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From Passive Receptacles to Active Contenders: Ovulation and Intrasexual Competition in Human Females

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Abstract

Recent evidence has suggested that ovulation in humans might be accompanied by subtle cues. Furthermore, several studies have suggested that women engage in intrasexual competition, or competition with members of the same sex, with the aim of obtaining high quality mates. This competition involves the use of complex strategies including self-promotion and rival derogation. The link between ovulation and intrasexual competition remains largely underexplored, although a few studies have suggested that intrasexual competition might become intensified during ovulation. This paper explores the relationship between ovulatory cue detection and intrasexual competition and outlines two research proposals for future analysis of this topic. Study 1 proposes an investigation of men and women's perception of women's gait. In this study, male and female participants would rate the attractiveness of women's gait. Female participants would also rate these gaits on perceived threat. The menstrual cycle of both the walkers and raters would be taken into account. Either male or female confederates would walk behind the participants in order to test whether women reduce their gait attractiveness in the presence of female rivals and enhance it in the presence of potential mates. Study 2 outlines an experiment to test female scent as an ovulatory cue. Both males and females would rate the scent of women on attractiveness at different stages of the menstrual cycle. Females would also rate the scents on perceived threat. This study would help to clarify whether women's ratings of other women are dependent on the menstrual cycle of both the female rater and the female being rated. Both the literature review and the proposed studies suggest a view of women as active contenders that play an essential role in the mating process within an evolutionary framework.

Introduction

Women are passive recipients that serve as receptacles for men's genes. Men compete against each other for resources such as status and money in order to obtain women that will serve the purpose of bearing their children. Since this is undoubtedly the case, it is curious that evolution would have yielded women that move and talk. A more effective female model would be a woman that is completely sedentary and requires minimal resources in order to stay alive and bear children. It is truly puzzling that evolution could have produced such ineffective females. Perhaps evolution is an erroneous theory?

Alternatively, this view of women is utterly false and inaccurate. Evolution does not promote a view of women as passive receptacles. Rather, it is a misinterpretation of evolution that yields such a view. A careful survey of results reported by evolutionary studies provides an image of women as active competitors that have an essential and complex role within an evolutionary framework. Some of the actions that are performed by women, as well as some of the actions performed by men, are not morally superlative. For instance, derogating other people or attacking another person are acts that society might desire to reduce in frequency. Rather than ignoring these acts, it is more useful to acknowledge them and investigate them scientifically in order to devise potential solutions. This paper represents an analysis of human thought and behavior from an evolutionary perspective with the aim of better understanding human behavior. Specifically, this paper is concerned with the detection of ovulatory cues and intrasexual competition between human females.

Understanding Evolutionary Psychology

Before understanding intrasexual competition and ovulation through an evolutionary perspective, it is necessary to understand evolutionary theory itself. Charles Darwin popularized this theory in his classic book titled *On the Origin of Species* (Darwin, 1859). Even though Darwin was not the first one to propose this idea, his book serves as a milestone that revolutionized our understanding of human nature (for more on the history of evolutionary theory, see Buss, 2012). In this book, Darwin argued that every living being is subject to the law of natural selection. Natural selection refers to the gradual fluctuation in the frequency of traits in a population due to the pressures exerted by environmental conditions and the ability of individuals to survive and reproduce. Individuals that are better fit to their environment will pass on their genes to subsequent generations more effectively than individuals that are not as fit.

Individuals that possess the best adaptations will be most likely to survive and pass on their genes to subsequent generations. Although there are species that reproduce asexually and species that have multiple sexes, this paper will focus on species that reproduce sexually and have only two sexes. In the case of these species, adaptations that increase the chances of an individual reproducing are said to increase that individual's mate value. Mate value refers to how attractive a particular individual is perceived to be by members of the opposite sex. Individuals with a higher mate value will be more likely to reproduce successfully than individuals with a lower mate value.

Another set of terms that must be defined before continuing is the difference between ultimate causation and proximate causation as they are used in evolutionary theory. On one hand, ultimate causation refers to the evolutionary motivation behind a particular action. On the other hand, a proximate cause is the immediate reason why an action occurs. For example, you might

argue that the reason why you ate a pizza for breakfast is that you enjoy its taste. This would be a proximate explanation of this behavior. However, you might also say that you ate that pizza because you need the caloric intake in order to survive and reproduce, which would constitute an ultimate explanation for this action.

While evolutionary theory can be applied to any living being, this paper will focus on how it applies to human beings. More specifically, this paper will focus on how evolution has influenced humans' thought and behavior. The scientific field that makes predictions about how humans think and behave based on evolutionary theory is known as evolutionary psychology. This field is relatively new, but it is one that has grown much in recent years (Buss, 2012). The basic premise of evolutionary psychology is that certain ways of thinking and certain behaviors lead to more successful survival and reproduction. For instance, a person who is terrified of sexual intercourse to the point of avoiding it altogether might not be as successful at reproducing as a person who enjoys it. Furthermore, evolutionary psychology assumes that these thoughts and behaviors, or at least predispositions that increase the chances of these thoughts and behaviors to occur, are inheritable. An inheritable trait that enhances reproduction or survival is known as an adaptation. Thus, evolutionary psychology focuses on adaptations that relate to human thought and behavior.

There are also some misconceptions about evolutionary theory that must be addressed before describing the literature. One of the most common misunderstandings is the assumption that evolutionary theory is equivalent to genetic determinism. Genetic determinism refers to the belief that genes are the sole force shaping human behavior (Buss, 2012). However, evolutionary theory recognizes the important role of the environment. Evolution does not deny cultural differences. Instead, it encompasses both nature and nurture into a comprehensive model that

recognizes that cross-cultural differences exist within an evolutionary framework. Therefore, it follows that human nature is not unalterable. Human behavior can be shaped to a certain extent by changing the environment.

The second common misconception about evolution is called the naturalistic fallacy (Buss, 2012). Many people assume that saying that something is natural or a product of evolution is the same as saying it is good or acceptable from a moral standpoint. Evolution has attempted to explain behaviors such as murder and rape, but this does not imply that these behaviors are in any way justified or that we should allow them to occur. Similarly, evolution suggests that intrasexual competition, which involves self-promotion and derogation of competitors, is part of human nature. However, this does not mean that promoting yourself or derogating other people is either acceptable or unacceptable. Evolution provides us with a clearer picture of our nature. In doing so, it allows us to assess what environment would yield a desired moral result. However, evolution cannot serve as a moral justification for any action and it does not provide moral guidelines.

The evolutionary framework that has been described thus far must be taken into consideration throughout the rest of the paper. These definitions and considerations will help to guide readers so as to achieve a better understanding of the more specific findings that will be discussed. The paper will begin by exploring the potential role of non-reproductive sex among humans and other primates. Then, this paper will delve into the specifics of ovulation in humans and whether men can detect ovulation. The next sections will investigate intrasexual competition among human females and will highlight the importance of viewing women as active competitors. Finally, the paper will conclude with two proposed studies that would serve to

integrate the fields of ovulatory cues and intrasexual competition and would serve to answer important questions that have arisen in the field of evolutionary psychology.

Ovulation and Intrasexual Competition in Humans

Ovulation and Non-Reproductive Sex in Different Species of Primates

Whereas chimpanzees mostly copulate during female estrus, humans mostly copulate…around the clock.

The obvious evolutionary advantage for sexually reproducing species to engage in sexual intercourse is the production of offspring. Thus, the behavioral component of sex is easily explained in terms of ultimate causation. Similarly, the motivation to copulate, or sexual drive, can be explained as evolutionarily adaptive. An organism with sexual drive is motivated to seek out sexual intercourse, which would increase the chances of its genes being passed on to subsequent generations. If the benefit of sexual drive is to increase the chances of reproduction, it might seem logical to assume that sexual drive should only be present when reproduction is possible. Sexual drive that occurs when reproduction is impossible might seem superfluous; such mistimed sexual drive could result in unnecessary energy and resource expenditure that could be employed at other times or towards other adaptive objectives.

Following this logic, ovulation in females should be accompanied by increased sexual drive in females as well as the origination or intensification of cues in females to which males might be sensitive. These conditions would encourage males and females to engage in sexual intercourse exclusively at the time of ovulation. By limiting intercourse to the time of ovulation, organisms would maximize their chances of reproductive success without investing unnecessary energy. Consistent with this set of hypotheses, ovulation is blatantly obvious in most mammalian species. In the case of chimpanzees, humans' closest genetic relatives, ovulation is accompanied by estrus. Estrus refers to females' prominent display of cues to signal ovulation that can be detected by males. In chimpanzees, estrus involves a behavioral component, in the form of

mating displays, and a physical component, in the form of bright red genital swelling, which make estrus easily detectable by males. Most copulation among chimpanzees occurs during or close to the time of ovulation, which is also consistent with the hypothesis that the role of sexual drive is to increment the chances of reproduction (Hashimoto & Furuichi, 2006).

Although this theory of sexual drive might seem intuitive, it is not entirely accurate. Sexual drive in humans is not limited to the period of ovulation. It is useful to consider the case of other nonhuman primates in order to understand why this might be the case. Bonobos, humans' closest genetic relatives along with the chimpanzee, also mate at times other than ovulation (Thompson-Handler et al., 1984). These primates are known for their promiscuity and their use of sex as a social tool. Non-reproductive sex, defined as sex that does not occur during ovulation, has been found to serve functions such as tension regulation, coalition consolidation, and social status expression among bonobos (de Waal, 1987; Parish, 1994; Thompson-Handler et al., 1984). For instance, one observational study found that there was an increase in non-reproductive sex among bonobos following aggressive incidents (Abramson & Pinkerton, 1995). Moreover, tension was found to decrease after non-reproductive sex took place. Food sharing among bonobos was also found to increase after and during non-reproductive copulation. These findings suggest that copulation might play other roles in addition to reproduction among bonobos.

Extrapolating these findings to humans can serve to generate hypotheses with regards to the origins of non-reproductive human sexual behavior. One possible explanation for humans' tendency to engage in non-reproductive sex is that it might have served our evolutionary ancestors as a tool for reducing aggression and maximizing cooperation. The ability of humans to cooperate with each other might have aided our ancestors in accomplishing ventures such as

hunting. However, it is important to take into consideration the fact that humans are not as promiscuous as bonobos on average. Bonobos tend to engage in a sexual pattern known as polygamy (Abramson & Pinkerton, 1995). This means that they consistently have sexual intercourse with multiple partners. In contrast, most humans typically follow a pattern of serial monogamy, which involves having a multiple monogamous relationships throughout a lifetime, or mild polygyny, which involves a man having multiple female sexual partners (Buss, 2007). Furthermore, bonobos engage in homosexual acts more commonly than humans (Abramson & Pinkerton, 1995). The implications of this difference in mating patterns are significant. The reduction of aggressive behavior through non-reproductive sex is not as effective if copulation does not occur frequently between multiple members of the group.

The Origins of Cryptic Ovulation in Humans

If men fail to notice when women get a haircut, they certainly cannot tell when she's ovulating! Or can they?

It is necessary to delve into a different theory for the origination of non-reproductive sex in humans given that the reduction of aggressive behavior does not appear to be an explanation that accurately fits the human model. This theory involves human ovulation. In humans, ovulation is one of the stages of the menstrual cycle, which lasts approximately one month. However, cycles can range from 21 to 35 days in adults and from 21 to 45 days in young teens (Davis, 2013). This cycle is regulated by the release of hormones such as estrogen and progesterone. Ovulation, which is the focus of this paper, typically occurs at about day 14 of the cycle (Davis, 2013). Ovulation can be defined as the stage of the menstrual cycle during which the egg, or ovum, leaves the ovary. During this stage, hormone levels (such as estrogen and luteinizing hormone) tend to rise, which causes the uterine lining to thicken. After the egg leaves

the ovary, it travels into the uterus through the Fallopian tube. However, like in Hanuman langurs, the particular day when ovulation occurs is variable. Humans are most fertile during the phase of the menstrual known as the follicular phase and least fertile during the luteal phase. Conception is most likely the three days before or on the day of ovulation (Davis, 2013). Unlike chimpanzees or bonobos, ovulation is not accompanied by blantantly overt physical and behavioral signals. However, there might be subtle cues that allow men to detect ovulation to a lesser degree than males of other species of apes.

One study that provided evidence for the ability of men to detect ovulation was conducted in the context of gentlemen's clubs (Miller, Tibur, & Jordan 2007). In this study, 18 professional lap dancers kept a daily record of their tip earnings for 60 days. The participants also indicated whether they had begun or ceased menstruation. From this self-report data, the researchers determined that the participants had relatively regular cycles that ranged from 28 to 29 days. The researchers then divided the cycle into three phases: menstrual (days 1-5), fertile (days 9-15), and luteal (days 18-28). Participants also reported whether they were using oral contraceptives.

The study found that the same women received significantly more tips from men during their fertile phase (during or close to ovulation) than during their luteal phase. This difference was not observed for women who were taking oral contraceptives. These results suggest that men might be able to pick up on cues that signal women's ovulation. These results also suggest that detecting these cues, even on an unconscious level, can translate into behavioral outputs. Men were willing to give women a larger portion of their resources when they detected that women were ovulating than when they were not ovulating. This study did not address the specific mechanism involved in the detection of ovulation. For instance, it might have been the

smell or even the behavior of the lap dancers that changed throughout the menstrual cycle. However, this study serves as a demonstration that somehow women obtained more resources from men when they were ovulating and suggests that ovulation might not be entirely concealed.

In order to understand the results found by Miller et al. (2007), it is useful to investigate non-reproductive sex among Hanuman langurs. Studies with this species have shed light on why cryptic ovulation might have evolved in humans. Unlike chimpanzees and bonobos, Hanuman langur and human females do not exhibit obvious behavioral and physical cues during ovulation. Instead, ovulation in these species is labeled as cryptic, or not apparent. One important distinction that must be made is the difference between concealed ovulation and cryptic ovulation. In some of the early studies with Hanuman langurs, ovulation in this species was labeled as concealed (e.g. Heistermann et al, 2001). Concealed ovulation implies that the period of ovulation is entirely unknown to males of the species. Contrary to this claim, it has been found that langurs might be somewhat aware of a female's fertile state (Ostner et al., 2006). Cryptic ovulation refers to ovulation that is neither overt nor concealed, but rather roughly detectable through subtle cues.

Some people confuse the detection of ovulatory cues that happen in species possessing cryptic ovulation with conscious awareness of ovulation. This confusion inevitably leads to the conclusion that ovulation in humans is concealed; many people reason that men are unable to consciously predict when a female is ovulating, so ovulation must be concealed. However, it is important to recognize that detection of ovulation does not necessitate conscious awareness. Saying that ovulation is cryptic simply means that males are able to detect some cues that signal ovulation. These cues can be detected either consciously or unconsciously. The belief that ovulation is concealed in humans might seem intuitive, but recent evidence has suggested that

human males might respond to some subtle cues that signal ovulation (Haselton & Gildersleeve 2011). Therefore, like ovulation in Hanuman langurs, ovulation in humans is best described as cryptic.

Some researchers have suggested that cryptic ovulation might be an artifact of modern obsession with hygiene (Marlowe, 2004). This hypothesis proposes that many people in modern cultures attempt to mask their bodily scent through the use of artificial smells. Therefore, our hunter-gatherer ancestors might have been better able to detect ovulatory cues given the absence of products such as perfumes and soap. One study that tested this hypothesis interviewed Hadza hunter-gatherers in Tanzania (Marlowe, 2004). The Hadza are a hunter-gatherer group that has had minimal exposure to modern culture and is thought to resemble our hunter-gatherer ancestors. Therefore, studying this group of people could reveal some clues about our past.

Marlowe interviewed a group of both men and women that belonged to a Hadza community (2004). During his study, Marlowe addressed the hypothesis that people in hunter-gatherer societies can predict ovulation better than people in modern societies in which bodily scents are masked by artificial aromas. In this study, the predictability of ovulation was assumed to correspond to the frequency of copulations during the ovulatory phase. Thus, a high frequency of copulations during ovulation was interpreted as indicative of detectable ovulation, whereas a low frequency of copulations during ovulation was interpreted as indicative of cryptic ovulation. However, Marlowe decided that recording the frequency of copulations among the Hadza was both intrusive and impractical. Instead, he assessed participants' beliefs about the time of the menstrual cycle during which conception can occur.

Marlowe reasoned that people's beliefs about the time of conception are influenced by the frequency of copulations. In other words, he argued that if people know that sex causes

pregnancy, they are likely to equate the time of conception with the time of the cycle with most frequent copulation. Therefore, he thought that if the Hadza said that conception was most likely during ovulation, the frequency of copulations would be assumed to be highest during this stage and ovulation would be classified as overt. If the Hadza said that conception was most likely at a time other than ovulation, the frequency of copulations would be assumed to be highest during this stage and ovulation would be classified as cryptic.

The results of this study revealed that the Hadza believed conception to be most likely at the end of menstruation. This belief was interpreted by Marlowe as meaning that ovulation was cryptic among the Hadza. He concluded that ovulation in humans is cryptic regardless of whether bodily scents are left intact or contaminated by artificial aromas. Culture and technology revolutionized smells, but they are not entirely responsible for the puzzling nature of ovulation.

Ovulation in both humans and Hanuman langurs has been labeled as cryptic, but there is still some debate as to the evolutionary origins of this type of ovulation. In one study that addressed this question, researchers observed wild langurs in southern Nepal (Heistermann, Ziegler, Schaik, Launhardt, Winkler, & Hodges, 2001). The researchers proposed that cryptic ovulation might serve as an adaptation for generating paternity uncertainty. Paternity uncertainty can be defined as males' lack of confidence that the organisms that they believe to be their offspring are indeed genetically related to them.

In this study, fecal samples were collected and analyzed in order to determine the time of ovulation of each female langur in the group. The time of ovulation was found to be highly variable, which made it unpredictable. Furthermore, the number of copulations was not found to vary significantly throughout the receptive period, nor was it found to peak during ovulation. Finally, dominant males exhibited an ineffective mate-guarding pattern. This means that they

often prevented females from mating with other males during times other than ovulation. This ineffective guarding strategy resulted in offspring being sired by both dominant and subordinate males. Even though the dominant male engaged in the greatest amount of mate guarding, he did not sire more children than other males because the timing of his guarding attempts did not coincide with ovulation. The researchers concluded that cryptic ovulation in Hanuman langurs yields paternity uncertainty.

These findings provide evidence that paternity uncertainty is associated with cryptic ovulation, but its benefits remain unclear. One possibility is that paternity uncertainty might serve as a female strategy to reduce infanticide. Male langurs seem to employ infanticide as an adaptive strategy for getting rid of other males' offspring; murdering another male's offspring results in a greater number of sexually receptive females, which allows the murderous male to mate with more females (Borries, 1997). This male reproductive strategy conflicts with female interests because of females' high-energy investment in producing offspring.

One female strategy for countering infanticide might involve cryptic ovulation paired with sexual behavior. Females might create confusion with regards to paternity by copulating with multiple males and having a cryptic period of ovulation. This confusion would make males that copulate with a particular female less likely to kill her offspring because of the possibility that those offspring might be their own. This theory is consistent with the finding that male langurs who copulate with a particular female are significantly less likely to kill that female's offspring (Borries, Launhardt, Epplen, Epplen, & Winkler, 1999).

The role of cryptic ovulation as a tool for reducing the likelihood of infanticide cannot be directly extrapolated to humans. Unlike Hanuman langurs, humans typically do not engage in infanticide. It is possible that the low rates of infanticide among humans are the result of an

effective paternity uncertainty strategy. However, the success of this strategy depends on females consistently copulating with multiple males, which is usually not the case among humans (Buss, 2007). Studies with Hanuman langurs do suggest that cryptic ovulation might serve an adaptive role related to paternity uncertainty. Therefore, one possibility is that cryptic ovulation might have originated in an ancestral species as an adaptive female strategy to counter infanticide. This theory yields the possibility that cryptic ovulation in humans might be vestigial. However, it is unlikely that cryptic ovulation in humans is an evolutionary relic given its wide range of potential adaptive benefits.

Cryptic ovulation could serve an adaptive function by allowing women more freedom to pursue a short-term mating strategy. From a female perspective, pursuing a short-term mating strategy can pose the risk of forgoing male assistance in rearing her children. However, cryptic ovulation allows for several low-risk copulations to occur. A low-risk copulation can be defined as sexual intercourse that occurs at a point of low fertility in a woman's cycle. Such low-risk copulations could be employed as tools for obtaining resources, switching mates, evaluating long-term mate potential, and manipulating mates (Buss, 2012).

One potential benefit of cryptic ovulation is its ability to generate paternity uncertainty. As discussed earlier, paternity uncertainty can be employed as a tool for reducing infanticide. Even if infanticide is not prevalent in a species, paternity uncertainty might have other adaptive roles. For instance, females could use paternity uncertainty as a tool for obtaining additional resources. Imagine a female that copulates with multiple males and has an offspring. If paternity were certain, only the father of the offspring would be inclined to provide the female with resources. However, if multiple males believe that they might be father of the child, they might all be inclined to provide the female with resources. Each individual male might contribute fewer

resources if they are uncertain that the child is his. Thus, this benefit would only be viable if the total input of resources obtained by the female is higher when paternity is uncertain.

Furthermore, cryptic ovulation could be adaptive by making females sexually desirable for longer periods of time. This is consistent with the fact that men find women sexually desirable throughout their cycle. Prolonged sexual desire could then be employed as a tool for obtaining resources. If females were only found to be attractive during ovulation, they would only be able to trade sex for resources during their fertile phase. Instead, a hunter-gatherer woman who was found to be attractive throughout her cycle would have been able to trade sex for resources even during periods of her cycle when the risk of pregnancy is minimal. Moreover, prolonged sexual desire could serve to interfere with a male strategy of copulating with multiple females. A male that finds her partner sexually desirable throughout the menstrual cycle might be less likely to copulate with other females.

Another potential advantage of this form of ovulation is the ability to obtain both good genes and sufficient resources from multiple partners. A woman whose ovulation is cryptic is able to mate with an attractive partner to obtain genes during her fertile period and with a man that is able and willing to provide resources during a period of low fertility. By employing this strategy, women could maximize the reproductive success of their offspring by not limiting the provision of good genes and resources to a single male. This theory is supported by evidence that shows that females are most likely to cheat on their partners around the time of ovulation and with males that have good genes. One study that examined this prediction used a nationwide survey of 3,679 British women to examine the timing of extramarital affairs (Baker & Bellis, 1995). The study found that extramarital copulations typically coincided with ovulation. The pairing of an affair with ovulation maximizes the chances that the lover will sire a woman's

children.

Another possible explanation for the mystery of cryptic ovulation is that it might have originated as a byproduct. Proponents of the byproduct theory maintain that the origination of bipedalism in humans might have hindered the effectiveness of genital swelling as a mechanism for advertising ovulatory status (Pawlowski, 1999). Furthermore, this theory argues that genital swelling would have been unnecessarily costly in the African savannah, which is the environment in which many researchers believe that bipedalism originated. Such an environment requires water conservation, which might have reduced the benefit of advertising ovulation through genital swelling (Pawlowski, 1999). Regardless of how cryptic ovulation originated, it is now well established that ovulation is not entirely concealed. Next, we will delve into the different cues that might be employed by men to detect ovulation in women.

Detecting Cryptic Ovulation

Is that a new perfume? Nope. It's ovulation.

Men appear to possess the ability of detecting ovulation to some degree. However, the specific mechanisms that might aid men in determining that a woman is ovulating are still being debated. Some research indicates that one cue that men might employ is smell. In one study that investigated the role of olfactory cues, men were exposed to the scents of women (Miller & Maner, 2009). Men in this study smelled a t-shirt worn by an ovulating woman, a non-ovulating woman, or a control scent. Subsequently, men who smelled the scent of an ovulating woman displayed significantly larger increases in testosterone than men that smelled the scent of a non-ovulating woman or the control scent.

The results from Miller and Maner's (2009) study suggest that men are sensitive to olfactory cues for ovulation in women. These results are consistent with other studies that have

found that men rate the smell of ovulating women as more pleasant and attractive (Havlicek, Dvorakova, Bartos, & Flegr, 2006; Poran, 1994; Singh & Bronstad, 2001). Studies on the role of smell as a cue for ovulation have also found that the correlation between scent attractiveness and ovulation does not hold up for women who take oral contraceptives (Kuukasjarvi, Eriksson, Koskela, Mappes, Nissinen, & Rantala, 2004). Most oral contraceptives inhibit the release of lutenizing hormone (LH) and follicle-stimulating hormone (FSH), which prevents ovulation from occurring and inhibits the release of estrogen and progesterone (Kuukasjarvi et al., 2004). Thus, the suppression of ovulation might account for the lack of ovulation cues among women taking oral contraceptives.

Not all studies have found a positive correlation between scent pleasantness and ovulation. A study conducted by Roney and Simmons found results that were inconsistent with this hypothesis (2012). In this study, men were randomly assigned to one of two conditions. In one condition, men were exposed to the axillary scent of an ovulating woman. In the control condition, men were exposed to the scent of water. A subsequent comparison of the testosterone levels of men exposed to the two types of scent found no significant difference between the two groups. The researchers concluded that the participants' knowledge that they were exposed to the scent of a woman in Miller and Maner's study might have triggered the spike in testosterone. In contrast, men were unaware of the source of the scent that they were being exposed to in Roney and Simmon's study. Roney and Simmons conclude that men might require knowledge about the source of the scent in order for an increase in testosterone to occur. More research is needed to determine whether men's testosterone levels are sensitive to the smell of ovulating women.

Another study went beyond the scent of armpits and ventured into the intimacy of vaginal odor (Doty, Ford, Preti, Huggins, 1975). This study found that the scent of ovulating

women was rated as less unpleasant and less potent than the smell of women in their luteal phase. Thus, a less unpleasant vaginal smell might serve as a cue for fertility. However, it is more likely that a woman's overall smell, such as that captured in a sweaty t-shirt, might be more useful evolutionarily than a slightly less unpleasant smell in a woman's intimate area. Once a man is close enough to a woman to smell her genitals, it is unlikely that a slightly more or less pleasant vaginal smell would thwart his intentions.

Some researchers have proposed that the smell of women not only affects testosterone levels in men, but that it can also affect men's cognition and behavior. One study presented men with the scent of ovulating women, non-ovulating women, or a control smell (Miller & Maner, 2010). Then, participants were instructed to complete words that were missing some letters. These words were generated such that each word could be completed as at least one sex-related word and at least one non-sex related word. The researchers found that men exposed to the scent of ovulating women completed a greater proportion of the words to become sex-related words than men exposed to either the scent of non-ovulating women or to a control smell. The researchers concluded that the scent of ovulating women primes men to think about sex.

In a second experiment in the same study, participants estimated the level of sexual arousal in women by smelling their scent. The results of the study showed that on average, the scent of ovulating women was interpreted as higher in sexual arousal than the scent of women that were not ovulating (Miller & Maner, 2010). A third experiment by Miller and Manner sought to increase the ecological validity of their studies. During this experiment, male participants built a Lego structure along with a female confederate. Trained raters with no knowledge of the hypotheses of the study coded the number of times that the male participant mimicked the posture of the female confederate during this task. Behavioral mimicry was

assumed to correlate positively with mating motivation based on previous studies. The results for this part of the study found that men tended to mimic the female confederate more during her fertile period.

During the second part of Miller and Manner's experiment, participants engaged in a blackjack task designed to measure risk-taking while the female confederate watched. The study found that men took significantly more risks during the blackjack task when the confederate was closest to ovulation. In fact, risk-taking was found to rise and fall following the same pattern as fertility throughout the menstrual cycle of the confederate. Although this study does not draw a causal relationship between smell and either risk-taking or behavioral mimicry, it suggests that men might be able to perceive some kind of physical cues that signal women's fertility status. Furthermore, this study shows that men's unconscious perception of these fertility cues translates into predictable behavioral patterns such as increased risk-taking and mimicry.

Smell is not the only ovulation cue that has been investigated. Another cue that might aid men in detecting ovulation is vocal pitch. One study found that men rated women higher on voice attractiveness when women's risk of conception was highest (Pipitone & Gallup, 2008). Another study focused on the role of facial attractiveness as a cue for ovulation (Roberts, Havlicek, Flegr, Hruskova, Little, Jones, Perrett, & Petrie, 2004). The researchers found that both men and women rated photographs of the faces of ovulating women as more attractive than the faces of the same women taken during the luteal phase.

Another potential ovulatory cue that has received considerable attention is waist-to-hip-ratio (WHR). WHR refers to a measurement of the waist (the narrowest part of the torso) divided by a measurement of the hip (at the greatest protrusion of the buttocks). WHR is an especially popular trait for study among evolutionary psychologists. This trait has been found to be highly

reliable in predicting women's attractiveness (Singh, 1993). That is, there is high agreement between men that lower WHRs are more attractive in women (Singh, 1993). It might seem odd that WHR could be such a powerful contributor to ratings of subjective beauty. Evolutionarily, a trait would not be selected for unless it served some adaptive purpose. In the case of WHR, some researchers have proposed that it might have become a cue for beauty because it is predictive of both fertility and health (Singh, 1993). By preferring to mate with females with low WHRs, males might increase the probability that intercourse will yield offspring and that those offspring will be healthy.

With regards to ovulation, some research has suggested that WHR might vary throughout the menstrual cycle. One study found that there was a significant decrease in WHR in women around the time of ovulation (Kirchengast & Gartner, 2002). Thus, WHR might serve as an ovulatory cue apart from serving as a fertility and health cue. A reduction in waist to hip ratio during ovulation would enhance a woman's attractiveness, which is an adaptive adjustment at the time during which women are most fertile. These findings suggest that ovulation is linked to changes in traits that are valued and salient to men. This change in WHR was not observed in women who were taking oral contraceptives.

Much like scent, the reliabiliy of WHR as a cue for ovulation is still being debated. One study examining WHR found that it was not a reliable cue for ovulation (Bleske-Rechek, Harris, Denkinger, Webb, Erikson, & Nelson, 2011). In this study, women participants were photographed and measured twice. One measurement was performed close to ovulation and one measurement was performed during the luteal phase. This study failed to find a significant difference between the measurements taken during these two phases of the menstrual cycle. Furthermore, the study found that judges did not find the pictures of ovulating women more

attractive than the pictures of non-ovulating women. Thus, this study also questioned the reliability of enhanced facial attractiveness during ovulation as a cue signaling ovulatory status. The authors of the study suggested that the additional controls that were employed in this study might account for the failure to replicate previous results. For instance, women were measured in their dorm rooms right after waking up as opposed to measuring them at different times of the day. This study highlights the importance of replicating results in scientific studies. A single study is never enough to draw a definite conclusion since perils such as lurking variables, lack of control, and unrepresentative samples can sometimes lead us astray. Waist to hip ratio and facial attractiveness remain strong candidates for serving as reliable cues for ovulation, but further studies are needed before granting them this title.

Another potential cue for ovulation is pupil diameter. One study found an increase in pupil diameter in response to sexually relevant cues during ovulation using an infrared eye-tracking device (Laeng & Falkenberg, 2007). Interestingly, this increase only occurred in women who were not taking oral contraceptives and was specific to pictures of the women's actual sexual partners. The researchers suggested, by drawing from previous literature, that pupil dilation might occur during ovulation because it is related to an observer's level of interest and attention to stimuli as well as to physical pleasure. Ovulating women might be more attentive to and more interested in stimuli that remind them of sex. Pupil diameter is an especially interesting factor because it is not under conscious control of participants and might serve as a reliable measurement of sexual interest or arousal.

Another study focused on investigating the possibility that pupil diameter might influence men's ratings of women's attractiveness (Hess, 1975). Men rated pictures of women whose pupils had been artificially increased in diameter as "more feminine", "prettier", and "softer".

Furthermore, men's pupils dilated more when viewing pictures of women with larger pupils. Pupil diameter serves as an example of how subtle cues can have significant effects on a woman's overall attractiveness. Thus, changes that signal fertility need not include a red swelling of the genitals paired with repeated presentations of the genitals to attractive male partners. Rather, fertility cues can be entirely detached from reproductive organs and be subtle to the point where they are not consciously detected.

An additional physical characteristic that has been linked to the menstrual cycle is symmetry. Symmetrical individuals are rated as more attractive than asymmetrical individuals (Grammer & Thornhill, 1994). Symmetry in humans might serve as a cue for the ability to resist parasites. Thus, it is logical that symmetry might serve as a cue that indicates competency of the immune system (Grammer & Thornhill, 1994). One study found that women became more symmetrical during ovulation (Scutt & Manning, 1996). This study focused on measurements of the head and the hands. The results of the study showed that symmetry varied across the menstrual cycle and was predictive of fertility. Another study found an equivalent pattern for breast symmetry (Manning, Scutt, & Whitehouse, 1996).

Behavioral and Cognitive Changes in Ovulating Females

It's not that I don't like you. I just happen to be ovulating, so I need good genes!

Apart from physical body changes that signal fertility, women might experience behavioral and cognitive alterations in response to ovulation. Some outcomes might become especially attractive and some might become especially undesirable during peak fertility. Thus, women's attitudes and behaviors should change to maximize outcomes that are desirable and avoid outcomes that are undesirable.

One set of behaviors and attitudes that should become especially salient during ovulation

are behaviors and attitudes that might aid in the avoidance of sexual coercion. It is always in a woman's reproductive interest to avoid unwanted sexual contact. Sexual coercion is an especially traumatizing experience for women because it represents the negation of sexual choice. The cost of having offspring is much higher for women than for men. Women have to undergo pregnancy, breastfeed, and invest considerable resources in raising an offspring. Therefore, the opportunity cost of getting pregnant is extremely high for women. The time and resources that are invested into an unplanned child could have been invested in other reproductive or survival endeavors such as gathering resources or copulating with other men. Historically, sexual coercion has had the potential of resulting in a pregnancy that would require significant resource and time expenditure and that would negate a woman's ability to choose a mate. Furthermore, sexual coercion has far reaching negative implications for women ranging from a disruption in the parental care of other offspring to being abandoned or abused by her partner (McKibbin & Shackelford, 2011). Therefore, women have evolved to experience sexual coercion as a terrifying experience that must be avoided.

Ovulation represents a period of peak fertility. Thus, sexual coercion that occurs during ovulation is more likely to result in an unwanted pregnancy. Increased fertility should make avoiding sexual coercion especially important for women that are ovulating. One study that investigated this prediction presented normally ovulating women with videos of men trying to attract another woman and rated the men on how likely they were to be sexually coercive (Garver-Apgar, Gangestad, & Simpson, 2007). Women who were ovulating or near ovulation rated men higher on sexual coerciveness than women in their luteal phase. The researchers concluded that women might be more sensitive to cues for sexual coercion during ovulation because the cost of overestimating sexual coercion during peak fertility is usually lower than the

cost of underestimating it.

Another study explored the relationship between physical strength and cues signaling sexual coercion during ovulation (Petralia & Gallup, 2002). Women's handgrip strength was measured before and after reading an essay. In one condition, the essay that women read involved a description of a case of sexual coercion. In the control condition, the essay had no reference to sexual coercion. The study found that women who were ovulating had a stronger handgrip after being exposed to a description of sexual coercion than before reading the essay. This increase in handgrip strength was not observed for women in the control group or for women who were not ovulating. The results of this study suggest that women's handgrip strength might increase in response to cues signaling sexual coercion as an adaptive defensive mechanism during their stage of peak fertility. This increase in strength might be facilitated by cognitive heuristics that detect cues for sexual coercion, but the specific brain mechanisms that might trigger this change are not yet understood.

An increase in strength and sensitivity towards sexual assault cues could help women to defend themselves against sexual assault. Another effective way of avoiding sexual assault during ovulation might be to avoid dangerous situations that might place women at increased risk for sexual coercion. One study asked women to report the activities that they had engaged in during the past 24 hours (Chavanne & Gallup, 1998). A different group of women then rated the activities on how risky they were in terms of making someone vulnerable to sexual assault. The study found that women engaged in significantly fewer risky activities when ovulating than during other stages of the menstrual cycle. These results support the hypothesis that women's behavior and cognition might change following adaptive patterns throughout the menstrual cycle.

Sexual coercion avoidance is not the sole concern of an ovulating woman. There are also some behaviors that become more desirable at peak fertility. One such behavior is reproduction, which acquires exceptional importance during ovulation. As discussed earlier, human females are sexually receptive throughout the menstrual cycle. However, sexual intercourse that happens during ovulation is especially important because it is directly related to a woman's fitness, or her reproductive success. Therefore, some researchers have proposed that women might engage in more frequent sexual activity around the time of ovulation in order to maximize their chances of reproduction. This hypothesis has been supported with empirical evidence from several studies (Adams et al. 1978; Morris & Udry 1982; Persky et al. 1977; Udry & Morris 1970). These studies found a positive correlation between frequency of consensual sexual activity and fertility. Another study also found that women report higher sexual desire towards men during ovulation (Haselton & Gangestad, 2006).

Furthermore, a study that focused on women's responses to erotic films using functional magnetic resonance imaging (fMRI) to identify the parts of the brain that became active during sexual arousal at different stages of the menstrual cycle (Zhu, Wang, Parkinson, Cai, Gao, & Hu, 2009). In this study, women's brains were scanned while they viewed erotic films at three different points of their menstrual cycle: ovulation, menstruation, and at one other time of their convenience. The results of the study revealed that there was a different pattern of brain activation during the ovulatory phase than during the other measurements, which suggests that the brain processes sexual arousal differently during ovulation than during other phases.

Increasing the frequency of sex during peak fertility can be an adaptive strategy, but only if it happens with the right mate. On the one hand, sex that occurs at stages other than ovulation can have a wide array of non-reproductive benefits. For instance, a woman can obtain resources

by having sex with a man during a stage of low fertility. In doing so, this woman would obtain resources while maintaining a minimal risk of pregnancy. Thus, the ultimate function in this example is to increment fitness by obtaining resources, which is one of many possible benefits of non-reproductive sex (see *Cryptic Ovulation in Humans* section). On the other hand, sex that occurs during ovulation is most likely to result in pregnancy, which makes reproduction the ultimate function of sex during this stage.

Genetics should be the main consideration during ovulation if reproduction is the primary motivator of sex during this stage. Women can obtain at least two important benefits from men: genes and resources. A woman could obtain both of these benefits from one man. However, this need not be the case. If a woman is able to obtain one of these benefits from a man but not the other, she might be able to obtain the other benefit from another man. For instance, a woman who is in a monogamous relationship with a man that is both willing and able to provide resources might find that her partner has inadequate genes. Good genes in this context can be defined as a set of genes that are likely to yield children that are able to reproduce successfully. If a woman's partner has poor genes, she has the alternative of copulating with a different man during her period of peak fertility in order to provide her offspring with better genes while still obtaining resources from her partner.

Copulating with another man while in a monogamous relationship obviously has risks. A woman's monogamous partner might retaliate violently or withhold resources if he discovers that she had sexual relations with another man. However, engaging in extra-pair copulations might be adaptive if the benefits of obtaining good genes outweigh the risks. A woman's drive to obtain assistance for her offspring should be present throughout the menstrual cycle. In contrast, her attention to signals for good genes should correlate positively with her fertility. The phenotypic

cues for genetic characteristics of a sexual partner are especially important when a woman is at a high risk of conception. One hypothesis that can be drawn from this theory is that women who are in monogamous relationships with men that have poor genes should be more likely to be motivated to engage in extra-pair copulations during ovulation. Indeed, a study of copulation patterns among British women found that women are most likely to engage in extra-pair copulations during ovulation (Bellis & Baker, 1990). It is important to note, however, that most women secure both genes and resources from the same man (Buss & Shackelford, 2008).

A sexual partner's genes are especially important during a period of peak fertility. This prediction is known as the good genes hypothesis. A woman who is at a high risk for conception will maximize her fitness if she copulates with males that have high quality genes so as to produce successful offspring. One study investigating the good genes hypothesis exposed women to video clips of men introducing themselves (Gangestad, Garver-Apgar, Simpson, & Cousins, 2007). Then, the female participants had to rate the men on how attractive they were as short-term partners and as long-term partners. A different group of women participants coded the videos on traits that have been found to correlate with either short-term or long-term attractiveness. The traits that correlated positively with short-term attractiveness were labeled as intrasexual competitiveness. Intrasexual competitiveness included physical attractiveness, muscularity, being socially respected, and being confrontative. On the other hand, traits that correlated positively with long-term attractiveness were labeled good investing mate qualities. good investing mate qualities included the potential to be a good father, faithfulness, warmth, and financial success.

The results showed that women's mate preferences did not vary significantly over the menstrual cycle in both long-term and short-term contexts. However, the importance that was

placed on each category of trait varied depending on fertility status and the reproductive strategy being assessed. The importance placed on intrasexual competitiveness traits was significantly stronger in the context of a short-term reproductive strategy when women were ovulating than when they were in the luteal stage. Men rated higher in intrasexual competitiveness traits were also rated higher in attractiveness in the context of a short-term mating strategy by women who were ovulating than by women who were not ovulating. In contrast, the importance placed on good investing mate quality traits did not vary significantly with fertility status in the context of a long-term reproductive strategy.

In simpler terms, women that are looking for a short-term partner value attractive short-term traits more when they are ovulating, whereas the value of attractive long-term traits remains constant throughout the menstrual cycle. These results are consistent with the good genes hypothesis because they point to a higher preference for attractive short-term traits at the time of ovulation. Other studies have also reported an increase in women's attraction towards traits that signal masculinity and health in men (Penton-Voak & Perrett, 2000) and towards scents associated with higher levels of testosterone around the time of ovulation, which might be associated with a strong immune system (Thornhill, Flynn Chapman, & Gangestad, 2013).

It is also possible to make predictions about infidelity patterns by combining the good genes hypothesis and cuckoldry as a reproductive strategy. Cuckoldry refers to a reproductive strategy that involves a female mating with a short-term mate in secret and then having a long-term mate think that the child is his in order to obtain resources for the child. Cuckoldry takes advantage of cryptic ovulation and the paternity uncertainty that results from it. The benefit of this strategy involves obtaining good genes from the short-term partner while obtaining resources from the long-term partner. As described earlier, the risks of cuckoldry are high. A cheated

partner might react violently or withhold assistance and a woman's reputation might be ruined if discovered. Thus, cuckoldry is only an effective strategy when the genes of the short-term partner are significantly better than the genes of the long-term partner to the point where the risks are justified.

One prediction that can be drawn from the good genes hypothesis is that women are more likely to be drawn to males other than their long-term partners during ovulation in cases in which their long-term partners have poor genes. In this way, women in long-term relationships might be able to maximize their chances of obtaining good genes while still obtaining resources from their long-term partner. Unfortunately, filming women during their sexual escapades poses some serious logistical and ethical considerations. Therefore, it is necessary to rely on other methods to test these predictions.

One study employed self-report measures to assess women's sexual interest throughout the menstrual cycle (Gangestad, Thornhill, & Garver, 2002). This study found that women experience greater sexual interest and fantasy about males other than their primary sexual partner around the time of ovulation than during the luteal phase. Furthermore, women in this study reported that their primary partners engaged in significantly more mate guarding when they were ovulating than during the luteal phase. Mate guarding refers to behaviors performed by males aimed at reducing the risk that their sexual partner will engage in sexual behavior with another male. Mate guarding can take many forms such as being attentive or proprietary. It is logical that males would engage in mate guarding more vigorously during when the risk of conception is greatest in order to prevent other males from mating with their partner.

The good genes hypothesis proposes that ovulation is accompanied by an increase in the importance that women place on traits that indicate good genes in a mate. Therefore, this theory

predicts that females in a long-term relationship with males that exhibit poor genes will be most likely to cheat during ovulation. A study that examined this hypothesis focused on asymmetry as an indicator of poor genes (Gangestad, Thornhill, & Garver-Apgar, 2005). This study relied on previous literature that has found that symmetry is typically an indicator of immunocompetence and that it is a reliable predictor of physical attractiveness. Furthermore, symmetrical individuals have been found to be reproductively more successful than asymmetrical individuals on average across species (Moller, Thornhill, & Gangestad, 2005). Gangestad et al. (2005) found that women who were in long-term relationships with asymmetrical men experienced lower sexual attraction to their partners and greater attraction to other men during ovulation. These results are consistent with the good genes hypothesis since they suggest that women place special emphasis on genes during ovulation.

Consistent results have been found in other studies that have explored women's perceptions of their primary partners (Haselton & Gangestad, 2006; Pillsworth & Haselton, 2006). Women in long-term relationships with men who are perceived to be unattractive as short-term mates tend to feel more attraction towards other men during ovulation than during other stages. Similar results have also been found in other species. For instance, one study investigating collared flycatchers found that females were more likely to engage in extra-pair copulations during ovulation if their primary partners had small forehead patches – an indicator of poor genes (Michl, Torok, Griffith, & Sheldon, 2002).

These studies as a whole suggest that women's menstrual cycle can shape women's mate preferences, which serves as an indicator of how important ovulation is to understanding human behavior. So far, we have explored how ovulation has an impact on women's physiology, cognition, and behavior as well as on men's attraction and behavior towards women. The effects

of the menstrual cycle must be taken into consideration when conducting psychology research because of the wide array of effects that this phenomenon is responsible for. One area of investigation that is inextricably related to the menstrual cycle is intrasexual competition. The next section will focus on exploring the connection between intrasexual competition and ovulation and how this line of research has shaped our view of women within the field of evolutionary psychology.

Intrasexual Competition: Women as Active Contenders

It's not passive-aggression. It's competitive-aggression.

Throughout our evolutionary history, women invested more in offspring than have men. Egg production requires more energy than sperm. Women also possess a finite number of eggs, whereas men produce millions of sperm cells. Furthermore, men do not have to undergo pregnancy, which represents an obligatory prenatal parental investment for women. The survival of offspring during our evolutionary history also required maternal investment in forms that could not be provided by a male. For example, it is unusual for a man to breastfeed a child. Therefore, human females, as is the case in other mammals, are generally the higher investing sex. In contrast, human males are the lower investing sex.

Robert Trivers (1972) enriched the idea of differential (unequal) parental investment by linking it to mate selection. Trivers speculated that the sex investing more in offspring production and rearing (the sex with a higher reproductive cost) would generally be more selective when choosing a mate than the sex that invests less. This theory is based on the fact that the high-investing sex has more at stake when reproducing. In the case of humans, women are the high-investing sex. Thus, Trivers' theory would predict that women should be more discriminating than men when selecting a mate. This hypothesis has been supported by empirical

evidence (for example, Woodward & Richards, 2004).

Saying that women are more discriminating than men implies that, on average, women tend to be more critical when deciding whom to mate with. It does not mean that every woman is choosier than every man under every situation. Individual differences exist and different individuals might pursue different sexual strategies at different times and under different circumstances.

Trivers' theory revolutionized the way that people viewed women. Trivers, like Darwin before him, emphasized women's important role as choosers and rejected the idea that women might simply be passive receptacles of men's genes. Therefore, the role of women was recognized to be important and active within evolutionary theory. However, the view of women that emerged along with this framework was still incomplete. Trivers, like Darwin, suggested that men actively compete against each other in order to be chosen by a woman.

This interpretation emphasizes the importance of choice in the study of female behavior and highlights the importance of competition in the study of male behavior. Thus, until recently, women's competitive nature and variation on competition-related traits had been largely neglected. Choice is an important determinant of a woman's fitness, but women do much more than simply choose. A woman who is not an effective intrasexual competitor might have to settle for a low-quality mate, whereas a successful competitor might reproduce with a mate possessing high-quality genes and high-investing qualities. Therefore, recent investigations in the area of intrasexual competition have revealed a new and important facet of women: active competition.

Competition for mates that occurs within the same sex is known as intrasexual competition. Like men, women have to compete with members of the same sex for access to mates. However, the particular strategies that are employed by members of each sex might differ

based on the qualities that are valued by the opposite sex. For instance, women tend to value physical strength in men (Buss, 2012). Strength in men is a desirable trait because strong men would have been more competent at protecting their mates and providing resources in a hunter-gatherer context (Buss, 2012). Therefore, we would expect that men would demonstrate or exalt their strength as a competitive mating tactic in order to make themselves attractive to females. Similarly, men value physical attractiveness in females (Buss, 2012). Physical attractiveness can serve as a cue for health and fertility (Buss, 2012; Grammer & Thornhill, 1994). Therefore, we would expect females to make themselves physically attractive as a strategy for competing with female rivals.

Furthermore, the way in which males and females compete might differ due to unequal parental investment. Men have been found to be more likely to engage in risky behaviors as a strategy intended to impress women. For example, one study found that men were more likely than women to cross a busy road and that they were especially likely to do so in the presence of women (Pawlowski, Atwal, & Dunbar, 2008). The same effect was not found for women in the presence of men. Therefore, it appears that human males might employ risk-taking as a strategy for promoting themselves. In contrast, females tend to be more concerned with self-preservation and avoiding bodily harm (Vaillancourt, 2013). This concern for personal safety might be related to differential parental investment since human offspring rely more on their mothers than their fathers for survival (Trivers, 1972). Therefore, men might compete with each other through strategies that involve greater risk for bodily harm than females. Indeed, males have been found to engage in more direct aggression, such as physical or violent fights, than females (Campbell, 1999). However, this does not imply that females do not compete with each other. Instead, females have been found to compete vigorously though indirect aggression, such the covert

derogation of competitors (Vaillancourt, 2013). These forms of aggression are considered indirect in that they are intended to harm another person but they might not be perceived as aggressive acts.

Many of the fertility cues discussed in the previous section can also be applied to the context of intrasexual competition. Developing a pleasant smell, a lower WHR, or an increased libido at peak fertility can be construed as a competitive tactic. Having a pleasant smell during ovulation might allow women to outcompete their rivals and obtain high-quality mates. Thus, ovulation cues and intrasexual strategies are sometimes one and the same. Ovulation cues have mostly been explored in the literature from the point of view of a male sexual strategy. This approach arose in response to theories of concealed ovulation that argued that women's ovulation could not be detected. However, it is necessary to move beyond a male-centric view of ovulatory cue detection and consider whether the menstrual cycle might play a role in intrasexual competition.

Linking intrasexual competition to the menstrual cycle is a natural extension of this area of study. Women's sexual motivation and behavior correlate positively with their ovulatory status (Adams et al., 1978; Haselton & Gangestad, 2006; Morris & Udry, 1982; Persky et al., 1977; Udry & Morris, 1970). Women reach peak fertility during ovulation, which should increase their competitive behaviors around this time. Thus, the use of indirect aggression in women should be more prominent around the time of ovulation. The next sections of this paper will explore this hypothesis by examining a broad array of female intrasexual competition strategies and the extent to which they are employed at different stages of the menstrual cycle.

Before delving into a more thorough analysis of intrasexual competition, it is useful to consider the broader range of strategies that are employed by women. One classic study

conducted in 1988 asked women and men to write down strategies used by people of their same sex to make themselves more attractive to the opposite sex (Buss, 1988). This method allowed the researchers to pinpoint specific competitive tactics for further testing. The open-ended nature of the question allowed for creativity in the responses and did not limit the type of strategies that participants could mention.

However, this methodology also had its limitations. Coding the responses for analysis was a somewhat subjective procedure even though the researchers established clear guidelines for doing so. Furthermore, this approach makes three major assumptions. First, it assumes that people report what is true. In other words, it assumes that people do not withhold or alter information known to them and provide an accurate report of what they know. Second, it assumes that people are consciously aware of the strategies that are employed in intrasexual competition. As mentioned earlier, conscious awareness is not a necessary condition for evolutionary adaptations. Last, it assumes that these strategies are general to all human beings. It might be interesting to conduct a similar study in a different culture in order to investigate whether culture has an effect on the types of strategies that are employed.

Once these competitive strategies had been classified, the Buss asked a different group of participants to rate the frequency with which their closest friend of the same sex employed each of these strategies within the last three months. Once again, this methodology suffered from the weaknesses of self-report measures and benefitted from its strengths. The results showed that men engaged more frequently in tactics involving resource display, whereas women focused more on enhancing their appearance. Both of these results are consistent with evolutionary theory. The ability to provide resources is more highly valued by females in males, whereas physical beauty is more highly valued by males in females.

A second study conducted by Buss (1988) with a newlywed pool of participants confirmed these results. Women reported using appearance-enhancing strategies more than men, and men reported using resource display tactics more than women in order to "obtain" their spouses. A third study found that people perceive resource display to be a more effective strategy when conducted by men, whereas appearance-enhancement was rated as more effective when employed by women. Despite their limitations, these three studies by Buss (1988) provided an initial platform for analyzing some potential competitive strategies. These studies suggested that intrasexual strategies might be sex-specific to some degree.

Another set of three studies by Buss and Dedden (1990) found that intrasexual competition could also occur in the form of derogation of competitors. The results of these studies suggested that women are more likely than men to derogate another woman's fidelity, physical appearance, and sexual history. In contrast, men were found to be significantly more likely than women to derogate a competitor's financial resources, achievements, goals, physical strength, and athleticism. Taken together, these two sets of studies suggest that there are sex differences between the specific aspects of intrasexual competition strategies and that two major types of strategies employed by both sexes involve self-promotion and competitor-derogation.

A more recent study expanded on the results of Buss' studies (Buss, 1988; Buss & Dedden, 1990) on intrasexual competition and suggested two additional categories of strategies: mate manipulation and competitor manipulation (Fisher & Cox, 2011). In their first study, the researchers employed an open-ended qualititative approach. Participants in this study were asked to list ways in which they compete with others of the same sex for members of the opposite sex. The researchers found that participants listed behaviors that fell under four categories of intrasexual competition: self-promotion, competitor derogation, mate manipulation, and

competitor manipulation.

The researchers made a distinction between strategies intended to slant a comparison in someone's favor (self-promotion and competitor-derogation) and strategies involving a reduction in the need to compete (mate manipulation and rival manipulation). Mate manipulation was defined as a behavior directed towards one's mate that is intended to reduce the need for competition. Examples of mate manipulation include mate-guarding tactics such as attempting to convince one's mate not to attend a party where other rivals might be present. Rival manipulation refers to behaviors targeted towards one's competitors that aim to reduce the necessity to compete. For instance, one might attempt to convince a rival that the mate that they are interested in is not worth their time.

In a second study, Fisher and Cox (2011) provided participants with a series of strategies and asked them to rate how likely they were to employ each particular strategy. All responses were made using a 7-point Likert-type scale ranging from "definitely would not do" to "definitely would do". Based on the frequency of the strategies reported on their first study, the researchers hypothesized that men would be more likely to employ competitor derogation, while women would be more likely to employ self-promotion. Furthermore, they predicted that relationship status would have an effect on the types of strategies that were used the most. They expected that self-promotion would be more prominent among participants that were single, whereas competitor derogation would be more prominent among participants that were romantically involved.

The researchers found that the most common strategy for intrasexual competition was self-promotion, followed by mate manipulation. Rival derogation and rival manipulation were reported to be used to the same extent. Fisher and Cox explained their results by arguing that

people might prefer to use strategies that make them appear in a positive light and only use strategies that might be perceived as mean-spirited as a last resort. Contrary to their predictions, the researchers did not find a difference between men and women in the types of strategies that they used. The researchers' hypothesis with regards to relationship status was partially supported. While participants in relationships were more likely to derogate competitors, single participants were not more likely to self-promote.

Taken together, the studies by Fisher and Cox (2011) and Buss et al. (Buss, 1988; Buss & Dedden, 1990) suggest that sex differences exist in the specific types of strategies that are employed, but not in terms of the four meta-strategies of intrasexual strategies. In other words, men might display their resources more and women might focus on enhancing their appearance, but self-promotion occurs in both sexes to the same extent. Furthermore, the research by Fisher and Cox identified two categories of intrasexual competition that require further investigation: mate manipulation and rival manipulation. The next sections will delve into the details of each of the strategies that have been proposed thus far. Particularly, strategies involving competitor derogation and self-promotion will be explored in detail since these are the two meta-strategies that have received the most attention. Future research should focus on exploring the meta-strategies of mate manipulation and rival manipulation, as suggested by Fisher and Cox (2011), in more detail.

So far, four meta-strategies of intrasexual competition have been identified, but this list is not exhaustive. Further research might reveal that intrasexual competition occurs in complex forms that do not fit any of the present categories. For instance, one potential strategy might involve the formation of coalitions. Both males and females might strategically form alliances with other members of the same sex in order to achieve their mating goals. It is up to future

research to explore the intricacies of intrasexual competition and other potential strategies that might be employed by humans in the contest for mates.

Intrasexual Competition: Competitor Derogation

Love thy neighbor. However, if thy neighbor is sexually interested in thy mate, comment on thy neighbor's high waist-to-hip-ratio.

Recent experiments have found that the menstrual cycle might play a role in the derogation of same-sex rivals among women. One study revolutionized the field by bridging the gap between intrasexual competition and ovulation (Fisher, 2004). In this experiment, male and female participants were presented with a series of male and female faces and asked to rate them on attractiveness. The results showed that high estrogen levels in female raters resulted in lower attractiveness ratings of other women. In contrast, the ratings of male faces were the same regardless of the female raters' estrogen levels.

Fisher concluded that high estrogen levels are related to increased intrasexual competition and more competitor derogation. Ovulation, the period of peak fertility among women, involves an increase in estrogen. Therefore, fertility status seems to moderate, or to determine, the level of competitiveness that should be assumed by a woman at a given time. Peak fertility translates into greater derogation because competing becomes especially important for achieving conception.

Another study went beyond testing whether women employ derogation and investigated whether derogation has an effect on men's perceptions of women (Fisher & Cox, 2009). The purpose of competitor derogation is to alter men's perceptions of rivals' mate value such as to increase the derogator's own chances of reproduction. Therefore, men's perceptions of women must change after derogation has been employed in order for derogation to constitute as an

effective competitive strategy.

In this study, both men and women participants viewed a series of women's faces and rated them on attractiveness. Then, participants completed a distracter task. In the second phase of the experiment, participants were presented with either the face that they rated as the most attractive or the face that they rated as the least attractive and were told that this woman had previously provided an opinion about the faces that they had just rated. Next, participants rated the same faces on attractiveness while the "opinion" of the attractive or unattractive woman was displayed. The opinions that were displayed were negative, neutral, or positive.

The results of the study revealed that both male and female participants' attractiveness ratings of women were altered by the opinions of both attractive and unattractive women. The researchers also found that men were more influenced by the opinions of an attractive woman than an unattractive woman, whereas attractiveness did not have an effect on female participants' ratings. Furthermore, both positive and negative ratings had an effect on the ratings such that positive statements increased the ratings whereas negative statements decreased them. Interestingly, negative statements were found to be particularly powerful at influencing men's opinions of women when the opinion statement was provided by an attractive woman. Taken as a whole, these results suggest that derogating a woman's facial attractiveness constitutes an effective intrasexual competitive strategy among women.

Facial attractiveness is only one of many traits that might be derogated by women. There are probably several traits that have the potential of being derogated, yet not all traits are equal when it comes to bashing a competitor. Derogation should only be effective as a competitive strategy when the trait that is derogated is highly valued by the opposite sex. Commenting on a woman's inability to whistle might not be as effective as calling her ugly unless whistling

happens to be a trait that is highly attractive in women. Furthermore, future research should explore the possibility that women's ratings of other women on indicators of unfaithfulness might vary in accordance with fertility status given that fidelity is a trait valued by men (Buss, 2012). For instance, ovulating women might be more likely to rate other women high on likelihood to cheat and be promiscuous than women raters in their luteal phase.

Much like there are some traits that are more prone to be derogated, there are some women that are more prone to be the targets of derogation. One study found that a female confederate incurred more indirect aggression from female participants when she was dressed provocatively than when she was dressed more conservatively (Vaillancourt & Sharma, 2011). Furthermore, the confederate wearing revealing clothes was not wanted as a friend and did not receive the participants' approval to be introduced to their boyfriends. These results serve as an indication that females tend to aggress more towards females that are perceived as making themselves too sexually available.

Furthermore, females tend to aggress towards attractive women more than towards unattractive women. In fact, one study found that while men felt the most jealousy when they imagined their partners interacting with rivals that were high in social dominance, physical dominance, and social status, women felt most the most jealousy when the rivals were physically attractive (Dijkstra & Buunk, 2002). Another study found that attractive female rivals were 35% more likely to be the targets of indirect aggression than unattractive female rivals (Leenaars, Dane, & Marini, 2008). Women feel more threatened by attractive rivals, which triggers a stronger competitive response towards them. Additionally, women gossip more about other women when they are young and this relationship is mediated by mate value (Massar, Buunk, & Rempt, 2012). This finding is consistent with an evolutionary hypothesis because mate

competition should be especially intense among women who are young and fertile; women are most likely to reproduce successfully during this time period due to their higher mate value, which increases the pressure to compete.

Intrasexual Competition: Self-Promotion

The red genital swelling of an ovulating chimpanzee female does not seem particularly attractive to most human males. However, a red revealing dress might turn some heads.

A series of studies have suggested that red enhances men's attraction to women (for example, Elliot & Niesta, 2008). The hypotheses on why red might have this effect range from the physical properties and salience of this color to its role as a fertility cue among our closest primate relatives (Elliot & Niesta, 2008). However, these hypotheses are still under debate. Given that red yields sexual attraction in humans, it is sensible to wonder whether women might employ this as a cue for attracting male attention during ovulation. Consistent with this idea, one study found that female participants were more than three times more likely to wear red or pink when ovulating than when not ovulating (Beall & Tracy, 2013).

Wearing red at the time of ovulation might be one of multiple ways in which women compete with each other for mating access to high-quality males through appearance enhancement. Appearance enhancement refers to a competitive technique that involves increasing one's mate value by improving one's looks. Effective appearance enhancement depends on the salience of the cues being employed. Salience refers to how noticeable a stimulus is to a particular target group. In the case of women enhancing their appearance, the target group is men. For example, the color red is a stimulus that is noticeable to men and increments men's attraction to women. Thus, one effective method for female appearance enhancement is to wear red clothing.

Similarly, the use of revealing clothing is a cue worth investigating because it is salient to men. Indeed, a recent study found that women are more likely to wear revealing and sexy clothing around the time of ovulation (Durante & Haselton, 2008). This study relied on both experimental and naturalistic measures. Participants were photographed during two visits to the lab: once during ovulation and once during their luteal phase. Participants were also asked to draw an outfit that they would like to wear to a social gathering that evening. The researchers found that women both dressed significantly more provocatively and drew more provocative outfits during ovulation than during their luteal phase.

It is important to note that these findings do not imply that women evolved to dress in more revealing clothing during ovulation. Rather, women probably evolved a general drive to appear sexier during ovulation. In our modern context, appearing sexier might involve wearing more revealing clothing. Furthermore, it is instructive to remember that these behavioral changes have no need for conscious awareness. That is, saying that women evolved a drive to appear more attractive around the time of ovulation does not necessarily imply that women consciously want to appear more attractive. Instead, automatic cognitive mechanisms might engage to increase this drive around the time of ovulation.

Recently, researchers have begun to apply evolutionary theory to make predictions about consumer behavior. Women seem to behave differently across the menstrual cycle and have different preferences depending on their time of the month. Therefore, it is a sensible extension to consider how women might behave differently as consumers given what we know about their preferences and priorities throughout the cycle. An example of this is women's preference for red and revealing clothing during ovulation.

Another study examining consumer preferences across the cycle examined women's

purchasing behavior on a range of different categories (Saad & Stenstrom, 2011). This study found that women spend more money and have a grater desire for food products during their luteal phase. During this phase, women's conception risk is low. Therefore, women's priorities shift towards storing energy in order to maximize their chances of survival and be prepared in the event that they might have become pregnant during their previous fertile phase. In contrast, women become more concerned with accentuating their beauty during ovulation. The focus during their phase of peak fertility is reproduction, so women experience a desire to maximize their looks so as to attract a high quality mate. Thus, women during this phase tend to spend more money on products related to beautification such as makeup and sexy clothing.

Recent evidence has also suggested that ovulation might have an influence on the way that women walk. Gueguen (2012) conducted a study to test this prediction. In this study, women met a male confederate that posed as a participant in the study. Then, the experimenter excused himself and said that he had to answer a phone call. The experimenter asked the participants to meet him at the end of a long narrow hallway. The confederate walked behind the participant and activated a camera that videotaped the participants as they walked across the hallway. Participants were unaware that they were being videotaped as they walked. Women who were ovulating were found to walk more slowly than women who were not ovulating. Furthermore, two naïve male viewers rated the walk of ovulating participants as subjectively sexier than the walk of non-ovulating participants.

Another study linked women's gait during ovulation to high heels (Morris, White, Morrison, & Fisher, 2013). Women were recorded walking in either high heels or flat shoes using point-light methodology. Point-light methodology involves placing sensors on key areas of the body as a person walks such as to model their body movement. Participants in this

experiment then viewed these point-light videos of women walking and rated them on attractiveness. Women walking in high heels were rated as significantly more attractive than women walking in flat shoes. A series of biomechanical analyses also revealed that walking in high heels exaggerated feminine movements by reducing stride length as well as increasing the rotation and tilt of the hips. Such increases in walk femininity when wearing heels are comparable to increases in walk femininity observed during ovulation.

One earlier study found results that are inconsistent with the results reported by Gueguen (2012). This study found that men rated ovulating women's gait as less attractive than women's gaits during their luteal phase (Provost, Quinsey, & Troje, 2007). In fact, women's gait during ovulation was found to be identical to the gait of women who were taking oral contraceptives. These results are surprising given that a multitude of other studies have found that women taking oral contraceptives resemble women during their luteal phase across a multitude of different traits (Gueguen, 2012; Havlicek et al., 2006; Kuukasjarvi et al., 2004; Miller & Maner, 2009; Miller & Maner, 2010; Pipitone & Gallup, 2008; Roberts et al., 2004). In contrast, women who are ovulating display cues that attract men's attention such as a more pleasant smell, more attractive facial features, a lower waist to hip ratio, and a more attractive vocal pitch. Thus, it seems odd that women might display several ovulatory cues that make them more attractive around the time of ovulation while at the same time walking in a less attractive manner.

Provost et al. (2007) explained the discrepancy between their results and the literature by arguing that cues such as facial attractiveness might be more intimate than gait. A woman might desire to appear more attractive to men whom she chooses to interact closely with, whereas she might not want to attract the attention of men who are distant. It might be in a woman's interest to ward off unwanted male attention during ovulation in order to prevent unwanted sexual

contact. However, this explanation does not account for the findings of Gueguen (2012). Moreover, this explanation fails to account for ovulatory cues that enhance attraction at a distance such as women's preference for red and revealing clothing around the time of ovulation.

In order to understand the discrepancy between these two studies investigating women's gait, it is essential to consider the sex of the people conducting the experiment. In the experiment by Gueguen (2012), a male confederate walked behind the female participants while their gait was being recorded. Furthermore, the researchers ensured that the male confederate in this study was considered attractive by conducting a pretest session during which women rated several different male confederates on attractiveness. Thus, the presence of an attractive male confederate may aid in the interpretation of these results; the hypothesis of this study was that women's gait varies specifically to attract men's attention. It is possible that women's gait might vary throughout the cycle exclusively in the presence of men.

In contrast, the study conducted by Provost et al. (2007) was run exclusively with female experimenters. Therefore, participants in this study had no motivation (by this I am referring to an unconscious drive) to walk in an attractive manner because there were no males present. Rather, women might have been motivated to conceal their fertile status from other women in order to avoid becoming the targets of intrasexual competition. Walking in an unattractive manner in front of other women might represent a reproductive strategy that is distinct from walking in an attractive manner in front of men. Whereas the former might serve to attract male's attention during women's fertile stage, the latter might serve to avoid attracting the attention of same-sex competitors. If both males and females are present, however, there might be other factors moderating whether females advertise or conceal their ovulatory status such as the ratio of men to women present, whether the women present are ovulating, and whether the

women present are competing for the same mates.

The findings of a study that examined body movements support this interpretation (Grammer, Filova, & Fieder, 1997). In this study, women were recorded as they turned around. The premise for the study was that women might perform body movements in a more attractive manner when they are ovulating. This study measured several specific aspects of the movement performed by the participants including the duration, the number of basic movement units, the complexity of the movement, and the maximum speed of the turn. An analysis of the videos revealed that there were differences in the movement performed by women that were ovulating versus women that were not ovulating. This relationship seemed to be related to estrogen levels and the differences were so reliable that a trained artificial neural network (a computer program that is meant to serve as a model of brain activity) was able to predict women's fertility status based on the characteristics of the movement.

The key variable in this study was whether women were turning around in the presence of a male or a female researcher. Notably, the differences in the body movements of women were only present when a male researcher was conducting the study. When a female researcher was present and no men were present, the difference in the body movements between ovulating and non-ovulating women disappeared. Thus, it is imperative that future studies investigating behavioral components of ovulation take into account the sex of all people present during the experimental session.

The fact that the study by Provost et al. (2007) overlooked the importance of the sex of the people present during experimentation is symptomatic of the lack of integration within the field of evolutionary studies. Whereas some studies have focused on ovulatory cues, others have looked exclusively at intrasexual competition. However, some of the mechanisms that might

serve as ovulatory cues might also serve as competitive tools under different circumstances. Thus, it is imperative that the field begins to move towards a more cohesive view of adaptive mechanisms that considers mate attraction and intrasexual competition simultaneously in the light of ovulation. Study 1 will attempt to bridge ovulation and intrasexual competition research by focusing on women's gait as an ovulatory cue that adapts based on whether potential rivals or mates are present.

Another area that necessitates integration is the study of smell. A series of studies were described previously that looked at smell as an ovulatory cue (Doty et al., 1975; Havlicek et al., 2006; Miller & Maner, 2009; Roney & Simmons, 2012; Miller & Maner, 2010; Poran, 1994; Singh & Bronstad, 2001). Taken as a whole, these studies suggest that smell serves as a cue for ovulation that is detectable by men. Two pioneering studies broke away from the classic experimental procedure for investigating smell across the menstrual cycle (Kuukasjarvi et al., 2004; Trouton, Guitar, Carmen, Geher, & Grandis, 2012). The key factor that separates these two studies from previous literature is the sex of the raters. These studies had both men and women rate the smell of women across their menstrual cycle. Additionally, the study by Trouton et al. (2012) also examined the role of sexual orientation by having both heterosexual and homosexual participants rate the scents of women. Both of these studies found a clear significant relationship between smell pleasantness and attractiveness exclusively among heterosexual male raters.

Having women rate the attractiveness of other women's scents served to test the hypothesis that the ability to detect changes in smell across the menstrual cycle is confined to males. This hypothesis stems from the understanding of smell as a cue for ovulation intended to attract male attention during peak fertility. These studies conclude that women do not obtain a direct reproductive benefit from identifying a woman's reproductive status, which is why they do

not detect changes in the smell of women across the menstrual cycle.

The study by Kuukasjarvi et al. (2004) reported that there was no significant relationship between women's sexual attractiveness ratings of other women's scents and the fertility status of the women that provided the smell. However, further statistical analyses revealed that women might be able to detect other women's fertility status and that women's ratings of other women's scents approached significance. The authors were puzzled by these findings and reported that, "at present we have no obvious adaptive explanation supporting the interpretation that also females could detect the reproductive status of other women". This interpretation of the findings is indicative of a scientific tunnel vision that must be combated when conducting studies.

One adaptive explanation becomes evident in the light of intrasexual competition. Namely, it is possible that women benefit from deciphering the reproductive status of other women by determining which women pose a bigger competitive threat. Women that are at peak fertility will likely appear more attractive to men, which would make them into more threatening rivals. Thus, asking women whether other women's scents are attractive might not be the right way of measuring whether women can detect ovulation in other women. Rather, it might be more useful to ask women to rate other women's smells in terms of the level of threat that they pose. Such an approach would integrate research on ovulation with research on intrasexual competition and would help to explain the puzzling nature of the results found by Kuukasjarvi et al. (2004). Study 2 will investigate these research questions relating to the connection between changes in scent throughout the menstrual cycle and intrasexual competition.

Gait Attractiveness and Threat (Study 1)

Method

The participants for this study will all be undergraduate students. During the first part of the experiment, which will be referred to as the walking portion, female participants will be greeted by the experimenter during individual sessions and given a consent form. The consent form will not reveal the true purpose of the study. Rather, it will present the study as one concerned with decision-making. Then, the participants will be asked to complete a demographic questionnaire that will be long enough to allow the experimenter enough time to exit the room and walk to the other side of a long narrow hallway. While the participant completes the questionnaire, the experimenter will excuse himself/herself saying that he/she has to give instructions to a participant taking part in an experiment on the other side of the hallway. The experimenter will ask the participant to complete the demographic questionnaire in the room and then walk over to a room on the other side of the hallway where she will be met by the experimenter to complete the rest of the study.

There will be three conditions during this part of the experiment. In one condition, there will be an attractive male confederate waiting in the room when the participant walks in. The confederate will pretend to be a participant in the study. The confederate will be instructed to take slightly longer than the participant when completing the questionnaire so as to exit the room right after she does. As soon as the participant exits the room, the confederate will start a timer that will be hidden in his pocket and then start walking behind the participant at a distance of approximately one meter. As soon as the participant reaches the other side of the hallway, the confederate will stop the timer in his pocket. The time recorded with the timer will serve to calculate the speed at which the participant was walking. As the participant walks, there will be a

spy video camera located in the hallway recording the participant. This camera should be set up prior to the arrival of the participant.

In a second condition, a female confederate, as opposed to a male confederate, will be present in the room when the participant arrives. In a third condition, there will be no confederate present. Instead, two experimenters will greet the participant. One of the experimenters will excuse himself/herself and leave the room after handing the demographic questionnaire to the participant. Right before the experimenter leaves the room, both experimenters will start timers hidden in their pockets simultaneously. The second experimenter will instruct the participant to meet the first experimenter at the other end of the hallway once the participant finishes completing the demographic questionnaire. The second experimenter will stop the timer in his/her pocket as soon as the participant leaves the room. The first experimenter will then stop the timer in his/her pocket as soon as the participant arrives to the other end of the hallway. The difference between the time calculated by the first and second experimenters will serve to calculate the speed at which the participant was walking.

Once the participant arrives at the other end of the hallway, they will be asked to provide a salivary LH sample as in Gueguen's study (2012). This salivary sample will then be employed to determine the participant's fertility. Participants will be divided into one of three categories of fertility (low, medium, and high). The LH test will be conducted by providing participants with a buccal narrow test strip (Saliva Biotester QTest) and asking them to put it on their tongues for two seconds. The probability of fertility will be obtained with the help of a colored reagent associated with the LH concentration (Gueguen, 2012). Participants will then be asked to fill out a follow-up questionnaire. This questionnaire will ask participants what they think the purpose of the study was as well as a number of other pertinent questions such as relationship status,

whether they are taking any psychiatric medication, their usage of oral contraceptives, and their sexual orientation. Only participants that are heterosexual and are not taking any psychiatric medication will be retained during data analysis. Relationship status will not serve as an excluding variable, although it will be coded in order to test whether it affected the results. Although relationship status, sexual orientation, and the use of psychiatric medication will not be directly tested in this study, future studies should examine the possibility that these variables might have an effect on both attractiveness and threat ratings. Finally, participants will be debriefed.

It is essential that both the male and female confederates should be perceived as attractive. In order to achieve this, a minimum of two male research assistants and two female research assistants should all agree on an attractive male candidate and an attractive female candidate. The candidates should be approached and asked to participate in a brief study. If they agree, they will be asked to sign an informed consent. Then, two photographs will be taken of each candidate. One picture will be of their face and another will be a frontal picture of their entire face and body.

These pictures should be presented to both males and females at a different university (in order to protect the candidate's privacy), who will rate the people displayed on the pictures on physical attractiveness using a 9-point Likert-type scale ranging from "not at all attractive" to "extremely attractive". The mean and standard deviation of these ratings will be compared to those in Gueguen 2012 (mean=7.28, SD=2.38) in order to determine whether the candidates are attractive enough. Ideally, the mean should be equal or higher to that obtained by Gueguen (2012) and the standard deviation should be equal or lower. New candidates should be chosen if the desired results are not obtained with the first set of candidates.

The second part of the experiment will be referred to as the rating portion. Participants for the rating portion will be recruited at a university different from the one where the walking portion will take place to reduce the probability that the participants in the videos will be recognized. First, participants will be provided with an informed consent that will describe the experiment as a study of gait attractiveness. Then, participants will be asked to view the videos of the women that were filmed during the walking portion of the experiment. Faces will not be shown during the presentation of the videos in order to protect the privacy of participants. The videos will be presented using E-Prime software and the order in which the videos are presented will be randomized. Participants will rate each of the walks portrayed in the videos on attractiveness using a 5-point Likert-type scale ranging from "not at all sexually attractive" to "extremely sexually attractive".

The procedure will be slightly different for female participants. In addition to rating the videos on attractiveness, female participants will rate each of the gaits on threat level. Participants will be asked to imagine that they are very interested in a man and that the woman walking in each of the videos approaches that man and starts flirting with him. They will then be asked to rate the woman walking in each of the videos on how threatening they perceive her to be as a sexual competitor using a 5-point Likert-type scale ranging from "not at all threatening" to "extremely threatening". Participants will complete either the attractiveness or threat rating first, work on a distracter task, and then complete the other rating. Participants will be randomly assigned to either complete the threat rating or the attractiveness rating first. The distracter task will involve solving simple math problems.

After completing the rating, participants will complete a follow-up questionnaire. The follow-up questionnaire will vary slightly for male and female participants. The follow-up

questionnaire for male participants will include basic demographic questions such as age, sexual orientation, and relationship status. Male participants will be debriefed immediately after they complete the follow-up questionnaire. The follow-up questionnaire that will be given to female participants will also include questions about whether they are taking oral contraceptives or have taken them within the last 3 months and whether they are taking any psychiatric medication.

Female participants will be divided into four different categories during data analysis: high fertility, medium fertility, low fertility, and women taking oral contraceptives. In order to determine women's fertility, a salivary LH sample will be taken from female participants following the procedure described for the walking portion of the experiment. The LH sample will be taken after participants complete the ratings and the follow-up questionnaire to ensure that it does not arise any suspicion. Finally, female participants will be debriefed.

Projected Results

This study will be a rater (5) x walker (4) x confederate (3) design for attractiveness ratings and a rater (4) x walker (4) x confederate (3) design for threat ratings. The rater variable for the attractiveness ratings will include: male raters, high fertility female raters, medium fertility female raters, low fertility female raters, and female raters using oral contraceptives. The walker variable will be composed of: high fertility female walkers, medium fertility female walkers, low fertility female walkers, and female walkers taking oral contraceptives. Finally, the confederate variable will involve: male confederate, female confederate, and no confederate (control). The variables for the threat ratings will be identical to the variables for the attractiveness ratings except that males will not rate the gaits on threat.

There are eight major hypotheses that will be addressed with this study. First, ovulating women (those at high fertility) will walk slower on average than women lower in fertility (those

at low fertility and medium fertility) and women taking oral contraceptives, but only when they are walking in front of a male confederate. Second, men will rate the gait of ovulating women as more attractive than the gait of women lower in fertility and women taking oral contraceptives, but only when a male confederate walks behind her. These two hypotheses represent a replication of the results found by Gueguen (2012). The second hypothesis also expands on the results by Gueguen (2012) by taking into consideration the sex of the confederate that will be present as the women walk. This hypothesis stems from the findings of Grammer et al. (1997), which revealed that women's movement when turning around was only rated as more attractive in the presence of a male researcher and not in the presence of a female researcher.

Third, female raters low in fertility and raters taking oral contraceptives will rate other women's gait in a pattern similar to that of male raters. This hypothesis is compatible with the results of Fisher (2004) that found that women's attractiveness ratings by female participants were similar to the rating scores given by male participants. This hypothesis is also consistent with several previous studies that have found that women taking oral contraceptives display similar behavioral and physiological measures as women during their luteal phase (for example, Kuukasjarvi et al., 2004; Miller et al., 2007).

Fourth, ovulating female raters will rate the gait of other women as less attractive than female raters lower in fertility. This effect will be especially pronounced for ovulating participants walking in the presence of a male confederate. Ovulating women should perceive other ovulating women as threatening competitors, which should trigger a strong competitor derogation response. This hypothesis was derived from the findings of Fisher (2004), which suggest that ovulating women rate other women lower on attractiveness than female raters during their luteal phase. This hypothesis is also somewhat speculative since to my knowledge no other

published studies have taken into account both the menstrual cycle of the raters and the women being rated.

Fifth, ovulating female raters should rate the gait of ovulating females walking in the presence of a female confederate as more attractive than the gait of females walking in the presence of a male confederate or in the absence of a confederate. Ovulating female raters should also rate the gait of ovulating females walking in the presence of a female confederate as more attractive than the gait of females lower in fertility walking in the presence of a male confederate or in the absence of a confederate. Ovulating females might reduce the attractiveness of their gait in the presence of female rivals in order to avoid becoming the targets of derogation during their period of peak fertility. Thus, ovulating raters might perceive these women as a lower threat and derogate them less than other women. This finding would be consistent with the findings of Provost et al. (2007) that reported that males rated ovulating females walking in the presence of female experimenters as less attractive than females during their luteal phase walking in the presence of female experimenters. This finding would also be consistent with the findings of Grammer et al. (1997) that found that females' body movement was rated as less attractive by males when turning in the presence of females than when turning in the presence of males.

Sixth, female participants will rate the gait of ovulating women as more threatening than the gait of women lower in fertility or women taking oral contraceptives, but only when women are walking in front of a male confederate. This hypothesis will serve to test threat ratings as a possible moderating variable for attractiveness ratings given by females. Women should employ competitor derogation and rate other women lower on attractiveness only when they perceive them to be a threat. This hypothesis is supported by previous evidence that has found that women aggress against rivals that are physically attractive (Dijkstra & Buunk, 2002; Leenaars, et al.,

2008) and that wear provocative clothes (Vaillancourt & Sharma, 2011). These results suggest that females compete more vigorously against women that are perceived as attractive likely because they perceive them to be more threatening. It is likely that ovulating women will be perceived as particularly threatening since ovulation enhances the sexiness of women's gait when they are in the presence of potential mates (Gueguen, 2012).

Seventh, ovulating females will give higher threat ratings than female raters lower in fertility or taking oral contraceptives. Women should become sensitized to perceiving threat when they are ovulating as suggested by Fisher (2004). Eight, ovulating females walking in the presence of a female confederate should receive lower threat ratings than females walking in the presence of a male confederate or in the absence of a confederate. Females might reduce the attractiveness of their gait during ovulation so as to avoid being perceived as a threat by other females.

If these hypotheses were supported, this experiment would help to clarify the relationship between ovulation and both self-enhancement and competitor derogation as strategies for intrasexual competition. These results would suggest that women employ their gait as a mechanism for self-enhancement during their period of peak fertility in order to appear more attractive to males. Moreover, it would be possible to conclude that oral contraceptives suppress the use of this strategy for self-enhancement. It could also be argued that such self-enhancement is only activated in the presence of potential mates and not in the presence of female rivals. Ovulating females might suppress their self-enhancement mechanisms around rivals in order to avoid becoming the targets of intrasexual competition when potential mates are not present. Future studies should explore whether the suppression of ovulatory cues in the presence of rivals dissipates if both rivals and potential mates are present.

In addition, it would be revealed that females use competitor derogation when they are ovulating as a competitive strategy such that they rate the gait of other women as less attractive. Finally, these results would suggest that women rate the gait of ovulating women walking in front of men as more threatening. The threat perceived would be enhanced if the rater were ovulating. Thus, ovulating female raters would recognize that the gait of other ovulating women is threatening, but they would not rate it as particularly attractive in order to derogate their competitors.

Scent Attractiveness and Threat (Study 2)

Method

The first portion of the study will essentially be a replication of the study by Kuukasjarvi et al. (2004). As many participants as possible should be recruited for this part of the experiment; the study by Kuukasjarvi et al. (2004) recruited 82 female participants, so this study will seek to approximate that number as closely as possible. Female participants will wear a T-shirt for two consecutive nights. The instructions will specify that the T-shirt should be worn directly on the skin. All T-shirts will be unworn, the same brand, white, and made out of cotton. Furthermore, T-shirts will be prepared by washing them with odorless soap powder in order to rid them of the chemical smell of new T-shirts. T-shirts will be placed in odorless plastic freezing bags after washing and drying to protect them from extraneous smells. Women will keep the T-shirts inside of these same odorless bags when not wearing them.

Participants will also be provided with odorless soap powder to wash their bed sheets prior to the experiment, odorless bar soap for personal hygiene, and liquid odorless soap for hair cleaning during the experiment. Moreover, participants will receive a list of detailed instructions about behaviors that should be avoided during the experiment in order to prevent smell contamination. This list will be obtained from the procedure described by Kuukasjarvi et al. (2004). Some of the guidelines include refraining from using perfumes, perfumed deodorants, and perfumed soap powder; eating odor-producing food such as garlic, onion, strong spices, herbs, cabbage, celery, asparagus, yogurt, and lamb; smoking cigarettes, drinking alcohol, and using drugs; sleeping with another human or animal and engaging in sexual activity.

Women will return the T-shirts after being worn for two nights. T-shirts will be returned in the morning between 8:00am-10:00am. Once the T-shirts are returned, they will be stored in

glass jars that will be labeled and sealed. After returning the T-shirt, women will be given a questionnaire asking them to report honestly whether they had followed the directions of the study. Participants will be informed that their response to this questionnaire will be identified only through the use of a subject number and will not be tied to their individual name. Moreover, they will be told that their compensation will not be affected by their response, but that it is crucial that they respond with honesty because the results of the study could be compromised otherwise. In addition, the questionnaire will ask female participants about their use oral contraceptives, their relationship status, their use of psychiatric medication, and their sexual orientation. Only participants that are heterosexual and are not taking psychiatric medication will be retained for data analysis. Relationship status will not be used to exclude participants from the analysis, but it will be noted in order to test whether this variable might skew the results.

Once the questionnaire has been completed, participants will be asked to provide a salivary LH sample following the same procedure as in Study 1. The LH test will be conducted by providing participants with a buccal narrow test strip (Saliva Biotester QTest) and asking them to put it on their tongues for two seconds. The probability of fertility will be obtained with the help of a colored reagent associated with the LH concentration (Gueguen, 2012). This salivary sample will then be employed to determine the participant's fertility, or likelihood of ovulation. Participants will be divided into one of three categories of fertility (low, medium, and high).

During the rating portion of the study, participants will be provided with an informed consent upon entering the lab. The informed consent will describe the experiment as a study of scent attractiveness but will not reveal the specific hypotheses of the study. The rating portion will be conducted in eight sessions. Four of the sessions will be conducted on the same day that

the T-shirts are returned by the female participants and four will be conducted the day after. Each session will host 20 participants at a time and the jars with the T-shirts will be randomly circulated among them. Sessions will be composed of exclusively female or exclusively male participants due to the differences in the procedure between the sexes.

Each participant will be seated far apart from the other participants and facing a different direction to ensure that others do not influence their ratings. Talking will not be allowed during the sessions. In addition to the T-shirts worn by the female participants, there will be one jar containing a new washed T-shirt that will serve as a control. The research assistants that will be present during this portion will be blind to the menstrual cycle of the women that wore each of the T-shirts to avoid biases.

Participants will be provided with a set of instructions asking them to open each of the jars and smell them by placing it right under their nose. They will also be instructed not to touch the T-shirts directly. Both male and female participants will rate each of the scents on how sexually attractive they are using a 9-point Likert-type scale ranging from “not at all attractive” to “extremely attractive”. Female participants will also rate the scents on how threatening they are following a similar procedure as for Study 1. Participants will be asked to imagine that they are very interested in a man and that the each scent belongs to a woman that approaches that man and starts flirting with him. They will then be asked to rate the women whose scent they will smell on how threatening they perceive them to be as a sexual competitor using a 5-point Likert-type scale ranging from “not at all threatening” to “extremely threatening”. Female participants will complete either the attractiveness or threat rating first, work on a distracter task, and then complete the other rating. Participants will be randomly assigned to either complete the threat rating or the attractiveness rating first. The distracter task will involve solving simple math

problems.

Both males and females will complete a follow-up questionnaire once they finish the rating part of the experiment. Male participants will be asked questions such as their age, relationship status, and their sexual orientation. In addition to these questions, female participants will be asked questions regarding their use of oral contraceptives and psychiatric medication. Only participants that are heterosexual and are not taking psychiatric medication will be retained for data analysis. Relationship status will not be used to exclude participants from the analysis, but it will be noted in order to test whether this variable might skew the results.

Projected Results

This study will be a rater (5) x scent (4) design for attractiveness ratings and a rater (4) x scent (4) design for threat ratings. The rater variable for the attractiveness ratings will include: male raters, high fertility female raters, medium fertility female raters, low fertility female raters, and pill (oral contraceptive users) female raters. The scent variable will be composed of: the scent of high fertility women, the scent of medium fertility women, the scent of low fertility women, and the scent of women taking oral contraceptives. The variables for the threat ratings will be identical to the variables for the attractiveness ratings except that males will not rate the scents on threat.

There are three major hypotheses that will be addressed with this study. First, men will rate the scent of women at high fertility as the most sexually attractive, followed by the scent of women at medium fertility. The scent of women at low fertility will be rated as the least attractive along with the scent of women taking oral contraceptives. This projected result is supported by the findings of Kuukasjarvi et al. (2004).

One important factor that Kuukasjarvi et al. (2004) did not take into consideration is the

menstrual cycle of female raters. This study concluded that women did not appear to be able to identify other women's stage of the menstrual cycle based on scent attractiveness ratings. However, the authors were surprised to find a nonsignificant relationship that seemed to indicate that women might have the capability of detecting other women's ovulatory status. The authors were baffled by this finding and could not explain it within an evolutionary framework.

The current study predicts that the raters' menstrual cycle might help to explain the results found by Kuukasjarvi et al. (2004). Non-ovulating women (women at low or medium fertility and women taking oral contraceptives) should rate the scent of other females in a similar fashion as men. This hypothesis is supported by the findings of Fisher (2004) that revealed that women's attractiveness ratings by female participants were similar to the rating scores given by male participants. In contrast, ovulating female raters should experience a heightened sense of competition, which would result in lower scent attractiveness ratings of other women. These findings would be consistent with the findings of Fisher (2004), which reported that females rate other women lower on attractiveness when they are ovulating as a rival derogation competitive strategy. Moreover, the scent of ovulating women should trigger an especially strong competitive response among ovulating female raters, which should result in especially low scent attractiveness scores.

The third hypothesis for this study involves the threat ratings performed by female participants. Non-ovulating raters (women at low or medium fertility and women taking oral contraceptives) should rate the scent of other women as less threatening than ovulating raters. Moreover, the scent of ovulating women should be rated as more threatening than the scent of non-ovulating women. These results, in combination with the second hypothesis, would suggest that competitor derogation is used as an intrasexual competitive strategy and that this strategy is

used most against competitors that are perceived to be threatening rivals.

Summary of the Importance of the Proposed Studies

In conjunction, these two studies would serve to bridge the gap between the investigation of ovulatory cues and intrasexual competition. On one hand, ovulatory cues have been mostly examined within the context of men detecting ovulation in women. This view of ovulation represents a male-centric view of competition in which males compete for sexual access to passive females. These studies would serve to reaffirm females' active role in mating by exploring how women compete with each other. This competition occurs through the use of complex strategies such as self-enhancement and competitor derogation. On the other hand, the literature on intrasexual competition is still in its infancy and has not yet explored the detection of ovulatory cues by females and how these might moderate intrasexual competition. The proposed studies combine both areas into a set of hypotheses that suggest that women might be able to detect ovulatory cues in other females and adjust their competitive strategies accordingly. These studies propose that competitor derogation is moderated by the menstrual cycle of both the derogator and the target.

These studies do not propose to identify the specific biomechanical variations, hormonal fluctuations, or brain mechanisms involved in the changes in women's walking patterns and scent throughout the menstrual cycle. These questions would certainly be pertinent to the study of ovulatory cues and intrasexual competition and future studies should attempt to investigate the specific mechanisms responsible for these changes. However, these studies are a necessary first step in determining whether women can detect ovulatory cues in other women and whether they adjust their competitive strategies accordingly.

While both studies are related, each is necessary in order to advance the field. Study 1 is concerned with an ovulatory cue that could be subject to rapid modification. Walking, like other

body movements, can be modified quickly depending on the circumstances that an individual is in at a particular time. Walking is ideal for a study on the versatility of ovulatory cues because it allows for a test of whether some behavioral cues might be modified depending on whether a potential mate or a rival is present. The sex of the people present during the experiment is a key factor that has often been overlooked in evolutionary studies. While the presence of potential mates might increment self-enhancement competitive strategies, the presence of potential rivals in the absence of potential mates might suppress self-enhancement so as to avoid becoming the target of derogation or other intrasexual competitive strategies.

Study 2 is different from Study 1 because it involves the detection of an ovulatory cue that is predicted to change more slowly; scent might not change with the same ease and speed as walking. Scent is a more stable cue that has received copious attention within the field, yet none of the studies that have focused on scent have investigated the role of the rater's menstrual cycle (Doty et al., 1975; Havlicek et al., 2006; Miller & Maner, 2009; Miller & Maner, 2010; Poran, 1994; Roney & Simmons, 2012; Singh & Bronstad, 2001). Furthermore, this study would help to clarify puzzling and inconclusive findings that have suggested that women might be able to detect ovulation through smell (Kuukasjarvi, 2004).

Furthermore, these studies emphasize the importance of asking questions that address the goals of each sex by taking into account an evolutionary framework. Defining the detection of ovulatory cues using the same parameters for both males and females might yield confusing outcomes. Rather, asking the level of threat that a woman poses might be a more appropriate method for testing the detection of ovulatory cues among females. Females represent competitors in the eyes of other females, while males represent potential mates. Thus, the disposition of females towards each of these target groups should be different and should yield different

hypotheses. These studies would promote the idea that the detection of ovulatory cues, as well as other adaptations, does not necessarily serve a single purpose. Rather, the detection of these cues could be employed by men as a way of maximizing their efforts at mating with a fertile woman and by women as a mechanism for distributing their competitive efforts appropriately.

In summary, these two studies represent a natural extension of the current literature by integrating the detection of ovulatory cues and intrasexual competition while emphasizing the importance of asking appropriate questions within an evolutionary framework. Both are necessary in order to clarify the extent to which females to detect ovulation in other females. Most importantly, both of these studies propel the field of evolutionary studies towards a view of women as active competitors that have an essential role in determining mating outcomes.

General Conclusions

This paper began by introducing evolutionary psychology and tackling some common misconceptions about evolutionary theory. Then, it explored the role of non-reproductive sex in humans by comparing it to sex in other species of primates. Non-reproductive sex among humans seems to be related to the evolution of cryptic ovulation. Men appear to be able to detect some ovulatory cues in women and adjust their behavior in order to maximize their reproductive success. This paper also investigated the occurrence of intrasexual competition between women and emphasized the role of women as active contenders. Finally, two studies were proposed that aim to bridge the gap between the detection of ovulatory cues and intrasexual competition by suggesting that women might be able to detect ovulation in other women and alter their competitive strategies accordingly.

As a whole, this paper suggests that female behavior is highly complex. Furthermore, it reveals that evolutionary psychology can serve as a useful tool for generating predictions and better comprehending human nature. While evolution does not yield a view of women as passive receptacles, a misunderstanding of this theory can lead to erroneous conclusions. Therefore, it is important to propagate an accurate portrayal of evolutionary theory that depicts women as complex organisms that play an essential and active role in mate selection and intrasexual competition.

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