Perrett, May, & Yoshikawa, 1994), and (j) light skin (e.g., Van den Bergh & Frost, 1986). The preference for these traits is in line with the hypothesis that traits reflecting high levels of estrogen are attractive. Furthermore, female facial features that differ most significantly from average male facial features were preferred.

Fewer studies have attempted to determine if non-average facial features are attractive on men's faces. However, the results of these studies are consistent with the prediction that male secondary sex characteristics are preferred at a larger than average size. Six non-average features have been found to be most attractive on male faces: (a) prominent cheekbones (e.g., Cunningham, Barbee, & Pike, 1990; Grammer & Thornhill, 1994), (b) a wide jaw (e.g., Grammer & Thornhill, 1994), (c) a broad face (e.g., Grammer & Thornhill, 1994), (d) a large chin (e.g., Cunningham, Barbee, & Pike, 1990), (e) large eyes (e.g., Cunningham, Barbee, & Pike, 1990), and (f) a wide mouth (e.g., Grammer & Thornhill, 1994). Directional selection has resulted in larger than average secondary sex characteristics being perceived as ideally attractive on the male face.

The research indicates that non-average "supernormal" sex-typical facial traits are positively associated with facial attractiveness in both female and male faces. More feminine faces in the female range are judged more attractive and more masculine faces in the male range are judged more attractive. Jones and Hill (1993) suggest that both femininity and neoteny are attractive in female faces since many features typical of females faces are also typical of baby-faces (e.g., wide eyes, small nose, short lower face, light skin). They also suggest that these exaggerated feminine or supernormal features may simultaneously mark the sex (female) and age (young but past menarche) of a potential mate, and this might result in a preference for young women in a specific age range. The preference for exaggerated secondary sex characteristics appears to be an example of directional selection for extreme characteristics occurring due to the advertisement of health and, therefore, fertility.

The Left Side of the Face has a Greater Influence on the Perception of Attractiveness

Despite a paucity of research, a third factor may be a possible contributor to facial attractiveness. The left side of an individuals face, from the perceiver's perspective, may have a greater influence on the perception of attractiveness than the right side. The hypothesis that there is something special about the left side of the face arose from early facial recognition studies that found that the left side of a face was more recognizable as the individual than the right side of the face (e.g., Burt & Perrett, 1997). The hypothesis that this left side of face bias might also apply to judgements of facial attractiveness came from two findings: (a) right hemisphere superiority in the processing of visual information from the left hemifield, and (b) evidence for a right-hemisphere superiority in many types of facial perception such as the perception of age and femininity/masculinity of the face (e.g., Burt & Perrett). The left-side of face effect suggests some degree of lateralization in the perception of facial attractiveness.

As noted above, there is evidence for right hemisphere superiority (left-face bias) for both the perception of age and femininity/masculinity of a face (e.g., Burt & Perrett, 1997). Furthermore, the research on the attractiveness of sex-specific non-average traits has suggested that female faces that appear younger and more feminine are rated as more attractive than those perceived as older and more masculine (e.g., Johnston & Oliver-Rodgriguez, 1997; Jones & Hill, 1993). Taken together, research on the perception of age, femininity, and attractiveness suggest that the perception of facial attractiveness may also be lateralized (the left side of the face is more important).

Burt and Perrett (1997) were the first to suggest that the perception of facial attractiveness is lateralized. They presented 132 subjects with chimeric symmetric faces in which the two sides of the chimaeras were made of composite pictures that differed in attractiveness. Four stimuli were used: male employee face, female employee face, male model face, and female model face. One side of the male employee face was a composite made up of the 15 most attractive male employee faces, from a set of 59. The other side of the face was made up of a composite of the 15 least attractive faces. The other three types of faces were made in the same manner. For each of the four types of stimuli (male employee, female employee, male model, and female model), two faces were made. The "left attractive face" had the blend of more attractive faces on the perceiver's left side while the "right attractive face" had the blend of more attractive faces on the right side. Normal subjects were presented with these two forms of each stimulus type and were asked to choose the most attractive face from each pair. The subjects indicated a significant preference for the "left attractive face" when shown the male employee (67%) and female employee faces (60%). While there was a trend towards preferring the "left attractive face" in the male model (57%) and female model (55%) conditions, the preference was not significant. As noted by the authors, the lack of a significant preference for the model stimuli may have been due to a much smaller difference in attractiveness between the least and most attractive faces in the model groups than the employee groups. These findings support the hypothesis that the brain's method of processing facial information to make judgements of facial attractiveness (i.e., right hemisphere lateralization), makes the attractiveness of the left side of the face significantly more important than the right side in judgements of attractiveness.

Further support for preferential attention to the left side of the face in attractiveness judgements comes two studies. First, Farkas and Cheung (1981) reported that when facial asymmetries occurred in a group of children and adolescents, the left side of the face (the owner's right side) was more likely to be larger. Second, in a study by Zaidel, Chen, and German (1995), the left sides of women's faces were judged significantly more attractive than the right sides. This finding suggests that female faces have evolved to take advantage of the right hemisphere and left visual field superiority in the processing of facial information. Zaidel and colleagues presented 26 students with same-side composites made by taking one side of a facial photograph and aligning it with its mirror image. These right-right and left-left composite pairs were presented to the subjects and the subjects were asked to choose the composite that they considered to be more attractive. "Same" responses were allowed. Women's left-left composites were judged significantly more attractive than their right-right composites. While there was no significant difference in the preference for men's left-left and right-right composites, more left-left than right-right composites were preferred. It is noteworthy that symmetry differences cannot explain these results. The left side of a face must be either more average, or contain more supernormal sex-typical traits than the right side (e.g., Farkas & Cheung, 1981). These findings make sense since a greater tendency to focus on the left side of the face when making judgements about facial attractiveness judgements would result in a greater likelihood that individuals with attractive left sides of faces would be selected for. Furthermore, the greater degree of functional lateralization in the male than female brain would result in a greater selection pressure for women with attractive left sides of the face (Zaidel, Chen, & German). This suggests that evolutionary pressures have resulted in directional asymmetries in facial beauty.

Another study by Swaddle and Cuthill (1995) provides some data suggesting that the left side of the face is more attractive than the right side. Although the purpose of their research was to examine the influence of facial averageness and symmetry on facial attractiveness, their data also provide some information relevant to the differential attractiveness of the left versus right sides of the face. When male and female subjects rated the attractiveness of opposite-sex faces in the normal orientation or the mirror image orientation, normally oriented faces were judged more attractive than the mirror-image faces, with the difference being greater for the female ratings of male photos. Unfortunately, no significance tests were done for female ratings, male ratings, or all opposite-sex ratings. While the authors did compare same-sex and opposite-sex ratings of the normal faces with the mirror-image faces, no significant difference was found. Despite not having the appropriate statistical comparison of the attractiveness of normal versus mirror image faces when rated by the opposite sex, the data do suggest that, if we do in fact preferentially attend to the left side of a face when making attractiveness judgements about the opposite sex, the left side of the face has evolved to be slightly more attractive than the right.

Only one other study has examined the left-side of face bias in attractiveness (i.e., Chen, German, & Zaidel, 1997). Again, this study did not explicitly test the hypotheses that the left side of the face is preferentially attended to or that the left side of the face is significantly more attractive than the right side. Instead, the focus of the study was to examine whether identity judgements or attractiveness decisions are more affected by the left side of the face. While the results indicated that lateral reversal (mirror image) of a face is not rated any more, or less, attractive than the normal orientation of the face, two factors may have reduced the sensitivity of this study to detect differences. First, since one group of subjects rated the normal faces and a second group of subjects rated the mirror image faces, there was no within-subject comparison of the ratings. Second, while the subjects in this study were required to rate each individual face on a Likert-type scale of attractiveness, other studies have required subjects to choose the most attractive face from two stimuli (e.g., Burt & Perrett, 1997; Zaidel, Chen, & German, 1995). The use of a Likert-type scale, compared to a forced choice method, may be a less sensitive method of comparing the relative attractiveness of the two very similar faces.

Burt and Perrett (1997) reviewed four possible explanations for a left side of face bias in perceptions of attractiveness. First, greater attention to the left side of the face may be due to a greater efficiency of the right than left hemisphere in processing facial information. Second, the right hemisphere may be more efficient at processing any spatial visual pattern, and therefore play a greater role in face processing. Third, the tendency to scan from left to right as the result of reading patterns may result in more initial attention apportioned to the left side of the face. Fourth, humans may be biased to pay more attention to the side of the face that provides more information about either emotions or speech. Research has not provided support for this fourth hypothesis. While facial expressions are generally more intense on the lower right half of the face (e.g., Wylie & Goodale, 1988), research indicates that more attention is paid to the left side of the face in judgements of facial expression (e.g., Rhodes, 1993). In terms of speech information, more mouth movement can be observed on the left side of a person's face during speech. However, Burt and Perrett's (1997) found a bias towards the right side of the face when lip-reading. This last finding is not surprising for two reasons. First, the primary role of the left hemisphere in speech would likely extend to the right hemifield in judgements of speech information. Second, individuals with right-hemisphere posterior lesions have been found to lip-read normally while those with left-hemisphere posterior lesions are unable to lip-read (e.g., Campbell, 1987). Therefore, the most likely explanations for the left-face bias in judgements of facial attractiveness are a specific right-hemisphere superiority in facial processing or a more general right-hemisphere superiority in the processing of spatial visual information.

Support for brain lateralization in judgements of facial age, femininity, and attractiveness provides converging evidence for a greater importance of the left side of the face in judgements of attractiveness. Additionally, the finding that the left side of a woman's face is more attractive than the right, strengthens this hypothesis. The data suggest a trend towards a greater evolution of female left face attractiveness and greater lateralization of the processes involved in men's perception of facial beauty. However, further research is needed to examine lateralization in judgements of facial attractiveness before definite conclusions can be made.

Symmetrical Faces are Attractive

The final important factor in facial attractiveness is symmetry. A perfectly symmetrical face is a face in which paired features and reference points on either side of the face are placed an equal distance from the midline of the face and are equal in size. A symmetrical face is said to be low in fluctuating asymmetry (FA). FA refers to asymmetry of bilateral characteristics for which the population mean of asymmetry (the size of the right side minus the size of the left side) is zero and variability is roughly normally distributed. The position that bilateral facial symmetry affects facial attractiveness arose from the parasite theory of evolution (e.g., Grammer & Thornhill, 1994). This theory suggests that humans have evolved to detect and avoid FA in a mate as greater FA reflects a decreased resistance to parasites, and therefore, developmental instability. As the two sides of bilateral characters are not controlled by different genes, FA is believed to represent imprecise expression of the genotype due to developmental instability and low resistance to pathogens. In fact, fluctuating asymmetry (FA) is positively associated with protein homozygosity which suggests decreased resistance to parasites (Mitton & Grant, 1984). Higher levels of heterozygosity appear to buffer against negative environmental influences during development. While Watson and Thornhill (1994) suggested that the symmetry of secondary sexual traits may be more negatively influenced by parasites than the symmetry of other bilateral traits due to the negative immunological effects and developmental stress of the high levels of testosterone and estrogen required to create large secondary sex traits, research has not supported this hypothesis (Leung & Forbes, 1996).

FA is believed to be the result of both genetic (Moller & Thornhill, 1998) and environmental causes and to reflect decreased fertility and fitness. Some support for this theory comes from the finding that symmetry is heritable in humans (Livshits & Kobylianski, 1989; Moller & Thornhill, 1997). In addition, asymmetry is increased in: premature babies (Livshits, Davidi, Kobyliansky, Ben-Amitai, Levi, & Merlob, 1988); and in individuals with schizophrenia (Markow & Gotesman, 1989; Markow & Wandler, 1986), mental retardation (Malina & Buschang, 1984), and Down's syndrome (Garn, Cohen, & Geciauskas, 1970). A positive association was also found between the asymmetry of an infant's body and both the mother's body (Livshits et al., 1988) and the number of infectious diseases the mother had during pregnancy (Livshits & Kobyliansky, 1991). Furthermore, men with less asymmetry are heavier (Manning, 1995; Thornhill, Gangestad & Comer, 1995), are more physically aggressive (Furlow, Gangestad, & Armijo-Prewitt, 1998; Manning & Wood, 1998), and have lower resting metabolic rates (Manning, Koukourakis, & Brodie, 1997) than men with higher levels of asymmetry. Women with higher breast FA are both less fecund (Moller, Soler, & Thornhill, 1995) and less likely to marry. There is also evidence that the ability to detect facial symmetry is innate as newborn babies are able to distinguish between faces on the basis of vertical symmetry (e.g., Walton & Bower, 1992). These studies suggest that the ability to detect facial symmetry would therefore provide clues as to a potential mate's fitness.

Research also indicates that asymmetry increases with exposure to parasites (Bailit, Workman, Niswander, & MacLean, 1970; Moller, 1992), exposure to pollutants (Parsons, 1990), extreme temperatures (Parsons, 1990), protein deprivation (Parsons, 1990) and homozygosity (Lerner, 1954, Parsons, 1990). Furthermore, in a large range of species, higher FA is associated with decreased fecundity, growth rate, and survival (Mitton & Grant, 1984; Palmer & Strobek, 1986; Parsons, 1990). In fact, a meta-analysis by Leung and Forbes (1996) revealed a significant positive relationship between FA and stress measures (e.g., pollution, temperature, homozygosity) in 37 species ($r = .17$), and a negative relationship between FA and fitness measures (e.g., growth, dominance, body mass) in 61 species ($r = -.26$). Interestingly, despite predictions to the contrary (e.g., Watson & Thornhill, 1994), no differences in effect sizes were found between sexually selected and non-sexually selected traits or between performance (motor) and non-performance traits.

There is accumulating support for the theory that symmetrical bodies have adaptive characteristics. Studies indicate that information about symmetry provides information about fertility, physical fitness, psychological health, intelligence, and even the potential to provide sexual pleasure. First, there is support for a negative relationship between FA and fertility in men (Manning, Scutt, & Lewis-Jones, 1998). When Manning and colleagues examined 53 men from an infertility clinic, they found that as FA in finger length increased, sperm number per ejaculate, sperm speed, and sperm migration decreased. The relationships remained significant when height, weight, and age were controlled. These results gain credibility from the finding that bodily FA increases with age, $r\ (69) = .23$ (Gangestad, Thornhill, & Yeo, 1994). Second, Manning and Pickup (1998) found that male runners with greater symmetry in nostril width and ear size were significantly better athletes and had significantly faster 800 and 1500 metre times than the less symmetrical men. Third, Shackelford and Larsen (1997) found that facial FA is positively associated with psychological, emotional, and physiological distress in university students, with the relationship being stronger for males than females. This study utilized multiple methods for collecting data: self-reports, observer ratings, daily diary reports, and psychophysiological measures. Fourth, a study found negative correlations between bodily FA and IQ (*r*s = -.21 and -.24), which remained significant when the effects of age, sex, ethnicity, and head size were controlled for (Furlow, Armijo-Prewitt, Gangestad, & Thornhill, 1997). Furthermore, women with symmetric male partners have more orgasms during copulation than do women with less symmetric partners (Thornhill, Gangestad, & Comer, 1995). These studies provide further support for the argument that body symmetry does provide information about fitness.

The findings that male facial attractiveness is positively correlated with the symmetry of seven bodily traits (Gangestad, Thornhill, & Yeo, 1994; Thornhill & Gangestad, 1994) suggest that both facial and bodily symmetry are indicators of developmental stability or fitness. When the effects of age were partialled out, Thornhill and Gangestad found a significant negative correlation between bodily FA and facial attractiveness for men ($r = -.27$), but not for women. When Gangestad, Thornhill, and Yeo partialled out the effects of age, height, minor physical anomalies, and the curvilinear effects of height and feature size, men's facial attractiveness was significantly negatively correlated with bodily asymmetry (partial $r = -.33$), but not for women (partial $r = -.17$). In contrast, Furlow, Gangestad, and Armijo-Prewitt (1998) did not find a significant relationship between bodily FA and facial attractiveness for either men or women.

Symmetrical individuals also appear to have greater success in finding a sexual partner than their less symmetrical peers. Thornhill and Gangestad (1994) found that more symmetrical individuals had more lifetime sexual partners, and that more symmetrical men had their first sexual experience at a younger age. They found a correlation of .42 between men's bodily FA and age at first sexual intercourse, when the effects of age were partialled out. Three other studies have replicated the finding that men with low FA have a higher number of lifetime sex partners (Baker, 1997; Gangestad & Thornhill, 1997; Thornhill & Gangestad, 1999).

A meta-analysis of the relationship between FA and mating success, or sexual attractiveness, included 140 samples from 62 studies of 41 species (Moller & Thornhill, 1998). Both published and unpublished studies were included. The findings indicated that (a) a moderate significant negative relationship exists between FA and mating success or attractiveness ($r = -.42$, $p < .0005$), (b) this negative relationship is significantly stronger for males ($r = -.44$) than females ($r = -.34$), (c) the relationship is stronger for traits not involved in mobility ($r = -.48$) than those involved in mobility (e.g., legs) $r = -.37$), and (d) the relationship is also stronger for secondary sexual traits ($r = -.52$) than ordinary sexual traits ($r = -.29$). When facial features were considered a secondary sexual trait, the relationship between FA and mating success or attractiveness was even stronger ($r = -.59$). Eighteen of the samples consisted of human facial FA and attractiveness measures. Of these 18 samples, seven used female ratings of male faces (r s ranged from -.660 to .085) and nine used male ratings of female faces (r s ranged from -.920 to .-.043). Four samples were not included given that the disparity of their correlation coefficients from those in the other studies was believed to be due to problems with the methodology used to create computerized symmetrical faces (rs= .63, .70, .61, .69) (i.e., Langlois, Roggman, & Musselman, 1994; Swaddle & Cuthill, 1995). Other studies have shown that some computergenerated symmetrical faces have unnatural facial shapes, feature size, and texture.

Six studies have suggested that facial symmetry is an important factor in the perception of facial attractiveness (Grammer & Thornhill, 1994; Rhodes, Proffitt, Grady, & Sumich, 1998; Rhodes, Sumich, & Byatt, 1999, study 1; Rhodes, Sumich, & Byatt, 1999, study 2; Shackelford & Larsen, 1997; Zebrowitz, Voinescu, & Collins, 1996). On the other hand, five studies have not supported this position (Jones & Hill, 1993; Kowner, 1996; Langlois, Roggman, & Musselman, 1994; Samuels, Butterworth, Roberts, Graupner, & Hole, 1994; Swaddle & Cuthill, 1995). However, some problems have been noted with the methodologies of all five of the studies with negative findings. The studies with negative findings will be discussed first.

Jones and Hill (1993) investigated the role that symmetry plays in the perception of attractiveness in five populations. Photographed faces of European-American university students from the United States, Brazilian university students, and Ache Indians of Paraguay were rated for attractiveness by European-American university students from the United States, Brazilian adults, natives of an Ache village, Russian university students, and Hiwi Indians from southern Venezuela. Both the Ache and Hiwi Indian groups are foragers who have little contact with outsiders and very little exposure to Western media. The raters were shown nine photographs at a time and were asked to place the photographs in order from least to most attractive. Of the five population samples of raters, only the Russians showed a significant attraction to faces with low fluctuating asymmetry and this effect was significant for only female faces.

Langlois, Roggman, and Musselman (1994) provided two examinations of the relationship between attractiveness and symmetry. First, they examined the correlation between symmetry ratings and attractiveness ratings for 32 original faces, 8 attractive faces, 8 unattractive faces, a 32-face female averaged face, and 2 perfectly symmetrical mirror-imaged female faces. While the symmetry and attractiveness ratings were positively related, the correlation was not significant ($r = .11$). In the second examination of symmetry, the researchers did not find a preference for perfectly symmetric faces over normal faces. They created perfectly symmetric faces by attaching one half of a face to its mirror image (chimeric faces). The mean attractiveness ratings for the left and right symmetric faces were significantly lower than the normal unaltered faces. Although some faces were judged more attractive when symmetrical, these faces were originally less attractive than the other faces that were not improved by symmetry. However, a number of researchers have since pointed out that there are some problems with the technique used to create symmetric images in this study (e.g., Moller & Thornhill, 1998; Rhodes et al., 1998; Rhodes et al., 1999). Reflecting each hemiface about the midline can result in strange looking images due to structural abnormalities such as abnormal eye spacing, nose width, and chin width. One chimera will often be wider, and the other narrower, than a normal face, making the photos appear distorted and unattractive. Therefore, these findings are likely not reflective of the true relationship between facial symmetry and facial attractiveness.

Another study led the authors to conclude that vertical symmetry is not the only determinant of facial attractiveness as measured by babies' preference for faces (Samuels et al., 1994). Twenty-five infants from four to fifteen months of age looked at pictures of female faces that had been rated as either attractive or unattractive by adults. The infants also looked at the same attractive and unattractive faces in chimeric form. The babies spent more time looking at the normal and chimeric attractive faces than at the normal and chimeric unattractive faces. This suggests that something other than vertical symmetry was an important determinant in their preference. However, while the difference was not significant, the babies did spend more time looking at the chimeric than the normal faces. Two other findings were surprising. First, the adults' ratings of attractiveness did not differ significantly between the unattractive normal faces and the unattractive chimeric faces. Second, the adults rated the normal attractive faces as significantly more attractive than the chimeric versions of the same faces. While these findings suggest that symmetry does not increase the attractiveness of a face, the methodological problems discussed in relation to the study by Langlois and colleagues (1994) also apply here.

Swaddle and Cuthill (1995) altered the symmetry of faces without altering the mean size of the facial features and had 37 male and 45 female students rate the faces for attractiveness. Besides the predicted inverse relationship between FA and attractiveness, the authors predicted that symmetry would be more attractive in male than female faces for two reasons: (1) the negative immunological effects of testosterone may make deviations from symmetry more apparent in males, and (2) there is a higher cost for females if they make "bad" mate decisions. Facial photographs were morphed with their mirror images to create perfectly symmetrical faces. Morphs of intermediate (25% and 75%) symmetry between the normal and mirror image faces were also created. Each of the 82 subjects rated the attractiveness of 32 pictures (16 females and 16 males) with each subject rating only one of five possible pictures of each person (normal, 25% increased symmetry, 75% increased symmetry, perfect symmetry, or mirror image). The results did not support the hypothesis that FA is negatively related to attractiveness as the authors found that the normal and mirror photographs were rated as more attractive than the photos with enhanced and perfect symmetry. Enhanced symmetry photos were also rated as more attractive than perfect symmetry photos which led Swaddle and Cuthill to conclude that their findings were not simply the result of the manipulation of the faces, but instead due to differences in symmetry. It was also found that the only faces whose attractiveness ratings increased with enhanced symmetry were those faces that were rated least attractive in the normal state. In fact, the more attractive a face was in its normal proportions, the greater was the reduction in the ratings of attractiveness when the face was made perfectly symmetrical (males, $r = -.74$; females, $r = -.43$). Rhodes et al. (1998) have suggested that the failure to control for facial expression in this study is a confound. Asymmetric natural smiles would disappear as photos are made more symmetrical, resulting in a decrease in the attractiveness ratings of the photos. It is also possible that using between-subjects as opposed to within-subjects comparisons of attractiveness ratings of faces that differ only in symmetry would have weakened the results.

Kowner (1996) asked subjects to select the more attractive picture from two simultaneously presented pictures: the original photograph and a symmetrical composite made by attaching one hemiface to the identical vertically flipped hemiface. Computerized techniques were also used to paste the original hairstyle on the symmetrical face and to balance light differences and eliminate blemishes. When sixty-four undergraduates examined paired pictures of 32 young children, 32 young adults, and 32 seniors, their preference for the symmetrical faces (49%) did not differ from random choice. Only in one of the age groups, the seniors, was the symmetrical portrait selected more frequently (55%) than the asymmetrical one. For both young children (47.5%) and young adults (45%), the symmetrical portrait was actually selected significantly less frequently. Based on further experiments, Kowner suggested three conclusions. First, these results reflect a preference for a face that is not perfectly symmetrical given that a perfectly symmetric face may appear unnatural because normal faces show asymmetry of emotional expression. Second, while the symmetrical older person faces were rated more attractive because they looked younger, it is possible that given that higher levels of environmental stress in the first half of the century, these older individuals may have higher levels of FA. Third, Kowner also claimed that people are not tuned to perceive the low degree of fluctuating asymmetry that is present in normal faces. However, Kowner's findings must be viewed with caution given that she also created perfectly symmetrical chimeric faces by reflecting each half of the face about the vertical midline.

Grammer and Thornhill (1994) were the first to find that facial symmetry is positively related to facial attractiveness. They had 52 women and 44 men rate 23 pictures of the opposite sex in terms of attractiveness, sexiness, dominance, and healthiness. Each set of 23 pictures included 16 pictures of individual faces and 7 composite pictures made up of various numbers of the 16 pictures. Horizontal lines between the six different paired facial points were used for calculations of asymmetry: the outermost eye corners (D1), the innermost eye corners (D2), the widest point of the cheekbones (D3), the widest points of the nose (D4), the outer corners of the mouth (D5), and the left- and right-most face points on the same horizontal line as the mouth (D6) . Two measures of horizontal asymmetry were calculated for each face: overall facial asymmetry (FA) and central facial asymmetry (CFA). Each measure used the midpoints of each of the six lines between the paired points (D1 to D6). FA was based on the sum of all possible nonredundant differences between two midpoints of the lines (i.e., the sum of 15 difference values). Calculation of CFA involved the sum of the differences between the midpoints of all adjacent lines (e.g., the sum of five difference values). FA was calculated to determine whether people assess symmetry in the entire face while CFA examines whether the symmetry of adjacent points is more important. When the effects of facial averageness were partialled out, the two measures of FA were significantly negatively correlated with facial attractiveness ratings for both male, partial *r* (13) = -.60, and female, partial *r* (13) = -.53, faces, when rated by the opposite sex. When males rated females, both CFA and FA correlated negatively with ratings of sexiness, partial *r*s (13) = -.50, -.48. For the female ratings of males, CFA was also negatively correlated with ratings of sexiness, partial *r* (13) = -.51, and healthiness, partial *r* (13) = -.53; while FA was negatively correlated with ratings of healthiness, partial *r* (13) = -.54. These results indicate that when rated by the opposite sex, faces with low FA are given higher ratings of attractiveness and sexiness by both sexes and higher ratings of healthiness by females.

In a study by Zebrowitz, Voinescu, and Collins (1996), different subjects rated the attractiveness and the symmetry of facial photographs taken at five different times in life. Facial symmetry was strongly positively associated with attractiveness during childhood ($r = .45$), puberty ($r = .38$), adolescence ($r = .23$), and in the 50s ($r = .22$). While the relationship remained positive during the 30s ($r = .13$), the correlation between rated facial symmetry and attractiveness did not reach significance. Furthermore, symmetry accounted for 11% of the variance in attractiveness ratings across ages in the study.

Shackelford and Larsen (1997) hypothesized that facial symmetry is more important to the attractiveness of male than female faces. In a sample where 18 males and 19 females rated 57 unaltered male and female faces, the relationship between vertical FA and attractiveness for men's faces was negative but not statistically significant (-.37), a medium effect size. A nonsignificant positive relationship emerged for women's faces (.24). No relationships were found between horizontal FA and attractiveness. Although the effects were not replicated in a second sample, this study provides some weak support for the position that facial symmetry is more positively related to judgements of male facial attractiveness than female facial attractiveness. The authors suggested that the inclusion of same-sex, in addition to opposite-sex, ratings of the photos may have affected the results if males and females differ in terms of what they perceive as attractive.

Rhodes and colleagues (1998) tested four hypotheses. (1) Increased symmetry is associated with increased attractiveness. (2) Humans can detect subtle differences in facial symmetry and these differences are associated with attractiveness. (3) Previous contradictory findings were due to the creation of structural abnormalities in faces as the result of the methodological flaws inherent in using perfectly symmetric chimeras (e.g., the creation of faces that are wider or narrower than a normal face). (4) Previous findings supporting the symmetry hypothesis were not artifacts of the use of averaging or blending to create more or less symmetric composites. The authors created "low", "normal", "high", and "perfect" symmetry faces. The normal faces were photographs of individual faces and the perfect symmetry faces were made by blending a "normal" face with its mirror image. The "low" and "high" symmetry faces were created by finding the difference between specific points on the normal and perfect symmetry faces and increasing or reducing these distances by 50% respectively. Subjects rated the individual faces on Likert scales of attractiveness, symmetry, and appeal as a life partner. The results suggested that both attractiveness and mate appeal are positively related to symmetry for both natural faces and a group of faces including the artificially manipulated faces. The preference for symmetry was stronger for males rating female faces than females rating male faces. Increases in symmetry were also detected by subjects and positively associated with attractiveness. When forced choice comparisons of attractiveness were made for only blended faces, the significant preference for symmetry remained. This finding discounted previous arguments stating that more symmetrical faces were more attractive only because the blending technique used to create them made the faces both more average and/or more symmetrical in texture (e.g., skin colouring or patterns), and not because of increased shape symmetry (e.g., Langlois & Roggman, 1990).

Two studies by Rhodes, Sumich, and Byatt (1999) provide recent support for the importance of symmetry in ratings of facial attractiveness. In the first study, the authors found a correlation of .76 between ratings of attractiveness and the symmetry of faces ($r = .81$ for males and $r = .71$ for females). The photos included unaltered faces, an average face made up of 24 faces, high average faces with a 50 percent increase in averageness from the normal face, and low average faces with an equivalent decrease in averageness from the normal face. When the averaged faces were not included in the ratings, the overall correlation between symmetry and attractiveness ratings decreased to .46 ($r = .53$ for males; $r = .37$, n.s. for females). The authors then factored out the effects of averageness and facial expression and the correlation between symmetry and attractiveness for all faces remained highly significant, partial $r = .54$. When only unaltered faces were included in this analysis, the correlation remained significant for all faces (partial $r = .40$) but not when calculated for only male (partial $r = .07$) or female (partial $r = .30$) faces. These results indicate that the symmetry of a face contributes to its attractiveness but also suggests that a wide range of between-face symmetry increases the likelihood of finding such an effect.

In their second study, Rhodes, Sumich, and Byatt (1999) also found that symmetry contributes to facial attractiveness. They employed the same photos as in the first study, excluding the 24-face averaged face, as well as a symmetric version of each photo. The symmetric versions of all three types of faces were created by blending each original image with its mirror image. Symmetry was positively associated with both the attractiveness ratings (r = .43) and mate-appeal (r = .36) ratings of all faces. When the effects of distinctiveness and facial expression were factored out, symmetry remained significantly positively correlated with both attractiveness (partial r = .30) and mate appeal (partial r = .20). When only the normal and symmetric versions of unaveraged faces were included in the calculations, the correlations were even higher. Increases in symmetry also increased the attractiveness ratings of female faces more than male faces. However, while the attractiveness and mate appeal ratings were higher for the perfect symmetry than the normal symmetry faces, they were not significantly different. These findings provide support for the role of symmetry in judgements of facial attractiveness.

The studies reviewed above suggest that facial symmetry is positively related to facial attractiveness. Zebrowitz (1997) has noted that the effect size for the relationship between symmetry and facial attractiveness is medium-to-large for judgements of people between the ages of 10 and 15, and small-to-medium for judgements of people from age 18 to the late 50s. Only one study has examined the cross-cultural relationship between symmetry and attractiveness in faces (i.e., Jones & Hill, 1993). Given the problems with measurement error and the method of rating attractiveness used in this study, future research is needed to determine if symmetry is important to facial attractiveness in all cultures. Furthermore, evidence of newborn preferences for symmetrical over normal faces would provide further evidence of a biological mechanism for this preference.

The Relative Importance and Independence of the Four Factors Affecting Facial Attractiveness

The above review suggests that four factors increase the attractiveness of a face: symmetry, averageness, supernormal sex typical traits, and an attractive left side of the face. It might seem contradictory for an attractive face to be both average and contain nonaverage sex typical traits or to be both symmetrical and have a more attractive left side of the face. While all of these traits can increase facial attractiveness, the ideally attractive face would likely be completely symmetrical with nonaverage sex-typical traits (e.g., a wide jaw and face in men and a short lower face and prominent cheekbones in women) and average size non-sex-typical traits (e.g., nose) and configuration. Although it would be unlikely for the ideally attractive face to contain a left side that is more attractive than the right side, increasing the attractiveness of the left side of a face should increase the overall attractiveness of the face more than increasing the attractiveness of the right side of the face. One might also predict that asymmetrical attractive faces would be more likely to have more extreme sex-typical traits on the left side than the right side (e.g., larger left jaw in men or thinner left face in women). However, if two faces have left sides that are equally attractive, one would predict that the more symmetrical face would be rated as most attractive. Despite the difficulty inherent in such a task, some researchers have attempted to determine the relative importance of the components of facial attractiveness.

Perrett, May, and Yoshikawa (1994) compared the hypothesis that "attractiveness is averageness" with the hypothesis that specific "nonaverage" facial feature dimensions enhance the attractiveness of an average face. While their findings do not refute the idea that "averageness" enhances attractiveness, they do confirm that "averageness" is not optimally attractive. The addition of specific "nonaverage" sex typical facial feature dimensions to an average face does enhance attractiveness. The results also suggest that the directional selection pressure for specific facial features seems to have had more influence on the preference of female than male facial shape.

A study by Perrett and colleagues (1998) indicated that feminized female faces are preferred over average-shaped female faces. More surprising was the finding that feminized male faces were also preferred over masculinized or average male faces. This preference was found in both forced choice studies and studies involving interactive manipulation of the facial features. Interestingly, while Japanese and Caucasian subjects preferred feminization to averageness for all faces, they showed a greater preference for feminization in the faces of their own population than in the faces of the other population. While this study does indicate that the attractiveness of an "average" face can be enhanced by adding more feminine characteristics, it does not refute the idea that averageness does not also enhance attractiveness. Despite the authors' report that their findings "refute the averageness hypothesis"(p.885), it would seem that their findings only emphasize a preference for feminized average faces over average faces. This study did not examine either symmetry or left-face bias as all stimuli were symmetrical composites made using mirror-image reflections.

Rhodes, Sumich, and Byatt (1999) examined whether average facial configurations are attractive only due to the increased symmetry obtained by adding more faces to a composite. They reasoned that if symmetry was controlled for in all composites and an increase in attractiveness ratings still occurred as the number of faces included in the composites increased, then averageness would be an important determinant of attractiveness. In their first experiment, subjects rated the attractiveness of low-, normal-, and high-averageness versions of 48 faces as well as an average male composite and average female composite face. An average male composite face was made up of all 24 male faces and an average female composite face was made up of all 24 female faces. While the normal-averageness face represented each individual face, the low- and high-averageness faces were constructed by taking each individual face and morphing it halfway towards (high-averageness) or halfway away (low-averageness) from the same-sex average face. This morphing was done using 656 points on each face and the amount of change was based on the difference vector between the individual face and the same-sex average face. As expected, attractiveness increased as the manipulated averageness of the faces increased. These results supported the hypothesis that the importance of averageness to facial attractiveness is independent of symmetry.

In a second experiment, Rhodes and colleagues (1999) had subjects rate the attractiveness of the composites from the first experiment as well as a symmetrical version of each composite. The symmetrical composites were made by blending the image with its mirror image. Three main findings emerged. First, even when all images were perfectly symmetrical, the attractiveness ratings of the faces increased with the averageness of the faces. Second, the symmetrical faces were significantly more attractive than their non-symmetrical counterparts. Third, the male and female averaged faces were judged more attractive than all individual same-sex faces, the male symmetric averaged face was judged more attractive than any individual symmetric face, and the female symmetric averaged face was more attractive than all but two symmetric individual faces. This study also supports the hypothesis that both symmetry and averageness are independent factors in attractiveness.

It was suggested above that the importance of both the left side of the face and supernormal sex-typical features in facial attractiveness suggests that supernormal features relevant to attractiveness may be more dominant on the left side of the face. There is some support for this prediction. Chen, German, and Zaidel (1997) noted that research has shown that (a) in both men and women, the lower third of the left face is larger than in the right face, (b) the lower left face is slightly larger in men than women, (c) there are no sex differences in the right side of the face (Ferrario, Sforza, Pizzini, Vogel, & Miani, 1993). This is in line with both the left side of face hypothesis as well as the specific features hypothesis. However, further research is needed to examine if this finding is replicable and if non-secondary sex characteristics are more likely to be of average shape and size on the left side of the face than on the right side of the face.

To summarize, symmetry, averageness, and sex-typical extreme features appear to make independent contributions to facial attractiveness. While the importance of the left side of the face should, by definition, provide an independent contribution to attractiveness ratings, the relative importance of this factor in relation to the others has yet to be determined. There is a trend in the research suggesting that three of these factors are more important to the perception of female than male facial attractiveness. That is, equivalent increases in averageness and the extremeness of sex-typical features appear to result in greater increases in the attractiveness of female than male faces. It also appears that the difference in attractiveness of the left compared to the right side of the face is greater in female than male faces. While a similar trend is not as apparent for symmetry, the pattern suggests a greater evolutionary selection pressure on female facial attractiveness than male facial attractiveness.

A pattern of greater evolutionary selection pressure on female than male facial attractiveness is surprising in light of parental investment theory (Trivers, 1972). Since women are the choosier sex when it comes to selecting a mate due to their heavier parental investment burden, any physical indicators of good genes should be more important to women's ratings of men's attractiveness, if a sex difference exists. However, two methodological factors may limit the conclusion that averageness, extreme sex-typical features, and the left side of the face are not as important in attractiveness ratings of male compared to female faces. First, the research has generally not attempted to ensure that all female raters are in the same phase of their menstrual cycle. If hormones are involved in the perception of attractiveness as some studies have suggested (e.g., Frost, 1994; Johnston & Wang, 1991; Penton-Voak et al., 1999), it may be that the sex difference in the importance of these factors disappears when women raters are at a specific phase of their menstrual cycle (see below). Second, some studies had all subjects rate the attractiveness of both male and female faces, but did not provide a breakdown of the ratings by sex. If the mechanisms involved in the perception of attractiveness differ between male and female raters, the failure to differentiate between male and female ratings can obscure differences in the relative importance of specific factors of attractiveness in male and female faces. Future research should address these issues.

Behaviours that Fluctuate Over the Menstrual Cycle

The comparison of performance across different phases of the menstrual cycle is one paradigm that has been used to examine the relative activational effects of hormones on various behaviours. Among other variables, previous research suggests that specific cognitive abilities, olfactory sensitivity, sexual activity, and mood, vary systematically as a function of menstrual cycle phase (e.g., Alexander, Sherwin, Bancroft, & Davidson, 1990; Gangestad & Thornhill, 1998; Hampson, 1990a; Vierling & Rock, 1967). With regards to sexual desire and activity, the research suggests that in women, peaks in sexual desire and female-initiated sexual activity occur most commonly around the midfollicular or ovulatory phase (Adams, Gold, & Burt, 1978; Hill, 1988; Stanislaw & Rice, 1988). Furthermore, while women's intra-pair copulations (copulations within a steady relationship) are fairly constant across the menstrual cycle, women's extra-pair copulations (infidelities) peak during the last days of the follicular (preovulatory) phase, when fertility is highest (Baker & Bellis, 1995). These findings suggest that not only do a woman's cognitive abilities and sexual interest change across the menstrual cycle, but so do her preferences (Gangestad & Thornhill, 1998).

Evolutionary theory predicts that the human female has evolved such that she is best able to select, attract, and mate with the "fittest" male at the phase of her cycle when she is most fertile, and therefore, most likely to conceive a child (e.g., Gangestad & Thornhill, 1998). This theory would suggest that, as the result of natural and sexual selection, hormone levels around ovulation (e.g., high levels of estrogen), have become associated with patterns of behaviour, mood, and physiological responses that provide the greatest likelihood of conceiving a child with optimal genetics (Beach, 1976). As noted above, research indicates that during the preovulatory phase of the cycle, women experience better moods, have higher sex drives, are more sensitive to sexually dimorphic odours (Doty, 1981; Vierling & Rock, 1967), have a higher pain threshold, and wear tighter clothing that exposes more skin when going out to bars at night (Grammer, Dittami, & Fischmann, 1993). These factors would increase a woman's chances of mating. It is also hypothesized that a woman is best able to select the fittest mate during this phase of her menstrual cycle. If facial attractiveness is indeed a marker of evolutionary fitness, women should have evolved perceptual mechanisms to detect facial attractiveness that function optimally when the women are most fertile.

Hormonal theories of individual differences in cognitive ability suggest that specialized cognitive abilities are related to biologically distinct neurosystems rather than, or in addition to, anatomically distinct neuronal centres. Both organizational and activational theories of hormonal effects have been suggested to explain individual differences in cognitive functioning (e.g., Beach, 1945; Nyborg, 1983; Petersen, 1976). In terms of organizational hormonal effects, individual differences in hormone levels present during critical periods of development may lead to individual differences in the structure, wiring, function, and sensitivity of the brain. Activational hormonal effects may occur due to hormonal fluctuations that occur in menstrual, diurnal, or circannual cycles; or to simple individual differences in hormone levels. Given the hypothesized organizational influences of hormones on receptor sensitivity, it is difficult to separate organizational hormonal effects from activational hormonal effects.

The menstrual cycle comparison paradigm for examining activational effects provides an examination of the correlational relationship between hormones and cognitive ability within a woman's natural hormone range. While hormone treatment studies can provide cause-and-effect conclusions about the activational effects of hormones, the hormones are synthetic and exogenous and may be administered at levels differing from those that would be produced naturally by the body. Furthermore, studies correlating ability measures with specific assayed hormone levels are more often used to examine between-subject rather than within-subject differences. In contrast, menstrual cycle comparisons provide the best method of examining the actual activational effects of endogenous hormones that fluctuate naturally within a woman over time. The reliability and validity of these studies is highest when hormonal assays are also used.

A Neuroanatomical/Biochemical Mechanism for a Hormone-Cognition Relationship

Testosterone and estrogen are the two hormones most often implicated in cognition. Research suggests that plausible mechanisms exist through which both hormones could affect cognitive ability. As reviewed by Cherrier (1999), testosterone acts at androgen receptors found throughout the brain. The long-term and rapid effects of testosterone include decreased dopamine release, increased gamma amino butyric acid (GABA) turnover, and increased choline acetyltransferase levels. Testosterone may promote dendritic branching and arborization, regulate both the somatic and dendritic size of motoneurons, regulate the appearance of gap junctions between neurons in the spinal cord, and accelerate axonal regeneration rates (Lustig, 1998).

Estrogen is also associated with biochemical and neuroanatomical changes in the brain. As reviewed by Janowsky, Chavez, Zamboni, and Orwoll (1998), estrogen affects the GABA receptor chloride channels in the hippocampus, increases the density of one form of serotonin receptor in the frontal cortex of rats, modifies dendritic branching and synapse formation in the hippocampus during development and in adulthood, modulates dopamine-mediated striatal sensorimotor function, and modifies calcium channels at the cell membrane. In another review of the research, Lustig (1998) noted that estrogen increases axonal and dendritic growth in various estrogen-sensitive areas of the developing rat brain, and increases synaptic terminals and dendritic spines in the hypothalamus, brainstem, and hippocampus. It is also noteworthy that there is some evidence of a negative association between estrogen and cortical thickness (Pappas, Diamond, & Johnson, 1979) as well as the number of dendritic branches, dendritic length, and density of apical dendritic spines in some cells of the parietal cortex (Stewart & Kolb, 1994). Therefore, it appears that estrogen can act on many cortical brain regions and have both an excitatory and inhibitory effect on brain growth.

Lustig (1998) outlined the main differences between the actions of the estrogen and testosterone. He hypothesized that by increasing the number and arborization of neurites, testosterone acts to increase the target area of individual neurons, thereby increasing the chances of interneural communication. On the other hand, by increasing the formation of spines and gap junctions, estrogen acts to increase the contact potential of nearby cells, and therefore alters neuronal communication. However, two facts make it difficult to separate out the estrogenic and androgenic effects of testosterone. First, testosterone can be aromatized to estradiol in certain neurons. Second, estradiol and testosterone can have inhibitory effects on each other (Nyborg, 1983). Although both estrogen and testosterone cause biochemical and neuroanatomical changes in the brain that may impact cognitive ability, the aromatisation of testosterone and the interactive effects of hormones can make it more difficult to determine precise hormone-behaviour relationships.

Hormones and the Menstrual Cycle

While not all women's menstrual cycles are identical due to differences in length of the cycle, timing of ovulation, presence/absence of ovulation, and exact hormonal levels, most women's cycles follow a fairly consistent and predictable pattern of relative hormonal fluctuation. As described by Carlson (1991), the average 28-day menstrual cycle begins with the first day of menses (day 1), a period when moderate levels of the gonadotropin follicle stimulating hormone (FSH) are secreted by the anterior pituitary gland in order to stimulate the growth of ovarian follicles. During this period, the blood levels of luteinizing hormone (LH), estradiol, and progesterone are quite low. As the ovarian follicle grows, it secretes estradiol. Estradiol blood levels start to increase around day 8 and peak around day 13. The secretion of estradiol causes the growth of the lining of the uterus and eventually triggers the release of a large surge of LH and a subsequent smaller surge of FSH by the anterior pituitary. The LH surge occurs around day 13 and causes ovulation to occur around day 14 when the follicle ruptures and releases the ovum. The ruptured follicle becomes the corpus luteum which produces both estradiol and progesterone. Both estradiol and progesterone levels start to increase around day 16, with progesterone levels reaching higher levels than estradiol. Progesterone levels peak roughly between days 22 and 25, while estradiol levels reach a second lower peak roughly between days 23 and 25. The levels of both hormones then decrease as menses approaches. During this period of high progesterone and moderate estradiol levels (roughly days 16 to 28), levels of LH and FSH are low.

Testosterone levels also fluctuate slightly over the menstrual cycle with a peak at ovulation (Sherwin, 1988). The lowest levels of both free and total testosterone across the cycle are present during menstruation (Alexander et al., 1990). Levels of 20 to 30 ng/100ml have been observed in the early follicular phase, increasing to 50 ng/100ml at midcycle, and decreasing to about 30 ng/100ml in the later part of the cycle (Nyborg, 1983).

Due to differences in relative hormone levels, three phases of the menstrual cycle are most commonly compared when examining hormonal effects. The first phase is the menstrual phase (roughly days 1 to 5) when levels of progesterone, estradiol, LH and testosterone are all relatively low while FSH levels are moderate. The second phase is commonly referred to as the preovulatory phase (roughly days 10 to 14). During this phase, levels of estradiol, LH, and testosterone are high, levels of FSH are moderately high, and levels of progesterone are low. The third phase is known as the luteal or midluteal phase (roughly days 20 to 24, or 5 to 10 days prior to menses). The midluteal phase is characterized by high levels of progesterone, moderate levels of estradiol, and very low levels of LH, FSH and testosterone.

In summary, by comparing the menstrual and preovulatory phases, one can examine the relative effects of estradiol, LH, FSH, or testosterone on the relevant behaviour. Comparison of the menstrual and midluteal phases allows one to examine the impact of progesterone and estrogen on the behaviour. Finally, comparison of the preovulatory and midluteal phases allows one to look at the relative importance of progesterone compared to estradiol, LH, and FSH for the relevant behaviour.

The Menstrual Cycle and the Perception of Male-Related Stimuli

Three studies have suggested that women may have an adaption whereby they are particularly sensitive to male-related or sex-related stimuli at the preovulatory phase of their menstrual cycle, the time when they are most fertile (Krug, Pietrowsky, Fehm, & Born,1994; Krug, Plihal, Fehm, & Born, 2000; Macrae, Alnwick, Milne, & Schloerscheidt, 2002).

Krug et al. (1994) investigated menstrual phase differences in recognition speed and accuracy of visual stimuli presented by tachistoscope. The stimuli were meaningless syllables and three types of pictures (nude men, babies, and body care). The responses of 16 free-cycling women and 16 women taking oral contaceptives were compared at three menstrual cycle phases: menstrual (days 2 to 5), preovulatory (days 11 to 16), and luteal (days 18 to 24). Ovulation detection kits were used to confirm ovulation and blood tests were used to determine estrogen, progesterone, LH, and testosterone levels. The free-cycling women correctly recognized more sex stimuli (nude men), and were more likely to falsely categorize other stimuli as being sex stimuli, when they were in the preovulatory phase of their cycle. These women were also quicker to correctly recognize the baby stimuli during the luteal phase, compared to the other phases. While the same menstrual cycle effects were not present for the oral contraceptive users, the women taking oral contraceptives were more accurate in their recognition of all stimuli during the luteal phase compared to the other phases. These results suggest that during the preovulatory phase of their cycle, women are primed to attend to sexual stimuli and are more likely to perceive nonsexual stimuli as being sexual in nature.

In a second study, Krug and colleagues (2000), presented the same three types of pictures (and also pictures of ordinary people) to eleven free-cycling women at the same three phases of their menstrual cycle. This time, the women were asked to perform two tasks while changes in event-related brain potentials (ERPs) were recorded using EEG. The affective processing task required that participants rate the picture as being positive, neutral, or negative. The structural processing task required that the women estimate the number of parallel thin lines that were in each picture. The late positive component (LPC) and P3 waves are sensitive to emotionality and the valence of a stimulus. Three findings were noteworthy. First, when presented with the affective processing task in the preovulatory phase, the P3 wave was greatest following sex pictures and lowest following the people pictures. This pattern was not evident during the other two phases. Second, during the preovulatory phase, the LPC was highest following sex stimuli. Third, in terms of the affective ratings, fewer sex stimuli were rated as negative during the preovulatory phase compared to the other two phases. These findings suggest an effect of the menstrual cycle on the processing of sexual stimuli.

In order to determine whether women's ability to make male-related categorizations changes over the menstrual cycle, Macrae et al. (2002) had 18 free-cycling women complete two computerized tasks during two phases of their menstrual cycle. Each woman was tested during both the menstrual (days 1 to 3) and preovulatory (days 12-14) phases. In the first task, where participants were shown faces and required to quickly press a key to identify the gender of the face, the women were quicker to categorize the faces as male when they were in the preovulatory phase. In the second task, male or female faces were flashed on the screen followed by gender-stereotypic words. Women were asked to quickly press one of two buttons to indicate whether each adjective was generally associated with men or women. When they were primed by the male faces, the women classified the stereotype-matching words more quickly during the preovulatory phase than during the menstrual phase. Thus, it appears that women are faster at categorizing men and are more quickly able to access male-related information at high conception-risk phases of their cycle.

Taken together, these three studies suggest that during the portion of their cycle when women are most likely to conceive, free-cycling women are more attentive to and quicker to respond to male-related and sex-related stimuli, have enhanced brain activity when such stimuli are present, are quicker to categorize and access categorical information relating to men, and are less likely to categorize sexual stimuli as being "negative".

The Menstrual Cycle and Ratings of Facial Attractiveness

Five studies have examined whether perceptions of facial attractiveness change over the menstrual cycle. First, Johnston and Wang (1991) found an interaction between a woman's P3 amplitude (thought to represent emotional value) elicited by pictures and her hormonal status, as indexed by menstrual phase. The authors measured the event-related potentials (ERPs) of 30 women while they looked at pictures of babies, dermatological cases, ordinary people, male models, and female models. The subjects also rated each slide on scales with the following extremes: unsexy/sexy, unpleasant/pleasant, simple/complex, and unarousing/arousing. The women were categorized into their expected levels of androgens, estrogen, and progesterone on the basis of their menstrual cycle, in order to determine the effects of hormone levels on ERPs and the behavioural ratings. The results indicated that: (a) the P3 component to babies and male models was largest when progesterone levels were high, (b) high levels of progesterone were also associated with a decrease in the complexity and eroticism of all slide categories, and (c) high levels of estrogen were associated with an increase in the pleasantness of all categories of pictures. While not statistically significant, the P3 waves to the babies slide category increased with androgen levels more than the other slide categories. This study suggests that the schemas or brain areas involved in the perception of attractiveness are influenced by hormonal changes. Furthermore, the finding that the P3 amplitude varies with both the emotional value of a stimulus and hormone levels indicates that the P3 wave plays a role in judgements of attractiveness. The authors suggest that a high non-erotic interest and high P3 wave in response to men and babies during periods of high progesterone fits with the needs of women during the post-ovulatory/luteal phase or during pregnancy, a time of high progesterone levels. Furthermore, a decrease in perceived complexity of the stimuli may also reflect a decreased requirement for complex processing, given that the opportunity for conception has passed. The P3 component likely plays a role in or reflects aspects of the judgement of facial attractiveness. Faces that are more relevant to the current biological needs of the individual, as determined by hormone levels or other factors relevant to different biological states, will elicit a larger P3 component in ERP. This may be part of the process through which the different areas of the brain communicate about the current context and biological needs of the individual. Johnston and Wang propose that the P3 component reflects an adaptive context updating process. The biological state of an individual may influence the late positive component (LPC) amplitude as well as the subsequent perception of attractiveness. Women's LPC amplitude to pictures of faces differed as a function of menstrual cycle phase, suggesting that women's brains respond differently to specific faces at different phases of the menstrual cycle.

In a second menstrual cycle study, Frost (1994) found evidence to suggest that women's preferences for male facial skin colour are influenced by the menstrual cycle. In a between-subjects comparison of 56 free-cycling women, the women in the first two-thirds of their menstrual cycle, when there is a higher ratio of estrogen to progesterone, were more likely to prefer male faces with darker skin colour than were women in the last third of their menstrual cycle. No such menstrual phase effect was found when ratings were made of female faces or when the raters were women taking oral contraceptives ($N = 42$). This suggests that hormones, specifically estrogen, may activate or disinhibit a mechanism whereby women are more attracted to darker faces, as male complexions are typically darker than female complexions, during their period of greatest fertility. Progesterone may have inhibitory effects on this mechanism. As men do not have a regular cycle of hormone activity that ensures an enhanced preference for lighter skin when a women is most fertile, it appears they have developed a preference for women with skin colour that is slightly lighter than the average colour of their population. However, as some research suggests that female skin colour fluctuates with the menstrual cycle, being lightest near ovulation (McGuiness, 1961; Snell & Turner, 1966), female hormones take advantage of this preference. Therefore, besides increasing the attractiveness of darker skin on males when a woman is most fertile, female hormones also increase the attractiveness of a woman's skin and provide males with a possible cue to ovulation and fertility.

A third study implicated the menstrual cycle, and therefore hormones, in the preference for certain facial features (Penton-Voak et al., 1999). This group of researchers found that women preferred male faces with more masculine features during the time in the cycle when conception was most likely, and preferred male faces with more feminine features during low conception probability times. In a separate study, women were asked to choose the most attractive face for a "long-term relationship" or a "short-term sexual relationship". While the women's preference for a long-term relationship partner did not change as a function of the menstrual cycle phase, the women preferred a less feminine face for a "short-term sexual relationship" when they were in the follicular phase than in the other menstrual cycle phases. Again, this cyclic change in face shape preferences was not found for a group of women using oral contraceptives. This finding further suggests that the fluctuating hormone levels in free-cycling women play a role in facial attractiveness judgements.

Penton-Voak and Perrett (2001) replicated their finding of a greater preference for masculine facial features in the high conception risk phase of the menstrual cycle (days 6 to 14). In this study, the authors presented five faces that varied in masculinity/femininity in a national U.K. magazine. Readers were asked to choose the face that they considered most attractive and to complete a short questionnaire regarding hormone and menstrual cycle information. The women in the high conception risk phase ($n = 55$) were more likely to choose a masculine face compared to the women in the menstrual and luteal phases ($n = 84$), providing further support for cyclic changes in preferences for male face shapes.

Another study provided further evidence of women's greater preference for men with masculine facial features during high versus low conception likelihood phases (Johnston, Hagel, Franklin, Fink, & Grammer, 2001). A group of 42 free-cycling women preferred a more masculine than feminine face during the high-risk phase of their cycle. Interestingly, when the change in ratings were examined between the two testing sessions, there was a larger shift towards preferring the more masculine face in the higher conception likelihood phase for those women who scored low on a masculinity scale. This study indicates that other preferences may predict mate selection strategies.

These five studies suggest that hormones play a role in the extent to which non-average sex-typical features are perceived as attractive on male faces. When women are most fertile, their attractiveness ratings of all faces increase, and they have a preference for both masculine facial features and darker skin on males. These studies suggest that hormonal change across the menstrual cycle does play a role in the perception of facial attractiveness.

Symmetry across the Menstrual Cycle

Given that the preference for some factors in facial attractiveness has been found to vary across the menstrual cycle such that women prefer physical traits indicative of greater fitness around ovulation, it follows that women may also prefer more symmetrical men around ovulation. To date, no studies have examined whether a woman's ability to detect symmetry in a face (or in any other stimuli) changes over her menstrual cycle. However, one recent study, that was published during data collection for the current study, examined whether the preference for facial symmetry changes over the menstrual cycle (Koehler, Rhodes, & Simmons, 2002). No preovulatory preference for symmetrical faces was found compared to the rest of the cycle.

However, as discussed below, studies by three groups of researchers suggest that symmetry is more important around ovulation (Gangestad & Thornhill, 1998; Manning, Scutt, Whitehouse, Leinster, & Walton, 1996; Rikowski & Grammer, 1999; Scutt & Manning, 1996; Thornhill & Gangestad, 1999).

Three studies indicate that women show an olfactory preference for more symmetrical men at times in their menstrual cycle when they are most likely to conceive. First, Gangestad and Thornhill (1998) found that women prefer the scent of more symmetrical men near ovulation. Women were asked to sniff and rate the attractiveness of 41 *t*-shirts worn for two nights by different men. Despite having never seen the men, women at high fertility points in their cycle (days 6 to 14) preferred the scent of the t-shirts worn by the more symmetrical men. Women at low fertility points in their cycle and women taking oral contraceptives did not show this preference. The correlation between the men's FA and the mean attractiveness ratings by high fertility and low fertility groups of women were $r = -.31, p < .025$, and $r = -.02, p > .05$, respectively. In fact the correlation between conception risk and the preference for symmetry was highly significant, $r = .54, p = .001$. Although the measure of bilateral symmetry came from bodily and ear traits, this suggests that the ability to detect facial symmetry in men may also vary with changing hormone levels and that women may prefer men with more symmetrical faces when they are ovulating.

In a second study, Thornhill and Gangestad (1999) replicated their original finding. Women preferred the scent of symmetrical men at menstrual cycle phases of high conception likelihood. A total of 48 free-cycling women rated the scent of t-shirts that were worn by 68 men for two nights. The study controlled for extraneous factors that might have affected scent (i.e., foods eaten; laundering of bed sheets; use of scented soap, deodorant, or cologne; use of alcohol, drugs, or cigarettes; frequency of bathing). When the women rated the male scent, the correlation between fertility risk and preference for symmetry was positive and highly significant, r ($N = 48$) = .43. Interestingly, the results also indicated that the high fertility risk women preferred the scent of men whose faces were rated (by other raters) as being high in attractiveness. There was no evidence that men preferred the scent of symmetric women.

The third study to examine the relationships among body odour preferences, symmetry, and hormones, used the same basic methodology as the two studies described above (Rikowski & Grammer, 1999). When the scent of 16 men was rated for attractiveness, there was a positive relationship between body odour attractiveness and facial attractiveness, and also a positive relationship between body odour attractiveness and facial symmetry. However, these relationships were only present when the female raters were in the high fertile phases of their cycle. In contrast to the findings of Thornhill and Gangestad (1999), Rikowski and Grammer reported that men rated female body odour as more attractive when the women's faces were also considered more attractive. Of note here was the finding of a positive (although not significant) correlation between male body symmetry and facial symmetry, $r(n= 14) = .33$. These three studies suggest that women are highly sensitive to an olfactory symmetry signal of phenotypic and genetic male quality during the preovulatory phase.

In the second area of research, two studies indicate that women's paired soft tissue traits show an increase in symmetry on the day of ovulation. Manning and colleagues (1996) found that the asymmetry of women's ears, fingers, and breasts is highest at the beginning and end of the menstrual cycle and lowest in mid-cycle when fertility is highest. They also found evidence of an increase in asymmetry at midcycle, followed by a large decrease in asymmetry around ovulation. In their second study, Scutt and Manning (1996) further examined this increase followed by a decrease in asymmetry around ovulation. They measured the asymmetry of left and right ears; and third, fourth, and fifth digits in 30 women over days 12 to 16 of their menstrual cycle. Pelvic ultrasonography was used to confirm timing of ovulation. Asymmetry of the traits was lowest on the day of ovulation and decreased significantly from the previous two days. The researchers speculated that this cyclical asymmetry is evidence of "partially concealed" ovulation as it would provide clues as to the timing of ovulation only to males who attend to the female daily (i.e., steady partners) and would be able to observe small day-to-day changes in symmetry. Thus, the finding that womens' soft tissue paired traits become more symmetrical at ovulation suggests that symmetry is important and attractive to males. It also indicates that, for ovulating women, symmetry serves to increase their attractivity to men by signalling enhanced fertility.

The research by Gangestad and Thornhill (1998) and Scutt and Manning (1996) indicates menstrual cyclicity in women's bodily symmetry and their perception of symmetry. At ovulation, womens' ears, fingers, and breasts increase in symmetry and women show a preference for the smell of men with symmetrical body traits. Along with the above reviewed evidence for a preference for facial symmetry in both males and females, the research indicates that symmetry is an important quality in a mate and may become more important to a woman when she is ovulating. Natural and sexual selection may have "designed" women such that they have an increased probability of conceiving a child by a male who has better genes. These findings suggest that women may also have evolved to be better able to detect facial symmetry in males near ovulation (a time when sexual intercourse is most likely to result in conception) than at other points in their menstrual cycle when they are less likely to conceive.

The present study examines whether two variables change across a woman's menstrual cycle: (1) her ability to identify symmetrical male faces and (2) her preference for symmetrical male faces. Forty-five women rated the attractiveness and symmetry of male faces at two of three possible phases in their menstrual cycles (i.e., the menstrual, preovulatory, and luteal phases) using both Likert and forced choice rating methods. The male faces differed in terms of symmetry. At the two menstrual cycle phases, the women also completed a test assessing the ability to detect symmetry in dot patterns, questionnaires assessing their mood and sexual history, a visuospatial and verbal test, had body measurements taken (e.g., height and weight), and provided saliva samples for hormonal assay. The women also monitored their mood, sexual activity, and basal body temperature for one full menstrual cycle.

The literature suggested two main hypotheses. Hypothesis 1: During the preovulatory phase of the menstrual cycle, women are more accurate in detecting symmetry than during either the menstrual or luteal phases. Hypothesis 2: During the preovulatory phase, women rate more symmetrical men as more attractive than they do during the menstrual or luteal phases. Both hypotheses are based on the same rationale taken from the parasite theory of sexual selection: Women have evolved such that, during the phase of the menstrual cycle when sexual intercourse is most likely to result in conception, hormones optimize their ability to select (i.e., detect symmetry, preference for symmetry) and mate with the fittest males.

Method

Participants

The final sample consisted of 60 women for the first testing session, 49 women for the second testing session, and 45 of these same women for both testing sessions. The mean age of the 60 women was 24.08 (*SD* = 7.29). The participants were recruited from introductory psychology classes, upper-year psychology classes, any-year volunteers from other disciplines, and through postings on bulletin boards in the community. However, the majority of the women were introductory psychology students. These latter students received four points toward their final course grade if they completed the entire study. All participants who completed the full study had their names placed in a draw for two separate fifty dollar prizes.

A total of 481 women completed the screening portion of the study and 104 met the inclusion criteria for the study. The other 377 women were excluded for one or more of the following reasons: (a) current use of oral contraceptives ($n = 240$), (b) irregular or unpredictable menstrual cycles ($n = 71$), (c) current and/or chronic medical disorders that could affect hormone levels (e.g., thyroid disorders, depression, polycystic ovary disease) ($n = 45$), (d) current use of any medication that may affect hormone levels (e.g., thyroid medications, antidepressant medications) ($n = 45$), (e) use of oral contraceptives within the past six months ($n = 17$), (f) age greater than 45 ($n = 11$), and (g) a menstrual cycle that did not range between 25 (minimum) and 35 (maximum) days in length ($n = 6$).

Of the 104 women who met the above inclusion criteria, 68 women participated in the first testing session and 53 returned for the second testing sessions. A total of 36 did not participate in the study for the following reasons: (a) not interested in participation ($n = 14$), (b) could not be contacted by telephone ($n = 14$), (c) a busy schedule ($n = 4$), (d) leaving town during study ($n = 2$), and (e) failure to attend scheduled appointments ($n = 2$). Thus, from the screening questionnaire, the participation rate ranged from 65.38% (68 out of 104 women who met inclusion criteria) to 75.56% (68 out of 90 women who met criteria and who were contacted).

The dropout rate from the study was 22.06% as 15 out of 68 women completed only one of the two testing sessions. However, when the inclusion criteria were met, the data contributed by these participants were used for analyses that only examined the first session. Following the exclusion of data from participants whose testing days did not coincide with the menstrual cycle phase comparisons of interest, the resultant was 60 of 68 participants for the first session, 49 of 53 participants for the second session, and 45 of 53 participants for the two session comparisons.

In order to examine the representativeness of the final participant sample, analyses were undertaken to compare the following groups: (a) study participants and women who met the inclusion criteria but did not participate, and (b) full study participants and women who participated in only one of the two sessions.

Study Group compared to Non-Participants who met study criteria. The women who participated in at least one testing session (Study Group) were compared with the women who met the study inclusion criteria but did not participate for various reasons outlined earlier (Non-Participants). The means and standard deviations or frequencies and percentages for the ten comparison variables are presented in Tables 1 and 2. Two group differences were found. The study participants had an older age of menarche than the non-participants, $t\ (101) = 2.32, p = .02$, and the two groups differed in terms of the time of day that they reported optimal functioning, χ^2 $(2, N = 103) = 11.35, p < .01$. While the Study Group was more likely than the Non-Participants to indicate that they were happiest and most productive in the morning (28.36% vs. 2.78 %), the Non-Participants were more likely to report the evening to be their optimal time of day (55.55%

Table 1

Means and Standard Deviations for Nine Variables Used to Examine Group Differences between Study Participants (Study Group) and Women meeting Inclusion Criteria but who did not Participate (Non-Participants)

Variable	Study Group *n* = 68	Non-Participants *n* = 36
Age	24.03 (7.15)	22.53 (6.34)
Education (years)	14.57 (2.25)	14.59 (2.32)
Body Mass Index (kg/m^2)	25.61 (6.33)	24.48 (4.60)
Length of cycle (days)	28.06 (1.82)	28.33 (1.51)
Age of Menarche*	13.01 (1.41)	12.34 (1.35)
Positive Affect Score	29.50 (6.59)	31.42 (7.34)
Negative Affect Score	14.25 (3.79)	14.36 (4.40)

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

Table 2

Raw Frequency and Percentages for Three Categorical Variables Used to Examine Group Differences between Study Participants (Study Group) and the Women who met the Inclusion Criteria but did not Participate (Non-Participants)

Variable	Study Group $n = 68$	Non-Participants $n = 36$
Relationship Status		
partner	39 (57.35)	18 (50.00)
no partner	29 (42.65)	18 (50.00)
Optimal Time of Day**		
morning	19 (28.36)	1 (2.78)
evening	21 (31.34)	20 (55.55)
no preference	27 (40.30)	15 (41.67)
Family Psychiatric History		
yes	34 (51.52)	19 (52.78)
no	24 (36.36)	12 (33.33)
maybe	8 (12.12)	5 (13.89)

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

vs. 31.34%). Thus, the sample in the current study differs from the population of interest only in that the women started menstruating 0.67 years later and were more likely to be "morning people". While it is not known whether such a relationship has been found previously between study participation and optimal time of day, it is quite possible that "morning people" are generally more likely to volunteer to participate in studies than "night people". "Morning people" may feel that they have more time for such activities during the work/school day. In order to examine whether "morning people" are generally more likely to start menstruating at a later age than "night people", such data were examined from 304 women who completed the screening questionnaire and indicated that they functioned optimally in either the morning or evening. While the mean age of menarche was higher for the "morning people" ($M = 12.90$, $SD = 1.50$) than the "night people" ($M = 12.61$, $SD = 1.50$), the difference was not significant, $t\ (302) = 1.56$, $p = .12$.

Full Study Group compared to Drop-out Group. In order to determine whether differences existed between the women who completed the full study (full study group) and those who dropped out after the first session (drop-out group), the two groups were compared on twelve variables (see Tables 3 and 4). Two significant group differences were found. The drop-out group had a longer mean menstrual cycle length, $t\ (64) = 1.99$, $p = .05$, and were more likely to have a romantic partner, $\chi^2\ (2, N = 66) = 4.85$, $p = .03$, than the women in the full study group. A non-significant trend was also found indicating that the drop-out group had lower positive affect scores than the full study group, $t\ (64) = 1.74$, $p = .09$. It is possible that the women with a longer menstrual cycle length were more likely to drop out of the study because there were more days separating their two sessions, and thus an increased likelihood of an event occurring that would

Table 3

Means and Standard Deviations for Nine Variables Used to Examine Group Differences between Full Study Participants (Full Study Group) and Women who Dropped out of the Study after the First Session (Drop-Out Group)

Variable	Full Study Group $n = 53$	Drop-Out Group $n = 13$
Age	23.94 (7.09)	24.92 (7.92)
Education (years)	14.37 (2.21)	15.31 (2.29)
Body Mass Index (kg/m^2)	26.47 (6.36)	25.91 (6.80)
Length of cycle (days)*	27.92 (1.77)	29.00 (1.63)
Age of Menarche	12.91 (1.43)	13.31 (1.32)
Positive Affect Score	29.94 (7.01)	26.38 (4.63)
Negative Affect Score	14.75 (3.96)	13.15 (4.36)
Alcohol Frequency Score	1.21 (0.77)	1.38 (0.65)
Alcohol Consumption Score	1.34 (0.73)	1.38 (0.87)

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

Table 4

Raw Frequency and Percentages for Three Categorical Variables Used to Examine Group Differences between Full Study Participants (Full Study Group) and Women who Dropped out of the Study after the First Session (Drop-Out Group)

Variable	Full Study Group $n = 53$	Drop-Out Group $n = 13$
Relationship Status*		
partner	27 (50.94)	11 (84.62)
no partner	26 (49.06)	2 (15.38)
Optimal Time of Day		
morning	14 (26.92)	4 (30.77)
evening	17 (32.69)	3 (23.08)
no preference	21 (40.38)	6 (46.15)
Family Psychiatric History		
yes	26 (50.98)	7 (53.85)
no	19 (37.25)	5 (38.46)
maybe	6 (11.76)	1 (7.69)

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

limit their participation. Women with romantic partners may have had less time available to devote to the study and women with less positive affect might have been less likely to enjoy their experience, and therefore been more likely to discontinue. Neither relationship status nor menstrual length were significantly related to any of the dependent variables of interest in the current study.

Facial Stimuli

Digitized black-and-white photos of the faces of 20 young adult male volunteers were obtained from an internet face database: The Psychological Image Collection at Stirling (PICS) at http://pics.psych.stir.ac.uk/. The photos were all frontal views and the faces had neutral expressions. An initial set of 60 faces was rated for attractiveness by ten volunteers. The final 20 faces were selected from these 60 such that the widest range of attractiveness values were represented by the faces. Four versions of each face were produced by altering the photos using Microsoft Photodraw, Gryphon's Morph software, and a variation of the procedure outlined in Rhodes et al. (1998). The four versions of each face differed in terms of level of symmetry: Low, Normal, High, and Perfect symmetry versions. See Figure 1 for three examples of the faces.

Prior to the creation of the four symmetry versions of each face, Microsoft Photodraw was used to prepare the faces. First, blemishes, earrings, clothing, facial hairs, and stray pieces of hair were removed with the "clone" function. Second, the best-fitting line (found by eye) through the midpoints of the lines joining the inner eye corners, the outermost edges of the nose, and the outer corners of the mouth was aligned to vertical using the "rotate" function. Third, the midpoint between the eyes was centred on the screen. Fourth, "crop by shape" was used to place a black oval around each face in order to cut out most of the hair and background. Fifth, a black

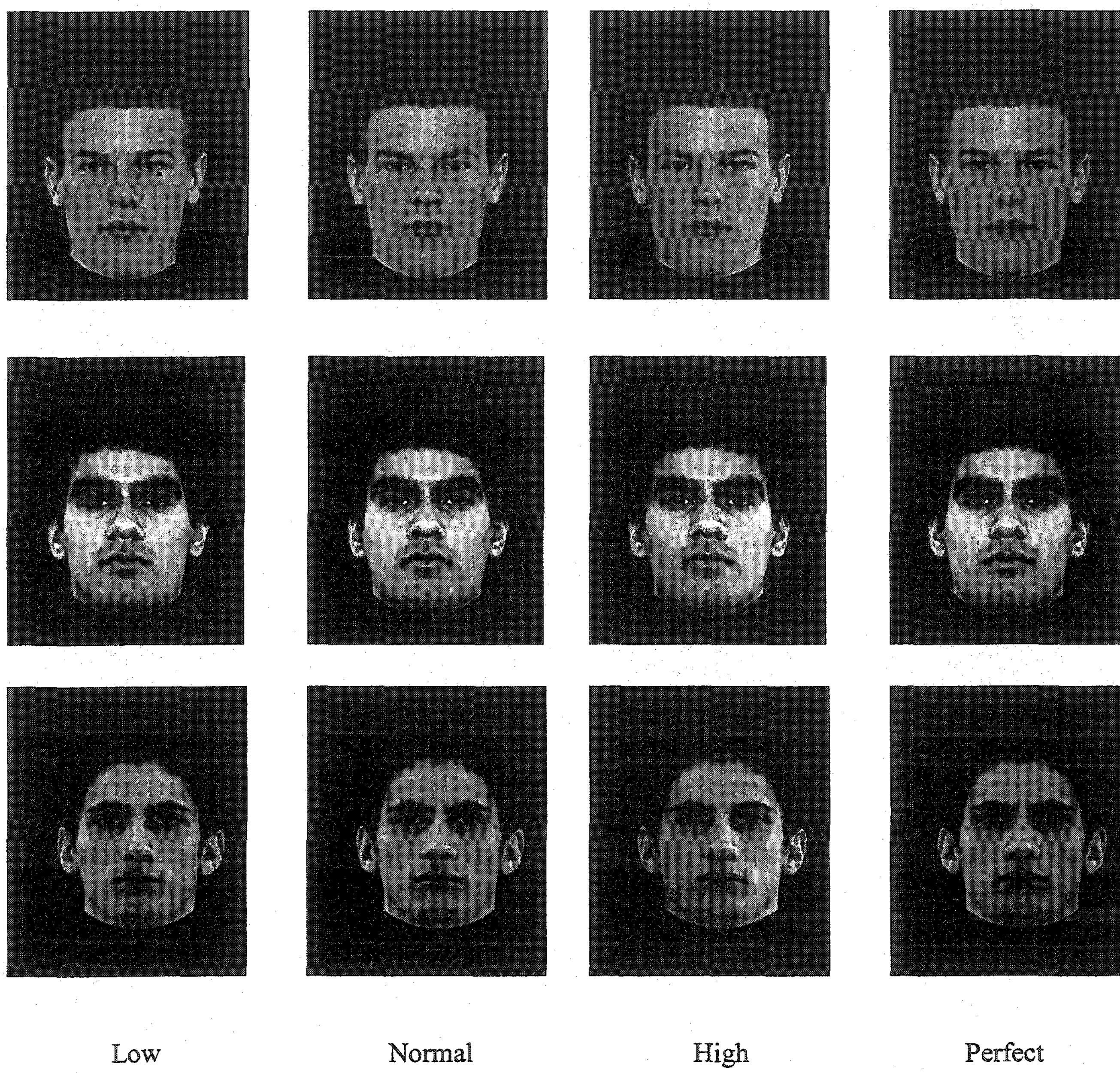


Figure 1. Examples of the facial stimuli used in the study. Each face was used in all four different symmetry levels (Low, Normal, High, Perfect).

background was created behind each face inside the oval using "format background". Sixth, the "flip" function was used to create a mirror image version of each original oval-enclosed face. These steps were taken prior to the manipulation of the symmetry levels using Gryphon's Morph.

Using Gryphon's Morph, a fixed set of between 140 and 180 landmark points (similar to the set of the 169 points used by Rhodes & Tremewan, 1996) were located on each face to outline the shape and position of the internal features and the face. The number of points differed slightly between faces due to differences in facial feature shape complexity. However, the number and positioning of the landmarks remained the same for all versions of a face. Prior to using the morph, warp, or caricature process on any two faces, the landmark points were plotted so that the program would know how to line up the two faces for the averaging process.

Perfectly symmetric (Perfect) versions of each face were made first by using the morph command to average the original and mirror image versions of each face in a 50:50 ratio. The procedure involves first averaging the locations of the points and then averaging the gray-level values in corresponding regions of the face (e.g., Beale & Keil, 1995; Rhodes et al., 1998). The resultant Perfect symmetry face had both perfect shape and colour symmetry.

High symmetry (High) versions of each face were made next using the morph command to average the original and mirror image versions of each face in a 25:75 ratio (remember that a 50:50 ratio results in perfect symmetry). Thus, the High symmetry faces had a symmetry level that was halfway between normal symmetry and perfect symmetry for both the facial shape and colouring.

In order to create a normal symmetry (Normal) face that had also been subject to the morphing procedures, *high* and *low* symmetry faces were created using warp and caricature.

Neither of these faces were used as one of the final four as they were created specifically to produce the other faces. First, the original and mirror image faces were warped together in a 50:50 ratio and the colours of the mirror image face were mapped onto the resulting face in order to create a face with perfectly symmetrical shape and the colours of the mirror image face (face 3). Face 3 was then averaged with the original face using warp in a 50:50 ratio and the colours of face 3 (also the colours of the mirror image face) were mapped onto this *high* symmetry face. The *low* symmetry face was created using caricature to meld together face 3 (which has perfect symmetry) and the original face in a 50:50 ratio resulting in a face that was below the original normal symmetry face in terms of symmetry level by the amount that is 50% of the difference between the normal and perfect symmetry level faces. This *low* symmetry face contained the colours of the original face. The *low* and *high* symmetry faces were then morphed together in a 50:50 ratio to create the Normal symmetry face with perfectly symmetrical colour. This face was constructed to have identical symmetry levels to the first original face but perfectly symmetric colouring.

The Low symmetry face was created by combining the *low* and *high* symmetry faces using warp such that the resultant face contained the same facial shape as the *low* symmetry face but contained 50% of the colours from each of the *low* (same colours as normal orientation face) and *high* (same colours as the mirror image face) faces. Thus, the Low symmetry face had perfectly symmetrical colouring but symmetry levels that were lower than the original face by the amount that was 50% of the difference between the original and perfect symmetry level faces.

To summarize, four versions of each face were created: Low (low shape symmetry but perfect colour symmetry), Normal (normal shape symmetry but perfect colour symmetry), High

(high shape symmetry and high colour symmetry), and Perfect (perfect shape and colour symmetry). The High symmetry faces represent a slight deviation from the others in that they do not contain perfect colour symmetry as it was not possible to create these faces with perfect colour symmetry. While it is unlikely that the this minor difference will affect the overall results, this variable should be kept in mind as a possible explanation for any unexpected findings.

The final 80 photos (4 symmetry versions of 20 faces: Low, Normal, High, Perfect) were used in the creation of two different computerized facial judgement procedures: facial rating procedure and forced choice procedure. Microsoft Powerpoint was used for both presentation styles. The facial rating presentation contained 80 slides with one of the 80 photos on each slide. The order of the photos was chosen randomly and each face was presented on the screen for an unlimited amount of time. Participants were requested to make the specified Likert-type ratings in a booklet for each face and then to press the space bar to advance to the next slide. The forced choice presentation contained 120 slides with two photos of the same person on each slide. All versions of each of the 20 faces were paired with each other on a slide (i.e., Low-Normal, Low-High, Low-Perfect, Normal-High, Normal-Perfect, and High-Perfect). The placement of the higher symmetry face on the right versus the left side of the screen was counterbalanced across the 120 slides and across the 6 different comparisons for each of the 20 faces. The order of the facial symmetry level comparisons was randomized within each of the 6 sets of 20 slides. That is, each set of 20 slides contained different faces but the six different symmetry level comparisons were randomized across the 6 sets of 20 slides. As with the Likert-type rating procedures, participants had an unlimited amount of time to select one of the two faces based on specified criteria, circle their response in a booklet, and then press the space bar to proceed to the next slide.

Measures

Four self-report instruments were used in the study: a Screening Questionnaire (SQ), a Daily Rating Questionnaire (DRQ), a First Session Questionnaire (FSQ), and a Second Session Questionnaire (SSQ). In addition, the following measures were employed: the Attractiveness of Facial Symmetry Test, the Facial Symmetry Detection Test, two facial rating tests, the Dot Symmetry Detection Test, the Vandenberg (1971) adaptation of Shepard and Metzler's (1971) three-dimensional Mental Rotations Test, a modification of Hampson's (1990a; 1990b) Verbal Articulation Test Battery, a handedness assessment, body measurements, basal body temperature measures, and salivary hormonal assays. While data collected from the following measures will not be reported herein, the measures themselves will be described: Verbal Articulation Test Battery, handedness assessment, body measurements, basal body temperature measures, and hormonal assays

Screening Questionnaire. The SQ (see Appendix A) included questions used to determine whether the women met the inclusion and exclusion criteria for the study. The SQ included five sections: demographic information, medications and medical information, reproductive history, relationship information, and the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988).

The 20-item PANAS is designed to independently measure both positive affect and negative affect. Participants are instructed to rate each adjective on a five-point scale reflecting the extent to which they have experienced the emotion "today". The scale ranges from 1 (*very slightly or not at all*) to 5 (*extremely*). The two scales of the PANAS have been shown to have sound psychometric properties (Watson et al., 1988). Internal consistencies for the PA and NA scales respectively are .90 and .87. The PA-NA correlation is -.12, which means the two scales are reasonably uncorrelated. Test-retest reliability of daily ratings for PA and NA are .47 and .39. Finally, the correlations between PA and NA and the Hopkins Symptoms Checklist overall score (-.29, .65) and the Beck Depression Inventory (-.35, .56) suggest adequate validity.

Daily Rating Questionnaire. The DRQ (Appendix B) consisted of the PANAS (described above), a section to record morning basal body temperature (BBT) (see below), and questions about health behaviours, reproductive health, sexual activity, and social activity. Question number 7, "Are you menstruating (bleeding) today?" was one method used to confirm each women's menstrual cycle dates. Each DRQ package consisted of 35 DRQs. Participants were instructed to complete one each day for 35 days.

First Session Questionnaire. The FSQ (Appendix C) consisted of seven sections: health information (e.g., smoking, sleep, drug use), the PANAS (see above for details), the Sociosexual Orientation Inventory (SOI) (Simpson & Gangestad, 1991; 1992), the Romantic Partner Attribute Index (Simpson & Gangestad, 1992), the Social Participation Scale of Jackson's Personality Inventory (JPI) (Jackson, 1994), reproductive information, and a question about sexual orientation

The SOI assesses five attitudinal and behavioural markers of sociosexual orientation that are aggregated to form a composite measure: number of sexual partners in the past year, estimated number of partners in the next 5 years, number of "one-night stands", frequency of sexual fantasy, and attitudes toward casual sex. High scores reflect an unrestricted sociosexual orientation while low scores reflect a restricted sociosexual orientation. Someone with restricted sociosexuality requires more time and commitment before entering into a sexual relationship with a romantic partner while someone with an unrestricted sociosexuality requires less time and a weaker attachment. The internal consistency of this inventory is reasonable (Cronbach's alpha = .73; Simpson & Gangestad, 1991) and the two-month test-retest reliability is high (*r* = .94; Simpson & Gangestad, 1991). Convergent and discriminant validity are also high (Simpson & Gangestad, 1991). Unrestricted individuals engage in sex earlier in relationships; engage in sex with more than one partner at a time; and are involved in relationships with less commitment, love, and investment. However, as predicted by Simpson and Gangestad, scores on the SOI are not related to sex drive and are negligibly correlated with measures of sexual satisfaction, anxiety, and guilt. Two questions that Simpson and Gangestad included in an earlier version of their questionnaire was also included in the present questionnaire. (i.e., number of lifetime sex partners, frequency of sexual thoughts). The second question was included as a measure of sex drive.

The Romantic Partner Attribute Index (Simpson & Gangestad, 1992) consists of 15 attributes which participants rate on a scale from 1 (not at all important) to 9 (extremely important) according to how much each attribute influences their selection of a romantic partner. Simpson and Gangestad found that two factors account for over 40% of the variance in the scale: personal/parenting qualities and attractiveness/social visibility.

The Social Participation Scale of the JPI (Jackson, 1994) consists of 20 items. While individuals are typically asked to indicate whether or not the statements are descriptive of themselves using a true or false format, a Likert-type scale ranging from 1 (not at all true) to 5 (extremely true) is used here. This format was chosen as it is more likely to be sensitive to menstrual cycle effects. The scale is a measure of the extent to which an individual eagerly joins in a variety of social groups, seeks both formal and informal association with others, values positive interpersonal relationships, and is actively social. The correlations between the Social Participation Scale and self- and peer-ratings of social participation are .47 and .34, respectively (Jackson, 1976).

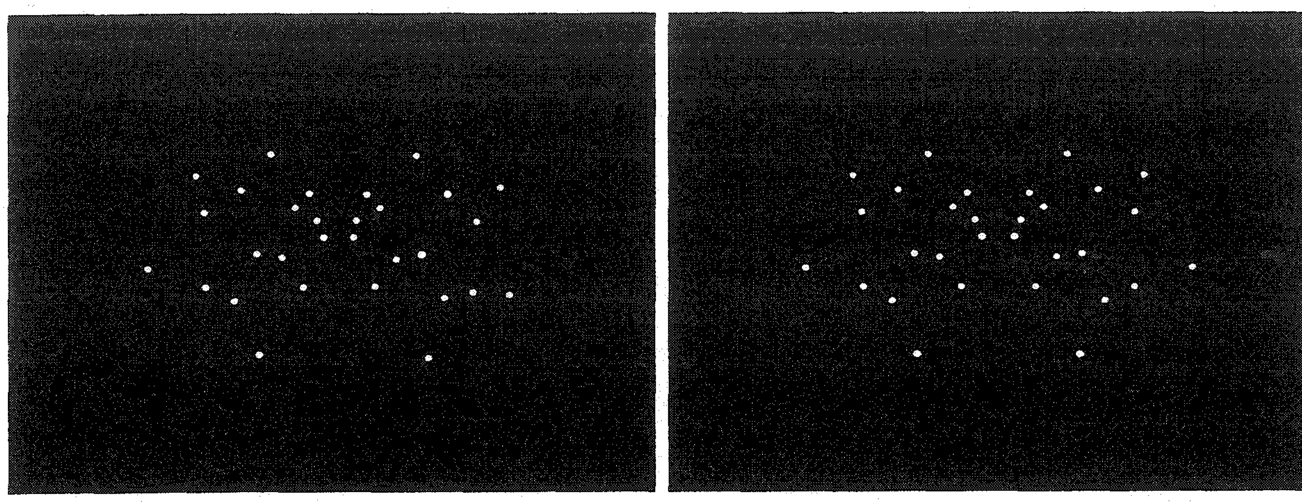
Second Session Questionnaire. The SSQ (Appendix D) included the same seven sections as the FSQ.

Attractiveness of Facial Symmetry Test. This computerized test was constructed specifically for this study in order to examine the degree to which symmetry affects judgements of facial attractiveness and, specifically, whether the attractiveness of facial symmetry changes across the menstrual cycle (see the description of the facial stimuli above). The forced choice procedure was used and participants had an unlimited amount of time to select the face from each pair that they considered to be more attractive. Test completion time ranged from about 15 to 25 minutes.

Facial Symmetry Detection Test. This computerized test examines one's ability to perceive and differentiate between different levels of facial symmetry by presenting two faces simultaneously and asking participants to choose the more symmetrical face of the two. The test was developed for this study to determine whether the ability to detect facial symmetry changes across the menstrual cycle. The test uses the same computer program, test stimuli, and forced choice format as the Attractiveness of Facial Symmetry Test. The only difference is that participants are asked to choose the more symmetrical of the two faces (i.e., choose the face that is more alike on both sides if you were to draw a line down the middle). This test takes between 15 and 25 minutes to complete.

Facial Rating Tests. Two facial rating activities were used in the study to examine how various types of facial ratings change with the symmetry level of faces. Both tests used identical facial stimuli (which were described earlier) and the identical facial rating procedure. The only difference between the two tests were the rating scales used to judge the faces. In the first facial rating test, Face Rating Test A, participants were asked to rate the faces on the basis of five variables: attractiveness, sexiness, healthiness, willingness to have as a long-term relationship partner, and willingness to have for a one-night stand partner (a one-time sexual encounter). Each rating was made on a ten-point Likert-type rating scale that ranged from 1 (*not at all*) to 10 (*extremely*). The second facial rating test, Face Rating Test B, requested ratings on two variables: symmetry and distinctiveness. The same ten-point Likert-type rating scale was used. The primary reason for including the two separate Likert-type Face Rating Tests, as opposed to one, was to ensure that participants would not be cued to think about symmetry when making the attractiveness judgements. Thus, all facial attractiveness judgements were completed prior to any facial symmetry judgements. The Face Rating Tests A and B take about 25 and 15 minutes to complete, respectively.

Dot Symmetry Detection Test. This test was created to examine the ability to detect symmetry differences using non-facial stimuli. It involves the brief presentation of 40 symmetrical and asymmetrical stimuli on a computer screen using Microsoft PowerPoint. The stimuli consist of simple dot patterns created by Evans, Wenderoth, and Cheng (2000) from complex biological images (i.e., photographs of insects and crustaceans) (see Figure 2 for examples). They made symmetrical versions of the animal photographs by splitting each photo of the animal at the midline, discarding one side at random, mirror-reversing the remaining side, and



Asymmetrical Symmetrical

Figure 2. Examples of the dot symmetry stimuli used in the Dot Symmetry Detection test. Each stimulus was either asymmetrical or symmetrical along the vertical plane.

pasting it down so that it abutted the original half. For each symmetrical and asymmetrical version of each animal photograph, a matching dot pattern was created by placing 30 small anti-aliased yellow discs on a graphics layer overlaid on top of the digitised image. The dots were placed so as to correspond with conspicuous morphological characters on the body and periphery of the animal, with the constraint that a roughly equal number of dots should appear in each region. The dot layer of each stimuli was then saved independently to create a series of dot patterns with black backgrounds. Of the 40 dot stimuli used in the Dot Symmetry Detection Test, 20 are based on the natural asymmetry of the animals and 20 are based on the symmetrical versions of these stimuli. The axis of symmetry for all stimuli is the vertical axis. Each stimulus was presented to the participant on a computer screen for 2 seconds. Following each exposure, the women were required to indicate whether the pattern was symmetrical or asymmetrical. The 2 second exposure duration was chosen based on pilot data indicating a mean correct response rate of 70%. This hit rate was deemed appropriate as it is most likely to eliminate ceiling and floor effects.

Verbal Articulation Test Battery. Hampson's (1990a; 1990b) Verbal Articulation Test Battery consists of three tests: Speeded Counting, Colour Reading and Naming, and Syllable Repetition. In the Speeded Counting test, subjects are timed while they count to 50 as quickly as possible. The score is number of seconds to completion. An adaptation of the Colour Reading and Naming test was used. Subjects were asked to read aloud a list of 112 colour names and then to name the colours in a series of 112 coloured dots. Participants were asked to perform both tasks as quickly as possible. Scoring was based on the number of seconds to completion in each task. The Syllable Repetition test (Mateer & Kimura, 1977) involves two parts. In the monosyllabic task, subjects repeat single syllables (/ba/ and /ga/) as many times as possible in 5 seconds. A mean rate of production was calculated for the monosyllabic task. In the trisyllabic task, subjects are asked to repeat the sequence /ba/, /da/, /ga/, as many times as possible in 5 seconds. The sequence is first presented slowly by the examiner and repeated slowly until the subject produces at least two successive correct productions of the entire sequence. The examiner then demonstrates rapid repetition of the sequence for 7 seconds and the subject is asked to produce the sequence as rapidly as possible. Tape recordings of the responses were made and used to determine the number of syllables correctly produced for the monosyllabic task and the number of correct productions of the entire sequence for the trisyllabic task. The data from this test battery are not reported here but will be reported in subsequent manuscripts.

Mental Rotations Test. The Vandenberg (1971) adaptation of Shepard and Metzler's (1971) mental rotations test is a measure of visuospatial ability that involves mentally rotating a target three-dimensional shape and matching it to other three-dimensional shapes. The participant is required to choose which two of four drawings depict the target drawing in a rotated position. The test has 20 items in two sets of ten items. Each item consists of a criterion figure, two correct alternatives, and two "distractors". The correct alternatives are structurally identical to the criterion but are shown in a rotated position. For half of the items, the distractors are rotated mirror-images of the criterion while distractors in the other items are rotated images of one or two of the other structures. In total there are 40 correct responses. Standard test instructions were used. Three sample problems were provided and then subjects were given three minutes for each of the two parts (10 items each). Two scoring methods were used. First, a total correct score was calculated indicating the number of correctly chosen responses (range of 0 to

40). Second, a corrected total score was calculated whereby, within each question, one point was given for each correct answer and one point was subtracted for each incorrect answer (range of 0 to 40). As is apparent by the range, points from individual questions were not subtracted from the overall total if there were no correct responses to the question. Vandenberg and Kuse report adequate Kuder-Richardson$_{20}$ internal consistency (.88), test-retest reliability (.83), and split-half reliability corrected by the Spearman-Brown formula (.79). Previous research suggests that this test is sensitive to menstrual cycle effects (Moody, 1997; Phillips & Silverman, 1997; Silverman & Phillips, 1993) and a meta-analysis of menstrual cycle effects for visuospatial ability indicated that, of all available visuospatial ability tests, this test produces the largest menstrual cycle effect (Oinonen, 2003).

Handedness Assessment. Two measures of handedness and lateral dominance were used in order to include both a behavioural and self-report measure. First, the 12-item Lateral Dominance Examination (Reitan & Davison, 1974) includes seven behavioural measures of hand preference, three eye preference items, and two foot preference items. Dodrill and Thoreson (1993) found that after five years, 92 to 100% of subjects showed the same preference for all seven hand preference items, the three eye preference items, and one of the foot preference items (i.e., kicking a football). Given that only 81% of subjects used the same foot to "squash a bug" after five years and that foot preference for kicking may reflect compensatory behaviour as opposed to dominance (Friedes, 1978), an item inquiring into preference for hopping on one foot was also included, as recommended by Friedes. Second, Brigg's and Nebes (1975) revision of Annett's (1967) Handedness Inventory will also be administered. This 12-item self-report measure requires that participants indicate their hand preference for activities on a 5-item Likert-type scale ranging from "always left" to "always right". Scoring for each item on this questionnaire ranges from -2 to +2 with the left preferences as negative and the right preferences as positive. Total scores range from -24 to +24 and the authors have labelled participants based on the following scoring system: scores of +9 to +24 suggest "right-handedness", scores of -8 to +8 suggest "mixed-handedness", and scores from -9 to -24 suggest "left-handedness". The data from the handedness tests will not be reported here but will be reported in subsequent manuscripts.

Body Measurements. K-E anthropometric tape was used to measure waist circumference, hip circumference, and right and left ankle circumference. A tape measure was used to measure height and a digital scale was used to measure weight. Mitutoyo Electronic Digital calipers (Model MIT-500-171) were employed in the measurement of the length of digits 2 to 5, wrist width, and ear length. Both left- and right-sided traits were measured twice to reduce measurement error and to assess test-retest reliability of the FAs. Digits two, three, four, and five of both hands were measured on their ventral surface from the basal crease to their tip, using the electronic digital calipers measuring to 0.01 mm. These measurements have shown a high degree of test-retest reliability, *r*s = .81 to .89 (Manning, Scutt, & Lewis-Jones, 1998). Body mass index (BMI), a measure of body fat, was calculated in kg/m^2 using weight (kg) and height (m). The left and right-sided measurements were taken to calculate absolute FA as the difference in length between the left and right side of the trait (L - R) taking into account trait size, according to procedures recommended by Palmer and Strobeck (1986). These finger measurements are not discussed in the present paper but will be reported in subsequent manuscripts.

Basal Body Temperature Measures. Basal body temperature (BBT) is a person's morning body temperature. It is commonly used to determine if and when ovulation occurs, and thus determine the most fertile phases of the menstrual cycle (e.g., the sympto-thermo method of birth control). A BBT shift is an indication that ovulation has occurred as ovulation occurs shortly before the BBT shift (Zuspan & Zuspan, 1979). A BBT shift is defined as a rise in body temperature of at least 0.2° F (0.1° C) above the highest normal body temperature attained prior to BBT shift, lasting for at least three days (Stanislaw & Rice, 1988). The presence of a hyperthermic response indicates that ovulation has occurred. The World Health Organization defines a hyperthermic response as three consecutive BBTs that are at least 0.2° C higher than the previous six daily temperatures (Zuspan & Zuspan, 1979). A Becton Dickinson glass basal thermometer was used by the female participants to orally measure their morning temperature. These thermometers allow measurements to at least a tenth of a degree on the Celsius scale. According to Guerrero (1978), the fertile period likely extends from about five days prior to the BBT shift to the day of the shift itself. Due to some problems with the thermometers, BBT data was not available for all participants. As a result, the temperature data was not discussed here but will be examined in future manuscripts.

Hormonal Assays. Saliva samples were collected in polystyrene test tubes pretreated with sodium azide, a bacteriocide. Salivation was stimulated with sugarless gum (Trident Cherry) previously shown to be inert in the radioimmunoassay procedure. The salivary samples were frozen at -20 degrees Celsius until all participant testing was completed. The samples were courièred to a University of Western Ontario laboratory in London, Ontario, to have the levels of estradiol and progesterone in the saliva assayed by an experienced technician specializing in salivary radioimmunoassay techniques. For estradiol, the specimens will be centrifuged and submitted to a double ether extraction prior to assay. The assay procedure will employ a tritium label and specific estradiol antiserum. Progesterone will be assayed without extraction using an ^{125}I Coat-A-Count progesterone kit modified for use with saliva. For technical reasons, the salivary assay results were not available at the time of this writing. However, the assays are not critical for the results that are being reported in this dissertation. This data will be reported in subsequent manuscripts

Procedure

The study consists of five stages: Stage 1 (Screening), Stage 2 (Instructions), Stage 3 (First Experimental Session), Stage 4 (Second Experimental Session), and Stage 5 (Debriefing).

Stage 1: Screening. During Stage 1, subjects were asked to participate in the Screening Phase of a study of neuroendocrine effects on physical, psychological, and emotional variables. It was emphasized that their participation was voluntary, that participants could withdraw at any time without penalty, and that all data would remain anonymous and confidential once the consent forms were removed from the questionnaires. The detachment of the consent forms was done following the selection of subjects for the study as the consent forms contained the participants' names and phone numbers. Subjects were provided with Consent Form A (see Appendix E), a Screening Questionnaire, Debriefing Form A (see Appendix F), and an envelope. They were asked to read and sign the consent form, complete the Screening Questionnaire, place both in the provided envelopes, and deliver them to a specially marked box. Completion of the questionnaire took approximately ten minutes. Based on an examination of the responses on the Screening Questionnaire, women that met the inclusion and exclusion criteria were selected to participate in the study and contacted by telephone. At this time, the procedures of the study were explained, participants were given an opportunity to ask questions, and a date and time was set up for Stage 2. The study received Ethics approval from the Ethics Review Board.

Stage 2: Instructions. During Stage 2 each woman met individually with one of the five experimenters and was asked to read and sign Consent Form B (see Appendix G) if they agreed to participate. She was then provided with a package containing an instruction sheet, 35 DRQs and a thermometer. She was instructed to complete the DRQ at the same time each day and to take and record her daily morning temperature upon rising. The procedure for measuring BBT was demonstrated and explained (i.e., place the thermometer under the tongue for four minutes). The DRQ (and BBT measure) were completed for 35 days to collect data for one full menstrual cycle. A date and time was set up for Stages 3 and 4 and participants were instructed that, on the day of testing, they should abstain from eating, drinking, smoking, or brushing their teeth for at least one hour prior to testing due to the salivary assessment (e.g., Moffat & Hampson, 1996).

Stage 3: First Experimental Session. The Stage 3 date was chosen based on the information that each women provided about her menstrual cycle both in the Screening Questionnaire and on the telephone, as well as by random assignment of subjects to one of six conditions (the conditions are described below). Each woman completed two experimental sessions (Stages 3 and 4) that were timed to take place during two of the following three times: (a) menstrual phase (days 1 to 5), (b) preovulatory phase (days 10 to 14 or 14 to 18 days prior to expected menses), and (c) luteal phase (days 20 to 24 or 5 to 9 days prior to expected menses). In order to increase the sample sizes for the final data analyses, the decision was made to include participant data if the testing day fell one day to either side of the three testing phases (i.e., days 28 to 6; days 9 to 15 or days 13 to 19 prior to menses; and days 19 to 25 or 4 to 10 days prior to menses).

The three menstrual phases were chosen in order to represent phases in the menstrual cycle that differ both in the probability of conception occurring following intercourse, and in relative hormone levels (estrogen, progesterone, LH, FSH). In terms of conception probability, research suggests that the rank order of the phases for the likelihood of conception is: preovulatory > menstrual > luteal (preovulatory has the highest probability) (Baker & Bellis, 1995; Guerrero, 1978; Jöchle, 1973). In terms of hormone levels, the rank order for estrogen levels is preovulatory > luteal > menstrual. The menstrual phase is the only phase where all hormone levels are relatively low, the luteal phase is the only phase where progesterone levels are high, and the preovulatory phase is the only phase where LH and FSH levels are high. Since the preovulatory phase has both the highest likelihood of conception and the highest estrogen levels, this is the phase that is most likely to be associated with evolutionary adaptations that might maximize the likelihood of finding a mate with "good genes". The inclusion of *both* the luteal and menstrual phases as comparison phases was decided upon in order to attempt to tease out the neuroendocrine variables involved in any preovulatory effects, given that hormone levels differ significantly in the menstrual and luteal phases.

Although each of the three testing phases are five days in length, attempts were made to schedule sessions for the menstrual, preovulatory, and luteal phases on days 2, 12, and 22, respectively, whenever possible. These dates were chosen for three reasons. First, day 12 of a 28-day cycle is believed to be the most fertile day of the cycle (2 days prior to ovulation and 16 days prior to expected menses) (Barrett & Marshall, 1969). Second, an equal number of days (10) separate the menstrual and preovulatory, preovulatory and luteal, and luteal and menstrual phases. Third, selecting a middle day within the range will increase the likelihood that the testing day will actually fall within that phase of the menstrual cycle.

The women were assigned to the groups in an attempt to place an equal number in each of the three possible phase comparison combinations: (a) menstrual and preovulatory phases (final $n = 15$), (b) menstrual and luteal phases (final $n = 14$), and (c) preovulatory and luteal phases (final $n = 16$). To control for practice and order effects, the order for completing the phases within each phase comparison combination was counterbalanced. Therefore, in order to include all permutations of the phase comparisons, subjects were randomly assigned to one of six conditions that describe the phase order of their sessions: (1) menstrual then preovulatory (MP condition) ($n = 9$), (2) preovulatory then menstrual (PM) ($n = 6$), (3) menstrual then luteal (ML condition) ($n = 7$), (4) luteal then menstrual (LM) ($n = 7$), (5) preovulatory then luteal (PL condition) ($n = 8$), and (6) luteal then preovulatory (LP) ($n = 8$).

For half of the conditions, Stages 3 and 4 were separated by approximately ten days (MP, PL, LM) while the other half were separated by approximately twenty days (ML, PM, LP). In actuality, the overall mean number of days separating the two testing sessions was 16.86 (SD = 9.70) for the participants whose sessions fit into the specified groups. The mean number of days separating the two sessions for each of the six groups were MP = 19.67 (SD = 15.25), PM = 18.17 (SD = 1.72), ML = 17.29 (SD = 3.15), LM = 13.00 (SD = 11.63), PL = 10.00 (SD = 1.83), LP = 21.75 (SD = 9.05). Overall, the six groups did not differ significantly in terms of the mean number of days separating the two testing sessions, $F(5, 38) = 1.61, p = .18$. Of the five methods used to compare data from both sessions between the groups (discussed below), it is only for the comparison between the PL and LP group that the groups differed in terms of number of days separating testing sessions, $F(1, 13) = 11.29, p < .01$.

During Stage 3, the women completed the following tasks in order: (1) one 5 to 6 ml sample of saliva was collected prior to testing; (2) First Session Questionnaire; (3) Face Rating Test A (faces were rated in terms of attractiveness, sexiness, healthiness, willingness to have as a long-term relationship partner, and willingness to have for a one-night stand partner); (4) Attractiveness of Facial Symmetry Test; (5) Verbal Articulation Test Battery; (6) Mental Rotations Test; (7) Face Rating Test B (faces were rated in terms of symmetry and distinctiveness); (8) handedness assessment; (9) body measurements (i.e., waist circumference, hip circumference, ankle circumferences, height, weight, length of digits 2 to 5, wrist widths, and ear lengths); (10) Facial Symmetry Detection Test; (11) Dot Symmetry Detection Test; and (12) a second 5 to 6 ml sample of saliva was provided. The session took approximately two hours and participants were provided with a treat (e.g., candy) at the end, as they had not eaten in at least 3 hours.

Stage 4: Second Experimental Session. During Stage 4, the session followed the same procedures as during Stage 3 except that the SSQ replaced the FSQ. In addition, at the end of the session, all Psychology 1100 students received an additional 3 points towards their final course mark, all participants had their names placed in the draw for two fifty dollar prizes, and all participants were given the opportunity to provide their e-mail or mail address in order to receive a summary of the results of the study.

Stage 5: Debriefing. During Stage 5, the women returned the DRQs and thermometer, and received a copy of Debriefing Form B (Appendix H). They were also given an opportunity to ask questions and were reminded that they could receive a summary of the results by mail. For many of the participants, Stage 5 was combined with Stage 4 or they returned the DRQ package to a drop box.

Data Reduction and Analyses. Using menstrual cycle date information from the screening questionnaire, the FSQ, the SSQ, the DRQ, and information provided by participants over the phone, participants were categorized based on the phase of their first session (menstrual, preovulatory, luteal), the phase of their second session (menstrual, preovulatory, luteal), and their overall group based on the category and order of their first and second session menstrual cycle phases (menstrual-preovulatory, preovulatory-menstrual, menstrual-luteal, luteal-menstrual, preovulatory-luteal, luteal-preovulatory).

For the main analyses, five different types of scores (12 scores in total) were calculated for each participant. Three test scores were calculated for each woman for each menstrual cycle phase: Attractiveness of Facial Symmetry score, Facial Symmetry Detection score, and Dot Symmetry Detection score (6 scores total). In addition, two difference scores were calculated for each women between her first and second testing session for all three test scores (6 scores total). The difference scores reflect any within-subject difference in performance between two menstrual cycle phases: session two minus session one difference scores (second minus first difference scores) and session one minus session two difference scores (first minus second difference scores). While the second minus first differences scores are more likely to be positive than the first minus second difference scores due to practice effects, for both sets of scores higher numbers reflect better performance than lower or more negative numbers for the stated menstrual cycle phase. Both sets of difference scores were calculated in order to conduct two sets of identical analyses examining the same hypothesis but comparing groups with different participant compositions.

Three main types of analyses were used in the present study: (1) a one-way between group MANOVA conducted on first session scores and then on second session test scores, (2) a one-way between group MANOVA conducted on each set of difference scores (essentially a group comparison based on within-subject phase differences), and (3) a 2 between (group) x 2 within (testing session) repeated measures MANOVA for each of the three menstrual phase comparisons (i.e., menstrual vs. preovulatory, menstrual vs. luteal, preovulatory vs. luteal). Thus, seven MANOVAs were conducted. To provide clarification regarding the comparison groups for the MANOVA on the differences scores, groups were organized such that higher and lower scores in a group would reflect better and worse performance, respectively, in the specified phase of the menstrual cycle compared to the other two phases (see Table 5). For all of the main analyses in the study, the independent variable was phase of the menstrual cycle and the three dependent variables were either the raw or difference scores for the Attractiveness of Facial Symmetry test, Facial Symmetry Detection test, and Dot Symmetry Detection test. Significant MANOVAs were followed up by univarate ANOVAs and Tukey's Honestly Significant Difference (HSD) post hoc comparisons were done on significant effects with an alpha level of .025.

The above analyses addressed the two main hypotheses as follows. Hypothesis 1: During the preovulatory phase of the menstrual cycle, women are more accurate in detecting symmetry than during either the menstrual or luteal phases. Results consistent with this hypothesis would reveal significant group differences between the preovulatory group and the other menstrual phase groups on the Facial Symmetry Detection Test and the Dot Symmetry Detection Test. The

Table 5

Composition of the Six Menstrual Phase Comparison Groups for the Difference Score Analyses: First Minus Second Difference Score Groups and Second Minus First Difference Score Groups

	Groups		
	Menstrual	Preovulatory	Luteal
First Minus Second Difference Score Groups			
	Menstrual-Preovulatory	Preovulatory-Menstrual	Luteal-Menstrual
	Menstrual-Luteal	Preovulatory-Luteal	Luteal-Preovulatory
Second Minus First Difference Score Groups			
	Preovulatory-Menstrual	Menstrual-Preovulatory	Menstrual-Luteal
	Luteal-Menstrual	Luteal-Preovulatory	Preovulatory-Luteal

Note. First minus second difference score groups all contain participants whose first session was in the specified phase so difference scores reflect how much better performance was in the stated phase than in the other phases. The second minus first difference score groups all contain participants whose second session was in the specified phase so that difference scores reflect how much better performance was in the stated phase than in the other phases.

strongest tests of this hypothesis are the MANOVAs on difference scores and the two repeated-measures MANOVAs, as these analyses control for between-subjects differences. For all analyses, the hypothesis suggests that Facial Symmetry Detection scores and Dot Symmetry Detection scores will be higher during the preovulatory phase. Hypothesis 2: During the preovulatory phase of the menstrual cycle, women rate more symmetrical men as more attractive than they do during the menstrual or luteal phases. Support for this hypothesis would be in the form of significant group differences between the preovulatory group and the other phase groups on the Attractiveness of Facial Symmetry Test. Again, the analyses using difference scores and repeated-measures analyses represent the most powerful tests of this hypothesis. The hypothesis predicts that scores will be highest during the preovulatory phase, indicating that facial symmetry is considered more attractive at this phase of the menstrual cycle.

Results

Preliminary Analyses

Internal Consistency and Reliability of Measures

Facial Symmetry Detection Test. Cronbach's alpha coefficients were calculated to examine the internal consistency of the test. The alphas for the first and second testing sessions were .79 and .73, respectively, indicating a homogeneous set of items. Test-retest correlations were calculated between the first and second session scores on the Facial Symmetry Detection Test, $r(53) = .73, p < .001$. While the correlation indicated adequate reliability, it should be noted that test-retest reliability may not be the best measure of reliability for the dependent measures in the present study given that the test was constructed and testing days were chosen based on the hypothesis that the test scores would differ on the specified days of the menstrual cycle.

Attractiveness of Facial Symmetry Test. Cronbach's alpha coefficients for the first and second testing sessions were .82 and .86, indicating good internal consistency. Despite the above-noted expectation of differences between testing session scores, correlations between the scores on the Attractiveness of Facial Symmetry Test for sessions 1 and 2 suggested adequate test-retest reliability, $r(53) = .60, p < .001$.

Dot Symmetry Detection Test. The alphas for the first and second testing sessions were .57 and .47, indicating low but adequate internal consistency. Test-retest reliability was low as indicated by the correlation between Dot Symmetry Detection test scores for the two testing sessions, $r(53) = .43, p < .001$. Such a reliability coefficient is not particularly surprising given the above-noted caveat regarding the examination of test-retest reliability of the dependent measures in the current study.

Validity of Measures

Facial Symmetry Detection Test. Two methods were used to examine whether the differences in levels of symmetry (i.e., Low, Normal, High, Perfect) between the stimuli/faces in the Facial Symmetry Detection test were in fact detectable by the participants. These analyses represent both manipulation checks and examinations of the construct validity of the test. First, the mean Likert-type symmetry ratings of the 80 faces were examined as a function of symmetry level (Low, Normal, High, Perfect). As illustrated in Figure 3 (see Table 6 for means and standard deviations), the ratings of symmetry increased with the actual level of symmetry for both the first session, $F(3, 195) = 276.54, p < .001$, and the second session, $F(3, 156) = 149.77, p < .001$. Tukey Least Significant Difference (LSD) post hoc tests confirmed that all of the four different symmetry levels differed significantly from each other for both the first session [Low vs.

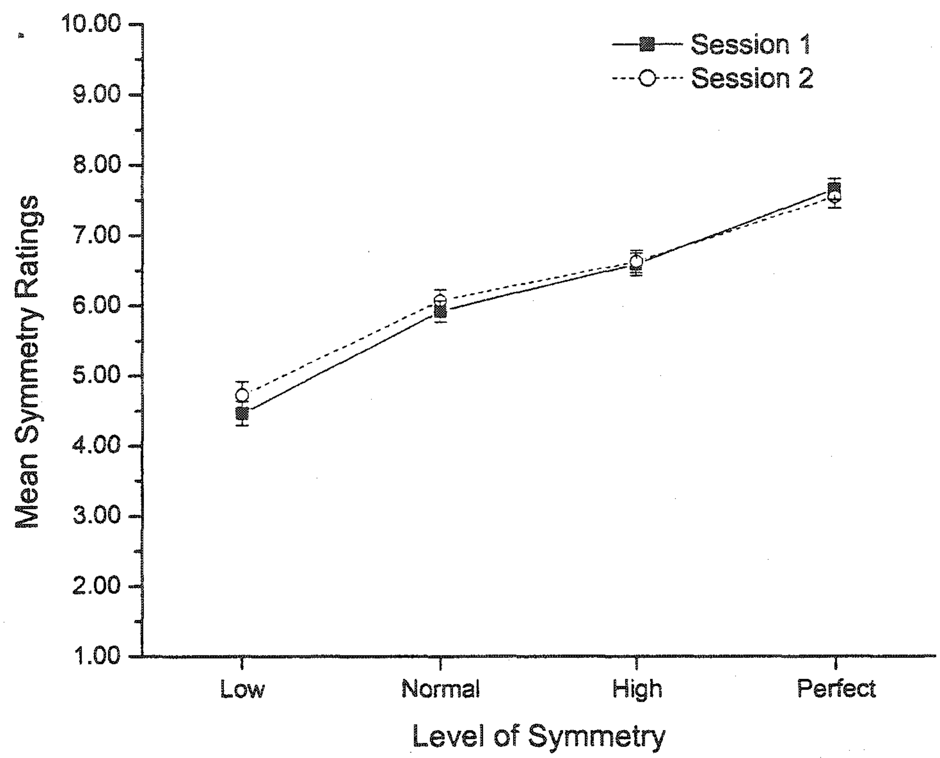


Figure 3. Mean facial symmetry ratings as a function of the manipulated level of symmetry of the faces. Symmetry ratings increased with the actual level of symmetry for both testing sessions. Error bars represent the standard error of the mean.

Table 6

Validity of the Facial Symmetry Detection Test: Mean Likert-type Facial Symmetry Ratings as a function of Symmetry Level (Low, Normal, High, and Perfect) and Mean Number of Correctly Chosen "More Symmetrical" Faces as a function of the Number of Levels of Symmetry separating the two faces

	Session 1	Session 2
Symmetry Level		
Low	4.46 (1.42)	4.72 (1.37)
Normal	5.92 (1.26)	6.07 (1.19)
High	6.59 (1.28)	6.63 (1.19)
Perfect	7.66 (1.22)	7.55 (1.18)
Symmetry Level Difference		
One (LN, NH, HP)	15.72 (1.54)	15.72 (1.42)
Two (LH, NP)	17.68 (1.51)	17.90 (1.43)
Three (LP)	19.26 (1.35)	19.49 (0.78)

Note. LN = Low versus Normal comparison, NH = Normal versus High comparison, HP = High versus Perfect comparison, LH = Low versus High comparison, NP = Normal versus Perfect comparison, LP = Low versus Perfect comparison

Normal, $q(df = 195) = 1.47$; Normal vs. High, q (195) = 0.67; High vs. Perfect, $q(df = 195) = 1.07$; all $p < .001$], and the second session, [Low vs. Normal, $q(df = 156) = 1.36$; Normal vs. High, $q(df = 156) = 0.56$; High vs. Perfect, $q(df = 156) = 0.93$; all $p < .001$]. These results indicate that the different levels of facial symmetry were in fact detectable and thus provides support for the construct validity of the test.

In the second examination of construct validity (a second manipulation check), the 120 pairs of faces (120 slides) were classified into three categories based on the number of levels of symmetry differentiating the two faces: three levels (Low-Perfect comparisons), two levels (Low-High and Normal-Perfect comparisons), and one level (Low-Normal, Normal-High, and High-Perfect comparisons). For each of the six different symmetry level comparisons (20 comparisons for each), the mean number of correctly chosen "more symmetrical" faces was calculated for both testing sessions (see Figure 4). These six means were then used to calculate the mean number of correctly chosen "more symmetrical" faces as a function of the three symmetry difference levels. As shown in Figure 5 (see the bottom of Table 6 for means and standard deviations), the participants correctly chose the more symmetrical face significantly more often when there was a greater difference in symmetry level between the two faces (three > two > one) for both session one, $F(2, 130) = 254.14$, $p < .001$, and session two, $F(2, 104) = 226.95$, $p < .001$. Tukey HSD post hoc tests indicated that the three symmetry level difference comparisons were significantly different from each other for both the first session [one vs. two, $q(df = 130) = 1.58$; two vs. three, $q(df = 130) = 1.97$; both $p < .001$], and the second session, [one vs. two, $q(df = 104) = 1.59$; two vs. three, $q(df = 104) = 2.18$; both $p < .001$]. This fits with the expected pattern whereby larger differences in symmetry between faces should be easier to detect than smaller differences. Thus,

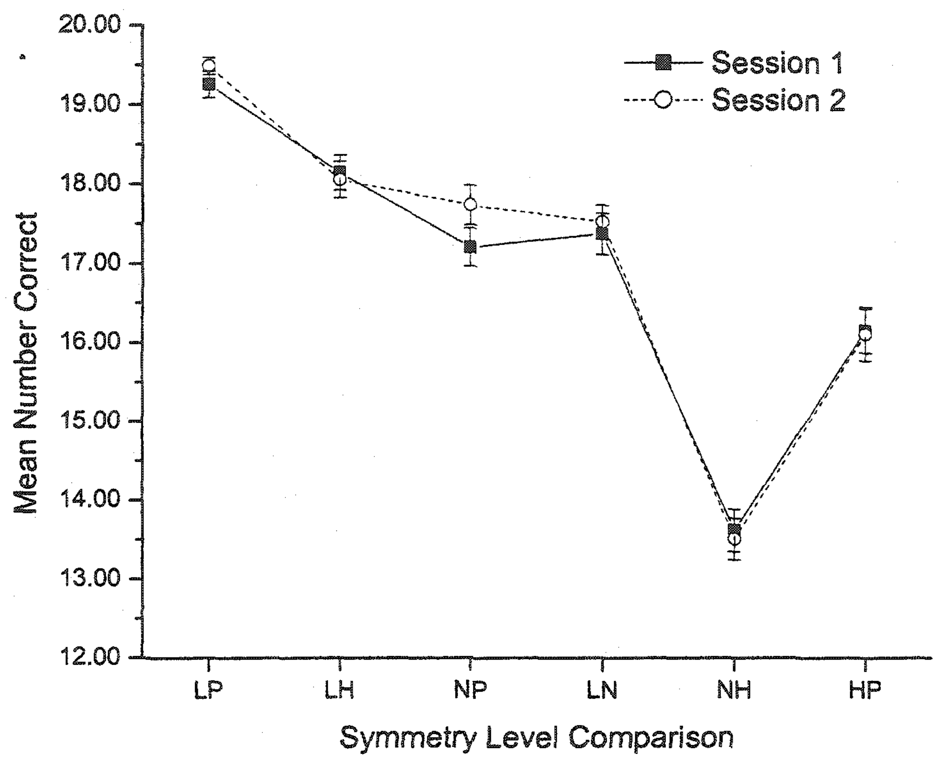


Figure 4. Mean number of correctly chosen "more symmetrical" faces (out of 20) for each of the six different symmetry level comparison groups (LP = Low vs. Perfect, LH = Low vs. High, NP = Normal vs. Perfect, LN = Low vs. Normal, HP = High vs. Perfect). Note that for all comparison groups the mean number correct was above 50% (10 out of 20). Error bars represent the standard error of the mean.

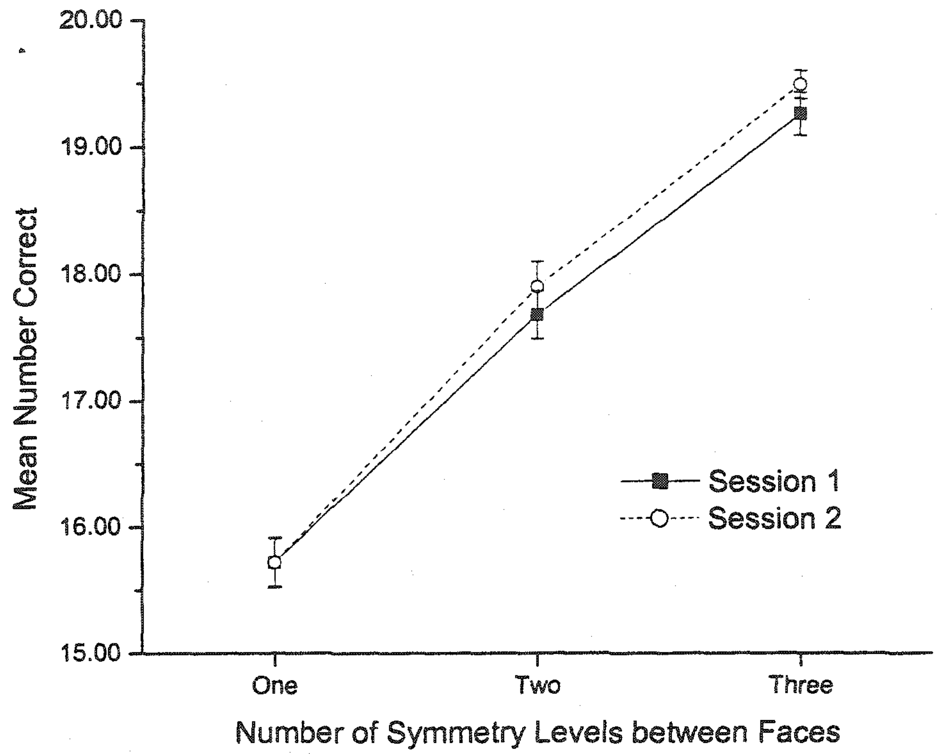


Figure 5. Mean number of faces (out of 20) that were correctly chosen as being "more symmetrical" for each of the three symmetry difference levels. As the degree of symmetry between the faces increased, so did the likelihood of correctly identifying the more symmetrical face. Error bars represent the standard error of the mean.

as intended, the four variations of each of the 20 faces used in the test do appear to exhibit valid detectable differences in level of symmetry and the test contains stimuli that differ in degree of symmetry.

The concurrent validity of the Facial Symmetry Detection test was examined by calculating correlations between scores on this test and scores on another test that was developed as a measure of the ability to detect symmetry, the Dot Symmetry Test. The correlations for both session one, $r(66) = .30, p = .01$, and session two, $r(53) = .41, p < .01$, suggested adequate convergent concurrent validity.

Attractiveness of Facial Symmetry Test. The premise underlying the creation of this test was based on research indicating that symmetry is attractive and that more symmetrical faces are judged more attractive than less symmetrical faces. Two sets of analyses were conducted in order to test the validity of this premise and to examine the construct validity of the test. First, the mean Likert-type attractiveness ratings of 72 faces were examined as a function of symmetry level (Low, Normal, High, Perfect) (see Table 7 for the means and standard deviations). It should be noted that these attractiveness ratings represent an underestimate of the overall attractiveness of the faces used in the study as eight faces were not used in these analyses because two different faces were accidentally not included in the Likert-type rating task [first session $M = 4.96$, $SD = 1.82$; second session $M = 5.18$, $SD = 1.88$]). The ratings of attractiveness differed based on the actual level of symmetry for both the first session, $F(3, 195) = 14.06, p < .001$, and the second session, $F(3, 156) = 17.75, p < .001$. As illustrated in Figure 6, Tukey LSD post hoc tests revealed that while Likert-type attractiveness ratings did generally increase with symmetry levels, Perfect symmetry faces were not rated as most attractive. High symmetry faces were

Table 7

Validity of the Attractiveness of Facial Symmetry Test: Mean Likert-type Attractiveness Ratings as a function of Symmetry Level (Low, Normal, High, and Perfect) and Mean Number of More Symmetrical faces Chosen as "More Attractive" as a function of the Number of Levels of Symmetry separating the two faces

	Session 1	Session 2
Symmetry Level		
Low	3.05 (1.29)	3.38 (1.23)
Normal	3.19 (1.30)	3.50 (1.22)
High	3.33 (1.36)	3.64 (1.27)
Perfect	3.22 (1.31)	3.58 (1.21)
Symmetry Level Difference		
One (LN, NH, HP)	15.72 (1.54)	13.45 (1.77)
Two (LH, NP)	17.68 (1.51)	14.05 (2.40)
Three (LP)	19.26 (1.35)	16.06 (2.52)

Note. LN = Low versus Normal comparison, NH = Normal versus High comparison, HP = High versus Perfect comparison, LH = Low versus High comparison, NP = Normal versus Perfect comparison, LP = Low versus Perfect comparison.

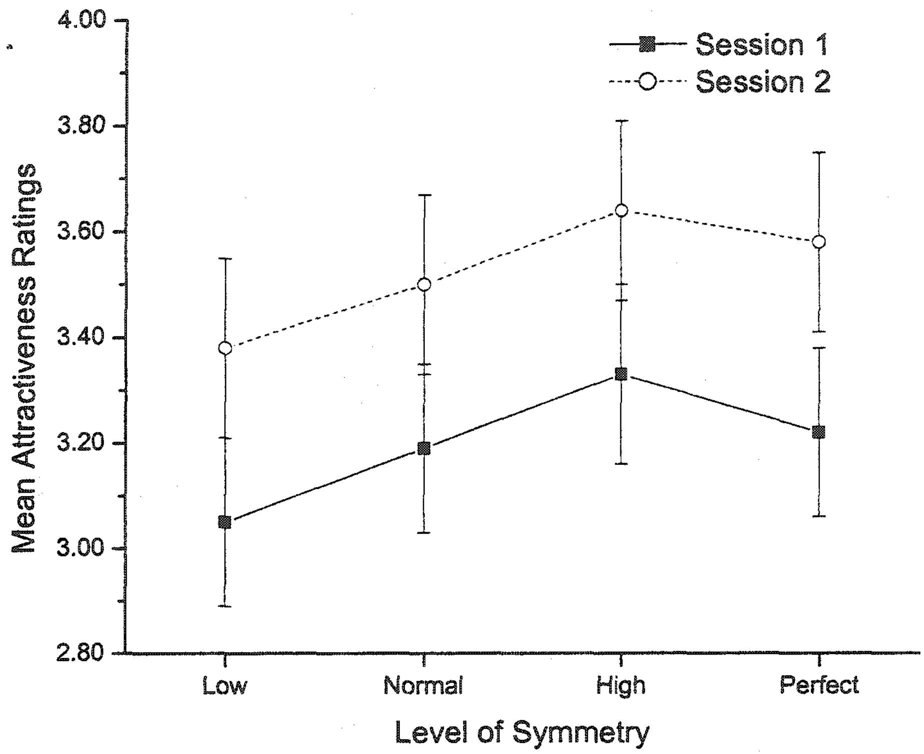


Figure 6. Mean likert-type facial attractiveness ratings as a function of the manipulated level of symmetry of the faces. For the first session, high symmetry faces were rated as most attractive and low symmetry faces the least attractive. For the second session, ratings of high and perfect symmetry faces did not differ significantly but low symmetry faces were rated as least attractive. Error bars represent the standard error of the mean.

actually rated as more attractive than Perfect symmetry faces. For the first testing session, the order of the attractiveness ratings, from highest to lowest, was: High symmetry > Perfect symmetry, $q(\text{df} = 195) = 0.11, p < .01$; Perfect symmetry versus Normal symmetry, $q(\text{df} = 195) = 0.03, p = .50$; and Normal symmetry > Low symmetry, $q(\text{df} = 195) = 0.14, p < .01$. For the second testing session, the order of the attractiveness ratings was: High symmetry vs. Perfect symmetry, $q(\text{df} = 156) = 0.06, p = .07$; Perfect symmetry > Normal symmetry, $q(\text{df} = 156) = 0.08, p = .01$; and Normal symmetry > Low symmetry, $q(\text{df} = 156) = 0.12, p < .01$. These results indicate that more symmetrical faces are generally more attractive than less symmetrical faces, but that perfect symmetry is not as attractive as high symmetry when rated using individual Likert-type ratings of faces. As this test is intended to measure the extent to which individuals consider symmetry to be attractive, this manipulation check of the faces provides support for the construct validity of the test.

In the second manipulation check (examination of construct validity), the 120 pairs of faces (120 slides) were again classified into the three categories based on the number of levels of symmetry differentiating the two faces: three levels (Low-Perfect comparisons), two levels (Low-High and Normal-Perfect comparisons), and one level (Low-Normal, Normal-High, and High-Perfect comparisons). For each of the six different symmetry level comparisons (20 comparisons for each), the mean number of higher symmetry faces chosen as "more attractive" was calculated for both testing sessions. For all of these comparisons, participants were more likely to rate the more symmetrical face as more attractive (see Figure 7). Of particular note was the finding that the Perfect symmetry faces were chosen as "more attractive" than the High symmetry faces 65.68% of the time in the first session and 71.70% of the time in the second session. The means

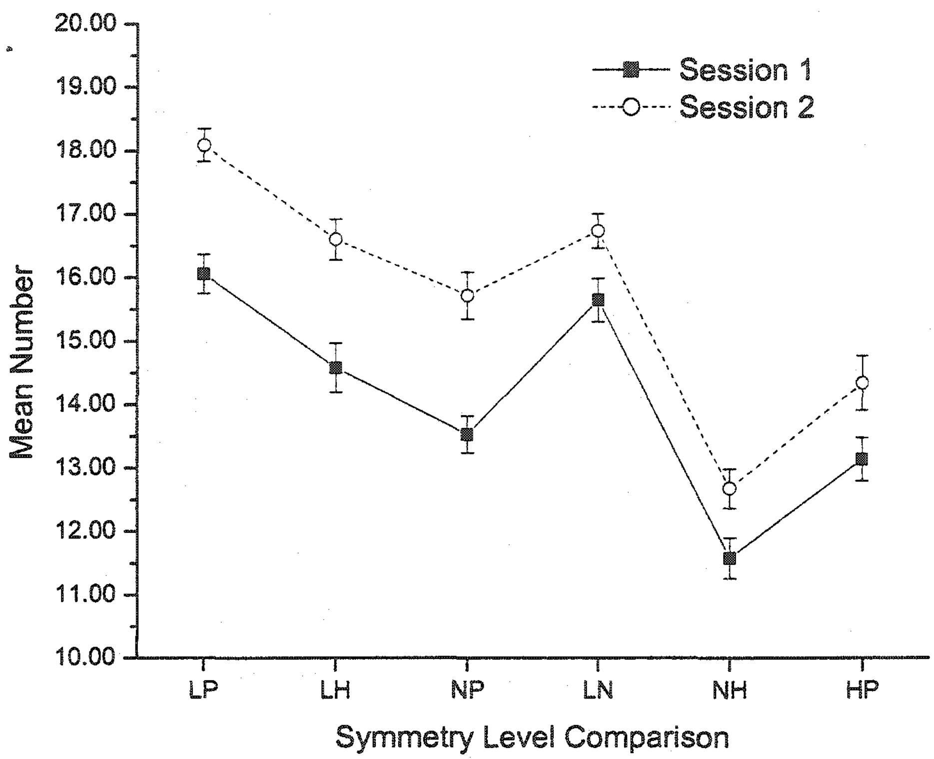


Figure 7. Mean number of higher symmetry faces chosen as "more attractive" (out of 20) for each of the six different symmetry level comparison groups (LP = Low vs. Perfect, LH = Low vs. High, NP = Normal vs. Perfect, LN = Low vs. Normal, HP = High vs. Perfect). Note that for all comparison groups the participants chose the face with greater symmetry as more attractive more than 50% of the time (50% = 10 out of 20). Error bars represent the standard error of the mean.

for the six different symmetry level comparisons were then used to calculate the mean number of higher symmetry faces chosen as "more attractive" for each of the three symmetry difference levels (means and standard deviations can be found in the bottom of Table 7). As shown in Figure 8, not only were the participants more likely to indicate that the more symmetrical face was more attractive, but this occurred significantly more often when there was a greater difference in symmetry level between the two faces (three > two > one) for both session one, $F(2, 130) = 55.32$, $p < .001$, and session two, $F(2, 104) = 130.76$, $p < .001$. Tukey HSD post hoc tests indicated that the three symmetry level difference comparisons were significantly different from each other for both the first session [one vs. two, $q(df = 130) = 2.01$, $p < .001$; two vs. three, $q(df = 130) = 0.60$, $p = .01$], and the second session, [one vs. two, $q(104) = 1.93$; two vs. three, $q(df = 104) = 1.58$; both $p < .001$]. This fits with the expected pattern whereby larger differences in symmetry between faces are associated with a greater likelihood of choosing the more symmetrical face as more attractive. Thus, the four variations of each of the 20 faces used in the test do appear to exhibit valid detectable differences in level of symmetry and the higher symmetry faces are more likely to be chosen as more attractive than their lower symmetry versions.

Dot Symmetry Detection Test. As noted above, there is evidence of adequate convergent validity for this test as a measure of the ability to detect symmetry. This conclusion is based on the significant positive correlations between scores on this test and scores on another symmetry detection test that used different stimuli and did not impose time limits, the Facial Symmetry Detection Test (session 1: $r(66) = .30$, $p = .01$; session 2: $r(53) = .41$, $p < .01$).

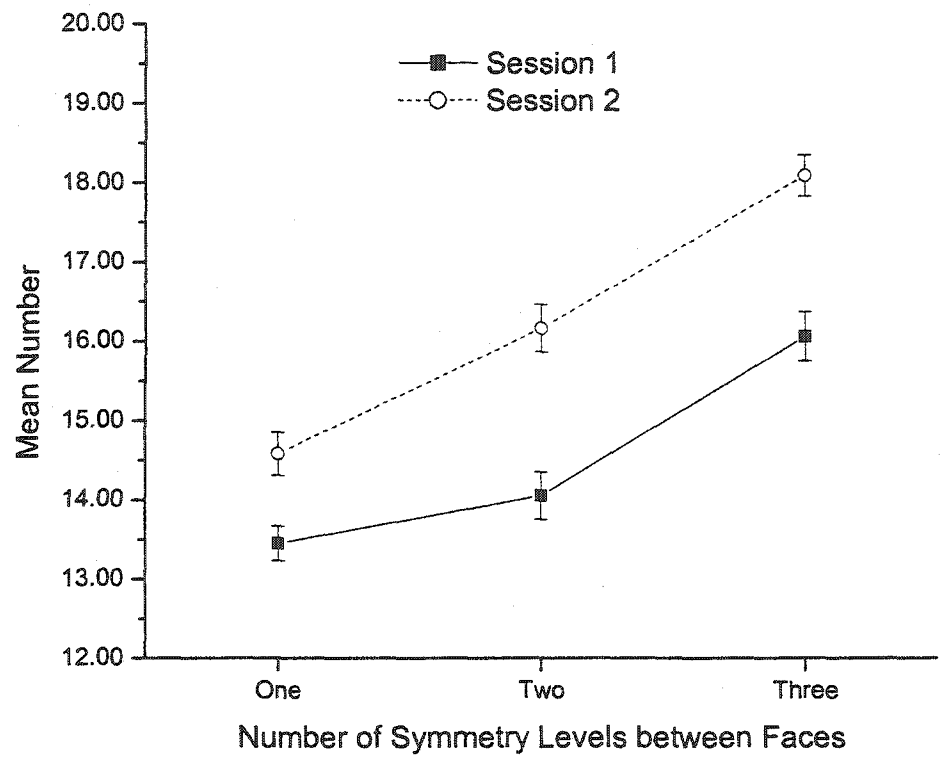


Figure 8. Mean number (out of 20) of higher symmetry faces chosen as "more attractive" for each of the three symmetry difference levels. As the degree of symmetry increased between faces, so did the likelihood of choosing the more symmetrical face as most attractive. Error bars represent the standard error of the mean.

Data Screening

Prior to the main analyses, the distributions of raw and difference scores for the three primary variables (Attractiveness of Facial Symmetry, Facial Symmetry Detection, and Dot Symmetry Detection) for each session/menstrual phase combination were examined for the presence of univariate and multivariate outliers based on the suggestions by Tabachnick and Fidell (2001). None of the values were classified as univariate outliers based on the criteria of standardized scores in excess of 3.29. In addition, no multivariate outliers were found using Mahalanobis distance ($p < .001$ criterion). The data set did not contain any missing values.

Assessing Multivariate Assumptions

Before undertaking analyses to test the main hypotheses, the data were examined to ensure that the assumptions of MANOVA (and split-plot MANOVA where appropriate) were met. Graphical checks of linearity using bivariate scatterplots indicated that linearity was adequate for all dependent variables. Criteria for normality included passing a visual check of the distribution of scores as well as using the following formulas: [(skewness ÷ standard error of skewness) < 3] and [(kurtosis ÷ standard error of kurtosis) < 3]. The assumption of normality was judged adequate for all distributions.

Box's M multivariate test for homogeneity of variance-covariance matrices found adequate homogeneity of variance-covariance matrices for all (but one) analysis: first session raw scores on all three dependent variables, $F(12, 14768) = 0.85$, $p > .05$; second session raw scores, $F(12, 9121) = 1.23$, $p > .05$; first minus second session difference scores, $F(12, 8299) = 0.74$, $p > .05$; second minus first session difference scores, $F(12, 7603) = 1.05$, $p > .05$; raw scores for groups three and four (ML and LM), $F(21, 530) = 1.22$, $p > .05$; and raw scores for groups five and six (PL and LP), $F(21,721) = 0.871, p > .05$. Multivariate Box's M was not calculated for the raw scores for groups one and two (MP and PM) due to the fact that there were fewer than two nonsingular cell covariance matrices (within the dot symmetry test, two means were identical). However, based on Tabachnick and Fidell's (2001, p. 330) guidelines, heterogeneity is unlikely to be a problem given that sample sizes are not highly discrepant and cells with larger sample sizes generally produce larger variances and covariances. Levene's test of equality of error variances indicated homogeneous variances for the univariate analyses on the first minus second difference scores for attractiveness of symmetry, facial symmetry detection, and dot symmetry detection, Fs(2, 42) = 0.35, 1.22, 0.34, all ps > .05.

Correlations between the three dependent variables (raw scores and difference scores) are listed in Table 8 both as a function of testing session and menstrual cycle phase. While correlations between the three sets of difference scores were nonsignificant and close to zero, significant positive correlations were identified between all of the dependent variable raw scores in at least one menstrual cycle phase. Thus, while multicollinearity was not a problem for the difference scores, the raw scores were significantly correlated with each other. The relationships between these dependent variables have not been examined in previous research and are of interest here. Due to both the robustness of MANOVA to correlations below .90 (Tabachnich & Fidell, 2001) and the relevance of these correlations to the current study, multicollinearity was not judged to be a problem and no adjustments were made to the variables.

As a result of the above tests of multivariate assumptions the following decisions regarding data analyses were made. For each of the three sets of main analyses, MANOVAs were performed on either the raw or difference scores using an alpha level of .05. Significant

Table 8

Intercorrelations Between the Three Dependent Variables: Scores on the Attractiveness of Facial Symmetry Test (ATT-SYMM), Facial Symmetry Detection Test (FACE-SYMM), and Dot Symmetry Detection Test (DOT-SYMM)

Group	ATT-SYMM & FACE-SYMM	ATT-SYMM & DOT-SYMM	FACE-SYMM & DOT-SYMM
		Raw scores	
Session 1 ($n = 60$)	$.45^{***}$	.17	$.31^{*}$
Session 2 ($n = 49$)	$.62^{***}$	$.52^{***}$	$.44^{**}$
Menstrual phase			
Session 1 ($n = 22$)	.32	$.44^{*}$	.37
Session 2 ($n = 14$)	$.70^{**}$	.46	.24
Preovulatory phase			
Session 1 ($n = 20$)	$.54^{*}$	.14	.38
Session 2 ($n = 18$)	$.50^{*}$	$.61^{**}$	.43
Luteal phase			
Session 1 ($n = 18$)	$.50^{*}$	.01	.18
Session 2 ($n = 17$)	$.76^{***}$	.42	$.66^{**}$
		Difference scores	
All subjects ($N = 45$)	-.08	.04	-.14

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

MANOVAs were followed up by univariate ANOVAs. The conservative Pillai's criterion for evaluating multivariate significance was used in all analyses. Tukey's Honestly Significant Difference (HSD) post hoc comparisons were done on the significant effects and interactions with an alpha level of .025 to control for Type I errors.

Assessing Group Equivalency

Group equivalency was examined for the seven sets of analyses (see Tables 9 to 12 and Appendices I to K for raw data). For all analyses, the groups of women (group membership was based on random assignment to participate in testing during two of three menstrual cycle phases) did not differ significantly in terms of age, years of education, body mass index, frequency of alcohol use, hours of sleep the night before testing, or relationship status (whether or not one had a romantic partner). However, for some analyses the groups of women did differ in terms of the amount of reported alcohol consumption per typical drinking episode.

In four of the seven analyses, the groups were significantly different in terms of alcohol consumption per drinking episode. In the MANOVA comparing first minus second session difference scores (see Table 9 for means), group differences, $F(2, 42) = 7.33, p < .01$, indicated that the women in the luteal phase difference score group reported significantly lower consumption than the women in the menstrual, $q(df = 42) = 0.82, p < .01$, and preovulatory, $q(df = 42) = 0.78, p < .01$, groups. Group differences were also found between the groups in the MANOVA comparing the second minus first session differences scores (see Appendix K), $F(2, 42) = 3.59, p = .04$. Women in the luteal phase difference score group reported significantly higher consumption per drinking session than women in the preovulatory phase group, $q(df = 42) = 0.62, p = .04$. Two of the three split-plot ANOVA analyses also showed group differences on

Table 9

Means and Standard Deviations or Raw Frequency and Percentages for the Seven Variables Used to Assess Group Equivalency Across the Three Menstrual Phase Groups for the First minus Second Session Difference Score Analyses

Variable	Menstrual Phase $n = 16$	Preovulatory Phase $n = 14$	Luteal Phase $n = 15$
	Means (Standard Deviations)		
Age	24.75 (9.01)	21.64 (4.41)	24.87 (7.05)
Education (years)	13.94 (2.11)	14.36 (1.82)	14.86 (2.44)
Body Mass Index (kg/m^2)	25.41 (4.49)	28.58 (8.49)	27.47 (6.37)
Alcohol Frequ. Score	1.38 (0.72)	1.29 (0.47)	0.93 (0.70)
Alcohol Consump. Score**	1.69 (0.79)	1.64 (0.50)	0.87 (0.64)
Sleep (hours)	7.81 (1.22)	7.21 (1.42)	7.67 (1.59)
	Raw Frequency (Percentage)		
Relationship Status			
partner	7(43.75)	8 (57.14)	8 (53.33)
no partner	9 (56.25)	6 (42.86)	7 (46.67)

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

Table 10

Means and Standard Deviations or Raw Frequency and Percentages for the Seven Variables Used to Assess Group Equivalency Across the Menstrual-Preovulatory and Preovulatory-Menstrual Groups

Variable	Menstrual-Preovulatory $n = 9$	Preovulatory-Menstrual $n = 6$
	Means (Standard Deviations)	
Age	26.89 (9.92)	22.17 (4.58)
Education (years)	14.33 (2.74)	14.83 (1.47)
Body Mass Index (kg/m^2)	24.76 (4.44)	27.03 (7.49)
Alcohol Frequ. Score	1.56 (0.73)	1.00 (0.00)
Alcohol Consump. Score	1.44 (0.73)	1.67 (0.52)
Sleep (hours)	7.67 (1.12)	7.00 (1.41)
	Raw Frequency (Percentage)	
Relationship Status		
partner	6 (66.67)	2 (33.33)
no partner	3 (33.33)	4 (66.67)

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

Table 11

Means and Standard Deviations or Raw Frequency and Percentages for the Seven Variables Used to Assess Group Equivalency Across the Menstrual-Luteal and Luteal-Menstrual Groups

Variable	Menstrual-Luteal $n = 7$	Luteal-Menstrual $n = 7$
	Means (Standard Deviations)	
Age	22.00 (7.51)	24.86 (8.07)
Education (years)	13.43 (0.79)	14.00 (1.83)
Body Mass Index (kg/m^2)	26.26 (4.74)	26.85 (6.56)
Alcohol Frequ. Score	1.14 (0.69)	1.00 (0.82)
Alcohol Consump. Score*	2.00 (0.82)	0.86 (0.69)
Sleep (hours)	8.00 (1.41)	8.00 (1.73)
	Raw Frequency (Percentage)	
Relationship Status		
partner	4 (57.14)	4 (57.14)
no partner	3 (42.86)	3 (42.86)

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

Table 12

Means and Standard Deviations or Raw Frequency and Percentages for the Seven Variables Used to Assess Group Equivalency Across the Preovulatory-Luteal and Luteal-Preovulatory Groups

Variable	Preovulatory-Luteal $n = 8$	Luteal-Preovulatory $n = 8$
	Means (Standard Deviations)	
Age	21.25 (4.56)	24.88 (6.60)
Education (years)	14.00 (2.07)	15.79 (2.81)
Body Mass Index (kg/m^2)	29.74 (9.49)	28.00 (6.59)
Alcohol Frequ. Score	1.50 (0.53)	0.88 (0.64)
Alcohol Consump. Score*	1.63 (0.52)	0.88 (0.64)
Sleep (hours)	7.38 (1.51)	7.38 (1.51)
	Raw Frequency (Percentage)	
Relationship Status		
partner	4 (50.00)	4 (50.00)
no partner	4 (50.00)	4 (50.00)

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

alcohol consumption amount: the women in the menstrual-luteal group reported higher consumption than those in the luteal-menstrual group, $t(12) = 2.83, p = .02$ (see Table 11), and women in the preovulatory-luteal indicated higher consumption than those in the luteal-preovulatory group, $t\ (14) = 2.58, p = .02$ (see Table 12).

Pearson product-moment correlations revealed that amount of alcohol consumption was not significantly related to any of the raw score dependent variables: attractiveness of facial symmetry, $r(45) = -.05, p = .74$; facial symmetry detection, $r(45) = .08, p = .62$; and dot symmetry detection, $r(45) = .16, p = .29$. However, for the difference score analyses, the number of drinks consumed per drinking occasion (mean of first and second session report) was related to changes in facial symmetry detection scores between sessions, $r(45) = -.38, p = .01$. That is, as the reported average number of drinks per typical drinking occasion increased, less improvement was found in facial symmetry detection scores from the first to second testing session. Graphical illustration of this relationship between quantity of alcohol consumption and improvement on the facial symmetry detection test nicely illustrates the inverse dose-response relationship, $F(3, 41) = 2.99, p = .04$ (see Figure 9). Tukey HSD post hoc tests did not find significant differences between the four levels of alcohol consumption (likely due to small sample sizes in two of the four groups) but a trend was evident for a difference between zero drinks and four to seven drinks, $q(df = 41) = 7.43, p = .07$.

Frequency of alcohol use was less strongly related to the change in facial symmetry detection scores, $r(45) = -.24, p = .12$. Thus, number of drinks per drinking occasion accounted for more of the variance in the facial symmetry detection difference scores than did a total alcohol score (frequency of alcohol uses multiplied by the number of drinks per occasion), $r(45) = -.29$,

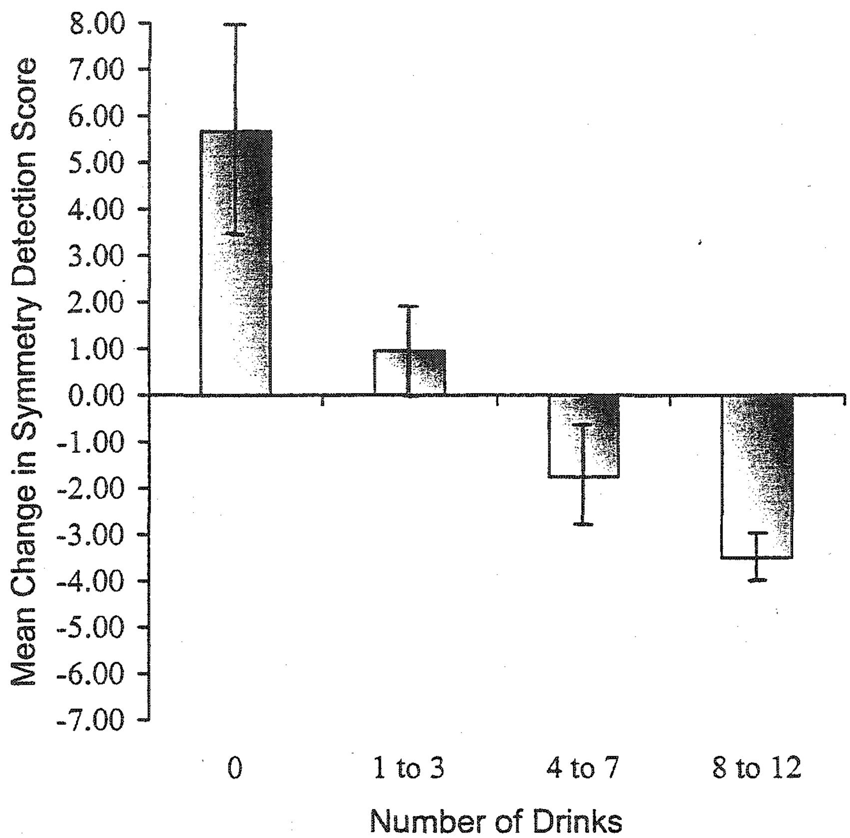


Figure 9. Improvement on the facial symmetry detection test from the first to second session as a function of reported number of drinks consumed per drinking occasion. Positive means reflect an improvement in score while negative means reflect a decrease in score from the first to second session. Score improvements were seen at low levels of alcohol consumption while decrements were seen at higher levels of consumption. Error bars represent the standard error of the mean.

$p = .05$. These results suggest the possibility that if alcohol use does in fact decrease one's ability to improve on a facial symmetry detection test, it seems to be the number of drinks or amount of alcohol intake, as opposed to the frequency of alcohol use, that is the more critical factor. The lack of group equivalency in typical amount of alcohol intake combined with the significant relationship between this variable and the facial symmetry detection difference scores suggests the need to consider alcohol intake as a third variable that might be obscuring or accounting for any findings.

Main Analyses

Simple Descriptive Data

Tables 13 to 18 list the overall mean attractiveness of facial symmetry scores, facial symmetry detection scores, and dot symmetry detection scores for the seven different methods of analyses. Visual examination of the data suggests three general patterns to the results: (1) Scores on the facial symmetry detection test were highest during the menstrual phase and lowest during the luteal phase for all of the six different methods of group comparison that examined these phases. (2) Scores on the attractiveness of facial symmetry test were not consistently higher or lower in one phase of the cycle. However, the trend among the seven methods of group comparison was for higher scores (indicating a greater preference for symmetry) in the menstrual phase (i.e., three of six comparisons) and lower scores (indicating less of a preference for symmetry) in the preovulatory phase (i.e., four of six comparisons). (3) Scores on the dot symmetry detection test were highest during the luteal phase for all six group comparisons and there was a trend towards the lowest scores being attained during the menstrual phase (i.e., four of six comparisons).

Table 13

Mean Scores for the Attractiveness of Facial Symmetry (ATT-SYMM), Facial Symmetry Detection (FACE-SYMM), and Dot Symmetry Detection (DOT-SYMM) tests as a function of Menstrual Cycle Phase and Testing Session

Test	Phase of Menstrual Cycle			
	Menstrual	Preovulatory	Luteal	All Phases
		First Session		
	$n = 22$	$n = 20$	$n = 18$	$N = 60$
ATT-SYMM	86.23 (9.50)	85.50 (10.25)	85.11 (13.11)	85.65 (10.75)
FACE-SYMM	104.05 (5.83)	101.05 (8.37)	100.67 (6.06)	102.03 (6.90)
DOT-SYMM	27.45 (3.04)	26.75 (3.88)	27.78 (3.70)	27.32 (3.50)
		Second Session		
	$n = 14$	$n = 18$	$n = 17$	$N = 49$
ATT-SYMM	96.07 (8.01)	92.17 (11.98)	95.82 (11.22)	94.55 (10.65)
FACE-SYMM	102.93 (6.72)	102.28 (6.86)	102.12 (7.25)	102.41 (6.82)
DOT-SYMM	28.14 (2.48)	28.22 (4.31)	29.71 (3.06)	28.71 (3.45)

Table 14

Mean First Minus Second Difference Scores (first session score minus second session score) for the Attractiveness of Facial Symmetry (ATT-SYMM), Facial Symmetry Detection (FACE-SYMM), and Dot Symmetry Detection (DOT-SYMM) tests as a function of Menstrual Cycle Phase

Test	Phase of Menstrual Cycle			
	Menstrual (*n* = 16)	Preovulatory (*n* = 14)	Luteal (*n* = 15)	All Phases (*N* = 45)
ATT-SYMM	-7.62 (9.04)	-11.00 (8.53)	-7.47 (9.99)	-8.62 (9.15)
FACE-SYMM	3.19 (4.43)	-0.29 (4.86)	-3.27 (3.37)	-0.04 (4.96)
DOT-SYMM	-1.63 (3.28)	-1.57 (3.80)	0.60 (3.54)	-0.87 (3.61)

Note. Scores reflect the mean difference between performance in the specified phase of the menstrual cycle and the other two phases of the menstrual cycle. High negative numbers reflect poorer performance in the stated menstrual cycle phase while high positive numbers reflect better performance in the stated menstrual cycle phase.

Table 15

Mean Second Minus First Difference Scores (second session score minus first session score) for the Attractiveness of Facial Symmetry (ATT-SYMM), Facial Symmetry Detection (FACE-SYMM), and Dot Symmetry Detection (DOT-SYMM) tests as a function of Menstrual Cycle Phase

Test	Phase of Menstrual Cycle			
	Menstrual (n = 13)	Preovulatory (n = 17)	Luteal (n = 15)	All Phases (N = 45)
ATT-SYMM	9.46 (9.67)	7.59 (10.39)	9.07 (7.57)	8.62 (9.15)
FACE-SYMM	1.46 (4.49)	-0.18 (4.30)	-0.93 (5.69)	0.04 (4.96)
DOT-SYMM	-0.08 (3.25)	1.06 (4.16)	1.47 (3.29)	0.87 (3.61)

Note. Scores reflect the mean difference between performance in the specified phase of the menstrual cycle and the other two phases of the menstrual cycle. High positive numbers reflect better performance in the stated menstrual cycle phase while negative numbers reflect poorer performance in the stated menstrual cycle phase, compared to the other two phases.

Table 16

Mean Scores for the Attractiveness of Facial Symmetry (ATT-SYMM), Facial Symmetry Detection (FACE-SYMM), and Dot Symmetry Detection (DOT-SYMM) tests as a function of Group (Menstrual-Preovulatory and Preovulatory-Menstrual) and Testing Session

Session	Test	Group		
		Menstrual-Preovulatory ($n = 9$)	Preovulatory-Menstrual ($n = 6$)	(Session Means)
1		(menstrual phase)	(preovulatory phase)	
	ATT-SYMM	84.44 (5.77)	92.67 (9.69)	87.73 (8.36)
	FACE-SYMM	104.56 (6.39)	107.17 (4.67)	105.60 (5.73)
	DOT-SYMM	27.22 (2.73)	28.67 (3.61)	27.80 (3.08)
2		(preovulatory phase)	(menstrual phase)	
	ATT-SYMM	93.89 (9.62)	101.83 (4.17)	97.07 (8.68)
	FACE-SYMM	102.00 (8.11)	105.50 (6.63)	103.40 (7.51)
	DOT-SYMM	30.11 (3.37)	28.67 (1.87)	29.53 (2.88)

Table 17

Mean Scores for the Attractiveness of Facial Symmetry (ATT-SYMM), Facial Symmetry Detection (FACE-SYMM), and Dot Symmetry Detection (DOT-SYMM) tests as a function of Group (Menstrual-Luteal and Luteal-Menstrual) and Testing Session

Session	Test	Group		
		Menstrual-Luteal ($n = 7$)	Luteal-Menstrual ($n = 7$)	(Session Means)
1		(menstrual phase)	(luteal phase)	
	ATT-SYMM	88.43 (11.30)	81.14 (9.21)	84.79 (10.60)
	FACE-SYMM	103.14 (6.36)	96.57 (5.83)	99.86 (6.78)
	DOT-SYMM	27.71 (3.64)	28.00 (4.08)	27.86 (3.72)
2		(luteal phase)	(menstrual phase)	
	ATT-SYMM	93.71 (12.49)	90.86 (7.69)	92.29 (10.07)
	FACE-SYMM	99.14 (7.99)	100.71 (6.99)	99.93 (7.26)
	DOT-SYMM	27.71 (2.63)	27.86 (3.13)	27.79 (2.78)

Table 18

Mean Scores for the Attractiveness of Facial Symmetry (ATT-SYMM), Facial Symmetry Detection (FACE-SYMM), and Dot Symmetry Detection (DOT-SYMM) tests as a function of Group (Preovulatory-Luteal and Luteal-Preovulatory) and Testing Session

Session	Test	Group		
		Preovulatory-Luteal (n = 8)	Luteal-Preovulatory (n = 8)	(Session Means)
1		(preovulatory phase)	(luteal phase)	
	ATT-SYMM	84.50 (7.23)	85.13 (17.61)	84.81 (13.01)
	FACE-SYMM	101.25 (9.04)	99.75 (6.27)	100.50 (7.55)
	DOT-SYMM	28.13 (3.36)	27.00 (2.20)	27.56 (2.80)
2		(luteal phase)	(preovulatory phase)	
	ATT-SYMM	96.88 (11.05)	90.63 (15.32)	93.75 (13.30)
	FACE-SYMM	103.00 (6.41)	102.25 (6.16)	102.62 (6.09)
	DOT-SYMM	30.88 (2.70)	26.00 (4.66)	28.44 (4.46)

Between Group Analysis for First Session Data

A one-way between-subjects multivariate analysis of variance (MANOVA) was performed on three dependent variables: attractiveness of facial symmetry, facial symmetry detection, and dot symmetry detection (data presented in the top of Table 16). The independent variable was phase of menstrual cycle (menstrual, preovulatory, luteal). With the use of Pallai's criterion, the combined dependent variables were not significantly affected by menstrual cycle phase, $F(6, 112) = 0.72, p = .64, \eta^2 = .04$, power = .27. Thus, when different women were compared across menstrual cycles, there were no significant differences in their scores on the three tests between menstrual cycle phases.

Between Group Analysis for Second Session Data

An identical MANOVA to the one above was performed on the second session scores (data presented in the bottom of Table 16). Similar to the first session results, the three combined dependent variables were not significantly affected by phase of the menstrual cycle, $F(6, 190) = 0.81, p = .57, \eta^2 = .05$, power = .30.

Between Group Analysis of Difference Score Data: First Session minus Second Session Scores

A one-way between-subjects MANOVA was performed on the three dependent variables: attractiveness of facial symmetry difference scores, facial symmetry detection difference scores, and dot symmetry detection difference scores. The independent variable was phase of menstrual cycle (menstrual, preovulatory, luteal). Scores for each of the independent variables represented the difference between a score in a particular phase and that obtained in one of the other two phases (first minus second difference scores) (i.e., first session score minus second session score). For example, a difference score for the menstrual phase indicates the degree to which the score during that phase is higher or lower than that obtained in either the preovulatory or luteal phase. The MANOVA revealed a significant effect of menstrual cycle phase on the combined dependent variables, F (6, 82) = 3.26, p = .006, η^2 = .19, power = .91.

A follow-up one-way ANOVA was conducted for each of the three dependent variables. The results indicated that there was not a significant effect of menstrual cycle phase for either the attractiveness of facial symmetry difference scores, F (2, 42) = 0.68, p = .51, η^2 = .03, power = .16; or the dot symmetry detection difference scores, F (2, 42) = 1.94, p = .16, η^2 = .08, power = .38. However, there was a significant group effect for the facial symmetry detection difference scores, F (2, 42) = 8.94, p = .001, η^2 = .30, power = .96. As illustrated in Figure 10, post hoc Tukey's Honestly Significant Difference (HSD) tests revealed that the women's facial symmetry detection difference scores were significantly higher during the menstrual than the luteal phase, q (df = 42) = 6.45, p < .001. There were also trends towards higher scores in the menstrual than preovulatory phases, q (df = 42) = 3.47, p = .08, and the preovulatory than luteal phases, q (df = 42) = 2.98, p = .15. In other words, when compared to other menstrual cycle phases, the women were best able to detect facial symmetry in the menstrual phase of their cycle and this performance was significantly better than in the luteal phase.

Between Group Analysis of Difference Score Data: Second Session minus First Session Scores

The one-way between-subjects MANOVA was repeated for difference scores obtained by subtracting the second session scores from the first session scores (second minus first difference scores). The MANOVA did not reveal an overall significant effect of menstrual cycle phase for the combined dependent variables, F (6, 82) = 0.50, p = .81, η^2 = .04, power = .19.

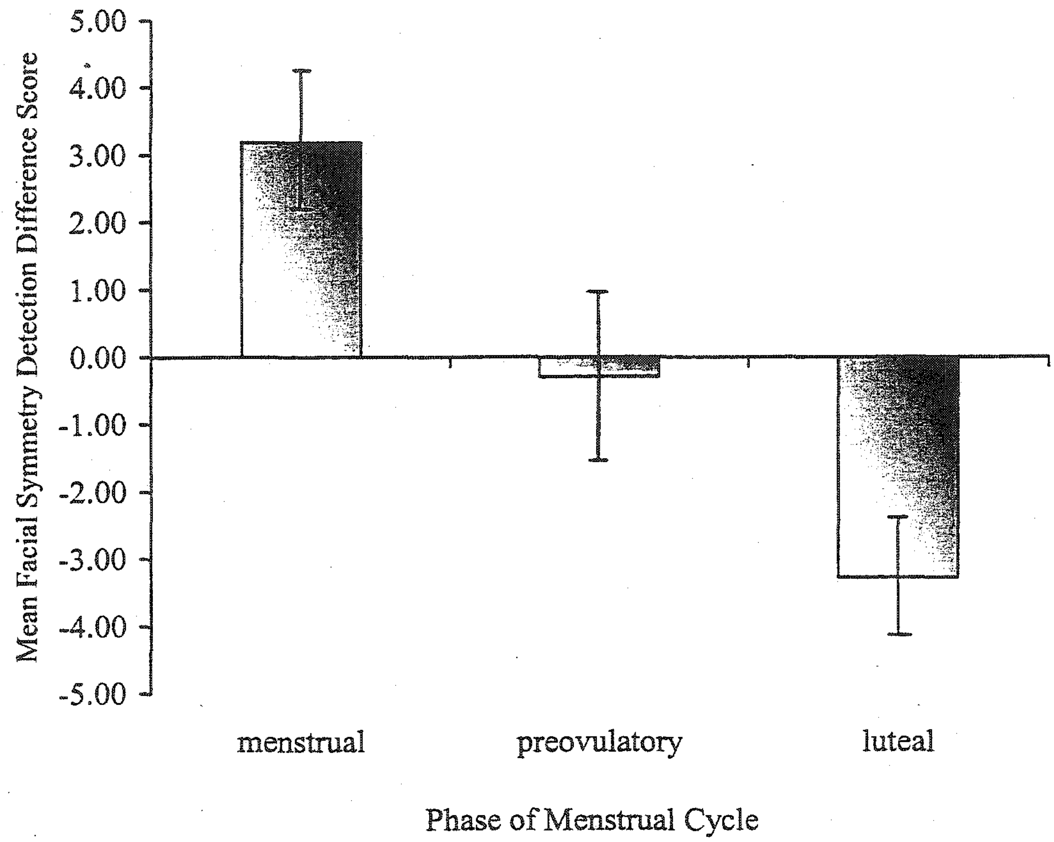


Figure 10. Mean difference scores on the facial symmetry detection test as a function of menstrual cycle phase (first minus second session): Better performance during the menstrual than luteal phase. Error bars represent the standard error of the mean.

Repeated Measures Comparison of Menstrual and Preovulatory Session Scores

A 2 between (group) x 2 within (session) repeated-measures MANOVA was performed on three dependent variables: attractiveness of facial symmetry, facial symmetry detection, and dot symmetry detection (see means in Table 16). The independent variables were group (menstrual-preovulatory, preovulatory-menstrual) and testing session (first session, second session). There was a borderline trend towards a group effect, F (3, 11) = 3.20, p = .07, η^2 = .47, power = .57; a significant session effect, F (3, 11) = 3.60, p = .05, η^2 = .49, power = .62; and no significant group x session interaction, F (3, 11) = 0.72, p = .56, η^2 = .17, power = .16. Follow-up repeated measures univariate ANOVAs revealed the following.

Attractiveness of Facial Symmetry. Analyses revealed a significant effect of group, F (1, 13) = 7.31, p = .02, η^2 = .36, power = .71, indicating that the preovulatory-menstrual group scored significantly higher than the menstrual-preovulatory group on the test that evaluated the degree to which they judged symmetry as attractive. A significant effect of session indicated a practice/learning effect such that the women scored higher in the second than the first session, F (1, 13) = 11.16, p = .005, η^2 = .46, power = .87. The group x testing session interaction was not significant, F (1, 13) = .00, p = .96, η^2 = .00, power = .05.

Facial Symmetry Detection. No main effects for group, F (1, 13) = 0.82, p = .38, η^2 = .06, power = .13; testing session, F (1, 13) = 3.73, p = .08, η^2 = .22, power = .43.; or the group x session interaction, F (1, 13) = 0.16, p = .69, η^2 = .01, power = .07, were found. Interestingly, the trend towards a main effect of testing session was due to lower scores during the second than first testing session (a reverse practice effect?) (see means in Table 16).

Dot Symmetry Detection. None of the main effects were significant: group, F (1, 13) =

0.00, $p = 1.00$ (the means were identical), $\eta^2 = .00$, power = .05; session, $F(1, 13) = 2.34$, $p = .15$, $\eta^2 = .15$, power = .29; and group x session interaction, $F(1, 13) = 2.34$, $p = .15$, $\eta^2 = .15$, power = .29.

Repeated Measures Comparison of Menstrual and Luteal Session Scores

A 2 between (group) x 2 within (session) repeated-measures MANOVA was performed on the three dependent variables with the following independent variables: group (menstrual-luteal, luteal-menstrual) and testing session (first session, second session) (see means in Table 17). The MANOVA revealed that the combined dependent variables were not significantly affected by group, $F(3, 10) = 0.47$, $p = .71$, $\eta^2 = .12$, power = .12; or by session, $F(3, 10) = 3.46$, $p = .06$, $\eta^2 = .51$, power = .59. However, there was a borderline significant group x session interaction, $F(3, 10) = 3.58$, $p = .05$, $\eta^2 = .52$, power = .61. Follow-up repeated measures univariate ANOVAs revealed the following.

Attractiveness of Facial Symmetry. While there was no main effect for group, $F(1, 12) = 1.00$, $p = .34$, $\eta^2 = .08$, power = .15; there was a significant session main effect, $F(1, 12) = 11.43$, $p = .005$, $\eta^2 = .49$, power = .87, indicating a practice/learning effect on the attractiveness of facial symmetry test. There was no main effect for the group x session interaction, $F(1, 12) = 1.00$, $p = .34$, $\eta^2 = .08$, power = .15.

Facial Symmetry Detection. Analyses indicated neither a main effect for group, $F(1, 12) = 0.53$, $p = .48$, $\eta^2 = .04$, power = .10; nor session, $F(1, 12) = 0.00$, $p = .95$, $\eta^2 = .00$, power = .05. The latter finding indicated a lack of a learning/practice effect for the facial symmetry detection test. However, there was a significant group x session interaction for the facial symmetry detection scores, $F(1, 12) = 11.28$, $p = .006$, $\eta^2 = .49$, power = .87, revealing better performance on the facial symmetry detection test during the menstrual than the luteal phase of the menstrual cycle (see Figure 11 for an illustration of the interaction).

Dot Symmetry Detection. There were no main effects for group, $F(1, 12) = 0.02, p = .90, \eta^2 = .00$, power = .05; session, $F(1, 12) = 0.01, p = .92, \eta^2 = .00$, power = .05; or the group x session interaction, $F(1, 12) = 0.01, p = .92, \eta^2 = .00$, power = .05.

Repeated Measures Comparison of Preovulatory and Luteal Session Scores

A 2 between (preovulatory-luteal group, luteal-preovulatory group) x 2 within (session 1, session 2) repeated-measures MANOVA was performed on the three dependent variables (see means in Table 18). The MANOVA revealed that the combined dependent variables were not significantly affected by group, $F(3, 12) = 1.62, p = .24, \eta^2 = .29$, power = .32. There was a significant main effect for session, $F(3, 12) = 2.05, p = .004, \eta^2 = .66$, power = .94; but no significant group x session interaction, $F(3, 12) = 2.05, p = .16, \eta^2 = .34$, power = .40. Follow-up repeated measures univariate ANOVAs revealed the following.

Attractiveness of Facial Symmetry. There was no main effect for group, $F(1, 14) = 0.20, p = .66, \eta^2 = .01$, power = .07; and no group x session interaction, $F(1, 14) = 2.36, p = .15, \eta^2 = .14$, power = .30; but that there was a main effect of session, $F(1, 14) = 15.98, p = .001, \eta^2 = .53$, power = .96. The last finding indicates a practice/learning effect on the attractiveness of facial symmetry test.

Facial Symmetry Detection. While there was no main effect for group, $F(1, 14) = 0.11, p = .74, \eta^2 = .01$, power = .06; there was a marginally significant main effect of session, $F(1, 14) = 4.37, p = .06, \eta^2 = .24$, power = .50, indicating a trend towards a practice effect (better performance in the second than first session; see Table 18). The group x session interaction was

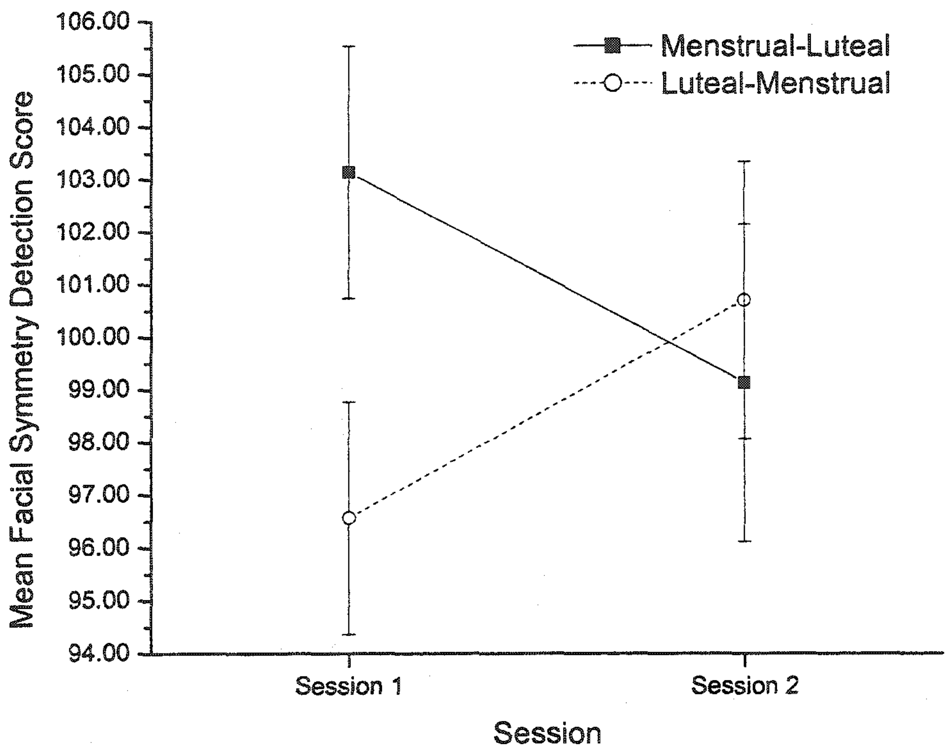


Figure 11. Group x testing session interaction for facial symmetry detection scores: The interaction reveals better symmetry detection ability during the menstrual than luteal phase. Error bars represent the standard error of the mean.

not significant, F (1, 14) = 0.14, p = .72, η^2 = .01, power = .06.

Dot Symmetry Detection. There was a main effect of group, F (1, 14) = 4.76, p = .05, η^2 = .25, power = .53, indicating that the preovulatory-luteal group obtained higher scores overall than the luteal-preovulatory group. There was no main effect of session, F (1, 14) = 0.83, p = .38, η^2 = .06, power = .14. While not significant, there was a trend towards a group x session interaction, F (1, 14) = 3.80, p = .07, η^2 = .21, power = .44, with higher dot symmetry scores being attained during the luteal than the preovulatory phase.

Analyses Controlling for Alcohol Consumption per Drinking Episode

A one-way analysis of covariance (ANCOVA) was conducted using the first minus second facial symmetry detection difference scores as the dependent variable, menstrual phase (3 groups) as the independent variable, and number of drinks per typical drinking occasion as the covariate. This was done in order to control for the following findings: (1) The first minus second session difference score analysis groups differed as a function of alcohol consumption per drinking episode (see Table 9). (2) There is a negative relationship between number of drinks and difference scores on the detection of facial symmetry test. (3) The direction of the group difference was such that the women in the luteal phase difference score group reported significantly lower consumption than the women in the menstrual and preovulatory groups which meant that the lack of group equivalency might partly account for the significant menstrual cycle phase effect reported above. The results of the ANCOVA revealed a significant main effect for menstrual cycle phase, F(2, 41) = 5.52, p = .008, partial η^2 = .21, power = .83, indicating that the effect still remained after controlling for alcohol use (see Figure 12). Post hoc Tukey LSD tests indicated that performance on the facial symmetry detection test was significantly better in the

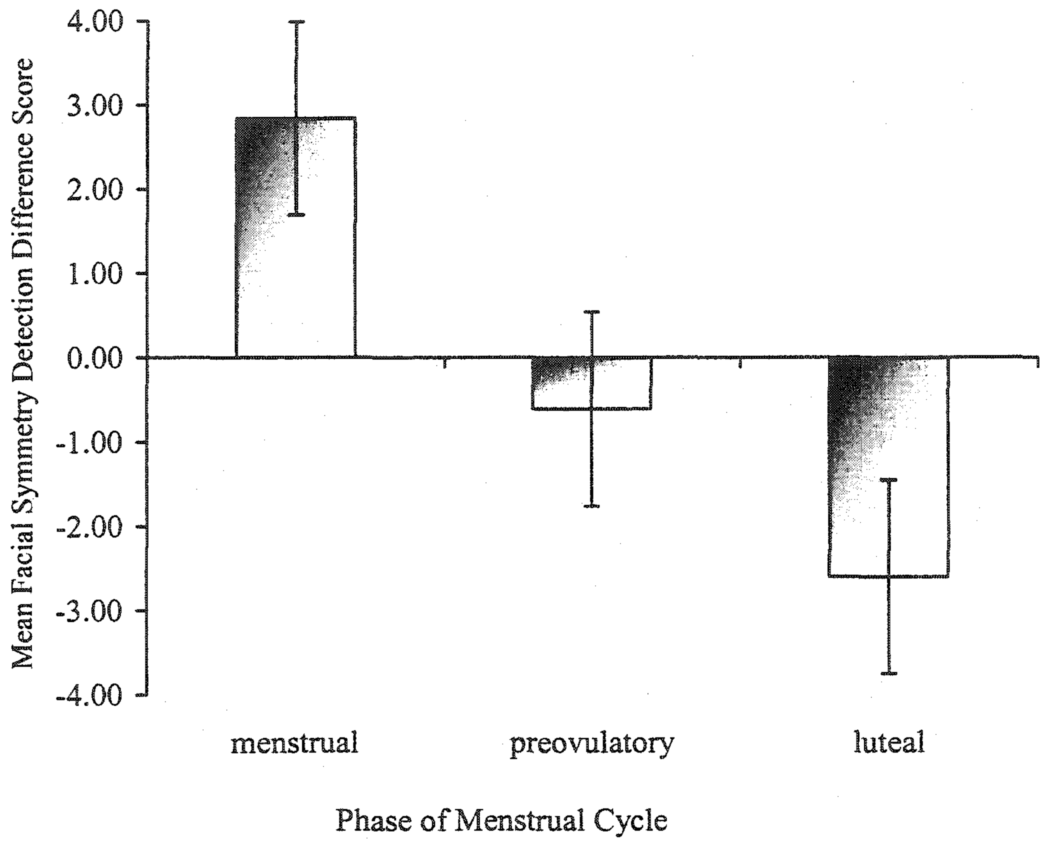


Figure 12. Mean difference scores on the facial symmetry detection test as a function of menstrual cycle phase (first minus second session) controlling for typical number of drinks per drinking episode: Better performance during the menstrual than preovulatory and luteal phases. Error bars represent the standard error of the mean.

menstrual phase than both the luteal phase, $q(\mathrm{df} = 41) = 5.44, p < .01$, and the preovulatory phase, $q(df = 41) = 3.46, p = .03$. The latter effect is stronger than was found in the ANOVA. Performance in the preovulatory and luteal phases did not differ significantly, $q(df = 41) = 1.98, p = .26$.

Supplementary Analyses

Three sets of supplementary analyses were undertaken: (1) In order to increase the power of the main analyses by increasing the cell sample sizes in the repeated measures design, a one-way repeated measures MANOVA was conducted using the same three dependent variables (attractiveness of facial symmetry, facial symmetry detection, and dot symmetry detection) and one independent variable (group) that contained two new groups: menstrual-nonmenstrual ($n = 17$) and nonmenstrual-menstrual ($n = 14$). The menstrual-nonmenstrual phase group had their first session in the menstrual phase (days 28 to 6) and the second session in another phase of the cycle (days 9 to 25). The nonmenstrual-menstrual group had sessions in the opposite order. (2) Given the research suggesting a menstrual phase advantage on visuospatial tasks, a 2 between (group) x 2 within (testing session) repeated measures MANOVA was conducted for the menstrual comparison phases described above (menstrual-nonmenstrual and nonmenstrual-menstrual). The two dependent variables were the uncorrected mental rotation scores and corrected mental rotation scores. (3) An analysis was done to examine whether the Likert-type facial ratings of attractiveness, sexiness, long-term relationship interest, short-term relationship interest, healthiness, and symmetry differed as a function of "fertility risk" or likelihood of conception, based on phase of menstrual cycle. The menstrual cycle was divided up into two phases: preovulatory phase or "high conception risk" (days 9 to 15) and non-preovulatory phase or "low conception risk" (days 1 to 6 and 18 to 28). Thus there were two groups: preovulatory-nonpreovulatory and nonpreovulatory-preovulatory. A 2 between (group) x 2 within (testing session) repeated measures MANOVA was conducted. The dependent variables were the six different Likert-type facial ratings means.

Attractiveness of Symmetry and Symmetry Detection

The 2 between (menstrual-nonmenstrual group and nonmenstrual-menstrual group) x 2 within (session 1, session 2) repeated-measures MANOVA was conducted using the three dependent variables: attractiveness of facial symmetry, facial symmetry detection, and dot symmetry detection (see Table 19 for means and standard deviations). The analysis revealed that the combined dependent variables were not significantly affected by group, $F(3, 27) = 0.16$, $p = .92$, $\eta^2 = .02$, power = .08. However, there was a significant main effect for session, $F(3, 27) = 6.76$, $p < .01$, $\eta^2 = .43$, power = .95; and a significant group x session interaction, $F(3, 27) = 3.17$, $p = .04$, $\eta^2 = .26$, power = .67. Follow-up repeated measures univariate ANOVAs revealed the following.

Attractiveness of Facial Symmetry. There was no main effect for group, $F(1, 29) = 0.39$, $p = .54$, $\eta^2 = .01$, power = .09; and no group x session interaction, $F(1, 29) = 0.65$, $p = .43$, $\eta^2 = .02$, power = .12; but there was a main effect of session, $F(1, 29) = 21.02$, $p < .001$, $\eta^2 = .42$, power = .93, indicating that the faces were considered more attractive during the second session than the first session.

Facial Symmetry Detection. No main effects were found for either group, $F(1, 29) = 0.72$, $p = .79$, $\eta^2 = .00$, power = .06; or session, $F(1, 29) = 0.96$, $p = .34$, $\eta^2 = .03$, power = .16. However, the group x session interaction was significant, $F(1, 29) = 7.62$, $p = .01$, $\eta^2 = .21$,

Table 19

Mean Scores for the Attractiveness of Facial Symmetry (ATT-SYMM), Facial Symmetry Detection (FACE-SYMM), and Dot Symmetry Detection (DOT-SYMM) tests as a function of Group (Menstrual-Nonmenstrual and Nonmenstrual-Menstrual) and Testing Session

Session	Test	Group: Menstrual-Nonmenstrual (n = 17)	Group: Nonmenstrual-Menstrual (n = 14)	(Session Means)
1		(menstrual phase)	(nonmenstrual phase)	
	ATT-SYMM	86.88 (8.75)	83.21 (13.22)	85.23 (10.96)
	FACE-SYMM	104.00 (6.01)	101.14 (7.21)	102.71 (6.62)
	DOT-SYMM	27.65 (3.08)	27.86 (3.92)	27.74 (3.43)
2		(nonmenstrual phase)	(menstrual phase)	
	ATT-SYMM	94.29 (10.43)	93.79 (10.64)	94.06 (10.35)
	FACE-SYMM	101.00 (7.74)	102.57 (6.96)	101.71 (7.32)
	DOT-SYMM	29.12 (3.12)	27.93 (2.34)	28.58 (2.81)

power = .76. This interaction is illustrated in Figure 13 and is very similar to the one illustrated in Figure 11. Clearly, both groups of women achieved higher facial symmetry detection scores during the menstrual phase compared to their scores during nonmenstrual phase days of their cycle.

Dot Symmetry Detection. There were no main effects for group, $F\ (1, 29) = 0.25, p = .62$, $\eta^2 = .01$, power = .08; session, $F\ (1, 29) = 1.82, p = .19$, $\eta^2 = .06$, power = .26; or group x session interaction, $F\ (1, 29) = 1.50, p = .23$, $\eta^2 = .05$, power = .22.

Mental Rotation Ability

A 2 between (menstrual-nonmenstrual group and nonmenstrual-menstrual group) x 2 within (session 1, session 2) repeated-measures MANOVA was conducted using two dependent variables: uncorrected mental rotation scores and corrected (for guessing) mental rotation scores (see Table 20 for means and standard deviations). Visual examination of the means does not suggest any evidence of a menstrual phase effect. The MANOVA revealed that the two dependent variables were not significantly affected by group, $F\ (2, 28) = 0.62, p = .54$, $\eta^2 = .04$, power = .14; and there was not a significant group x session interaction. $F\ (2, 28) = 0.06, p = .94$, $\eta^2 = .00$, power = .06. However, the main effect for session was significant, $F\ (2, 28) = 4.51\ p = .02$, $\eta^2 = .24$, power = .72, indicating better performance in the second session. Follow-up repeated-measures univariate ANOVAs revealed the following. Similar results were found for both uncorrected and corrected mental rotation scores. Neither scores showed a main effect for group, $Fs\ (1, 29) = 1.10, 1.18$, $ps = .30, .28$, η^2s = .04, power = .18; nor a group x session interaction, $Fs\ (1, 29) = 0.31, 0.85$, $ps = .86, .77$, η^2 s = .00, power = .05, .06, respectively. However, for both uncorrected and corrected mental rotation scores there was a main effect of

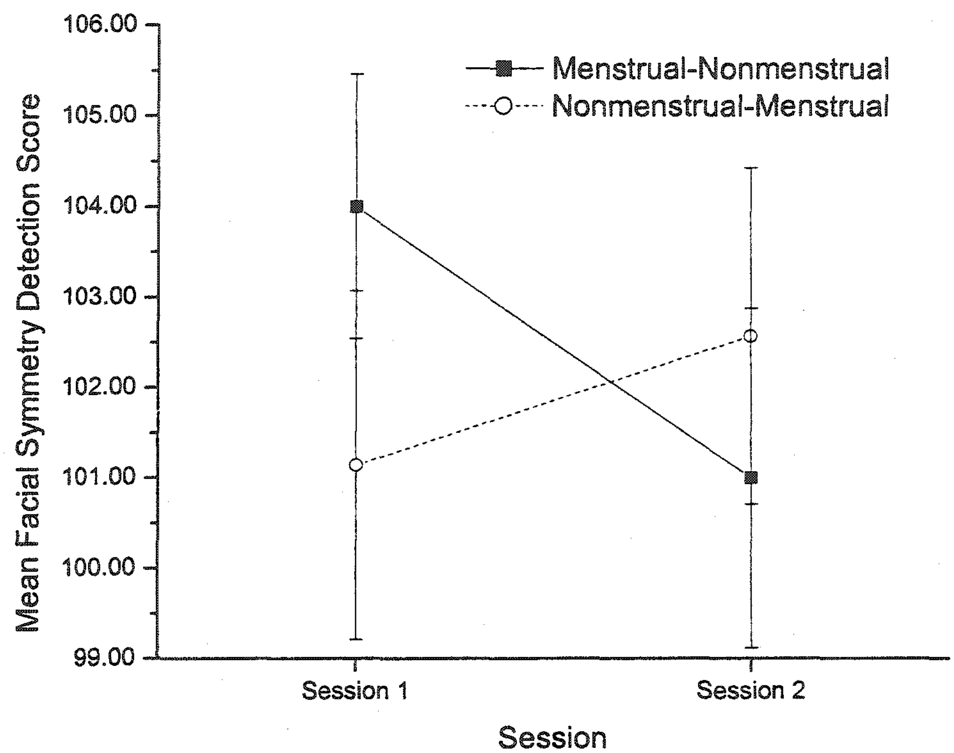


Figure 13. Group x testing session interaction for facial symmetry detection scores: The interaction reveals better symmetry detection ability during the days of the menstrual phâse than during the other days of the cycle. Error bars represent the standard error of the mean.

Table 20

Means and Standard Deviations for both Uncorrected Mental Rotation Scores and Corrected (for guessing) Mental Rotation Scores as a function of both Testing Session and Group (Menstrual-Nonmenstrual versus Nonmenstrual-Menstrual)

Session	Score	Group		
		Menstrual-Nonmenstrual (*n* = 17)	Nonmenstrual-Menstrual (*n* = 14)	(Session Means)
1		(menstrual phase)	(nonmenstrual phase)	
	Uncorrected	19.76 (5.94)	17.57 (5.50)	18.77 (5.76)
	Corrected	13.76 (4.99)	11.21 (6.40)	12.61 (5.72)
2		(nonmenstrual phase)	(menstrual phase)	
	Uncorrected	23.12 (7.30)	21.36 (5.79)	22.32 (6.61)
	Corrected	17.41 (8.27)	15.64 (6.34)	16.61 (7.40)

session indicating a practice effect, *Fs* (1, 29) = 8.37, 9.12, *ps* < .01, η^2s = .22, .24, power = .80, 83.

Conception Risk and Likert-type Ratings of Attractiveness, Sexiness, Long-term Relationship Interest, One Night Stand Interest, Healthiness, and Symmetry

A 2 between (preovulatory-nonpreovulatory group, nonpreovulatory, preovulatory group) x 2 within (testing session 1, testing session 2) repeated measures MANOVA was conducted on the six dependent variables (Likert-type facial rating means). The means and standard deviations are presented in Table 21. The MANOVA revealed no main effect for group, F (6, 25) = 0.60, p = .73, η^2 = .13, power = .20; but a significant main effect for session, F (6, 25) = 2.44, p = .05, η^2 = .37, power = .72; and the group x session interaction, F (6, 25) = 2.63, p = .04, η^2 = .39, power = .76. Follow-up univariate ANOVAs were conducted and the results are displayed in Tables 22 and 23.

None of the six facial ratings showed a univariate main effect for group. While all six Likert-type ratings showed at least a trend towards a main effect of session, only the ratings of attractiveness and sexiness were significantly higher during the second than the first testing session. The most interesting finding was a group x session interaction for the Likert-type sexiness facial ratings. As illustrated by the interaction in Figure 14, the women rated the male faces as sexier when they were in the preovulatory phase of their cycle, the "high conception likelihood phase", than when they were at any other point in their menstrual cycle. Two other Likert-type rating scales showed a nonsignificant trend towards a group x session interaction: ratings of symmetry (p = .09) and attractiveness (p = .12). While the direction of the attractiveness effect was similar to the interaction for the ratings of sexiness,

Table 21

Means and Standard Deviations for Six Likert-type Facial Ratings as a function of Group (Preovulatory-Nonpreovulatory, Nonpreovulatory-Preovulatory) and Testing Session

Session	Rating	Group		
		Preov.-nonpreov. (n = 14)	Nonpreov.-preov. (n = 18)	(Session Means)
1		(preovulatory)	(nonpreovulatory)	
	Attractiveness	3.77 (1.19)	3.19 (1.26)	3.44 (1.24)
	Sexiness	3.06 (1.19)	2.74 (1.26)	2.88 (1.22)
	Longterm Partner	3.28 (1.55)	2.62 (1.33)	2.91 (1.45)
	One Night Stand	2.03 (0.91)	1.75 (1.03)	1.87 (0.98)
	Healthiness	5.61 (1.30)	5.14 (1.46)	5.34 (1.39)
	Symmetry	6.15 (1.43)	6.43 (1.40)	6.31 (1.40)
2		(nonpreovulatory)	(preovulatory)	
	Attractiveness	3.93 (1.04)	3.70 (1.41)	3.80 (1.25)
	Sexiness	3.08 (1.04)	3.19 (1.43)	3.15 (1.26)
	Longterm Partner	3.49 (1.42)	2.86 (1.49)	3.13 (1.47)
	One Night Stand	2.26 (1.04)	1.79 (1.03)	1.99 (1.04)
	Healthiness	5.68 (1.20)	5.52 (1.20)	5.59 (1.18)
	Symmetry	6.67 (1.12)	6.43 (1.15)	6.54 (1.12)

Table 22

Univariate Analysis of Variance (ANOVA) Table for the Between Subjects Results for all 6 Likert-type Facial Rating Variables

Source	*df*	*F*	η^2	Power
		Between subjects		
Group-Attractiveness	1	0.87	.03	.15
S within-group error	30	(2.92)		
Group-Sexiness	1	0.06	.00	.06
S within-group error	30	(3.02)		
Group-Longterm Partner	1	1.64	.05	.24
S within-group error	30	(3.96)		
Group-One Night Stand	1	1.20	.04	.19
S within-group error	30	(1.89)		
Group-Healthiness	1	0.49	.02	.10
S within-group error	30	(3.06)		
Group-Symmetry	1	0.00	.00	.05
S within-group error	30	(2.95)		

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

*$p < .05$.

Table 23

Univariate Analysis of Variance (ANOVA) Table for the Within Subjects Results for the 6 Likert-type Facial Rating Variables

Source	*df*	*F*	η^2	Power
		Within subjects		
Session-Attractiveness	1	9.57**	.24	.85
Session x Group	1	2.54	.08	.33
Error	30	(0.18)		
Session-Sexiness	1	6.78*	.18	.71
Session x Group	1	5.63*	.08	.63
Error	30	(0.13)		
Session-Longterm Partner	1	3.47	.10	.44
Session x Group	1	0.02	.00	.05
Error	30	(0.22)		
Session-One Night Stand	1	2.09	.07	.29
Session x Group	1	1.10	.04	.17
Error	30	(0.14)		
Session-Healthiness	1	2.61	.08	.35
Session x Group	1	1.19	.04	.18
Error	30	(0.31)		
Session-Symmetry	1	3.13	.09	.40
Session x Group	1	3.03	.09	.39
Error	30	(0.34)		

Note. Values enclosed in parentheses represent mean square errors.

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

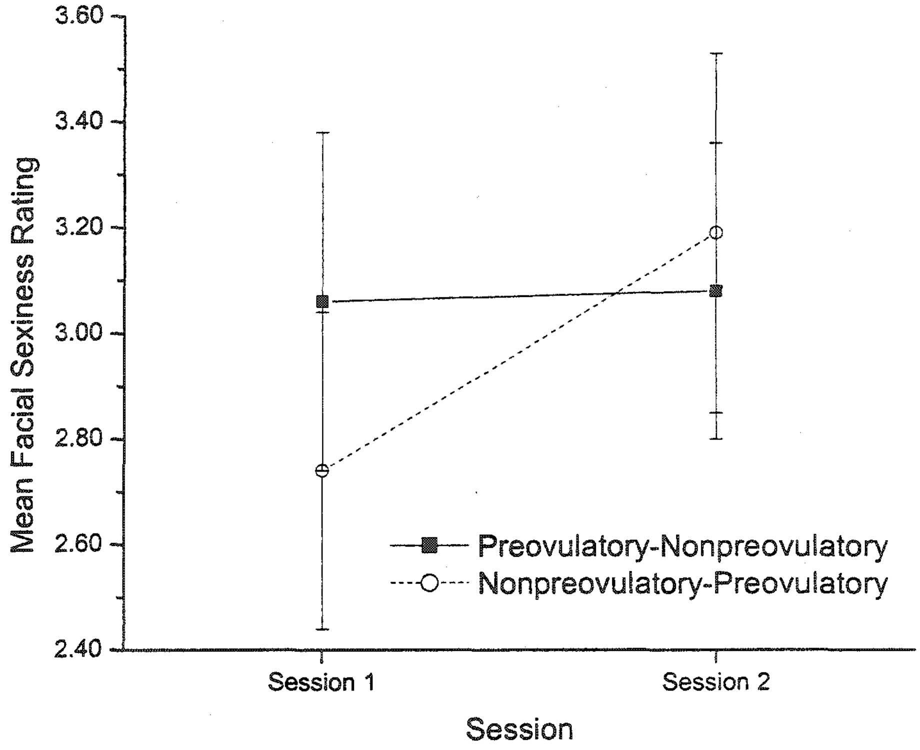


Figure 14. Group x testing session interaction for facial ratings of "sexiness". The interaction reveals that women gave higher ratings of "sexiness" to the male faces when they were at the preovulatory phase of their menstrual cycle (the phase when conception is most likely) compared to at days in the rest of the menstrual cycle. Error bars represent the standard error of the mean.

the group x session interaction for the ratings of symmetry revealed a different direction to the effect. As illustrated in Figure 15, there was a strong nonsignificant trend towards women rating the same group of male faces as less symmetrical when they were in the preovulatory phase of the cycle compared to other times in their cycle.

Discussion

Summary of the Findings

Main Hypotheses. Neither of the main hypotheses were supported in the present study. There was no evidence that women were better able to detect symmetry or that they had a greater preference for symmetry when they were in the preovulatory phase of their menstrual cycle (the time of highest conception likelihood), compared to other times in the menstrual cycle. However, a strong menstrual phase advantage was found for facial symmetry detection. Women were significantly better at perceiving facial symmetry when they were in the menstrual phase of their cycle compared to the luteal phase and compared to all other days of the cycle. A trend was also evident for a luteal phase advantage in terms of detecting symmetry in dot patterns under timed conditions.

Supplementary Analyses. Two other hypotheses were examined in the supplementary analyses. There was no evidence of a menstrual phase advantage on the mental rotation visuospatial test. In fact, no phase effects were found for this test. However, a menstrual cycle phase effect was found for women's ratings of male facial "sexiness". Women rated the same male faces as being "sexier" when they were in the preovulatory phase of their menstrual cycle than when they were at any other time in their cycle. There was also a trend towards the women rating the same group of male faces as more attractive and less symmetrical during the

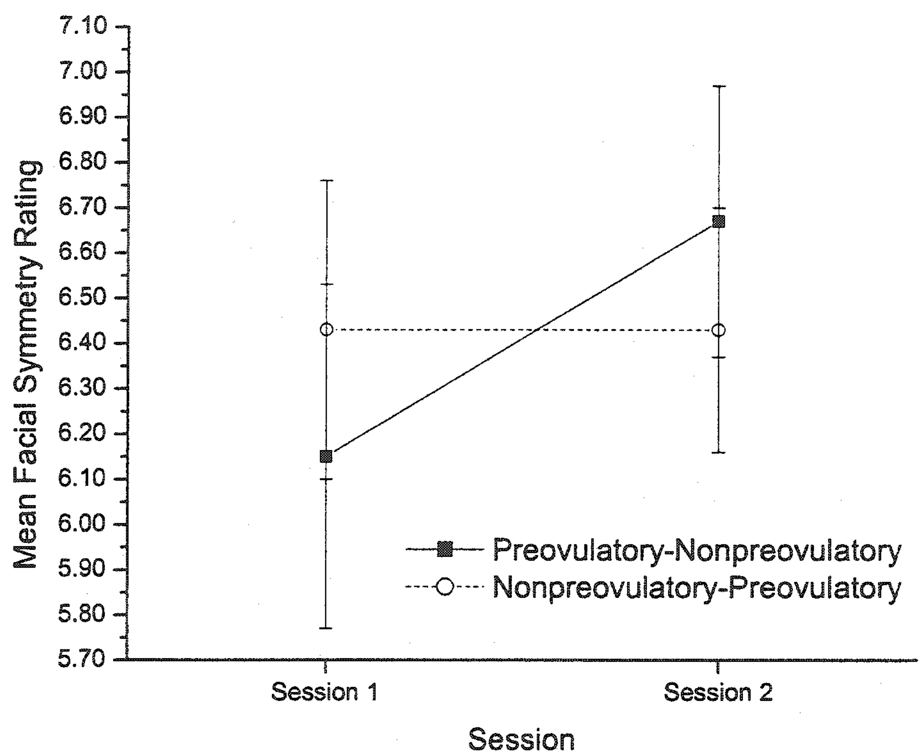


Figure 15. A trend towards a group x testing session interaction for the likert-type facial ratings of "symmetry". The interaction (although nonsignificant) illustrates the trend towards women giving lower ratings of "symmetry" to the same male faces when the women were in the preovulatory phase of their menstrual cycle (the phase when conception is most likely) compared to days in the rest of the menstrual cycle. Error bars represent the standard error of the mean.

preovulatory phase.

Additional Findings. Two additional findings are worth discussing. First, there were high significant positive correlations between scores on the Facial Symmetry Detection test and the Attractiveness of Facial Symmetry test (rs = .45 and .62 for the first and second session), indicating that women who were better able to detect facial symmetry differences were also more likely to choose the more symmetrical face as being more attractive. Second, there was a significant negative correlation between reported alcohol consumption and improvement on the Facial Symmetry Detection test from the first to second testing session (r = -.38). A dose-effect relationship was evident whereby women who reported that they typically consume a higher number of alcoholic drinks were less likely to improve on their facial symmetry detection score and were more likely to show a decrease in score.

Discussion of Results

A Menstrual Phase Advantage for Facial Symmetry Detection

The present results did not provide support for the hypothesis that women have better facial symmetry detection abilities during the preovulatory phase, the phase of highest conception likelihood. Instead, the analyses indicated that women are significantly better at detecting facial symmetry during the menstrual phase of their cycle. There appears to be a decrease in facial symmetry detection ability that occurs with rising gonadal steroids (see Figure 10). The menstrual phase advantage was strongest when the luteal phase was used as the comparison phase, and it should be noted that menstrual cycle phase accounted for 49% of the variance in the Facial Symmetry Detection scores. Previous research has not examined menstrual cyclicity in facial symmetry perception (or any type of symmetry perception, for that matter). These results provide very strong evidence of an activational effect of gonadal hormones on the ability to detect facial symmetry. Higher levels of hormones appear to inhibit the ability to detect facial symmetry.

The enhanced ability to detect symmetry during the menstrual phase suggests that women *cannot* optimally detect facial symmetry when sexual activity is most likely to result in conception (i.e., the preovulatory phase). This finding seems inconsistent with the parasite theory of sexual selection and the "good genes" mating strategy as the results suggest that women are less able to perceive the most symmetrical, and therefore "healthiest", mate at the time when such perception could most affect the health of her offspring. However, while clearly not the most obvious hypothesis, the possibility does remain that a menstrual-phase advantage in facial symmetry detection could still affect mate selection. Given that, following first visual contact, a period of courtship generally precedes mating, the enhanced ability to detect facial symmetry during menstruation would be of benefit for choosing a high quality mate if a woman were to choose her mate approximately 5 to 10 days prior to mating with him. The possibility of coitus-induced ovulation (Jöchle, 1973) strengthens the possibility that enhanced symmetry detection abilities immediately preceding ovulation might enhance one's likelihood of having a preference for men who honestly advertise immunocompetence. Additionally, as will be discussed below, our finding that women tend to rate all male faces as sexier during the preovulatory phase suggests that women may actually be less selective when they are most likely to conceive. If this is the case then there appears to be a greater need for more selectivity in mate selection earlier on in the cycle.

Although previous research has not examined menstrual cyclicity in the ability to visually detect symmetry, three studies did examine olfactory preferences for symmetry (Gangestad &

Thornhill, 1998; Rikowski & Grammer, 1999; Thornhill & Gangestad, 1999). While evidence of a positive relationship between conception likelihood and an olfactory preference for degree of bodily symmetry does not directly suggest a menstrual cycle effect on symmetry detection ability, it does provide some indirect evidence. Demonstration of a preference for the scent of symmetrical men during phases of high conception likelihood (days 6 to 14) suggests an enhanced ability (although perhaps not conscious) to detect smell differences between various levels of bodily symmetry. However, confirmation of the olfactory findings using a *within-subject* design and a menstrual phase analysis (as opposed to conception probability values), in order to rule out a purely hormonal explanation for the finding, would allow for greater confidence in this conclusion. Taken together, the results of the symmetry detection research suggest that women have an enhanced ability to visually detect facial symmetry during menstruation (days 1 to 6), followed by an enhanced ability to detect bodily symmetry through olfactory means from days 6 to 14 of the cycle. Given the relative degree of contact involved in the natural stages of meeting, courting, and mating, it makes sense from an evolutionary perspective that an enhanced ability to visually detect symmetry would directly precede an olfactory one.

Symmetry detection is not considered a spatial ability as it is akin to simple perceptual matching (i.e., determining if two visual stimuli are identical in all features)(Hampson, 1995). However, the menstrual cycle advantage reported here for facial symmetry perception is consistent with the findings for visuospatial ability. Numerous studies have found enhanced visuospatial ability during the menstrual phase of the cycle (e.g., Hampson, 1990a; 1990b; Moody, 1997; Silverman & Phillips, 1993). Examination of the relative strength of the menstrual cycle effect for the various types of visuospatial tests has suggested that it is the spatial transformation requirement, and not the presence of pictorial material, in visuospatial tasks that is responsible for this menstrual-phase advantage on spatial tasks in women (Kimura & Hampson, 1994). In fact, when Linn and Petersen's (1985) three types of visuospatial ability were examined through meta-analysis (Oinonen, 2003), the largest menstrual phase advantage was found for mental rotation tests, followed by the spatial visualization tests. Although the spatial perception tests had a negligible effect overall, one spatial perception test, the Rod-and-Frame test, did show a significant menstrual phase advantage. Only one (viz., Epting & Overman, 1998) of four published studies (Hampson, 1990a; 1990b; Hampson & Kimura, 1988) did not find an enhanced ability to align the rod to vertical during menstruation. It is possible that performance on the Facial Symmetry Detection test involves similar abilities to the Rod-and-Frame test as the latter test might require that the test-taker be able to envision a symmetrical line on the opposite side of vertical in order to know whether a correction is required. However, the effect size of the menstrual phase facial symmetry detection advantage appears larger than that for the rod-and-frame test or for other visuospatial tests.

One possible explanation for the menstrual phase advantage on the Facial Symmetry Detection test comes from the research on asymmetries in hemispheric activation (e.g., Bibawi, Cherry, & Hellige, 1995). Lower levels of both accuracy asymmetry and response bias asymmetry between the left and right visual field during the menstrual phase may play a role in the enhanced facial symmetry detection effect present at menstruation. Three studies provide data in support of this hypothesis (Bibawi, Cherry, & Hellige, 1995; Chiarello, McMahon, & Schaefer, 1989; Mead & Hampson, 1996). First, Chiarello, McMahon, and Schaefer (1989) found that for all men, and for those women in the preovulatory and luteal cycle phase, stricter criteria (i.e., more misses and fewer false alarms) are used when making judgements on a lexical decision task for stimuli that are presented by tachistoscope in their left visual field (LVF) compared to their right visual field (RVF). However, this pattern is reversed in women during the menstrual phase, such that stricter criteria is used in the RVF. In addition, while LVF performance is stable across the cycle, it appears that it is the RVF (or left hemisphere) stringency that varies with the menstrual phase for this lexical decision task. Although not commented on by Chiarello and colleagues, visual inspection of their data indicates differences between the stringency of LVF and RVF criteria such that the response criteria was most similar for the two visual fields during the menstrual phase (a mean difference of 0.07 for the menstrual phase compared to 0.10 for the luteal phase and 0.17 in the preovulatory phase). Such a variation across the menstrual cycle suggests the possibility that a similar low level of response bias asymmetry during the menstrual phase may have facilitated performance on the Facial Symmetry Detection Test.

Two other studies have reported larger left-right visual field asymmetry on the accuracy of face recognition (Mead & Hampson, 1996) and chair-identification (Bibawi, Cherry, & Hellige, 1995) tachistoscope tasks during the midluteal phase compared to the menstrual phase. High levels of left-right visual field accuracy asymmetry would make it difficult for an individual to judge the symmetry of a face given that the different hemispheres may be differentially sensitive to spatial differences. Bibawi and colleagues suggested that shifts in hemispheric asymmetry would be more evident on tasks that reflect asymmetric activation as opposed to specialization of function. Their finding of a menstrual phase effect for a chair identification task, but not a facial processing task, provided support for their hypothesis. The present results fit with their findings in that a facial processing task, which normally has a right hemisphere advantage (but differs depending on task requirements), was adapted to optimally detect differences in hemispheric activation by requiring participants to look for left-right asymmetry. Of tests that do not use tachistoscope presentation, this Facial Symmetry Detection test may actually be one of the most sensitive tests for examining hemispheric asymmetry. It is not clear whether the right visual field (left-hemisphere) advantage during the luteal phase is due to activation of the left hemisphere, suppression of the right hemisphere, or a little of both. However, as indicated by Mead and Hampson, it appears likely that the visual field asymmetry may be due to a relative suppression of right hemisphere processing during the phases with higher estrogen levels. Taken together, the findings of these three studies on visual cerebral lateralization provide support for the hypothesis that lower levels of left-right hemisphere response bias asymmetry and accuracy asymmetry during the menstrual phase (compared to the luteal phase) contributed to the menstrual phase symmetry detection advantage for this non-timed test.

It should be noted that the menstrual phase symmetry detection advantage cannot be accounted for by greater visual sensitivity, fewer physical/somatic symptoms, or a decreased fatigue effect during the menstrual cycle. In fact, there is evidence that visual sensitivity is lowest (Diamond, Diamond, & Mast, 1972; Wong & Tong, 1974) and that women report experiencing more negative physical symptoms (e.g., Oinonen & Mazmanian, 2001) when they are in the menstrual phase compared to other cycle phases. Given the two hour length of the testing sessions and the placement of the facial symmetry in the latter half of the session, it is important to examine whether boredom or fatigue could have affected performance. However, the only way that a boredom/fatigue effect could threaten the validity of the current findings would be if boredom/fatigue were to exert a greater negative effect on performance in cycle phases other than menstruation. The only study containing data during the menstrual phase that might address this issue provided neurophysiological evidence indicating weakened selective attention in the menstrual phase compared to the rest of the cycle, using a within-subject design (Basinska-Starzycka, Arnold, Moskwa, Thorell, & Wozny, 2001). Thus, if women are differentially affected by boredom or fatigue across the menstrual cycle, it is most likely that they would be more affected during the menstrual phase than any other phase. Such an effect would only serve to strengthen the present finding of a large effect size menstrual phase advantage on facial symmetry perception.

<u>Detection of Non-facial Symmetry under Timed Conditions: A Luteal Phase Advantage?</u>

Performance on the Dot Symmetry Detection test was also not in line with the hypothesis of enhanced performance during the preovulatory phase. However, there was a nonsignificant trend towards better performance on this test during the luteal than the preovulatory phase of the cycle. Based on the size of the F value and the power of the analysis, increasing the sample size would likely result in a significant effect.

The trend towards enhanced dot symmetry detection ability during the luteal phase initially seems inconsistent with the menstrual phase advantage for facial symmetry detection. However, it is likely that differences in the method of stimuli presentation (as well as possibly the stimuli themselves) account for the different findings. On the Facial Symmetry Detection test the faces were presented for an unlimited amount of time and participants made their responses while looking at the face. On the Dot Symmetry Detection test the dot stimuli were presented for 2 seconds and participants usually made their responses after the dot pattern had disappeared. While the facial test method seems to be an ecologically valid method for examining facial perception, the Dot Symmetry Test scores may reflect perceptual/information processing speed, attention, iconic memory, and perhaps visual sensory perception (e.g., visual thresholds), in addition to symmetry detection ability.

Given the above noted abilities that are potentially reflected in the Dot Symmetry Test due to the method used to present the dot stimuli, three factors may partly explain the trend towards the luteal phase advantage on this test. First, there is evidence of enhanced visual sensitivity during the luteal phase of the menstrual cycle (Diamond, Diamond, & Mast, 1972; Wong & Tong, 1974). Second, Hampson (1990b) reported a luteal phase advantage on tests of perceptual speed. One of these tests was a matching to sample test (Identical Pictures) in which participants were required to choose one of five alternatives that matched a target item. Somewhat consistent with this finding is neurophysiological evidence suggesting weakened selective attention in the menstrual phase, highest sensory excitability to non-important stimuli during the premenstrual phase, and fastest information processing speed in the premenstrual phase (Basinska-Starzycka et al., 2001). While our study did not examine the premenstrual phase, the pattern of these neurophysiological findings suggest faster information processing and higher brain activity during the luteal phase, which would have been beneficial on a task involving short presentation times. Finally, there is evidence of higher visual memory during the luteal phase compared to the menstrual phase (Phillips & Sherwin, 1992). Thus, enhanced visual sensitivity, information processing speed, and visual memory may have contributed to the finding of a trend towards higher scores on the Dot Symmetry Detection test in the luteal phase.

Research on asymmetric hemispheric activation provides an additional explanation for the trend towards a luteal phase advantage on the Dot Symmetry Test. Two studies have found evidence of decreased right-left visual field asymmetry during the luteal phase of the cycle for reaction times (Heister, Landis, Regard, & Schroeder-Heister, 1989; Rode, Wagner, & Gunturkun, 1995). Both of these studies found evidence of a left visual field (LVF) advantage in reaction time during the menstrual phase which decreased over the cycle such that the lowest degree of left-right visual field asymmetry in reaction times was present during the midluteal phase. As the dot symmetry stimuli were only presented on the screen for two seconds each (in contrast to the unlimited viewing time given for the faces in the Facial Symmetry Detection test), it is possible that reaction time asymmetry might play a role in judgements of symmetry, especially if faster reaction times reflect faster information processing. It follows that perception of symmetry on the Dot Symmetry Test would be most accurate in the luteal phase of the cycle when the least visual field reaction time asymmetry is present.

No Phase Preferences for Facial Symmetry

Although the faces with higher symmetry were generally rated more attractive, there was no evidence of a greater preference for facial symmetry during the preovulatory phase. In fact, there was not even a trend towards more symmetrical faces being considered more attractive at one particular phase compared to the others. These findings are inconsistent with the study's hypothesis based on the parasite theory of mate selection which suggests that women are more attracted to men who are more symmetrical at the time of their cycle when they are most likely to conceive. However, the present results are consistent with the only other study to examine this question (Koehler, Rhodes, & Simmons, 2002), which was published during data collection for the current study.

The lack of a preovulatory visual preference for symmetrical faces is inconsistent with the results of other studies indicating enhanced visual preference for signs of a "healthy" mate when conception is most likely (Frost, 1994; Johnston et al., 2001; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999; Perret et al., 1999). Of most relevance to the present study are the three studies indicating menstrual cyclicity in women's preference for the scent of symmetrical men (Gangestad & Thornhill, 1998; Rikowski & Grammer, 1999; Thornhill & Gangestad, 1999). The present results suggest that, despite showing a preference for the scent of symmetrical men when they are most likely to conceive, women do not show a greater visual preference for symmetry at this point in the cycle. One possible reason for the discrepancy between the visual and olfactory research relates to baseline levels of preference. While women do not show any olfactory preference for symmetry during the low conception likelihood phases of their cycle (e.g., Gangestad & Thornhill), the results of the present study indicate that women show a high visual preference for facial symmetry at all points in their cycle (see Figures 6, 7, and 8). When a strong visual preference for symmetry is present throughout the cycle, there might be no need to enhance preference at times of high conception likelihood. Furthermore, the relative importance of the two senses at the different stages in mate selection might be relevant. During the early stages of mate selection when visual cues about symmetry might determine whether or not a woman approaches or attempts to avoid a potential mate, olfactory cues would be less likely to play a role. Olfactory cues may be more important once the visual symmetry "selection test" has been passed. Scent cues to symmetry might operate on only those men who have passed the initial visual check and been allowed close enough to be smelled. Thus, it would make sense that midcycle is the only time when women have a greater interpersonal distance preference for unknown men than women (O'Neal, Schultz, & Christenson, 1987), as it could be costly to allow strange men to approach if they have not passed the visual test during the menstrual phase.

The lack of a cyclic visual preference for male facial symmetry may also be related to the general benefits of having a symmetrical mate and to the lack of any advantage of choosing a less symmetrical mate at any point in the cycle. For example, changes in the preference for masculine versus feminine facial features across the cycle might allow for resource or parenting benefits for a woman who chooses to mate with a male who has feminine facial features during phases of low conception likelihood (Penton-Voak & Perrett, 2001). Furthermore, while feminine facial features do not advertise optimal immunocompetence, as masculinized features might, there would not be any major disadvantage or danger that would arise by mating with or producing offspring with such a mate. However, such is not the case with facial symmetry. While higher levels of symmetry signify health, low levels of symmetry may signify poor health (e.g., low parasite resistance or poor diet) and are associated with higher rates of infertility (Manning, Scutt, & Lewis-Jones, 1998), schizophrenia (Markow & Gotesman, 1989), premature birth (Livshits et al., 1988) and mental retardation (Malina & Buschang, 1984). Thus, the costs of exhibiting a lower preference for facial symmetry at any point in the cycle might be too great for cyclic visual preferences to have evolved. A decreased preference for symmetry at any point in the cycle could potentially impact the likelihood of a woman being able to pass on her genes or the health of any resultant offspring.

The most likely explanation for the lack of a preovulatory preference for symmetry is that no such preference exists. This is the most likely conclusion for four reasons. First, the results are concordant with the only other study to examine this question (Koehler, Rhodes, & Simmons, 2002). The fact that Koehler and colleagues used Likert-type ratings as opposed to the forced choice procedure used here adds to the robustness of these results. Second, the Attractiveness of Facial Symmetry Test appears to be a reliable and valid measure of one's preference for symmetrical faces. Third, cyclic effects on preferences have been found with smaller sample sizes than the current study (e.g., Gangestad & Thornhill, 1998; Penton-Voak et al., 1999) and with less sensitive between-subjects designs (e.g., Gangestad & Thornhill, 1998; Penton-Voak & Perrett, 2000). Fourth, for the six analyses that examined this question, none of the means were in the direction of suggesting an enhanced preference for symmetry during the preovulatory phase.

One question that remains is why there is a menstrual phase advantage in detecting facial symmetry yet this enhanced symmetry detection ability is not reflected in preferences for symmetry. This seems surprising given that, as discussed above, it seems logical that a greater ability to detect a stimulus would be reflected in one's emotional response to that stimulus (e.g., If one's taste buds are sensitive to the taste of licorice, this could be reflected in higher or lower ratings of a food containing licorice, depending on whether one likes or dislikes the taste of licorce). While it is possible that an enhanced ability to detect facial symmetry compensates for a low preference for symmetry during the menstrual phase, there was no evidence of menstrual cyclicity in the preference for facial symmetry when the data was re-analysed by factoring out the variance due to facial symmetry detection ability (Facial Symmetry Detection Score was a covariate).

No Menstrual Cycle Phase Effect for a Visuospatial Mental Rotation Test

The present results were not consistent with previous studies indicating better performance on visuospatial tests during the menstrual phase (e.g., Hampson, 1990a; 1990b;

Moody, 1997; Silverman & Phillips, 1993). This is particularly surprising given that an unpublished meta-analysis of both published and unpublished studies indicated support for a menstrual phase advantage (Oinonen, 2003). However, the current findings are consistent with the results of some methodologically strong studies in this area (e.g., Epting & Overman, 1993; Gordon & Lee, 1986).

These findings suggest the possibility that visuospatial ability does not fluctuate across the menstrual cycle. Five factors lend support to this conclusion. First, examination of the direction of the means as well as the size of the *F* and η^2 values indicate that there was not even a trend towards a menstrual cycle effect being present. Furthermore, there was no evidence of a menstrual phase advantage when the data was re-analysed in the following two ways: (1) comparing performance in three menstrual cycle phases (as opposed to the menstrual versus non-menstrual phase comparison presented here), and (2) re-defining the menstrual phase as only days 3 to 5 of the menstrual cycle in order to exclude days on which menstruation-related somatic symptoms might be a confound (i.e., days 1 and 2). Second, the use of a repeated-measures design lends support to the present results. Third, the sample size ($N = 34$) in the repeated-measures analysis was comparable to previous studies which have reported a menstrual phase advantage (e.g., Moody, 1997; Silverman & Phillips, 1993). Fourth, it is unlikely that lack of a phase effect is due to the choice of visuospatial test given that the Vandenberg (1971) adaptation of Shepard and Metzler's (1971) mental rotations test was chosen specifically because an unpublished meta-analysis by the writer (Oinonen, 2003) had indicated that this visuospatial test was most sensitive to the menstrual phase effect. Finally, it is worth noting that the design was powerful enough to detect other menstrual phase differences.

Keeping in mind the possibility that visuospatial ability does not fluctuate across the menstrual cycle, there are a number of potential explanations for the discrepancy between the current results and previous findings. First, there was evidence of a large significant practice effect on this test. Participants' uncorrected and corrected scores increased by a mean of 3.55 (*SD* = 6.73) and 4.00 (*SD* = 7.29) points, respectively, from the first to second session. It is possible that the strong practice effect may be covering up any differences that might have otherwise occurred as a function of hormonal variation. A baseline testing session or use of alternate forms (e.g., Hampson, 1990b) for the two testing sessions might have ameliorated this effect. Second, the use of fairly strict participant inclusion criteria might account for differences between the current and previous results. While the present study excluded participants who were taking any medication that could affect hormone levels or mood, and used very specific criteria for selecting women with regular and predictable menstrual cycles, it does not appear that equally strict criteria were used in other studies (e.g., Silverman & Phillips, 1993). However, one would think that such criteria might enhance any menstrual phase effect. Third, it is possible that the context in which the visuospatial test was completed may have altered the underlying ability that was being measured. Each testing session lasted approximately two hours and the mental rotation test was completed approximately half way through the session. The length of the testing session suggests that performance on the mental rotation test in the current study may reflect vigilance and the ability to withstand fatigue, in addition to visuospatial ability. Given some neurophysiological evidence for weakened selective attention in the menstrual phase compared to the rest of the cycle (Basinska-Starzycka et al., 2001), it is possible that a non-menstrual phase advantage for vigilance or the ability to withstand fatigue/boredom could have obscured any menstrual phase advantage on this visuospatial test.

Women Rate Male Faces as Sexier during the Preovulatory Phase: Are Women Less Selective when More Likely to Conceive?

The present results indicate that women rated the male faces as more "sexy" when they were in the preovulatory phase of their cycle compared the other days of their cycle. There was also a trend towards the faces being rated as more attractive and less symmetrical during the preovulatory phase, compared to the rest of the cycle.

Only three other studies that looked at visual facial preferences across the menstrual cycle have examined whether general pleasantness or attractiveness ratings change predictably across the menstrual cycle (Johnston & Wang, 1991; Koehler, Rhodes, & Simmons, 2002; Krug, Plihal, Fehm, & Born, 2000). While Koehler, Rhodes, and Simmons did not find a significant difference in ratings of facial attractiveness across the menstrual cycle in free-cycling women, the present findings are somewhat consistent with the results of the other two studies. Krug and colleagues reported that women were less likely to categorize pictures of nude men as "negative" during the preovulatory phase, compared to the luteal and menstrual phases. They also noted a trend towards more "positive" categorizations of nude men during the preovulatory phase compared to the other two phases. The findings of Johnston and Wang also seem to fit with the present results. Their participants rated all faces as more pleasant during high estrogen phases (days 9 to 13 and 22 to 25) than low estrogen phases (days 1 to 7 and 26 to 28). While they also found menstrual cyclicity for "erotic" ratings, they did not specifically examine whether these ratings differed as a function of conception risk. Thus, although not inconsistent with previous research, our finding of a tendency to rate male faces as more sexy during a period of high conception likelihood is the clearest evidence of such an effect to date.

Studies examining olfactory preferences across the menstrual cycle have had inconsistent findings. While two studies did not find any overall change in the pleasantness ratings of male scent based on conception risk (Gangestad & Thornhill, 1988; Thornhill & Gangestad, 1999), Grammer (1993) found that women rated the smell of androstenone as less unattractive when they were at midcyle. However, it is worth noting that all three of these studies used the less sensitive between-subjects design which would decrease the likelihood of finding a menstrual cycle effect.

Bearing on the present findings are the results of three studies which suggest an enhanced attention to sexual stimuli during the preovulatory phase (Krug et al., 1994; Krug et al., 2000; Macrae et al., 2002). Krug et al (1994) reported that women were more accurate at recognizing sexual stimuli during the preovulatory phase and were more likely to incorrectly identify non-sexual stimuli as sexual-stimuli (more sex-related false alarms) when they were in the preovulatory phase. These effects were not found for stimuli in other categories (i.e., babies and body care). In a second study, Krug et al.'s (2000) examination of event-related potentials in response to sexual and non-sexual stimuli across the menstrual cycle provided evidence of an increased LPC amplitude in the ovulatory phase during affective judgements of sexual stimuli compared to non-sexual stimuli. The fact that this enhanced LPC activity was not apparent either for a structural processing task using the same faces in the preovulatory phase, or for any stimuli during any other phase suggests that the present finding of enhanced "sexiness" ratings during the preovulatory phase might be reflective of this enhanced LPC activity to sexual stimuli. The study by Macrae and colleagues demonstrated that compared to the menstrual phase, women in the preovulatory phase were faster at categorizing male faces and at accessing category-related stereotypes about men. These phase effects were not present for female faces or stereotypes. The enhanced ability to categorize men and access male stereotypes during the preovulatory phase might explain the tendency for ratings of sexiness and attractiveness to increase in the preovulatory phase while ratings of symmetry decreased. Since it is much more common or stereotypical to think about male faces as being "attractive" and "sexy" as opposed to "symmetrical", a greater accessibility to male-related stereotypes during the preovulatory phase might lead to increases in male related stereotypical ratings and decreases in ratings not commonly associated with maleness.

Also possibly relevant here is Ho, Gilger, and Brink's (1986) use of signal detection theory to examine the stringency of criteria used in making decisions during the menstrual cycle. They found that women applied less stringent criteria in their decision making process during the ovulatory phase than during the menstrual phase on a test of spatial reaction-time. The women spent less time working on the problems, responded faster, and applied a less stringent criteria in the decision process. While this test is clearly different than rating faces, it is possible that a response bias apparent on one test may translate to another task.

The tendency to rate a male face as more sexy during the time in the cycle when a woman is most likely to conceive suggests a decrease in selectivity moderated by gonadal steroids. Such a trait would be adaptive in that it would increase the likelihood of finding a potential mate attractive enough to copulate with, and thus increase the likelihood of passing on one's genes. This decrease in selectivity would be selected for through sexual selection as any gene that codes for a trait that increases the likelihood of copulating when one is most likely to conceive, would be passed on to any female offspring. However, if additional mate selection mechanisms were not operating simultaneously (e.g., olfactory symmetry detection) such a general mating strategy would likely have some "costs" in terms of offspring health.

The general increase in sexiness ratings during ovulation cannot be accounted for by poorer visual sensitivity as visual sensitivity is greatest at midcycle (Diamond, Diamond & Mast, 1972). However, it is possible that Wright and Badia's (1999) finding of decreased alertness during the preovulatory phase on a maintenance of wakefulness test for sleep deprived women may reflect or play a role in the use of less stringent criteria for evaluating male sexiness.

Ability to Detect Facial Symmetry is Related to the Preference for Symmetrical Faces

This study appears to be the first to specifically examine the relationship between one's ability to detect symmetry and one's preference for symmetry. As predicted, there were highly significant positive correlations between scores on the Facial Symmetry Detection test and scores on the Attractiveness of Facial Symmetry test (*r*s = .45 and .62 for the first and second session). The scores from the first session are most relevant as the ratings of attractiveness in the second session may be affected by previous exposure to the symmetry rating task. The results indicated that women who were better able to detect facial symmetry differences were also more likely to choose the more symmetrical face as being more attractive. This relationship suggests that facial symmetry is an important factor in judging the attractiveness of a face, that people differ in their ability to detect symmetry, and that the ability to detect symmetry affects the degree to which one judges symmetrical faces as attractive. As noted earlier, it is somewhat surprising that our findings indicate that the ability to detect facial symmetry changes across the menstrual cycle but that there are no cyclic changes in the preference for facial symmetry.

Alcohol Consumption Associated with a Failure to Improve on the Facial Symmetry Detection Test

Women who reported drinking greater than three alcoholic beverages per drinking occasion were more likely to show a decrease in their score on the Facial Symmetry Detection Test from the first to the second testing session, while the scores of non-drinkers and light to moderate drinkers (less than four drinks) generally increased. The correlation between mean typical number of alcoholic beverages consumed per drinking occasion (mean drinks) and Facial Symmetry Detection Difference scores was significant, $r(45) = .38$, $p = .01$, and examination of the data revealed a dose-effect relationship (see Figure 9). This finding suggests the possibility that alcohol has a neurotoxic effect on the brain and that cognitive abilities such as visual learning are affected in young women, as well as in older chronic alcoholics (Chelune & Parker, 1981). Evidence of clearly lower improvement on the test as a function of mean drinks is a serious concern, especially given the young age of the participants. However, two alternative explanations might account for this finding: (a) The relationship may reflect a premorbid biological/genetic difference that serves as a marker for vulnerability to alcohol use. (b) Personality factors may account for the relationship. Each of these possibilities will be examined.

The first alternative to the possibility that alcohol causes neurotoxic effects at high doses is that the decrement observed on the Facial Symmetry Detection test reflects the decreased visuospatial learning ability that has been observed in children of alcoholic parents (Schandler, Cohen, & Antick, 1992). It is possible that the failure to improve on the symmetry detection test reflects premorbid deficits attributable to genetics as opposed to alcohol use. This could be examined in future research by comparing women with alcoholic versus non-alcoholic parents who themselves are equivalent in terms of alcohol consumption.

It is also possible that the same personality factors that are associated with or are responsible for high alcohol intake (e.g., high sensation seeking, greater need for arousal/stimulation, high extraversion) would also make an individual less likely to put forth a full effort on the Symmetry Detection Test on second testing due to boredom or lack of stimulation/interest. Research indicates that the following personality traits are associated with alcohol use: low conscientiousness, high extraversion, high neuroticism, and high sensation seeking/impulsivity (Baer, 2002; Vollrath & Torgersen, 2002). Given the two hour length of the testing session, the repetition of the tests from the first session in the second session, and the tedious nature of some of the tests, it is entirely possible that individuals with a greater need for stimulation might not have given their best effort at the second testing session. Two sets of post-hoc analyses were undertaken to examine this hypothesis within the present study. First, mean scores on the social participation scale of Jackson's Personality Inventory (JPI) (Jackson, 1994) were calculated based on scores from the two testing session. This scale is a measure of sociability and extroversion. Significant positive correlations were found between the mean social participation score and mean drinks, $r(45) = .30, p < .05$, and as well as Facial Symmetry Detection Difference scores, $r(45) = .30, p = .04$. These results suggested that individuals who require or enjoy more social stimulation also tend to drink more alcohol per drinking occasion and tended to perform worse on their second Facial Symmetry Detection test than the first. However, when the social participation score was controlled for, the correlation between mean drinks and Facial Symmetry Detection difference scores decreased slightly but remained significant, partial $r(42) = .32$, $p = .03$. These findings suggest that the need/desire for social stimulation is associated with both higher alcohol use and a decrement in performance on the Facial Symmetry Detection test. However, the correlations also indicate that this personality trait clearly cannot account for the decrement in performance that is associated with alcohol use. While these analyses cannot answer the question of whether alcohol-associated brain dysfunction is responsible for our findings, they do suggest that further research examining other personality characteristics and family alcohol history is warranted.

Study Limitations and Future Research

Overall, the design of the present study was quite sound and lends validity to the findings. The strengths of this study include: the within-subject design, a larger sample size than most studies examining change in mate selection based on conception probability, inclusion of three menstrual phases in the design (menstrual, preovulatory, and luteal), strict participant exclusion criteria, the use of a valid and reliable test of Facial Symmetry Detection Ability, inclusion of five different methods to obtain menstrual date information (Screening Questionnaire, telephone call, First Session Questionnaire, Second Questionnaire, and Daily Rating Questionnaire), and the completion of a daily questionnaire throughout the study which allowed for prospective (as opposed to retrospective) reports of menstruation dates. In addition, the fact that each woman was tested twice and completed most tests and questionnaires twice increases the reliability of any menstrual phase and non-menstrual phase findings as mean scores could be calculated across the testing sessions.

Three aspects of the study design could be improved upon. First, the ideal situation would have involved each woman completing the testing session during all three phases of her menstrual cycle. However, due to the already extensive participation requirements of the study and the large practice effects on some tests, such a design would not have been feasible and the drop-out rate would have been high. Second, the use of BBT measurements and/or salivary hormonal assays to confirm phase of menstrual cycle and ovulation would enhance the one's confidence in the current findings. While BBT measures were taken by many women and salivary samples were collected from all women, these results will be reported in future manuscripts. Third, the internal consistency of the Dot Symmetry Test is quite low. Adding more stimuli would likely enhance the reliability and validity of this test. Fourth, it is not entirely clear how the extensive participation requirements of the study were related to the type of women who volunteered for and completed the study. However, when considering the generalizability of the current results, both subject inclusion/exclusion criteria and possible personality factors associated with completion of such a study (e.g., conscientiousness) should be kept in mind. Finally, despite the high reliability and validity of the Facial Symmetry Detection test, the attractiveness ratings of the faces were quite low and some participants commented on the general unattractiveness of the male faces. While an attempt was made to include faces with a wide range of attractiveness values, some women did consider many faces to be unattractive. Thus, the possibility does remain that different findings might emerge with the use of facial stimuli that exhibit higher levels of attractiveness.

The results of this study suggest a number of future research projects. One unanswered question is whether the menstrual phase advantage on the Facial Symmetry Detection test (a test with no time component) is specific to facial stimuli or more sensitive to facial stimuli. Similarly, it is not clear whether the trend towards a luteal phase advantage on the Dot Symmetry test is specifically related to the time component of the test. If this is the case then a facial symmetry detection test presented in the same manner would result in the same luteal phase advantage. There are three possible answers to this question. The first possibility is that there is less hemispheric asymmetry for nontimed tests during the menstrual phase, less hemispheric asymmetry for timed tests during the luteal phase, and that the nature of the stimuli is irrelevant (i.e., facial vs. nonfacial). The second possibility is that less hemispheric asymmetry occurs when judging facial symmetry during the menstrual phase and non-facial symmetry during the luteal phase, and that the method of test presentation is irrelevant. It is also possible that both the nature of the stimuli (facial versus nonfacial) and the nature of the task (time component versus no time component) are affected by different aspects of hemispheric activational asymmetry across the menstrual cycle. These questions could be answered by examining performance on four tests across the menstrual cycle: Facial Symmetry Detection with unlimited stimulus presentation time, Facial Symmetry Detection with a 3 second stimulus presentation time, Dot Symmetry Detection with unlimited stimulus presentation time, and Dot Symmetry Detection with a 3 second stimulus presentation time. A second unanswered question deserving further research (and suggestions were provided above) is whether high alcohol intake causes a visuoperceptual learning decrement on the Facial Symmetry Detect test.

There are three main suggestions that could be provided for future research in this area. First, the asymmetric hemispheric activation interpretation of the menstrual phase advantage on the Facial Symmetry Detection test highlights an important suggestion for any research examining evolutionary hypotheses. If examining differences between high and low conception probability phases of the cycle, it is important to include women from all phases of the menstrual cycle in the design as opposed to just examining the menstrual versus preovulatory phases (e.g., Macrae et al., 2002) or the preovulatory versus luteal phases. Failure to include all three phases leaves open the possibility that any significant conception probability effect might be better explained by hemispheric asymmetry rather than conception likelihood. Had the present study only included the preovulatory and luteal phase, no effect would have been evident for the Facial Symmetry Detection test while a comparison of only the preovulatory and menstrual phases would have missed the gradual decrease in facial symmetry detection ability that occurs with rising gonadal steroids (see Figure 10). Second, although the significance of the relationship is unclear at this point, the finding of an association between alcohol use and Facial Symmetry Detection difference scores suggests the importance of controlling for substance use in any study examining perceptual abilities. While important in any study on perception or cognition, this would be particularly important for menstrual cycle research as some drugs exhibit cyclic effects on cognition across the menstrual cycle (e.g., Pomerleau, Teuscher, Goeters, & Pomerleau, 1994).

Summary

In summary, the present study provides strong support for a role of gonadal steroids in modulating perceptual abilities and mate selection criteria. Although there was no evidence to support the hypotheses that women have an enhanced ability to detect symmetry and show a preference for symmetrical faces during the preovulatory phase, a number of other interesting findings emerged. The major findings are of an activational effect of hormones on the ability to detect facial symmetry and on the general sexiness ratings of male faces. The ability to detect facial symmetry was optimal in the menstrual phase of the cycle and the ratings of sexiness were significantly higher for all male faces during the preovulatory phase, compared to the rest of the cycle. In addition, strong nonsignificant trends were evident for a luteal phase advantage on the

Dot Symmetry Test and for the pattern of rating male faces as more attractive and less symmetrical during the preovulatory phase of the cycle. The findings were interpreted in the context of asymmetric hemispheric activation and evolutionary mate selection theory. Additional noteworthy findings include a failure to replicate the menstrual phase advantage on a visuospatial task, and evidence of a dose-effect association between alcohol consumption and decreased visuoperceptual learning. The present findings contribute to knowledge about the relationships between menstrual phase hormonal fluctuations and both cognitive/perceptual ability and mate selection.

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Appendix A

Subject Number: ________

Screening Questionnaire

1) Age: ________

2) Sex (Circle your answer): male female

3) Years of Education (years from grade 1 to 13 + years of university/college): ________

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

5) Weight: ________ (pounds) or ________ (kg)

6) Today's date: ________ ________ ________
Day of week (e.g., Monday) Day of Month (e.g., 5th) Month: (e.g., May)

7) What subject are/were you majoring in if you are/were in school (e.g., English, Psychology): ________

8) What degree are/were you working towards if you are/were in school (e.g., BA, BSc)?: ________

9) Are you currently taking any medications? (Circle your answer) YES NO

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

____

____

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

____

____

11) Do you think that any of your first degree relatives (i.e., parents, siblings, grandparents, aunts/uncles) have had any psychiatric problems (e.g., depression, anxiety, mood problems, schizophrenia, eating disorder, alcoholism, panic attacks)? (Circle your answer)

YES NO MAYBE

12) If asked to choose, what colour eyes would you prefer in a romantic partner? (Check the box)

[ ] blue [ ] brown

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

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

15) If your are currently in a steady relationship, what colour are your partner's eyes? ___________

16) This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you have felt this way *today*. Use the following scale to record your answers.

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

____ interested	____ enthusiastic	____ attentive
____ distressed	____ proud	____ jittery
____ excited	____ irritable	____ active
____ upset	____ alert	____ afraid
____ strong	____ ashamed	
____ guilty	____ inspired	
____ scared	____ nervous	
____ hostile	____ determined	

17) Please report the eye colour of the following people (only answer for those that you are fairly confidant about):

You ____________________________
Your mother ____________________ Your father ____________________
Your mother's father ____________ Your father's father ____________
Your mother's mother____________ Your father's mother: ____________

18) a) When you were growing up (birth to age 16), were there ever any **males** living in your home(s) that you were **not related to biologically** (by blood)? (Circle your answer) YES NO

b) If you answered "YES" to part (a), **how many** different males (that you were not related to biologically) lived in your home(s) between your birth and the time you turned 16? ___________

c) If you answered "YES" to part (a), please describe the relationship of each male to you (e.g., stepfather, adopted brother, family friend), their approximate age range when they lived with you (e.g., age 40 to 60), and your age range when they lived with you (e.g., age 4 to 16):

male #1) relationship ____________
male's age ____________
your age ____________

male #2) relationship____________
male's age____________
your age____________

19) Check the box of the statement that best describes you:
[ ] I feel happiest and most productive in the morning hours of the day.
[ ] I feel happiest and most productive in the evening hours of the day.
[ ] I am equally happy and productive in the morning and evening.

THE FOLLOWING QUESTIONS ARE FOR FEMALES ONLY:

20) Are you currently pregnant? (Circle your answer) YES NO MAYBE

21) Are you currently taking oral contraceptives? (Circle your answer) YES NO

22) If you are currently taking oral contraceptives, for how many years and months have you been taking oral contraceptives?______years and ________months

23) If you are currently taking oral contraceptives, please put an 'X' beside the type of oral contraceptive you are currently taking.

Alesse	____	Ortho-Cept	____
Brevicon 0.5/35	____	Ortho 7/7/7	____
Brevicon 1/35	____	Ortho 10/11	____
Cyclen	____	Synphasic	____
Demulen 30	____	Tri-Cyclen	____
Loestrin	____	Triphasil	____
Marvelon	____	Triquilar	____
MinEstrin	____	Demulen 50	____
Min-Ovral	____	Norlestin 1/50	____
Norinyl	____	Ovral	____
Ortho 1/35	____	Ortho-Novum 1/50	____
Ortho 0.5/35	____	Other	____ Name:______________

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

25) If you have **previously taken oral contraceptives** but are not taking them right now, how many years and months has it been since you last took oral contraceptives? ______years and ________months

26) What is the average length of your menstrual cycle (i.e., how many days are there from the first day of one period to the first day of your next period)? ________

27) What is your average length of menstruation (i.e., how many days does your period last)? ________

28) Which statement best describes your menstrual cycle? (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.

29) How old were you when you first started menstruating? ________ years old

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

May

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		

June

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

July

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				

August

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	

31) How confidant are you that the above circled days include most of the days of your last period? (Circle the best response)

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

32) How confidant 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

Appendix B

Subject Number: ________

Daily Rating Questionnaire

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

Attached to this sheet is a package of 35 questionnaires. You are to **fill out one questionnaire every day at the same time for the next 35 days starting today**. Please write your subject number at the top of each page and fill out each questionnaire on the day it is to be filled out. If you forget to fill out the form for one day, then fill it out when you remember, but check the box indicating that you completed it a day late. With regards to taking your **morning temperature, take it when you wake up each morning before you get out of bed or do any activity whatsoever**. Record the temperature right away. (It is probably best to keep the thermometer and Daily Rating Questionnaire on your bedside table.) Upon waking, place the thermometer in you mouth under your tongue for four minutes and lie still, before reading the temperature. Record the temperature in °C to two decimal places (e.g., 36.65 or 36.40). After taking your temperature and recording it, shake the thermometer with your full arm so that the mercury falls below 35 °C/94°F and the thermometer will be ready for the next day. In terms of cleaning the thermometer, do not wash it in hot water. Instead, use cold soapy water. You can choose any time of the day to complete the rest of the questionnaire as long as you complete it at the same time each day.

The date and time of your **first and second experimental sessions** are listed below. **Please bring this questionnaire to each of these sessions (or be sure to bring your subject number)** as subject numbers are used to keep track of participants. Please be assured that all your responses on the questionnaires will remain anonymous as your name is not connected to any of your responses. Unless you object (and please make sure to tell the researcher today), you will receive a reminder phone call from the experimenter prior to each of the experimental sessions. On the day of both the first and second experimental testing sessions, **do not eat, drink, smoke, or brush your teeth for at least one hour prior to the session**.

Once you have completed all 35 days of the study, come to the **final session** to **return this package of Daily Rating Questionnaires and the thermometer**. At this time you will receive your three bonus points (if you are a Psychology 1100 student) and have your name placed in the two draws for $50 each.

The date and time of your First Session is: ____________________
The date and time of your Second Session is: ____________________
The date and time of your Final Session is: ____________________

If you need to reschedule the date and/or time of these sessions, please call Kirsten Oinonen (344-5739) or Dr. Mazmanian (343-8257). If you have any questions about the study then do not hesitate to call. Just leave a message on the machine saying that you are a subject in the study and leave your phone number. Your call will be returned as soon as possible.

---

1) Today's date: ____________________ ____________________ ____________________

Day of week (e.g., Monday) Day of Month (e.g., 5th) Month: (e.g., May)

2) What is your morning temperature? __________°C (to 2 decimal places)

3) How many hours did you sleep last night? ___________

4) If you smoke, how many cigarettes did you smoke in the past 24 hours? _________

5) Do you have any reason to believe that you may have a fever? (e.g.., hot forehead and feel sick)

[ ] yes [ ] no

6) **This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you have felt this way *today*. Use the following scale to record your answers.**

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

____ interested	____ hostile	____ nervous
____ distressed	____ enthusiastic	____ determined
____ excited	____ proud	____ attentive
____ upset	____ irritable	____ jittery
____ strong	____ alert	____ active
____ guilty	____ ashamed	____ afraid
____ scared	____ inspired	____ sexual desire

7) Are you menstruating (bleeding) today? (Check the appropriate box) [ ] yes[ ] no

8) How many times did you have sexual intercourse during the past 24 hours? _________

9) If you had sexual intercourse during the past 24 hours, who initiated the activity? Check the appropriate box. (If you had sex more than one time, put numbers in the appropriate boxes.)
[ ] me
[ ] my partner
[ ] both of us

10) Of the past 24 hours, how many hours did you spend alone? (Please include any time spent sleeping if you were sleeping alone) ________ hours

11) Check the box that best describes what you would prefer to do tonight.

[ ] spend a quiet evening alone

[ ] attend a social event

12) Give your best estimate of the number of telephone calls that you made during the past 24 hours? _____

13) Approximately how much time did you spend on the telephone in the past 24 hours? (in minutes or hours)

____

14) Check the box that best describes the time that you completed this questionnaire (Please try to complete the questionnaire at the same time each day).

[ ] on the correct day [ ] one day late

Appendix C

Subject Number: ________

First Session Questionnaire

1) Today's date: ____________________ ____________________ ____________________

Day of week (e.g., Monday) Day of Month (e.g., 5th) Month: (e.g., May)

2) Do you smoke cigarettes? (Circle response) YES NO

3) If you are a smoker, how many cigarettes on average do you smoke per day? ___________

4) How many hours did you sleep last night? _______

5) How often do you normally consume alcohol? Circle one number from 0 to 4.

never	once or twice a month	once or twice a week	three to four times a week	almost every day
0	1	2	3	4

6) What is the average number of drinks you have when/if you drink? Circle one number.

none	one to three	four to seven	eight to twelve	more than 12
0	1	2	3	4

7) How often do you use illegal drugs such as marijuana, hash, cocaine, LSD, etc.?

never	once or twice a month	once or twice a week	three to four times a week	almost every day
0	1	2	3	4

8) **Rate the importance of the following characteristics in your selection of a potential romantic partner. (Circle the number that best describes the importance of these traits in a romantic partner):**

	Not at all Important								Extremely Important
kindness and understanding	1	2	3	4	5	6	7	8	9
sex appeal	1	2	3	4	5	6	7	8	9
faithfulness and loyalty	1	2	3	4	5	6	7	8	9
physical attractiveness	1	2	3	4	5	6	7	8	9
stable personality	1	2	3	4	5	6	7	8	9

social status	1	2	3	4	5	6	7	8	9
responsibility	1	2	3	4	5	6	7	8	9
financial resources	1	2	3	4	5	6	7	8	9
sense of humour	1	2	3	4	5	6	7	8	9
fun and exciting personality	1	2	3	4	5	6	7	8	9
similar values and beliefs	1	2	3	4	5	6	7	8	9
desire for children	1	2	3	4	5	6	7	8	9
qualities of a good parent	1	2	3	4	5	6	7	8	9
quality of health	1	2	3	4	5	6	7	8	9
intelligence	1	2	3	4	5	6	7	8	9

9) **Please answer all of the following questions honestly. For the questions dealing with behaviour, *write* your answers in the blank spaces provided. For the questions dealing with thoughts and attitudes, *circle* the appropriate number on the scales provided.**

a) With how many different partners have you had sex (sexual intercourse) within the past year? _____

b) How many different partners do you foresee yourself having sex with during the next five years? (Please give a *specific, realistic* estimate) ______

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

d) How often do (did) you fantasize about having sex with someone other than your current (most recent) dating partner? (Circle one; If you have not been in a dating relationship then leave this question blank)

1. Never
2. Once every two or three months
3. One a month
4. Once every two weeks
5. Once a week
6. A few times each week
7. Nearly every day
8. At least once a day

e) Sex without love is OK.

I Strongly Disagree ... I Strongly Agree

1 2 3 4 5 6 7 8 9

f) I can imagine myself being comfortable and enjoying "casual" sex with different partners.

I Strongly Disagree — I Strongly Agree

1 2 3 4 5 6 7 8 9

g) 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/her"

I Strongly Disagree — I Strongly Agree

1 2 3 4 5 6 7 8 9

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

i) How frequently do you think about sex?

Virtually Never — Almost all of the time

1 2 3 4 5 6 7 8 9

j) During the past year, with how many different partners have you had only one occasion of sexual contact (e.g., hands to genitals, hands to breasts, oral-genital) that did not include sexual intercourse? ________

10) **This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you have felt this way *today*. Use the following scale to record your answers.**

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

____ interested	____ irritable
____ distressed	____ alert
____ excited	____ ashamed
____ upset	____ inspired
____ strong	____ nervous
____ guilty	____ determined
____ scared	____ attentive
____ hostile	____ jittery
____ enthusiastic	____ active
____ proud	____ afraid

11) **A number of statements are listed below. Read each statement and describe to what extent each statement describes you. Use the following scale to record your answers.**

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

a) I only telephone friends when there is something important to discuss. ______
b) My life would be miserable if I didn't know a lot of people. ______
c) It wouldn't bother me to go for days without seeing another person. ______
d) I enjoy group activities more than the things I do by myself. ______
e) I like working where I won't be bothered by others. ______
f) I dislike eating alone. ______
g) I don't particularly like to be surrounded by a group of noisy people. ______
h) When travelling alone, I enjoy engaging in conversations with strangers. ______
i) I like spare time activities which allow me to get away from people. ______
j) I get lonely when I am left by myself. ______
k) I would prefer a quiet evening at home to attending a social event. ______
l) I would rather telephone a friend than read a magazine in my spare time. ______
m) I am not interested in knowing a great many people. ______
n) I like to meet as many new people as I can. ______
o) I find it very relaxing to travel by myself. ______
p) I spend a great deal of my spare time with other people. ______
q) I don't need the company of others to be happy. ______
r) Rather than spend an evening by myself, I would invite a neighbour in to talk. ______
s) Generally, I prefer to be by myself. ______
t) At a social event, I like to get around and talk to all the guests. ______

12) Check the box that best describes your sexual orientation.
[ ] heterosexual [ ] bisexual [ ] homosexual

13) Check the box that best describes your handedness.
[ ] right-handed [ ] left-handed [ ] ambidextrous (use both hands a lot)

14) Are you colour-blind? [ ] yes [ ] no

15) At what age did you first start menstruating? ________
16) Are you currently menstruating (i.e., today)? YES NO
17) If you are currently menstruating, for how many days have you had your period (including today)? _____
18) If you are not currently menstruating, what day are you at in your cycle (day 1 = the first day of your last period)? __________
19) Please check the box of any of the following medical disorders if one of your **family members/blood relatives** (e.g., parent, grandparent, sibling, aunt, uncle) has ever been diagnosed with it:
[ ] cancer (specify type if known:__________) [ ] heart disease
[ ] diabetes [ ] thyroid disorder (specify type if known:________

Appendix D

Subject Number: ________

Second Session Questionnaire

1) Today's date: ____________________ ____________________ ____________________
Day of week (e.g., Monday) Day of Month (e.g., 5th) Month: (e.g., May)

2) Do you smoke cigarettes? (Circle response) YES NO

3) If you are a smoker, how many cigarettes on average do you smoke per day? ____________

4) How many hours did you sleep last night? ________

5) How often do you normally consume alcohol? Circle one number from 0 to 4.

never	once or twice a month	once or twice a week	three to four times a week	almost every day
0	1	2	3	4

6) What is the average number of drinks you have when/if you drink? Circle one number.

none	one to three	four to seven	eight to twelve	more than 12
0	1	2	3	4

7) How often do you use illegal drugs such as marijuana, hash, cocaine, LSD, etc.?

never	once or twice a month	once or twice a week	three to four times a week	almost every day
0	1	2	3	4

8) **Rate the importance of the following characteristics in your selection of a potential romantic partner. (Circle the number that best describes the importance of these traits in a romantic partner):**

	Not at all Important								Extremely Important
kindness and understanding	1	2	3	4	5	6	7	8	9
sex appeal	1	2	3	4	5	6	7	8	9
faithfulness and loyalty	1	2	3	4	5	6	7	8	9
physical attractiveness	1	2	3	4	5	6	7	8	9
stable personality	1	2	3	4	5	6	7	8	9
social status	1	2	3	4	5	6	7	8	9
responsibility	1	2	3	4	5	6	7	8	9
financial resources	1	2	3	4	5	6	7	8	9

sense of humour	1	2	3	4	5	6	7	8	9
fun and exciting personality	1	2	3	4	5	6	7	8	9
similar values and beliefs	1	2	3	4	5	6	7	8	9
desire for children	1	2	3	4	5	6	7	8	9
qualities of a good parent	1	2	3	4	5	6	7	8	9
quality of health	1	2	3	4	5	6	7	8	9
intelligence	1	2	3	4	5	6	7	8	9

9) **Please answer all of the following questions honestly. For the questions dealing with behaviour, *write* your answers in the blank spaces provided. For the questions dealing with thoughts and attitudes, *circle* the appropriate number on the scales provided.**

a) With how many different partners have you had sex (sexual intercourse) within the past year? _____

b) How many different partners do you foresee yourself having sex with during the next five years? (Please give a *specific, realistic* estimate) ______

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

d) How often do (did) you fantasize about having sex with someone other than your current (most recent) dating partner? (Circle one; If you have not been in a dating relationship then leave this question blank)

1. Never
2. Once every two or three months
3. One a month
4. Once every two weeks
5. Once a week
6. A few times each week
7. Nearly every day
8. At least once a day

e) Sex without love is OK.

I Strongly Disagree — I Strongly Agree

1 2 3 4 5 6 7 8 9

f) I can imagine myself being comfortable and enjoying "casual" sex with different partners.

I Strongly Disagree — I Strongly Agree

1 2 3 4 5 6 7 8 9

g) 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/her"

I Strongly Disagree — I Strongly Agree

1 2 3 4 5 6 7 8 9

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

i) How frequently do you think about sex?

Virtually Never — Almost all of the time

1 2 3 4 5 6 7 8 9

j) During the past year, with how many different partners have you had only one occasion of sexual contact (e.g., hands to genitals, hands to breasts, oral-genital) that did not include sexual intercourse? _______

10) **This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you have felt this way *today*. Use the following scale to record your answers.**

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

____ interested
____ distressed
____ excited
____ upset
____ strong
____ guilty
____ scared
____ hostile
____ enthusiastic
____ proud
____ irritable
____ alert
____ ashamed
____ inspired
____ nervous
____ determined
____ attentive
____ jittery
____ active
____ afraid

11) **A number of statements are listed below. Read each statement and describe to what extent each statement describes you. Use the following scale to record your answers.**

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

a) I only telephone friends when there is something important to discuss. _____

b) My life would be miserable if I didn't know a lot of people. ______
c) It wouldn't bother me to go for days without seeing another person. ______
d) I enjoy group activities more than the things I do by myself. ______
e) I like working where I won't be bothered by others. ______
f) I dislike eating alone. ______
g) I don't particularly like to be surrounded by a group of noisy people. ______
h) When travelling alone, I enjoy engaging in conversations with strangers. ______
i) I like spare time activities which allow me to get away from people. ______
j) I get lonely when I am left by myself. ______
k) I would prefer a quiet evening at home to attending a social event. ______
l) I would rather telephone a friend than read a magazine in my spare time. ______
m) I am not interested in knowing a great many people. ______
n) I like to meet as many new people as I can. ______
o) I find it very relaxing to travel by myself. ______
p) I spend a great deal of my spare time with other people. ______
q) I don't need the company of others to be happy. ______
r) Rather than spend an evening by myself, I would invite a neighbour in to talk. ______
s) Generally, I prefer to be by myself. ______
t) At a social event, I like to get around and talk to all the guests. ______

12) Check the box that best describes your sexual orientation.
[ ] heterosexual [ ] bisexual [ ] homosexual

13) Check the box that best describes your handedness.
[ ] right-handed [ ] left-handed [ ] ambidextrous (use both hands a lot)

14) Are you colour-blind? [ ] yes [ ] no

15) At what age did you first start menstruating? ________

16) Are you currently menstruating (i.e., today)? YES NO

17) If you are currently menstruating, for how many days have you had your period (including today)? _____

18) If you are not currently menstruating, what day are you at in your cycle (day 1 = the first day of your last period)? __________

19) Please check the box of any of the following medical disorders if one of your **family members/blood relatives** (e.g., parent, grandparent, sibling, aunt, uncle) has ever been diagnosed with it:
[ ] cancer (specify type if known:___________) [ ] heart disease
[ ] diabetes [ ] thyroid disorder (specify type if known:________)

Appendix E

CONSENT FORM A

This study is being conducted by Kirsten Oinonen under the supervision of Dr. D. Mazmanian of the Department of Psychology at Lakehead University. The purpose of the study is to examine neuroendocrine effects on physical, psychological, and emotional variables. 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 stage of the study will receive three bonus points towards their final mark for participating (if they are Psychology 1100 students) and will have their names placed in a draw for two $50 cash prizes.

Your participation in the screening 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, medical information, reproductive history, relationship information, and mood.

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. D. Mazmanian at Lakehead University and remain anonymous and 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 and telephone number on this form (please do not detatch 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 both anonymous and 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: ____

Date: ____

If you have any questions or concerns regarding this study please contact Kirsten Oinonen (344-5739) or the supervisor of the study, Dr. Mazmanian (343-8257).

Appendix F

DEBRIEFING FORM A

Thank you for participating in the screening phase of our study. Portions of this research constitute a Doctoral Dissertation by Kirsten Oinonen. If your are selected to participate in the second part of the study, you will be contacted by the researcher, Kirsten Oinonen, in the next three weeks. Participants in the next phase of the study will receive three points towards their final mark (if they are Psychology 1100 students) and all participants will have their names entered into two draws for $50 each.

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 anonymous. If you would like more information on the results of this study then please fill in your address on the attached mailing label and a summary will be sent to you at the end of this study.

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Appendix G

CONSENT FORM B

This study is being conducted by Kirsten Oinonen under the supervision of Dr. D. Mazmanian of the Department of Psychology at Lakehead University. The purpose of the study is to examine neuroendocrine effects on physical, psychological, and emotional variables.

The study consists of four phases that will all take place within 35 days. Phase 1 involves completing a short questionnaire daily for 35 days. On this questionnaire you will also be asked to record your morning temperature upon waking. Phases 2 and 3 are two sessions that will take place at Lakehead University during the 35 days and last approximately two hours. The two sessions will be scheduled approximately 10 to 14 days apart. During each session you will be asked to: complete a questionnaire, complete perceptual tests, have some physical measurements taken (e.g., height and weight), rate male faces on a number of variables, and provide two samples of saliva (for neuroendocrine analysis). The questionnaire includes personal questions about topics such as: health information (e.g., smoking, sleeping), reproductive information, sexual and relationship information, and mood. At the end of 35 days, the Phase 4 session will be scheduled to drop off the Daily Rating Questionnaire. This last session will only take a few minutes and at this time, Psychology 1100 students will receive three points towards their final mark and all participants will have their names entered into two draws for $50 each. The winners will be notified at the end of the study (late summer).

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. D. Mazmanian at Lakehead University and remain anonymous and confidential. 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: ________________________________

If you have any questions or concerns regarding this study please contact Kirsten Oinonen (344-5739) or the supervisor of the study, Dr. Mazmanian (343-8257).

Appendix H

DEBRIEFING FORM B

Thank you for participating in this study. The data you have contributed will be used to investigate the effects of various biochemical indices (e.g., progesterone and estrogen) on mood, perceptual ability, and perceptions of attractiveness. Portions of this research constitute a Doctoral Dissertation by Kirsten Oinonen. We are particularly interested in determining the extent to which neuroendocrine functioning influence women's perceptions of male attractiveness. Research suggests that women's perceptions change over their menstrual cycle (e.g., Grammer & Thornhill, 1994; Penton-Voak et al., 1999).

Please be assured that all of your responses are coded to conceal your identity on the questionnaires and that all data will remain anonymous. Below are listed some related references which might be of interest to those who would like further information on the effects of hormones on perceptions of attractiveness. If you would like more information on the results of this study, then please fill in your address on the attached mailing label and a summary will be sent to you at the end of this study.

Grammer, K., & Thornhill, R.(1994). Human (Homo sapiens) facial attractiveness and sexual selection: The role of symmetry and averageness. Journal of Comparative Psychology, 108, 233-242.

Penton-Voak, I.S., Perrett, D.I., Castles, D.L., Kobayashi, T., Burt, D.M., Murray, L.K., & Minamisawa, R. (1999). Menstrual cycle alters face preference. Nature, 399, 741-742.

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Appendix I

Means and Standard Deviations or Raw Frequency and Percentages for the Seven Variables Used to Assess Group Equivalency Across the Three Menstrual Phase Groups for the First Testing Session

Variable	Menstrual Phase *n* = 22	Preovulatory Phase *n* = 20	Luteal Phase *n* = 18
	Means (Standard Deviations)		
Age	24.00 (8.18)	23.15 (6.79)	25.22 (6.93)
Education (years)	13.95 (1.99)	14.25 (1.71)	15.35 (2.52)
Body Mass Index (kg/m^2)	25.10 (4.78)	27.85 (8.27)	27.16 (6.25)
Alcohol Frequ. Score	1.41 (0.67)	1.15 (0.59)	1.11 (0.68)
Alcohol Consump. Score	1.59 (0.80)	1.35 (0.67)	1.11 (0.76)
Sleep (hours)	7.73 (1.35)	7.35 (1.42)	7.61 (1.58)
	Raw Frequency (Percentage)		
Relationship Status			
partner	15 (68.18)	10 (50.00)	9 (50.00)
no partner	7 (31.82)	10 (50.00)	9 (50.00)

Appendix J

Means and Standard Deviations or Raw Frequency and Percentages for the Seven Variables Used to Assess Group Equivalency Across the Three Menstrual Phase Groups for the Second Testing Session

Variable	Menstrual Phase $n = 14$	Preovulatory Phase $n = 18$	Luteal Phase $n = 17$
	Means (Standard Deviations)		
Age	24.21 (6.70)	25.50 (8.29)	22.18 (6.33)
Education (years)	14.21 (1.72)	14.82 (2.72)	14.12 (2.12)
Body Mass Index (kg/m^2)	26.94 (6.70)	26.24 (5.46)	27.67 (7.27)
Alcohol Frequ. Score	0.93 (0.62)	1.11 (0.76)	1.53 (0.80)
Alcohol Consump. Score	1.21 (0.80)	1.28 (0.67)	1.59 (0.62)
Sleep (hours)	7.43 (1.40)	7.33 (1.64)	7.94 (1.68)
	Raw Frequency (Percentage)		
Relationship Status			
partner	5 (35.71)	10 (55.56)	9 (52.94)
no partner	9 (64.29)	8 (44.44)	8 (47.06)

Appendix K

Means and Standard Deviations or Raw Frequency and Percentages for the Seven Variables Used to Assess Group Equivalency Across the Three Menstrual Phase Groups for the Second minus First Session Difference Score Analyses

Variable	Menstrual Phase	Preovulatory Phase	Luteal Phase
	$n = 13$	$n = 17$	$n = 15$
	Means (Standard Deviations)		
Age	23.62 (6.58)	25.94 (8.33)	21.60 (5.89)
Education (years)	14.38 (1.66)	14.94 (2.77)	13.73 (1.58)
Body Mass Index (kg/m^2)	26.94 (6.70)	26.29 (5.63)	28.11 (7.61)
Alcohol Frequ. Score	1.00 (0.58)	1.24 (0.75)	1.33 (0.62)
Alcohol Consump. Score*	1.23 (0.73)	1.18 (0.73)	1.80 (0.68)
Sleep (hours)	7.54 (1.61)	7.53 (1.28)	7.67 (1.45)
	Raw Frequency (Percentage)		
Relationship Status			
partner	5 (38.46)	10 (58.82)	7 (46.67)
no partner	8 (61.54)	7 (41.18)	8 (53.33)

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