

MECHANISM BEHIND THE MADNESS: INCREASED PERCEPTUAL ACUITY FOR  
MATING RELATED STIMULI AT OVULATION

by

SUMMER MENGELKOCH

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University of Minnesota  
Minneapolis, Minnesota

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## Mechanism Behind the Madness:

### Increased Perceptual Acuity for Mating Related Stimuli at Ovulation

“Would you like that shirt in lilac or mauve?” This question, posed to a woman, represents a choice between two distinct options. Posed to a man, this question represents a choice between two options, but he may not be able to reliably discriminate between the choices. This sex difference – although it is something that many find humor in – is more than just an unflattering stereotype of men. It is backed up by decades of scientific research. Researchers have investigated sex differences in the ability to discriminate colors and found women to hold a slight, but distinct advantage (Abramov, Gordon, Feldman, & Chavarga, 2012; Greene & Gynther, 1995; McGuinness & Lewis, 1976; Rodríguez-Carmona, Sharpe, Harlow, & Barbur, 2008). Additionally, men are significantly more likely to be red-green color blind when compared to women (Delpero, O’Neill, Casson, & Hovis, 2005). Beyond just color discrimination, evidence suggests that women’s sensory functions are more sensitive than men’s across all of the senses (Velle, 1987) – including audition (McFadden, 1998), touch (pain) (Bartley & Fillingim, 2013), taste (Bartoshuk, Duffy, & Miller 1994), smell (Brand & Millot, 2001), and some aspects of vision, (Handa & McGivern, 2015).

Women’s increased ability to notice slight differences in colors or other stimuli may not seem important when picking out a shirt, but what about women’s ability to discriminate between other subtle differences in stimuli that are presented to them in evolutionarily relevant contexts? For example, when gathering berries, a task that has, historically, been a primary occupation of women, being able to detect which berries are optimally ripe would provide a caloric benefit compared to someone who picks berries that have gone bad or are not yet ripe. Subtle differences in colors of the berries were a reliable cue used to assess

which berries were safe to eat and which were not. Silverman and Eals (1992) have theorized that men and women have evolved different visual and special abilities to facilitate hunting and gathering, respectively. In this context, an increased perceptual acuity to the subtle differences between colors would be highly advantageous for women.

Another context in which an increased ability to discriminate differences between stimuli may serve women particularly well is when they are making mating decisions. Here, I will draw from the literature concerning men's and women's mating psychologies, women's mate preferences and sexual strategies, and ovulatory shift effects in women, to develop an evolutionarily-informed framework predicting that women's ability to discriminate subtle differences between mating-relevant stimuli should be particularly robust at times when conception is possible.

### **Men's and Women's Mating and Sexual Psychologies Differ**

Throughout human evolutionary history, both men and women have had to solve a number of adaptive problems in order to survive and reproduce. In some domains, the challenges that men and women have faced in regard to survival and reproduction have been the same. In these cases, men and women's psychologies are expected to have evolved the same adaptive mechanisms to overcome these challenges. However, in cases where these challenges have been sex differentiated, their psychologies are expected to differ as well. Men and women have faced different challenges in passing on their genes to the next generation, and as such, each sex has evolved different mating and sexual strategies to help them to overcome these challenges and promote reproductive success.

One challenge that requires men and women to approach mating decisions differently is that men have a much higher reproductive potential, or reproductive value, than women

do. This asymmetry in the number of offspring that any given man and any given women could hypothetically produce in their lifetimes indicates that women are the rate limiting factor in human reproduction (Bateman, 1948). This is due to the large amount of obligate parental investment that a woman must invest in each offspring she produces (Trivers, 1972).

In each offspring a woman produces, she must invest the time and resources necessary to conceive a child, to carry the child to term, and to lactate. Mating with more men while pregnant or lactating will not further increase a woman's reproductive success. Instead, women can maximally produce one offspring every nine months, regardless of how many mating opportunities are taken advantage of.

For men, however, additional mating opportunities can continue to increase reproductive success without such limitations. Because men are only required to invest the time it takes to copulate in each potential offspring, men can increase their reproductive potential simply by mating with as many novel women as possible. A man could hypothetically have hundreds of children per year - particularly if he takes advantage of a very large number of mating opportunities, while investing very limited resources in the women he is mating with or in his offspring.

The asymmetry in reproductive potential that exists between men and women means that the strategies that would have best promoted reproductive success for men and women are somewhat sex differentiated. To optimize their fitness, men could benefit from pursuing many short-term sexual relationships. Women, on the other hand, optimize their fitness when they secure a mate who is willing and able to invest resources in her and her offspring. When evaluating a mating opportunity, men and women must weigh the costs and benefits involved in pursuing this opportunity.

The differential costs and benefits associated with men's and women's mating strategies lead men to overperceive sexual interest in women, as the cost of missing a sexual opportunity for a man is high (Haselton & Buss, 2000). If a man misses a sexual opportunity by not perceiving that a woman is sexually interested in him when she is, it could be the difference between passing on his genes to the next generation and ending his genetic lineage. At the same time, the cost of believing a woman is interested in a sexual opportunity when she is not is low – generally the only cost the man would incur is some embarrassment at the rejection. Women, on the other hand, tend to underperceive men's commitment. This is because the cost of believing a man is committed when he is not is high. If a woman becomes pregnant with a man's child, believing he is committed to her when he is not, the woman faces the risk that the man could abandon her and their child without providing resources to either. This has serious negative implications for both the mother and the child (Hurtado & Hill, 1992; Gubernick & Teferi, 2000). For women, this is far riskier than the potential of missing out on a mating opportunity in which a man is committed to her. As women are the rate limiting factor in human reproduction, they are not typically in short supply of mating opportunities. The different perceptual biases described function to help men and women to overcome the different challenges each sex must face to secure a mate and pass on their genes to the next generation; however, they also highlight the conflicting interests of both sexes which have differently shaped men's and women's mating psychologies.

Given women's greater minimum investment in offspring and constrained reproductive potential, it is costlier for women to make suboptimal mate choices than it is for men. Women who mate with unfavorable men, or with men who are not going to invest in them or their offspring, incur a large cost to their reproductive potential, while men who mate

with unfavorable women do not. These differences have shaped women, over evolutionary time, to be more cautious when deciding who to mate with than men. Decades of research has found support for this general prediction (e.g. Schmitt et al., 2012). For example, Kenrick, Sadalla, Groth, & Trost (1990) asked participants to rate the minimum level of different traits that would be acceptable in a partner at different levels of commitment. While men and women were similarly selective about their long-term partners, women were far more selective about the minimum traits they required in a partner for a short-term sexual partner than men were. This highlights that women are more cautious when deciding who to mate with when they are not first requiring the investment provided in a long-term mating context. Additionally, researchers have found that men desire a greater number of future sexual partners than women do on average (Buss & Schmitt, 1993; Pedersen, Miller, Putcha-Bhagavatula, & Yang, 2002). Both of these lines of research lend support to the theory that men are more opportunistic, while women are more selective, when choosing partners for short-term sexual encounters. These differing mating psychologies would have helped men and women to solve the different challenges they faced when striving to survive and reproduce throughout their evolutionary history.

### **Women's Mate Preferences and Sexual Strategies**

In addition to offering insights into the often sex differentiated nature of men's and women's mating strategies, an evolutionary perspective also offers unique insights into the content of men's and women's mate preferences. Given that women are the focus of the proposed research, this review will focus on the evolutionary foundations of women's mate preferences.

Broadly speaking, an evolutionary perspective on women's mate preferences predicts that women should prefer qualities in their partners that would help facilitate successful reproduction. Given women's historical dependence on men for provisioning and protection – particularly during pregnancy and when caring for young children – many of the qualities that women desire are those that bear on a man's ability to provide and protect. Because paternal investment greatly increases an offspring's survivability (Hurtado & Hill, 1992; Gubernick & Teferi, 2000), men who do not possess cues that they will be able to procure and provide resources, provide protection, and be a good father are not typically desired as long-term mates. For example, cross-cultural studies investigating women's mate preferences find that women prefer older men with access to resources (Buss, 1989). More recently, Li, Bailey, Kenrick, & Linsenmeier (2002), sought to confirm these observed preferences by forcing participants to make choices about which traits they most desired in a partner. The researchers gave participants in these studies a limited "mate budget" and told them that they could spend their mate budget dollars on the traits which they desired to create an ideal mate. When participants were given a large budget, very few sex differences in mate preferences emerged; however, when participants were given a constrained budget, women were found to allocate far more of their budget towards qualities that would ensure that their mates had high levels of status and resource access.

Researchers have also found evidence that women prefer men who have cues that they would be a good parent in their long-term mates. For example, Roney et al. (2006) found that how much men stated that they like children predicted how attractive the women rated the men as a long-term mate. Additionally, women in this study were able to accurately assess men's affinity for children based on photographs of the men's faces. When

investigating what women found attractive in their short-term mates, the researchers found that women did not prefer men that seemed like they would be good fathers, but rather that women preferred men with high levels of testosterone and facial masculinity – both of which are cues that men have high quality genes.

Perceptions of men's gene quality are typically inferred from cues of masculinity, health, testosterone levels, and attractiveness or symmetry, and these cues of high-quality genes are preferred when considering a man for a short-term-mate (Guéguen, 2014). Women may prefer men with traits such as masculinity, dominance, and symmetry for short-term mating partners when it would be advantageous to secure a mate with good genes, which could be passed onto their offspring. These traits are correlated with good health and high testosterone levels in men. Because testosterone is an immunosuppressant, having high testosterone is a signal to women that men are able to withstand the burden of a weakened immune system while remaining in good health (Folstad & Karter, 1992; Rhodes et al., 2003). These traits are also correlated with reduced parental investment in men (Penton-Voak & Perrett, 2000; Little et al., 2002; Burnham et al., 2003; Gettler et al., 2011), leading to a natural trade-off which women must make in their mate choices between men with high quality genes and men who would provide high levels of parental investment

In an ideal world, all women would be able to choose as partners men who possess both good genes and excellent parenting skills. However, these traits often do not co-occur at high levels in most men. As such, women must make tradeoffs. Under some conditions, women prefer men with cues of being a good dad, while under other conditions women prefer men with cues of having good genes. Beyond short-term and long-term mating contexts, environmental conditions, such as pathogen prevalence and resource scarcity, also

influence women's mate preferences. When pathogen prevalence is high (DeBruine, Jones, Crawford, Welling, & Little, 2010), or experimentally manipulated to be perceived as high, (Lee & Zietsch, 2011) women prefer men with more masculinized and symmetrical faces – indicators of good genes. This preference for good gene indicators would be advantageous in an environment in which the survival of one's offspring is considerably dependent upon the offspring's ability to combat disease threats. When resources were experimentally manipulated to be perceived as scarce, Lee & Zietsch (2011) found that women preferred more feminized male faces – which indicates good parental quality, as opposed to good genes. Preferring men who possess indicators that they would be a good parent would be advantageous in an environment in which the survival of one's offspring is considerably dependent upon the resources that are invested in said offspring.

To avoid making this tradeoff, some women may decide to pursue a dual mating strategy in which they secure good genes from one man while securing investment from another (Gangestad and Thornhill (1997). Scheib (2001) found support for this strategy by asking women which qualities they preferred in partners across a variety of contexts. When considering a man as a partner for an extra-pair mating opportunity, women prioritized attractiveness over good character, however this was not the case when considering a man as a good long-term partner. Support for this strategy has also been uncovered in research pertaining to changes in women's mate preferences across the ovulatory cycle (Gangestad & Simpson, 2000; Pillsworth & Haselton, 2006).

### **Women's Mate Preferences and Sexual Strategies Change Across the Ovulatory Cycle**

Although women's mate preferences and mating behaviors are fairly stable across time, one important factor that is known to play a role in women's mate preferences and sexual



behavior is where a woman is in her ovulatory cycle. Women who are naturally cycling (not taking any form of hormonal contraceptive) experience an ovulatory cycle that typically spans about 25-34 days (Harlow, Windham, & Paramsothy, 2013). About 7-9 days into a woman's cycle, her estrogen levels begin to rise, followed by a spike in her luteinizing hormone (LH). This is a signal to her body that it is time to ovulate, or release an egg from her ovaries, which travels through her fallopian tubes to the uterus. Typically, women ovulate between days 12-15 of their cycle. While men are able to father a child at any time, women are only able to conceive a child during the approximately five days occurring just before and during ovulation. Following ovulation, a woman's estrogen levels fall, and then begin to rise again as progesterone levels rise. If an egg is not promptly fertilized, the woman's body disposes of this failed attempt at reproducing during a woman's menstrual cycle. The beginning of the menstrual cycle marks the beginning of a new ovulatory cycle. As such, a woman has the highest likelihood of conceiving a child in the days just prior to, and during, ovulation.

Corresponding with differences in conception risk across the cycle, some researchers have found women's mate preferences shift during these few days a month in which a woman is capable of conceiving a child (Gangestad, Thornhill, & Garver-Apgar, 2005). In particular, researchers have hypothesized that women's mate preferences should prioritize qualities such as attractiveness, symmetry, and masculinity during this time, as these qualities are hypothesized indicators of high genetic quality (Gangestad & Simpson, 2000; Pillsworth & Haselton, 2006). This shift in women's preferences is hypothesized to be functional, in that it could help ensure that women conceive a child with high quality genes at times when conception is possible.

Consistent with this hypothesis, Gangestad, Garver-Apgar, and Simpson, (2007) tested naturally cycling women at various points in their ovulatory cycle. Women viewed videos of men, whom they were told to consider for a lunch date and rated them on their attractiveness as both a short-term and long-term mate. The researchers found that women at high fertility tended to prefer men for short-term mates who had indicators of good genes, while there were no differences in women's preferences in long-term mates.

There now exists a large body of research supporting these results. Women's preferences for short-term mates reliably change at high fertility, while their preferences for longer term partners do not (for a more exhaustive review of research in this area, see Gildersleeve, Haselton, & Fales, 2014). These preference shifts include an increased prioritization of cues such as facial symmetry (Little et al., 2007b), facial masculinity (Penton-Voak & Perrett, 2000; Johnston et al., 2001), body masculinity (Little et al., 2007a), vocal masculinity (Puts, 2005; Feinberg et al., 2006), and dominance (Gangestad et al., 2004). For example, Little et al. (2007b) investigated preferences for facial symmetry in naturally cycling women across two studies. The researchers presented women with 12 face pairs in the first study, and 15 face pairs in the second study, with each pair containing a symmetrical and asymmetrical version of the same male face and asked them to select the more attractive option. In the first study, they found women in the ovulatory phase of their cycle to prefer the more symmetrical face. In the second study, the researchers asked women to consider the face pairs for both short-term and long-term mates and found women in the ovulatory phase of their cycle to prefer the symmetrical face option specifically when considering him as a short-term mate. Little et al. (2007a) employed similar methods to investigate women's preferences for men's body masculinity and found the same pattern of

results: ovulating women preferred more masculine bodies in their short-term mates than women who were not ovulating. These findings indicate that naturally cycling women do seem to prefer men with more symmetrical faces and masculine bodies at ovulation, when considering them as potential short-term mates.

In addition to changing women's preferences for facial features, research finds that women's attunement to cues of vocal masculinity also change across the cycle. In one study, women's preference for male vocal pitch was investigated by collecting data from women who were at different points in their ovulatory cycles (Puts, 2005). The researcher played clips of different men speaking, and asked women to rate how attractive the man was for both a short-term and a long-term relationship. The researcher found that women in general prefer lower pitched male voices, and that this was not the case for clips of male voices that were altered to be lower in pitch. Additionally, the researcher found that altering male voices to be lower did impact attractiveness ratings, but only for women in the ovulatory phase of their cycle, and when rating the man's attractiveness as a short-term mate. This research highlights that women's preferences for masculinity in male voices is accentuated in ovulating women considering a man as a short-term mating partner.

Beyond vocal and auditory cues, women at high fertility have also been found to prefer the scent of symmetrical men to a greater degree than what is observed when conception risk is low (Thornhill & Gangestad, 1999). To test this preference, researchers collected a sample of men and began by measuring a variety of their features to assess each man's level of bilateral symmetry. Next, researchers provided these men with clean, unworn t-shirts to be worn for two nights while sleeping. Participants were given explicit instructions to use unscented laundry soap to wash sheets prior to these nights, and refrain from using any

scented products, eating any foods that may produce body odor, drinking, smoking, doing drugs, sharing a bed with someone, or engaging in sexual activity during the study. After use, participants were instructed to place the t-shirt in a sealed plastic bag until their next use, and then return the t-shirt in the sealed bag to the researchers after their second night wearing the t-shirt. Next, opposite sex participants were instructed to open the bags and smell 10 different shirts, one at a time, and to provide ratings of pleasantness, sexiness, and intensity of the shirt's odor. Researchers found that naturally cycling women preferred the scent of symmetrical men when conception risk was high, and that no such preference existed for naturally cycling women when conception risk was low, women taking hormonal contraceptives (HCs), or men rating the scent of women. These findings indicate that naturally cycling, ovulating women prefer the scent of men with indicators of good genes, even without visually assessing these indicators.

Taking this idea further, Renfro and Hoffman (2013) have found women at high fertility are better able to discriminate subtle differences in mating related - but not other - scents when compared to women taking HCs. This increased ability to discriminate between mating related scents at high fertility may drive women's preferences for scents associated with male symmetry at ovulation that was found in previous research (Thornhill & Gangestad, 1999). If an increased perceptual acuity to mating related scents is driving women's shift in preferences during ovulation, then changes in women's visual and auditory abilities to discriminate between mating-related cues at high fertility may exist as well. This differential discriminatory ability may be a mechanism that promotes the ovulatory shift effects found in women's mate preferences.

## **Methodological and Empirical Concerns with Ovulatory Shift Research**

While there exists a large body of research finding these ovulatory shift effects to be pervasive, a variety of methodological and empirical concerns have plagued this field of research. The first of these concerns surrounds the methods used to assess cycle phase. Many studies use unreliable methods of assessing ovulation. Of particular concern are the so-called counting methods for assessing cycle phase. One such method, called the forward counting method, requires that women track their menstrual cycles and report to researchers (a) the date in which their most recent menstrual cycle began and (b) the length of their average ovulatory cycle. Researchers then use this information to estimate the date on which a woman will ovulate and computes a conception risk probability for the date in which the woman is being tested. Another counting method, the backward counting method, calculates a women's conception risk the same way, with the exception that the researchers request to be informed of the start date of a woman's next menstrual cycle, and then estimate her ovulation and conception risk at the time of the study from this date.

While counting methods of assessing ovulation may be moderately reliable (Gangestad et al., 2016), many women have irregular cycles and do not track them with enough accuracy to depend upon this method to determine if a woman is ovulating. A more reliable method of assessing ovulation uses urine testing to detect the LH surge that occurs 24-48 hours prior to ovulation. While this method is more accurate, it is also expensive, time consuming, and, as such, compliance can be difficult. Additionally, confirmatory salivary hormonal assessments can be used to ensure women display the hormonal markers that indicate a high or low fertility point in her ovulatory cycle.

A second concern that has been raised with ovulatory shift research surrounds the average size of the effects found in this research, as they tend to be fairly small. The mean estimated effect size has been found to be between .20 and .30 (Gildersleeve et al., 2014; Gangestad et al., 2016), and many studies conducted to test for ovulatory shift effects have been underpowered, making them unlikely to detect any effects. Some studies investigating ovulatory shifts in women's preferences have been found to be moderated by relationship status (Durante, Rae, & Griskevicius, 2013) and partner attractiveness (Pillsworth & Haselton, 2006; Larson, Pillsworth, & Haselton, 2012), with women in relationships with less attractive men displaying increased preference towards attractive men at high fertility. There may also be important moderating factors which have been relatively unexplored. For example, a person's life history strategy, or how they allocate limited resources to maximize their own fitness, is known to influence short-term mating decisions. Life history strategies are considered as a continuum, from faster strategists - who are found to reach maturity earlier, reproduce earlier, have more offspring with more partners, and invest less in each offspring - to slower strategists, who display the opposite of these traits (Giudice, Gangestad, & Kaplan, 2015). It may be the case that ovulatory shift effects have a stronger effect in women with a faster life history strategy, as they may be more attuned to short-term mating opportunities (Kim et al., 2018). Short-term mating motivations of the women being studied may also be an important factor to consider when evaluating studies that find or do not find women to shift their mate preferences at ovulation, however these are rarely explicitly reported. Many sample sizes collected in previous studies have been far too small to find traditionally significant effects, especially considering these potential moderating variables.

A third concern with this line of research has been that few studies designed to investigate ovulatory shifts in women's mating psychology have examined the mechanism behind these shifts. What are the mechanisms by which women's preferences for markers of heightened masculinity or genetic quality shift? Although many theories have been proposed to explain the adaptive value of ovulatory shift effects, none have tested the mechanism or mechanisms that drive these effects. As it appears that some women do have differential preferences for potential partners at ovulation, and that this may have functioned to provide our ancestors with good genes for their offspring when conception was likely, then a logical question follows: how are women's preferences shifting?

### **The Current Research**

The current research aims to address these three methodological and empirical concerns in the extant ovulatory shift literature. In particular, the current research explores the possibility that the observed shifts in women's mate preferences at high fertility are driven by increased perceptual acuity to stimuli that communicate information about men's genetic quality. Because estrogen is neuroprotective and neurogenerative (Brann et al., 2007; Yang et al., 2010) and plays an important role in the structural plasticity of the brain (see e.g., Li et al., 2004; Woolley & McEwen, 1994), it is reasoned that high fertility within the ovulatory cycle may be linked to heightened perceptual acuity (Lee, Barens, & Graham, 2005) as well as increased motivation to attend to subtle differences between stimuli (Gray, & McNaughton, 1983; Frodl et al., 2007). I therefore hypothesized that naturally cycling women would be better able to discriminate between subtle differences in visual and auditory cues that offer information about mate quality at high compared to low fertility. Moreover, this heightened attunement to subtle differences in mating related stimuli may lead to stronger

preferences for traits that signal high mate quality. Because women on hormonal contraceptives do not experience hormonal changes across the cycle, I predict that these differences will be absent in women who are on the birth control pill.

The current research will also assess whether women's increased ability to discriminate between mating-related stimuli at high fertility is moderated by individual differences in mate attraction motivations. In particular, I will test the possibility that these effects will be more pronounced in (a) women with greater short-term mating motivations, (b) women in relationships with less attractive men, and (c) among women who report being less committed to their romantic partner. While it is not expected that women's neurons will be altered under these conditions, women may indeed be more motivated to attend to the mating related stimuli under these conditions when mating goals are paramount. At ovulation, which is the only time in which a woman is able to conceive a child, mate-searching motivations should be especially relevant. If women also have greater short-term mating motivations or are mated with partners who they do not find attractive, or who they are not very committed to, these motivations may be enhanced further in a way that specifically increases their attention to mating related stimuli.

The current research is designed such that it addresses key limitations of the previous work in ovulatory shift effects in three important ways: 1) The current study will have a large sample size to ensure adequate power to detect any effects that are present and to test for potential moderating effects; 2) A mixed model design will be utilized, testing women at both high and low fertility, and utilizing a control group of women taking HCs; 3) Ovulation testing will be scheduled via the forward counting method, and ovulation will be assessed via LH surge urinalysis prior to completing both sessions for naturally cycling women.



## Method

### Participants

A total of 354 female participants were recruited from Texas Christian University based upon their responses to a screening survey and from foot canvassing on the university campus. Out of these women, 112 did not complete their second session of the study, leaving a sample of 242 women. A total of 97 of these women were naturally cycling, and the other 145 were currently taking an oral hormonal contraceptive (HC). None of these women were currently pregnant or breastfeeding and only women taking a first through third generation oral contraceptive were included in the HC group, as fourth generation oral contraceptives contain progestins that are fundamentally different from those found in the first three generations of oral contraceptives. Women were excluded from analysis if they were in the naturally cycling condition and reported using oral contraceptives or emergency contraception within the last three months (i.e. “the morning after pill”;  $n = 6$ ), if they reported being asexual or exclusively homosexual ( $n = 4$ ), if indicated that they were not honest and did not answer survey questions carefully ( $n = 5$ ), if reported that they had been diagnosed with a hormonal or endocrine disorder ( $n = 22$ ), or if they failed more than two attention checks ( $n = 4$ ). After these exclusions, the final sample consisted of 80 naturally cycling women and 122 women taking hormonal contraceptives ( $M_{age} = 19.23$ ; 85.6% Caucasian). Participants were compensated with a choice of partial course credit or a gift card. If they were compensated with a gift card, women using HCs received a \$20 gift card and naturally cycling women received a \$30 gift card for completing both sessions. Naturally cycling women were compensated at a higher rate as they typically were required to come into the lab multiple times to confirm ovulation before completing their high fertility session.

## **Procedure**

### ***Scheduling Participants***

Prior to coming into the lab, participants were contacted by trained research assistants over the phone to confirm eligibility and schedule their first session. Potential participants were asked questions addressing the characteristics of their ovulatory cycle, including confirmation that they meet the eligibility requirements for the study, the start date of their most recent menstrual cycle, and the length of their typical ovulatory cycle. If eligible and interested, participants were scheduled for their first session using a forward counting method to estimate peak fertility. Participants were assigned to complete either their low fertility or high fertility session first based upon where they were currently at in their cycle when scheduling. For their low fertility session, all participants participated 4-8 days before the first day of their next expected menstrual period, ensuring that all women were in the luteal phase of their cycle for this session. To ensure that naturally cycling women were not ovulating during their low fertility session, these women were required to confirm the absence of the LH surge that accompanies ovulation via a urine test prior to testing. Women using HCs completed their high fertility session 11-14 days after the first day of their last menstrual period. All naturally cycling women were required to confirm the LH surge that accompanies ovulation via a urine test before completing their high fertility session. Urine testing was scheduled to begin 3-4 days prior to expected ovulation and was conducted daily until an LH surge was detected. If LH surge testing did not produce a positive result within five days, the participant was scheduled again the following month. Most naturally cycling women display an LH surge 11-14 days after the first day of their last menstrual period.

### ***Laboratory Sessions***

Upon entering the lab, researchers obtained informed consent from each participant. Naturally cycling women were then escorted to a restroom to provide a urine test to verify ovulation status. If the participant was completing her high fertility session, she was required to display a LH surge within 24-48 hours of completing the survey measures. After completing the urine test, participants were then escorted back to the lab. Women using HCs do not experience an LH surge or ovulation; therefore, they were not be required to provide a urine test. All participants were seated at a computer terminal in a private room and asked to provide a 3ml passive drool saliva sample, which was immediately stored in a -80-degree freezer for later hormonal analysis. Participants then began survey measures and behavioural tasks using Qualtrics online experimental survey software. After completing all Qualtrics survey measures of the first session, participants were thanked, partially debriefed, and compensated. After completing the second session, participants were fully orally debriefed by a trained research assistant as to the true nature of the study and hypotheses.

### ***LH Surge Urine Test***

All naturally cycling women were required to complete a urine test to confirm ovulation using an LH Ovulation Midstream Urine Test kit purchased from Meditests. Six hours prior to their session, participants received a text message and email reminding them of their appointment and requesting that they do not urinate or drink excess fluids in the four hours prior to their session. Women were then instructed to use the test kit per the manufacturer's instructions and then return the test kit to a trained research assistant. At this time, the research assistant set a timer and escorted the participant back to the lab. After five to seven minutes had passed, the research assistant read the test and determined if the

participant was eligible to complete their session at that time. Digital photographs were taken of each test result and stored on a secure drive. This allows researchers to review the results of each LH test to verify that results were correctly interpreted.

### ***Visual Discrimination Tasks***

During the survey-based portion of the study, participants were presented with three different types of visual discrimination tasks to assess their ability to discriminate subtle differences between stimuli in both faces and in gaits. (For a complete list of dependent measures and predictions, please see Table 1.)

**Facial Stimuli.** The faces used for the following tasks were morphed together using FantaMorph photo morphing software (Abrosoft, FantaMorph version 5.0, 2011). All photos were pre-rated on attractiveness prior to being morphed. The videos in which the faces change show changes at 15 frames per second, and videos were pretested to ensure that they displayed a subtle change.

**Facial Discrimination Task.** In the first visual discrimination task, participants were presented with 11 testing trials, presented in a random order, designed to assess their ability to notice subtle changes in faces. Prior to beginning the test trials, a practice trial was presented to participants to orient them to the task. The practice trial presented participants with a video of a male face which was being morphed with another male face. Participants were instructed to click a button if they noticed a change in the face that was presented, and their reaction time was scored as a measure of sensory acuity. Two trials contained an attractive male being morphed into an averagely attractive male face. Two trials showed an attractive male face being morphed into an attractive female face. Participants also participated in four sham trials in which a male face appeared, but was not morphed. This

was done to ensure that participants were only responding after they had noticed a change. In addition to the four sham trial, participants also completed three control trials: (a) one showing an attractive female being morphed with another attractive female, (b) one showing an attractive female being morphed into an average female, and (c) one showing an orange being morphed with a lemon. These control trials were included to assess the ability to detect subtle changes in stimuli not relevant to a mating context. All trials were presented six-seconds apart to allow participants to rest between trials.

After being shown the videos (and responding if and when they noticed a change), participants were asked to rate their certainty that a change had occurred using a 7-point scale (anchors: 1 = “I don’t think there was a change, 7 = “I am certain there was a change”).

I predicted that women at high fertility would have a faster response time to changes in the mating related trials, and not to changes in in the non-mating related trials. I also predicted that naturally cycling women would have a faster response time than women taking HCs.

**Facial Preference Task.** After performing the facial discrimination task, participants were shown six sets of forced choice trials in random order. Within each set of novel faces (or colors, in the control set), participants were presented with seven choices in which they must choose which face (or color) they found more attractive. This task was designed to measure women’s preference for differences in symmetry and masculinity in men’s faces, and to assess the strength of this preference. After each choice, participants were asked how strongly they felt about their choice on a 7-point scale (anchors: 1 = “Not at all strongly”, 7 = “Very strongly”) and how different the two choices were from each other 7-point scale (anchors: 1 = “Not at all different”, 7 = “Very different”). Two sets contained photos of

attractive men morphed with averagely attractive men. Two sets contained photos of attractive men morphed with attractive women. One control set contains photos of different shades of blue boxes morphed together. All trials compared the unmorphed photos to photos morphed 0-30% with another photo, in 5% intervals. Within each block, comparisons were programmed in a preselected, pseudorandom order, generated by a random number generator, but consistent within each block for each participant.

I predicted that women at high fertility would have a stronger preference for the more attractive and more masculine male faces compared to women at low fertility. Additionally, I predicted that women at high fertility would exhibit a more consistent preference for the more attractive and masculine faces when the differences between the faces are subtle (such as the difference between 0% and 5% morphed faces), while there would be no differences in preference when the differences are large (such as the difference between 0% and 30% morphed faces). That is, women at high fertility were predicted to consistently notice these subtle differences, leading to a stronger preference for the more attractive and masculine faces. I also predicted that naturally cycling women would have a stronger preference for the more attractive men's faces and the more masculine faces than women taking HCs, and that naturally cycling women would also exhibit a consistent preference for the more attractive and masculine faces when the differences were subtle, while there would be no difference in preference between the two groups of women when the differences were large.

**Gait Preference Task.** Next, participants viewed one set of seven forced choice trials displayed in the same manner as the previously described facial preference task. In this task, participants chose which video of a person's gait they found more appealing. The gait videos were obtained using pointwalker videos available online, retrieved from Bio Motion Lab,

(<https://www.biomotionlab.ca/Demos/BMLwalker.html>) that displayed animations of stick figures walking, with only the joints visible as points. These animations were created by using a motion capture system to track male and female walkers walking on a treadmill (Troje, 2002). The choices were made between a neutral walker, and walkers that were made incrementally more male or female (+5 male to +1 female, with a neutral walker [0] at the center, in increments of 1). Participants were asked how strongly they felt about their choice and how different the two choices were from each other, as in the previous task. The trials were presented in the same pseudorandom order described above.

I predicted that women at high fertility would have a stronger preference for the more masculine gait videos compared to women at low fertility. Additionally, I predicted that women at high fertility would exhibit a more consistent preference for the more masculine gait when the differences between the gaits were subtle (such as the difference between 0 and +1 male gaits), while there would be no differences in preference when the differences were large (such as the difference between 0 and +5 male gaits). That is, women at high fertility were predicted to consistently notice these subtle differences, leading to a stronger preference for the more masculine gaits. I also predicted that naturally cycling women would have a stronger preference for the more masculine gait videos than women taking HCs, and that naturally cycling women would also exhibit a consistent preference for the more masculine gaits when the differences were subtle, while there would be no differences in preference between the two groups of women when the differences were large.

### *Auditory Discrimination Tasks*

Following the visual discrimination trials, participants were presented with two different types of auditory discrimination tasks. One task assessed preferences for the masculinity of men's voices, and the other assessed attunement to musical quality.

**Vocal Preference Task.** To assess vocal pitch preference, participants listened to two sets of seven forced choice auditory discrimination tasks. After each choice, participants were asked how strongly they felt about their choice and how different the choices were from each other, using the same scale as the visual forced choice tasks. For one of the sets, participants were asked to listen to two audio files containing six-second tones using provided headphones and to indicate which tone they preferred. A midi tone was selected as the base option and was compared to tones in which the hertz had been adjusted, causing the tone to sound higher or lower in pitch. This was considered a control set. The other set was identical; however, it contained trials in which participants were asked to listen to two audio clips of a male voice stating, "The quick brown fox jumped over the lazy dog." Pitch was manipulated in both tasks to 90, 95, 98, 100, 102, 105, and 110 hertz, with 100 hertz as the neutral option in each forced choice trial. The order of the comparisons for each choice within both sets was pseudorandomized as described in the facial preference task. Showing a preference for the lower pitched voices would indicate a preference for vocal masculinity.

I predicted that women at high fertility would have a stronger preference for the lower pitched, more masculine vocal choices compared to women at low fertility but show no increased preference for the lower pitched tones. Additionally, I predicted that women at high fertility would exhibit a more consistent preference for the more masculine voice when the differences between the voices were subtle (such as the difference between 100 and 102



hertz), while there would be no differences in preferences when the differences were large (such as the difference between 100 and 110 hertz). That is, women at high fertility were predicted to consistently notice these subtle differences, leading to a stronger preference for the more masculine pitched voices. I further predicted that naturally cycling women would have a stronger preference for the more masculine pitched voices than women taking HCs, but no increased preference for the lower pitched tones. Finally, I also predicted that naturally cycling women would exhibit a consistent preference for the more masculine voice when the differences were subtle, while there would be no differences in preferences between the two groups of women when the differences were large.

**Musical Discrimination Task.** Next, I assessed participants' perceptual acuity to one type of courtship cue – music. Creating music is considered a courtship cue because it requires high levels of creativity and the ability to learn a complex skill, which has little other practical implications for survival (Miller, 2000). Sanders and Wenmoth (1998) have also found that women were more influenced by music at high fertility than low fertility in music listening tasks, showing that attunement to courtship cues may shift in an adaptive way when conception is possible.

To assess participants' ability to discriminate between quality of music, participants were told that they would be listening to four clips of the same song that four different local bands had submitted for a competition. Each clip was just over one-minute long. The amount of time that the participant spent listening to each clip was recorded. After each clip, they were asked to rate that band's rendition of the song on a seven-point scale on dimensions including how much they enjoyed the song, how skilled the band was, how attractive the band members were, and the if they noticed any mistakes in the song (anchors: 1 = “not at

all”, 7 = “very much”). They were also given the opportunity to provide additional open-ended feedback after the ratings. The song that was used is unreleased and written by a local musician, ensuring that all of the participants were unfamiliar with the song. Each version of the song contained a lead guitar, a rhythm guitar, and a bass guitar. No versions contained vocals. One version of the song was presented without errors. One version was manipulated such that the lead guitar was off-tempo. Another version was manipulated such that the bass guitar was slightly off-tempo. The final version was manipulated such that the bass guitar was very off tempo. The versions of the songs were presented to all participants in a random order. After hearing all four versions of the songs and rating each one, participants were presented with the audio clips and band names again and asked to rank each version from best to worst on a four-point scale, with one being the best rendition, and four being the worst rendition. The band’s names were listed as colors (ex. “Yellow Band”, “Blue Band”, etc.) to avoid influencing participants based upon the band’s name. Participants were also asked if they have received any formal music training (yes/no), and if yes, the number of years of musical training they have received (slider scale: 0 – 15 years).

I predicted that women at high fertility would be more likely to rank the song with no errors as better than those with errors compared to women at low fertility. I also predicted that women at high fertility would notice more errors in the versions of the songs that contain errors compared to women at low fertility. Additionally, I predicted that naturally cycling women would be more likely to rank the song with no errors as better than the versions with errors compared to women taking HCs, and that naturally cycling women would notice more errors in the songs that contain errors compared to women taking HCs. Results will be reported including and excluding those who reported previous musical training.

**Table 1.** Dependent measures and predicted results.

<b>Task</b>	<b>Construct Assessed</b>	<b>Prediction: high vs. low fertility</b>	<b>Prediction: NC vs HC</b>
<b>Facial discrimination</b>	Perceptual attunement to facial differences	High fertility = faster response time than low fertility	NC = faster response time than HC
<b>Facial preference</b>	Perceptual preference of facial differences	High fertility = stronger preference for masculine and symmetrical faces than low fertility	NC = stronger preference for masculine and symmetrical faces than HC
<b>Gait preference</b>	Perceptual preference of gait differences	High fertility = stronger preference for masculine gaits than low fertility	NC = stronger preference for masculine gaits than HC
<b>Vocal preference</b>	Perceptual preference of vocal differences	High fertility = stronger preference for masculine voices than low fertility	NC = stronger preference for masculine voices than HC
<b>Music preference</b>	Perceptual acuity to quality of courtship cues	High fertility = stronger preference for music without errors than low fertility	NC = stronger preference for music without errors than HC

*Note.* NC = naturally cycling group; HC = hormonal contraceptives group.

### ***Demographic Measures***

Participants were asked demographic measures including age, year in school, gender, race/ethnicity, sexual orientation, relationship status, relationship experience, medication status, health status, smoking status, and age at sexual debut.

### *Potential Moderators*

Previous research has found ovulatory shift effects to be moderated by many factors, including relationship status (Durante et al., 2013), partner attractiveness (Pillsworth & Haselton, 2006; Larson et al., 2012), and short-term mating motivations (Kim et al., 2018). Because of this, these factors were treated as potential moderators of women's ability to detect subtle differences in mating related stimuli at ovulation.

**Relationship Status and Partner Attractiveness.** If a woman reported currently being in a relationship (yes / no), she was asked to indicate how committed she was to her current romantic partner on 7-point scale (anchors: 1 = "Not at all committed", 7 = "extremely committed") and how attractive her partner was compared to others that she knows (anchors: 1 = "Very unattractive", 7 = "Extremely attractive"). Mean composites were created of participants' responses across both sessions. I first tested the moderating effect of being in a relationship. Within women currently in a romantic relationship, I then tested the moderating effect of commitment to partner, and then the moderating effect of partner attractiveness. I predicted that women who were partnered, and who were both committed to their partners and found their partners attractive, would not show as large of a difference in ability to discriminate between mating related stimuli between their high fertility and low fertility sessions as those who were single, or those who were not committed to their partners and/or who did not find their partners attractive. I further predicted that these moderating effects would be strong in naturally cycling women, and weak or absent in women taking HCs.

**Short-Term Mating Motivations.** To assess women's short-term mating motivation, participants were asked to provide information about their sociosexual orientation (Simpson & Gangestad, 1991). The revised nine-item sociosexual inventory (SOI) scale is broken into three subscales (Penke & Asendorph, 2008). The subscale assessing participants sociosexual behavior (SOIb) includes three items, (ex. "With how many different partners have you had sexual intercourse on one and only one occasion?") rated on a nine-point scale (endpoints: 1 = 0, 9 = 20 or more). The subscale assessing participants sociosexual attitudes (SOIa) also includes three items, (ex. "I can imagine myself being comfortable and enjoying "casual" sex with different partners.") (endpoints: 1 = "Very strongly agree", 9 = "Very strongly disagree"). Finally, three items assess participants' sociosexual desires (SOId), (ex. "How often do you have fantasies about having sex with someone you are not in a committed romantic relationship with.") (endpoints: 1 = "Never", 9 = "At least once a day"). A mean composite was calculated for the full scale and each of the three subscales, then mean composites were created of participants' composites across both sessions. I tested the moderating effects of the full scale, followed by each of the subscales, on the ability to detect subtle changes in mating related stimuli. I predicted that women who have higher SOI scores, or higher short-term mating motivations, would display a greater ability to detect subtle changes in stimuli at their high compared to low fertility session than those with lower SOI scores. I also predicted that these moderating effects would be strong in naturally cycling women, and weak or absent in women taking HCs.

### ***Birth Control and Ovulation***

Participants were then asked questions to assess if they have used HCs in the last three months, and if they have ever used HCs. If they reported using HCs in the past, they

were asked to provide the type of HC used and the name of the brand or brands they have used, along with their length of use. Participants were asked if they have ever had any children, if they are currently breastfeeding or pregnant, and if they had ever been diagnosed with a hormonal or endocrine disorder. Next, women were asked to provide the start date of their last period, the length of their ovulatory cycle, and how regular their cycle is. Finally, participants were asked at what age they began going through puberty, at what age they had their first period, and if they reached puberty before or after most of their friends.

### **Data Analytic Plan**

Data analysis was conducted using IBM's SPSS statistical package version 25 (IBM Corp., 2018) and the MEMORE macro (Montoya & Hayes, 2017), which allows continuous and dichotomous moderating variables to be tested in two instance, repeated measures models. A mixed model analysis of variance (ANOVA) was first performed on all dependent variables, testing the impact of between-subjects condition (naturally cycling vs. HC) and within-subjects factors (fertility status: high fertility vs. low fertility; repeated dependent measures) on all dependent measures. Session order (i.e. if participants completed their low fertility or high fertility session first) was tested as a covariate of these relationships utilizing analysis of covariance (ANCOVA). As session order was not a significant covariate,  $ps \geq .328$ , and was non-normally distributed, violating the assumptions of an ANCOVA, session order was not retained as a covariate.

Follow-up tests utilizing Tukey's LSD were performed to investigate the impact of fertility status within each condition for all analyses for both significant and non-significant interaction effects. Simple effects were reported for non-significant interactions because while it was predicted that fertility effects would be present in naturally cycling women and

absent in women taking HCs, this does not imply that a significant two way interaction would emerge, but rather that the simple effects may be significant in naturally cycling women and absent in women taking HCs.

Next, short-term mating motivations (i.e. SOI, SOIa, SOIb, and SOId) and relationship status were tested as potential moderators of the relationship between condition, fertility status, and all dependent variables. Within women who reported being in a relationship across both sessions, commitment to partner and then partner attractiveness were separately tested as moderating variables of the relationship between fertility status and discrimination ability. Because moderating variables tested within women in relationships only significantly moderated outcomes between condition, fertility status, and preferences for non-target measures and because of low power to detect these effects given the reduced sample size of women in relationships, these results will not be included here. Only significant moderating effects involving SOI, its subscales, and relationship status are thus reported.

The impact of all potential moderating variables was investigated utilizing the MEMORE macro for SPSS. Condition was entered as a moderating variable (dummy-coded: naturally cycling = 0, HC = 1), followed by other moderators of interest, and including a test of the interaction effect between all variables entered in the model on the dependent variable. The dependent variables varied based upon the task being investigated, however these were always entered in pairs where the dependent measure collected at the low fertility session was entered first and the same variable collected at the high fertility session was entered second. MEMORE constructs a difference score of these entered dependent variables, based on (Judd, Kenny, & McClelland, 2001), and results indicate the significance of the difference

between low fertility variable scores and high fertility variable scores for each moderator, and the interaction between the moderators. Conditional effects of fertility status are then reported within conditions at high levels (one standard deviation above the mean) and low levels (one standard deviation below the mean) of each moderator for all marginal or significant interaction effects.

## **Results**

### **Visual Discrimination Tasks**

#### ***Facial Discrimination Task Testing Trials***

For all facial discrimination tasks, video reaction times were assessed in seconds. Trials were excluded from analysis if participants clicked through the trial in less than six seconds. As the instructions for the trial was on the screen for this amount of time, it would have been impossible for participants to notice a change in less than six seconds. Trials were also excluded when Qualtrics did not record any clicks and participants indicated that they were certain that they saw a change in the stimuli presented (by indicating at least a six on a seven-point scale after the trial which asks participants how certain they were that they saw a change). This was done to control for the possibility that participants clicked the video instead of the response button at the time that they saw the change, which would prevent Qualtrics from recording their reaction time. Results are reported using these trimmed variables; however, it should be noted that the pattern of results does not change when using untrimmed variables.

Mean composites were created of time taken to notice a change in the stimuli presented for trials of the same nature and length. That is, a mean composite was created which was comprised of the trials in which an attractive male face was morphed with an



average male face (symmetry trials) and a separate mean composite was created which was comprised of the trials in which an attractive male face was morphed with an attractive female face (masculine trials). Trials containing morphs of female faces and fruit were analyzed separately.

**Symmetrical Face Morph Results.** A mixed model, 2 (within-subjects: high fertility vs. low fertility) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed on mean reaction time (in seconds) to notice a change when viewing videos of attractive men's faces being morphed with unattractive men's faces. Results revealed no significant effects of condition or fertility status on reaction times,  $ps \geq .126$ . Because I was specifically interested in the impact of fertility status within the naturally cycling condition, follow-up tests within condition were performed. Results revealed that within women who were naturally cycling, women were marginally faster to notice a change at their low fertility session than at their high fertility session,  $p = .095$ , and that fertility status did not impact reaction times within women taking HCs,  $p = .971$ . See Table 2 for descriptive statistics.

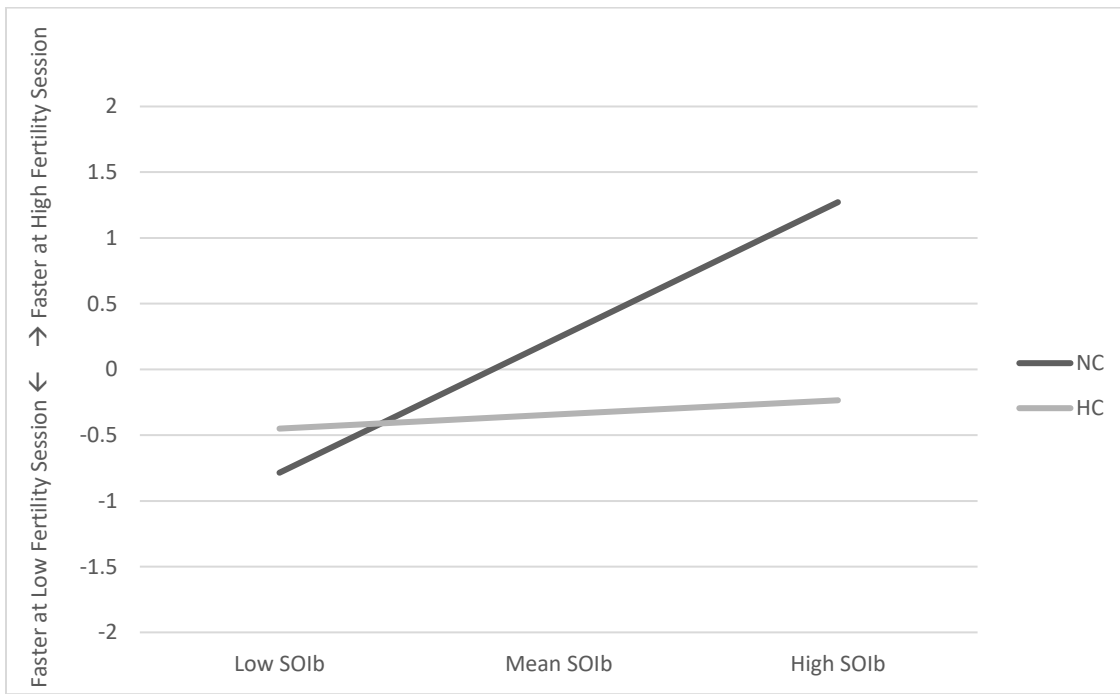
Next, moderating effects of relationship status and short-term mating motivations were tested on the relationships between fertility status, condition, and reaction times. There were no significant moderating effects of SOI, SOIa, SOIb, SOId, or relationship status on these relationships,  $ps \geq .243$ .

**Masculine Face Morph Results.** A mixed model, 2 (within-subjects: high fertility vs. low fertility) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed on mean reaction time (in seconds) to notice a change when viewing videos of attractive men's faces being morphed with attractive women's faces. Results revealed a marginal effect of fertility status  $F(1, 183) = 3.14$ ,  $p = .078$ ,  $\eta_p^2 = .02$ , such that women

noticed a change more quickly at their low ( $M = 15.12$ ), compared to their high fertility session ( $M = 15.40$ ). There was no significant main effect of condition, nor was there a significant two-way interaction between condition and fertility status on reaction times,  $ps \geq .301$ . Using follow-up tests to examine the impact of fertility status within conditions, results revealed that within women who were taking HCs, women were trending towards being faster to notice a change at their high fertility session compared to at their low fertility session,  $p = .110$ . Further, fertility status did not impact reaction times within naturally cycling women,  $p = .328$ . See Table 2 for descriptive statistics.

Next, moderating effects of relationship status and short-term mating motivations were tested on the relationships between fertility status, condition, and reaction times. There were no significant moderating effects of SOI, SOIa, SOId, or relationship status on these relationships,  $ps \geq .186$ , however, there was a main effect of SOIb,  $b = 1.45$ ,  $SE = 0.57$ ,  $t = 2.52$ ,  $p = .013$ , where SOIb, or past sexual behavior, was positively associated with being faster at noticing a change in the high fertility session than the low fertility session, which was qualified by a significant two-way interaction between SOIb and condition,  $b = -0.68$ ,  $SE = 0.31$ ,  $t = 2.22$ ,  $p = .028$ . See Figure 1 for interaction effect. Unpacking this interaction within condition revealed that, within naturally cycling women, those who reported low levels of SOIb were faster to notice a change at their low, compared to their high fertility session,  $b = -0.79$ ,  $SE = 0.31$ ,  $t = 2.54$ ,  $p = .012$ , while naturally cycling women who reported high levels of SOIb were faster to notice a change at their high, compared to their low, fertility session  $b = 1.27$ ,  $SE = 0.60$ ,  $t = 2.12$ ,  $p = .035$ . There were no differences in reaction times within the naturally cycling women who reported mean levels of SOIb,  $p = .408$ .

Within women taking HCs, results revealed that those reporting both low levels of SOIb,  $b = -0.45$ ,  $SE = 0.30$ ,  $t = 1.51$ ,  $p = .133$ , and mean levels of SOIb,  $b = -0.34$ ,  $SE = 0.20$ ,  $t = 1.74$ ,  $p = .084$ , were marginally faster to notice a change at their low, compared to their high fertility session, while there were no differences between low and high fertility sessions for those reporting high levels of SOIb,  $p = .300$ .



*Note.* NC = naturally cycling group; HC = hormonal contraceptives group; SOIb = sociosexual behavior.

**Figure 1.** The difference between low fertility reaction time scores and high fertility reaction times scores for masculine to feminine face morphs as a function of condition (naturally cycling vs. HC) and SOIb. Positive values indicate a faster reaction time at the high vs. low fertility session. Negative values indicate a faster reaction time at the low vs. high fertility session.

**Table 2.** Marginal means, standard errors, and group sample sizes (*n*) for facial discrimination task testing trials.

	Fertility Status		<i>n</i>
	High	Low	
<b>Symmetrical face task</b>			
Naturally Cycling	17.29 (0.34)	16.59 (0.35)	73
Hormonal Contraceptive	17.42 (0.27)	17.14 (0.28)	116
<b>Masculine face task</b>			
Naturally Cycling	15.23 (0.22)	14.99 (0.24)	73
Hormonal Contraceptive	15.52 (0.17)	15.21 (0.19)	112

### ***Control Morph Tasks***

There were three different types of control tasks; results of two of these will be reported here. In the first type of control trial, participants were presented with faces that did not change. Reaction times for these trials are not reported here, as a faster reaction time could indicate that a) participants thought there was a change when there was not, or b) that participants decided that there was not a change before the trial was complete and proceeded to the next task. In the second type of control trial, participants were presented with female faces that were morphed with other female faces. In the final type of control trial, participants were presented with a fruit that was morphed with another fruit. In the control trials which display a change, trials were excluded from analyses using the same trimming method described above.

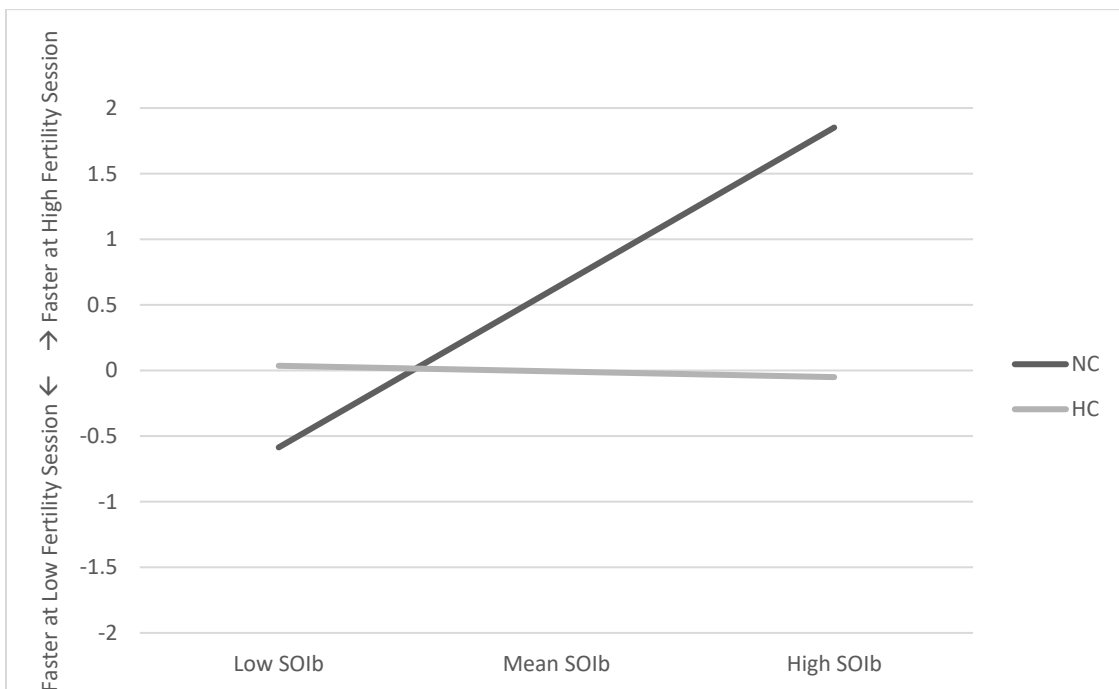
**Symmetrical Women’s Facial Morph Control Trial.** A mixed model, 2 (within-subjects: high fertility vs. low fertility) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed on mean reaction time (in seconds) to notice a change when viewing videos of an attractive woman’s face morphing into another attractive woman’s face. Results revealed a no significant effects of condition, fertility status, nor an interaction

between the two on reaction times,  $ps \geq .215$ . Within naturally cycling women, women were trending towards noticing a change faster in the low fertility, compared to the high fertility session,  $p = .122$ , while there was no effect of fertility status within women taking HCs,  $p = .974$ . Further, entering moderators into the model did not reveal any significant effects,  $ps \geq .391$ . See Table 3 for descriptive statistics.

**Feminine Women’s Facial Morph Control Trial.** A mixed model, 2 (within-subjects: high fertility vs. low fertility) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed on mean reaction time (in seconds) to notice a change when viewing videos of an attractive woman’s face morphing into an attractive man’s face. Results revealed a no significant effects of condition, fertility status, nor an interaction between the two on reaction times, nor were there any significant effects within conditions,  $ps \geq .254$ . See Table 3 for descriptive statistics.

While testing SOI, SOIa, SOId, or relationship status as a moderating variable in the relationships between fertility status and condition on reaction times to notice a change in the feminine female morph trial did not produce and significant effects,  $ps \geq .215$ , entering SOIb as a moderating variable revealed that SOIb was significantly positively associated with being faster at noticing a change in the high – compared to the low – fertility session,  $b = 1.77$ ,  $SE = 0.64$ ,  $t = 2.77$ ,  $p = .006$ . Additionally, naturally cycling women noticed a change marginally more quickly in their high fertility session than in their low fertility session compared to women taking HCs,  $b = 1.16$ ,  $SE = 0.67$ ,  $t = 1.74$ ,  $p = .084$ . Both of these effects, however, were qualified by a significant two-way interaction between SOIb and condition,  $b = -0.90$ ,  $SE = 0.35$ ,  $t = 2.61$ ,  $p = .010$ . See Figure 2 for the interaction effect. Within naturally cycling women, those who reported low levels of SOIb were trending

towards being faster to notice a change in their low fertility session compared to their high fertility session,  $b = -0.59$ ,  $SE = 0.38$ ,  $t = 1.54$ ,  $p = .126$ , while those reporting mean levels of SOIb,  $b = 0.63$ ,  $SE = 0.34$ ,  $t = 1.84$ ,  $p = .067$ , and high levels of SOIb,  $b = 1.85$ ,  $SE = 0.69$ ,  $t = 2.70$ ,  $p = .008$ , were marginally and significantly faster to notice a change in their high fertility compared to their low fertility sessions, respectively. Within women taking HCs, there was no impact of fertility for those reporting all levels of SOIb,  $ps \geq .852$ .



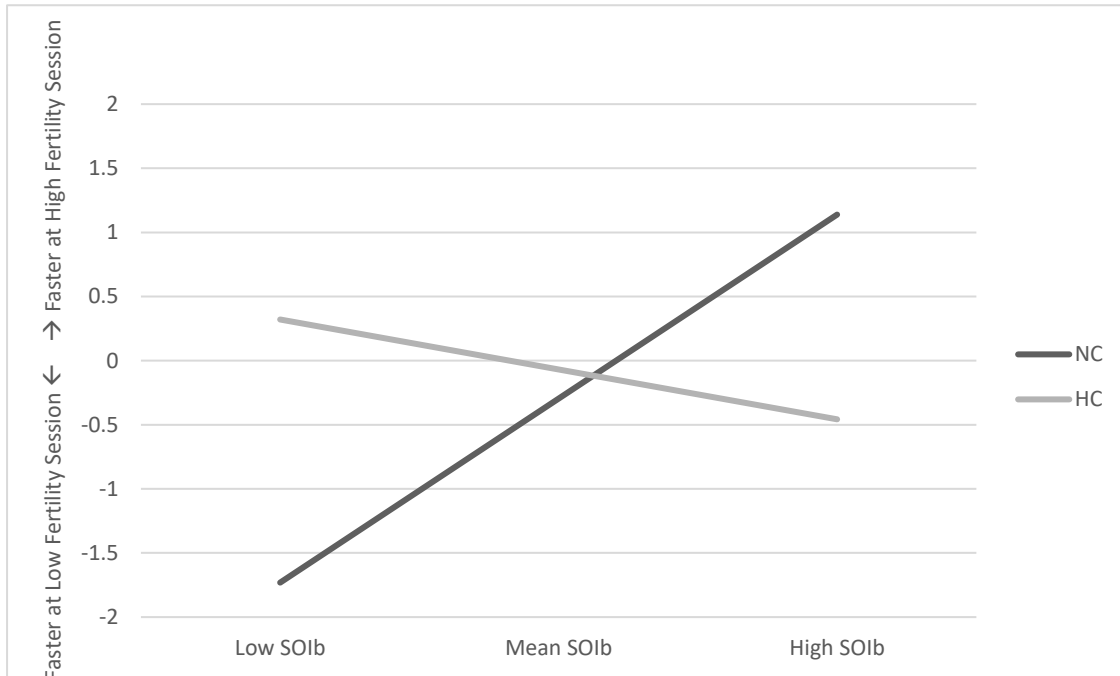
*Note.* NC = naturally cycling group; HC = hormonal contraceptives group; SOIb = sociosexual behavior.

**Figure 2.** The difference between low fertility reaction time scores and high fertility reaction times scores for feminine female face morphs as a function of condition (naturally cycling vs. HC) and SOIb. Positive values indicate a faster reaction time at the high vs. low fertility session. Negative values indicate a faster reaction time at the low vs. high fertility session.

**Fruit Morph Control Trials.** A mixed model, 2 (within-subjects: high fertility vs. low fertility) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed on mean reaction time (in seconds) to notice a change when viewing videos of one fruit morphing into another fruit. Results revealed a marginally significant main effect of fertility status on reaction times,  $F(1, 170) = 3.49, p = .064, \eta_p^2 = .02$ , such that women noticed a change more quickly at their low ( $M = 17.54$ ), compared to their high fertility session ( $M = 18.00$ ). There were no differences in reaction times between conditions, nor was there a significant two-way interaction between condition and fertility status on reaction times,  $ps \geq .202$ . Follow-up tests within conditions revealed that naturally cycling women were faster to notice a change in their low fertility session than in their high fertility session,  $p = .047$ , while there were no differences in reaction times between high and low fertility sessions for women taking HCs. See Table 3 for descriptive statistics.

While testing SOI, SOIa, SOId, and relationship status as a moderating variable in the relationships between fertility status and condition on reaction times to notice a change in the fruit morph trial did not produce any significant effects,  $ps \geq .248$ , entering SOIb into the model as a moderating variable revealed SOIb predicted significantly faster response times in the high fertility session than the low fertility session,  $b = 2.42, SE = 1.07, t = 2.26, p = .025$ . Additionally, naturally cycling women noticed a change significantly more quickly in their high fertility session than in their low fertility session compared to women taking HCs,  $b = 2.91, SE = 1.10, t = 2.65, p = .009$ . Both of these effects, however, were qualified by a significant two-way interaction between SOIb and condition,  $b = -1.35, SE = 0.58, t = 2.35, p = .020$ . See Figure 3 for the interaction effect. Within naturally cycling women, those who reported low levels of SOIb were significantly faster to notice a change in their low fertility

session compared to their high fertility session,  $b = -1.73$ ,  $SE = 0.61$ ,  $t = 2.86$ ,  $p = .005$ , while there was no impact of fertility for those reporting mean levels or high levels of SOIb,  $ps \geq .307$ . Within women taking HCs, there was no impact of fertility for those reporting all levels of SOIb,  $ps \geq .295$ .



*Note.* NC = naturally cycling group; HC = hormonal contraceptives group; SOIb = sociosexual behavior.

**Figure 3.** The difference between low fertility reaction time scores and high fertility reaction times scores for fruit morphs as a function of condition (naturally cycling vs. HC) and SOIb. Positive values indicate a faster reaction time at the high vs. low fertility session. Negative values indicate a faster reaction time at the low vs. high fertility session.



**Table 3.** Marginal means, standard errors, and group sample sizes (*n*) for control discrimination tasks which displayed changes in women’s faces or changes in fruit.

	Fertility Status		<i>n</i>
	High	Low	
<b>Symmetrical woman control</b>			
Naturally Cycling	17.38 (0.45)	16.58 (0.45)	62
Hormonal Contraceptive	17.41 (0.35)	17.42 (0.35)	102
<b>Feminine woman control</b>			
Naturally Cycling	15.51 (0.28)	15.63 (0.29)	56
Hormonal Contraceptive	15.94 (0.22)	15.92 (0.23)	94
<b>Fruit change control</b>			
Naturally Cycling	17.93 (0.44)	17.00 (0.40)	65
Hormonal Contraceptive	18.04 (0.34)	17.87 (0.31)	107

***Interim Summary of Facial Discrimination Results***

Results of the facial discrimination tasks in which reaction times were assessed to measure women’s perceptual acuity to stimuli revealed a few key patterns. In general, women were faster to notice changes at low- compared to high-fertility and these differences were most evident within naturally cycling women. Additionally, naturally cycling women were somewhat faster to notice changes across sessions than women taking HCs were – although not significantly so.

When including SOIb, which is a measure of a woman’s personal history of unrestricted sexual behavior and could indicate generally increased short-term mating motivations, as a moderator of the relationship between condition and fertility status on reaction times, SOIb was positively associated with difference scores between reaction times in the low fertility sessions and the high fertility sessions. Specifically, the results revealed that higher SOIb scores were associated with faster reaction times in the high fertility sessions than the low fertility sessions (positive difference scores), and lower SOIb scores

were associated with faster reaction times in the low fertility sessions (negative difference scores), specifically within naturally cycling women. This indicates that naturally cycling women with more sexual experience are faster to notice subtle differences in stimuli at high, compared to low, fertility.

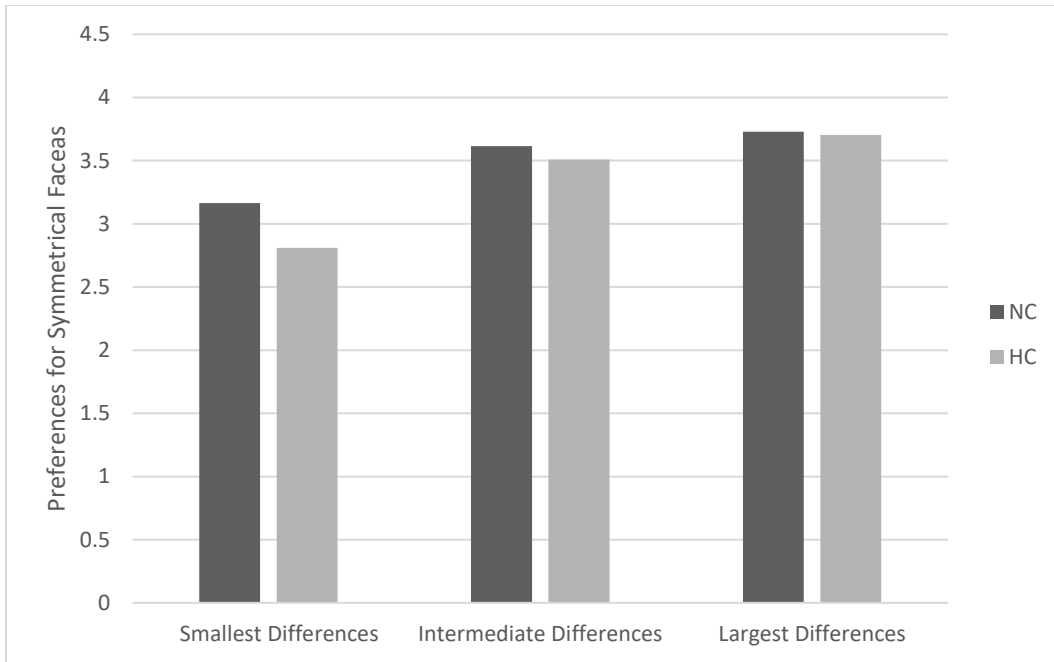
Of note, the same pattern of results emerges across different types of trials. That is, despite some evidence that women's perceptual acuity to notice subtle differences in stimuli does change depending on HC use, fertility status, and sexual experience, these changes do not appear to be restricted to mating related stimuli.

### ***Facial Preference Tasks***

Facial preference tasks were presented to participants as a series of forced-choice trials, in which participants were required to select the face that they preferred. Choices were coded such that selecting the more symmetrical or more masculine face as the preferred option was coded as one, while selecting the less symmetrical or less masculine face as the preferred option was coded as zero. The results of these preference choices were summed between two sets of stimuli each. That is, a total preference sum was computed for symmetrical trials and a separate total preference sum was computed for masculine trials. A higher score indicates a stronger preference for symmetrical and masculine faces, respectively. Next, sum composites were created for the trials in which the participants chose between faces with the two smallest differences (most similar to each other, very subtle differences between the choices), the two intermediate differences (more noticeable differences between the choices), and the two largest differences (least similar to each other, very noticeable differences between the choices), in order to test if naturally cycling women

not only preferred more symmetrical and masculine men at high fertility, but if they were also more attuned to the differences in the trials with more subtle differences.

**Symmetrical Male Facial Preferences.** First, a mixed model, 2 (within-subjects: high fertility vs. low fertility) X 3 (within-subjects: smallest differences vs. intermediate differences vs. largest differences) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed on preferences for symmetrical faces. Greenhouse-Geisser corrections are reported as they sufficiently correct violations of the assumption of sphericity. Results should, however, be interpreted with caution as a Levene's test revealed that, for one group, the assumption of homogeneity of variance was not met,  $F(1, 200) = 7.36, p = .007$ . Results revealed a main effect of difference type on preferences for symmetrical faces,  $F(1.53, 306.77) = 146.45, p \leq .001, \eta_p^2 = .42$ , with women showing a stronger preference for the more symmetrical faces when differences were the largest ( $M = 3.70$ ) compared to when differences were intermediate ( $M = 3.56$ ) or small ( $M = 2.99$ ),  $ps \leq .001$ . Women also preferred the more symmetrical faces when differences were intermediate compared to when they were the small,  $p \leq .001$ . Results also revealed with a main effect of condition on preferences for symmetrical faces,  $F(1, 200) = 3.87, p = .051, \eta_p^2 = .02$ , with naturally cycling women ( $M = 10.48$ ) showing a stronger preference for more symmetrical faces than women taking HCs ( $M = 10.02$ ), both of which were qualified by a significant two-way interaction between difference type and condition on preferences for symmetrical faces,  $F(1.53, 306.77) = 8.07, p = .001, \eta_p^2 = .04$ . See Table 4 for descriptive statistics and Figure 4 for interaction effect.



*Note.* NC = naturally cycling group; HC = hormonal contraceptives group.

**Figure 4.** Preferences for symmetrical faces as a function of condition (naturally cycling vs. HC) at levels of difference types. Positive values indicate a stronger preference for symmetrical faces.

Follow-up tests revealed that naturally cycling women reported a stronger preference for the symmetrical faces at the smallest differences in both the high and low fertility sessions,  $ps \leq .012$ , than did women taking HCs. There were no other differences between conditions in any of the other difference types,  $ps \geq .287$ . Looked at differently, within conditions, naturally cycling women displayed a stronger preference for the more symmetrical man when the differences were intermediate or large compared to when they were small, across both high and low fertility sessions,  $ps \leq .001$ , however in the low fertility session, they only showed a marginally stronger preference for the more symmetrical man when the differences were large compared to intermediate  $p = .087$ , while in the high

fertility condition they showed no differences in preferences for the more symmetrical man when the differences were large compared to intermediate  $p = .238$ .

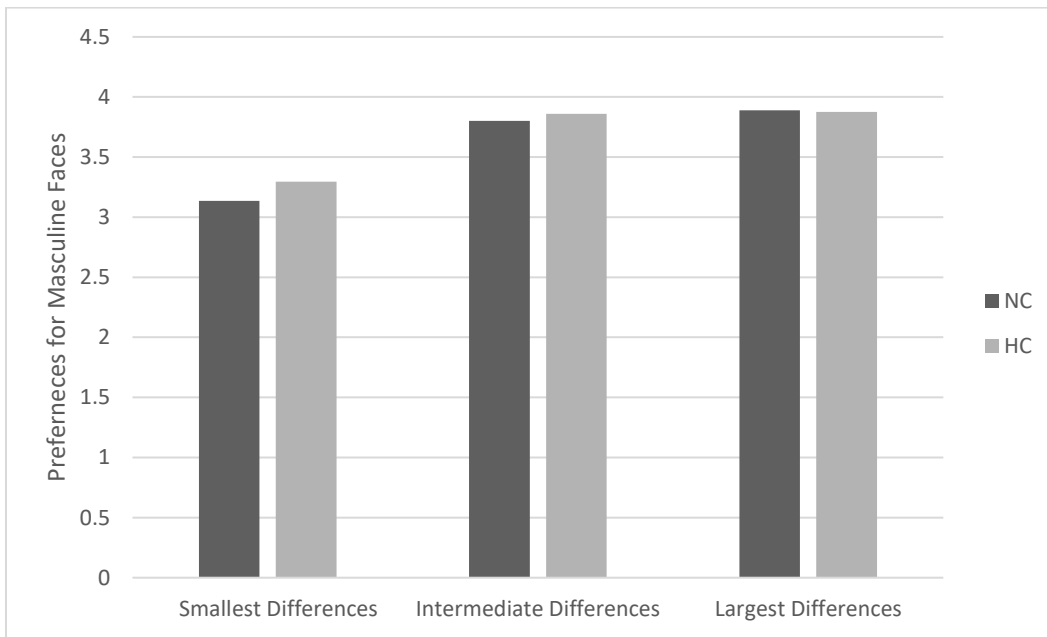
Next, the moderating impact of short-term mating motivations and relationship status was tested on the relationships between condition, fertility status, and preferences for symmetrical faces at the sum and each type of differences. No significant interactions emerged,  $ps \geq .165$ .

**Table 4.** Marginal means and (standard errors) for the symmetrical man preference task.

		<b>Fertility Status</b>	
		<b>High</b>	<b>Low</b>
<b>Naturally Cycling</b>			
	Sum	10.50 (0.22)	10.46 (0.21)
	Smallest Differences	3.20 (0.10)	3.13 (0.10)
	Intermediate Differences	3.62 (0.09)	3.61 (0.09)
	Largest Differences	3.73 (0.08)	3.73 (0.07)
<b>Hormonal Contraceptive</b>			
	Sum	10.06 (0.18)	9.98 (0.17)
	Smallest Differences	2.87 (0.08)	2.75 (0.08)
	Intermediate Differences	3.53 (0.07)	3.49 (0.07)
	Largest Differences	3.67 (0.06)	3.74 (0.06)

**Masculine Male Facial Preferences.** First, a mixed model, 2 (within-subjects: high fertility vs. low fertility) X 3 (within-subjects: smallest differences vs. intermediate differences vs. largest differences) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed on preferences for attractive faces. Greenhouse-Geisser corrections are reported as they sufficiently correct violations of the assumption of sphericity. Results revealed a main effect of difference type on preferences for masculine faces,  $F(1.31, 261.66) = 192.19, p \leq .001, \eta_p^2 = .49$ , with women showing a stronger preference for the more masculine faces when differences were the largest ( $M = 3.88$ ) or intermediate

( $M = 3.83$ ) compared to when differences the smallest ( $M = 3.21$ ),  $ps \leq .001$ , and showing a stronger preference for the more masculine faces when differences were large compared to intermediate  $p = .012$ . There was also, however, a trending two-way interaction between condition and difference type on preferences for masculine faces,  $F(1.31, 261.66) = 2.62$ ,  $p = .097$ ,  $\eta_p^2 = .01$ . See Table 5 for descriptive statistics and Figure 5 for interaction effect.



*Note.* NC = naturally cycling group; HC = hormonal contraceptives group.

**Figure 5.** Preferences for masculine faces as a function of condition (naturally cycling vs. HC) and levels of difference types. Positive values indicate a stronger preference for masculine faces.

Follow-up tests revealed that, within the smallest differences, women taking HCs displayed a somewhat stronger preference for the more masculine faces than did naturally cycling women,  $p = .179$ , specifically at low fertility. There were no other differences between conditions in any of the other difference types,  $ps \geq .308$ . Looked at differently,

within both conditions, all women displayed a stronger preference for the more masculine man when the differences were larger compared to when they were intermediate or smaller, and also displayed a stronger preference for the more masculine man when the differences were intermediate compared to when they were smaller,  $ps \leq .051$ .

Next, the moderating impact of short-term mating motivations and relationship status was tested on the relationships between condition, fertility status, and preferences for masculine faces at the sum and each type of differences. When investigating the moderating effects of SOIa, at the smallest differences, results revealed a significant main effect of condition,  $b = 1.70$ ,  $SE = 0.75$ ,  $t = 2.27$ ,  $p = .024$ , such that naturally cycling women showed a stronger preference for the more masculine man in their low fertility session than in their high fertility session compared to women taking HCs. Additionally, a marginally significant main effect of SOIa emerged,  $b = 0.41$ ,  $SE = 0.24$ ,  $t = 1.70$ ,  $p = .092$ , such that women with higher levels of SOIa, or more positive attitudes towards short-term sexual relationships, showed a stronger preference for more masculine faces at their low fertility session than their high fertility session compared to women who were lower in SOIa. Both of these effects were, however, qualified by a significant two-way interaction between the SOIa and condition,  $b = -0.34$ ,  $SE = 0.16$ ,  $t = 2.21$ ,  $p = .028$ . See Figure 6 for interaction effect.

Follow up tests revealed that women taking HCs with low levels of SOIa displayed a significantly stronger preference for more masculine men at low compared to high fertility,  $b = 0.46$ ,  $SE = 0.19$ ,  $t = 2.45$ ,  $p = .015$ , and that women taking HCs with mean levels of SOIa trended towards displaying a stronger preference for more masculine men at low compared to high fertility,  $b = 0.15$ ,  $SE = 0.11$ ,  $t = 1.35$ ,  $p = .180$ . There were no other differences between high and low fertility status in either condition based upon levels of SOIa,  $ps \geq .269$ .



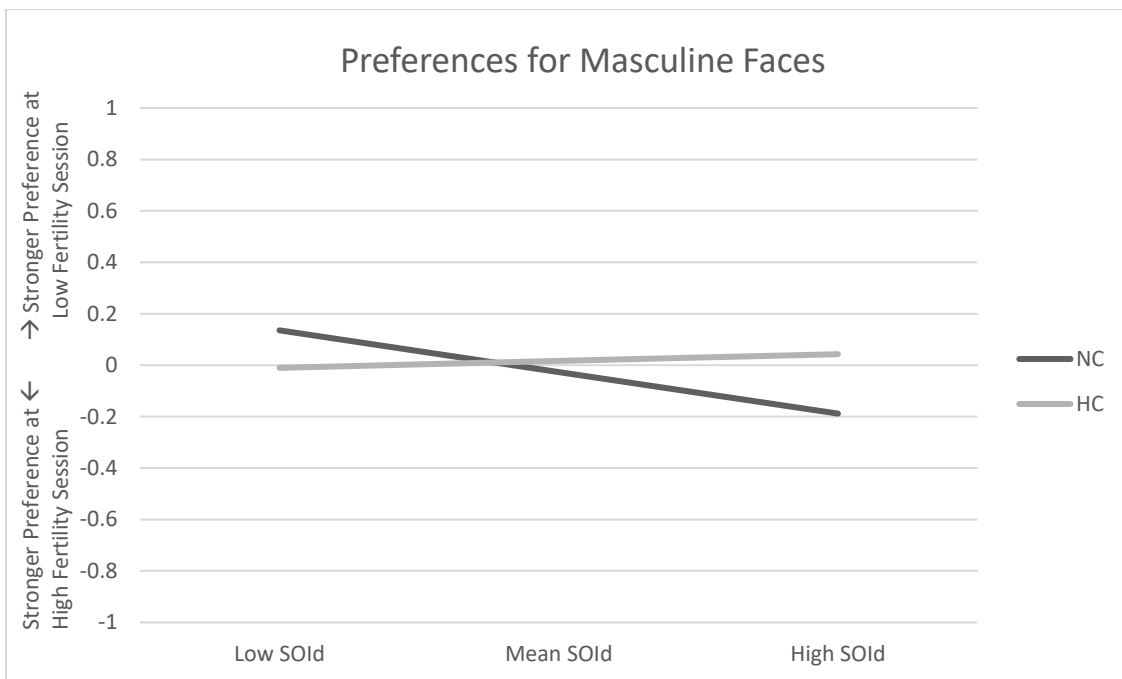
*Note.* NC = naturally cycling group; HC = hormonal contraceptives group; SOIa = sociosexual attitudes.

**Figure 6.** The difference between low fertility preferences and high fertility preferences at the smallest differences of masculine faces as a function of condition (naturally cycling vs. HC) and SOIa. Positive values indicate a stronger preference for masculine faces at the low vs. high fertility session. Negative values indicate a stronger preference for masculine faces at the high vs. low fertility session.

Additionally, when investigating the impact of SOId on the relationships between condition, fertility status, and preferences for masculine faces within the intermediate differences, a main effect of SOId emerged,  $b = -0.20$ ,  $SE = 0.09$ ,  $t = 2.15$ ,  $p = .033$ , such that women with higher levels SOId, or heightened desires for short-term sex, had a stronger preference for more masculine faces at high fertility than low fertility compared to women with low levels of SOId, which was qualified by a significant two-way interaction between



SOId and condition,  $b = 0.11$ ,  $SE = 0.06$ ,  $t = 1.97$ ,  $p = .050$ . See Figure 7 for interaction effect. Follow-up tests within naturally cycling women revealed that those with high levels of SOId were marginally more likely to show a stronger preference for the more masculine faces at high compared to low fertility,  $b = -0.19$ ,  $SE = 0.11$ ,  $t = 1.78$ ,  $p = .077$ . Naturally cycling women with low and mean levels of SOId and women taking HCs at all levels of SOId showed no differences in preferences for masculine faces between sessions,  $ps \geq .200$ .



*Note.* NC = naturally cycling group; HC = hormonal contraceptives group; SOId = sociosexual desires.

**Figure 7.** The difference between low fertility preferences and high fertility preferences at intermediate differences of masculine faces as a function of condition (naturally cycling vs. HC) and SOId. Positive values indicate a stronger preference for masculine faces at the low vs. high fertility session. Negative values indicate a stronger preference for masculine faces at the high vs. low fertility session.

No further significant interactions emerged between condition, fertility, and relationship status or other short-term mating motivations at any other difference types,  $ps \geq .128$ .

**Table 5.** Marginal means and (standard errors) for the masculine man preference task.

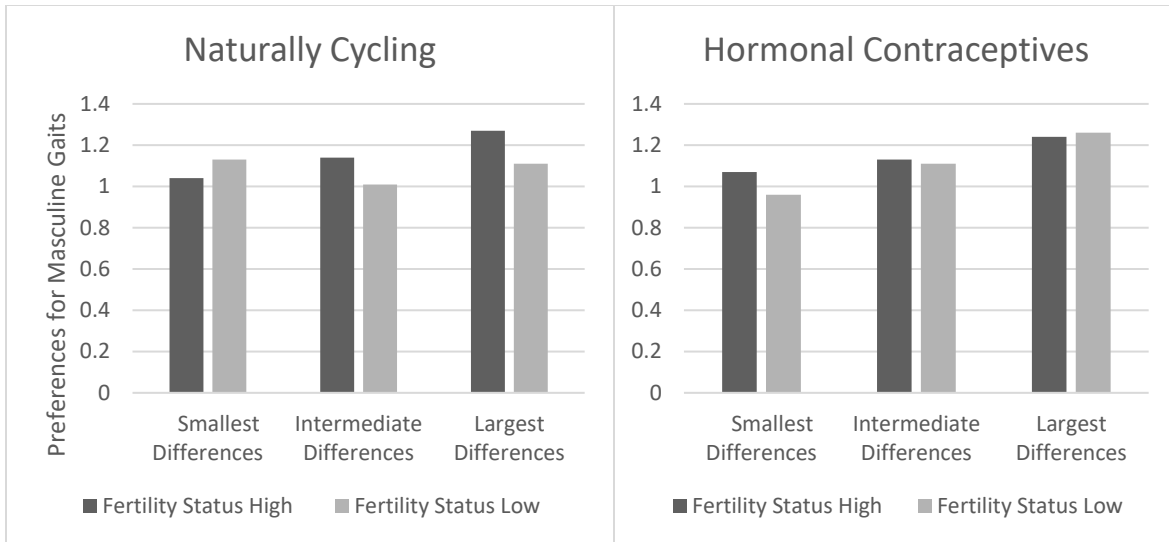
		<b>Fertility Status</b>	
		<b>High</b>	<b>Low</b>
<b>Naturally Cycling</b>			
	Sum	10.84 (0.17)	10.81 (0.19)
	Smallest Differences	3.11 (0.11)	3.16 (0.10)
	Intermediate Differences	3.81 (0.06)	3.79 (0.06)
	Largest Differences	3.89 (0.06)	3.89 (0.05)
<b>Hormonal Contraceptive</b>			
	Sum	10.99 (0.15)	11.07 (0.14)
	Smallest Differences	3.25 (0.09)	3.34 (0.08)
	Intermediate Differences	3.85 (0.05)	3.87 (0.05)
	Largest Differences	3.89 (0.05)	3.86 (0.04)

### ***Gait Preference Task***

Gait preference tasks were presented with the same type of forced-choice design as the previous tasks. Choices were coded such that selecting the more masculine gait as the preferred option out of the two gaits presented was coded as one and selecting the less masculine gait as the preferred option was coded as zero. These choices were summed to create a total preference sum for masculine gaits, with a higher sum indicating a stronger preference for more masculine gaits. Next, sum composites were created for the trials with the two smallest differences (most similar to each other, very subtle differences between the choices), the two intermediate differences (more noticeable differences between the choices), and the two largest differences (least similar to each other, very noticeable differences between the choices), in order to test if naturally cycling women not only preferred more

masculine gaits at high fertility, but if they were also more attuned to the subtle differences in the trials with smaller differences.

First, a mixed model, 2 (within-subjects: high fertility vs. low fertility) X 3 (within-subjects: smallest differences vs. intermediate differences vs. largest differences) X 2 (between-subjects condition: naturally cycling vs. HC) (ANOVA) was performed on preferences for masculine gaits. Results revealed a main effect of difference type on preferences for masculine gaits,  $F(2, 396) = 6.38, p = .002, \eta_p^2 = .03$ , with women preferring the more masculine gait more when the differences were largest ( $M = 1.22$ ) compared to when they were smallest ( $M = 1.05$ ) or intermediate ( $M = 1.10$ ),  $ps \leq .014$ , with no differences in preferences between when they were intermediate and smallest,  $p = .302$ . However, a trending three-way interaction between condition, fertility status, and difference type on preferences for masculine gaits also emerged.  $F(2, 396) = 2.25, p = .107, \eta_p^2 = .01$ . See Table 6 for descriptive statistics and Figure 8 for interaction effect.



**Figure 8.** Preferences for masculine gaits as a function of condition (naturally cycling vs. HC) and fertility status (high vs. low) at levels of difference types. Positive values indicate a stronger preference for masculine gaits.

Follow-up tests revealed that, within the smallest difference at low fertility, naturally cycling women trended towards displaying a stronger preference for the more masculine gait compared to women taking HCs,  $p = .111$ , while women taking HCs at low fertility were trending towards showing a stronger preference for the more masculine gait when the differences were largest, compared to naturally cycling women,  $p = .182$ . There were no other differences between conditions in any of the other difference types,  $ps \geq .379$ .

Looked at differently, within conditions, naturally cycling women at high fertility displayed a stronger preference for masculine gaits when the differences were largest compared to when they were smallest,  $p = .031$ . There were no other differences between difference types in naturally cycling women,  $ps \geq .204$ . Within women taking hormonal contraceptives, women at low fertility displayed a stronger preference for masculine gaits when the differences were the largest compared to when they were the smallest,  $p \leq .001$ , and

marginally so when compared to intermediate differences,  $p = .069$ . Women taking HCs at low fertility also showed a marginal preference for the more masculine gait when the differences were intermediate compared to when they were the smallest,  $p = .095$ . At high fertility, women taking HCs followed a similar pattern of results, showing a stronger preference for the more masculine gait when differences were the largest compared to when differences were the smallest,  $p = .043$ , and trending towards showing a stronger preference for the more masculine gait when differences were the largest compared to intermediate,  $p = .187$ , but showing no differences in preferences between when differences were intermediate and when differences were smallest,  $p = .449$ .

Next, the moderating impact of short-term mating motivations and relationship status were tested on the relationships between condition, fertility status, and preferences for symmetrical faces at the sum and at each type of differences. No significant interactions emerged,  $ps \geq .062$ .

**Table 6.** Marginal means and (standard errors) for the gait preference task.

	<b>Fertility Status</b>	
	<b>High</b>	<b>Low</b>
<b>Naturally Cycling</b>		
Sum	3.38 (0.18)	3.19 (0.17)
Smallest Differences	1.04 (0.08)	1.13 (0.08)
Intermediate Differences	1.14 (0.08)	1.01 (0.08)
Largest Differences	1.27 (0.09)	1.11 (0.09)
<b>Hormonal Contraceptive</b>		
Sum	3.43 (0.14)	3.33 (0.14)
Smallest Differences	1.07 (0.06)	0.96 (0.07)
Intermediate Differences	1.13 (0.07)	1.11 (0.07)
Largest Differences	1.24 (0.07)	1.26 (0.07)

### ***Interim Summary of Visual Preference Results***

Results of the preference tasks revealed more mixed findings than the discrimination tasks, although a few clear patterns did emerge. In the symmetrical preference task, naturally cycling women displayed a stronger preference for the more symmetrical faces compared to women taking HCs, especially when differences were the smallest, but this was not impacted by fertility status. In the masculine face preference task, at low fertility, women taking HCs displayed a stronger preference for the more masculine faces than naturally cycling women. On the other hand, in the masculine gait preference task, at low fertility, naturally cycling women showed a stronger preference for the more masculine gaits compared to women taking HCs when the differences were smallest, while women taking HCs displayed a stronger preference for the more masculine gaits than naturally cycling women when the differences were the largest.

Investigating moderating effects of short-term mating motivations and relationship status revealed a few interesting relationships. Specifically, in the smallest differences within the masculine face preference task, women taking HCs who reported lower SOIa, or less positive attitudes towards short-term mating, showed a stronger preference for more masculine faces at low compared to high fertility. At intermediate differences within the masculine face preference task, naturally cycling women with high levels of SOId, or higher desire for short-term mating, showed a stronger preference for more masculine faces at their high, compared to their low fertility session.

### **Auditory Discrimination Tasks**

Auditory preference tasks were presented in the same manner as the facial and gait preference tasks. Choices were coded such that selecting the lower pitched voice or lower

pitched tone (control task) as the preferred option was coded as one and selecting the higher pitched voice or tone as the preferred option was coded as 0. These preferences were summed to create a total preference sum for lower pitched voices and a separate total preference sum for lower pitched tones, with higher scores indicating a preference for lower pitches. Next, sum composites were created for the trials with the lowest pitches (noticeable differences between the choices), the middle-pitches (most similar to each other, very subtle differences between the choices), and the highest pitches (noticeable differences between the choices). Unlike the visual preference tasks, the comparison for each trial was at a middle pitch. As such, preferences for the lower of the middle-pitched voices and tones represents the smallest differences between the stimuli presented, and preferences for the lower of the lowest and highest pitched tones represents more intermediate differences between the stimuli presented. These composites are examined in order to uncover if naturally cycling women not only preferred lower pitched voices at high fertility, but if they were also more attuned to the subtle differences in the trials with smaller differences.

### ***Vocal Preference Task***

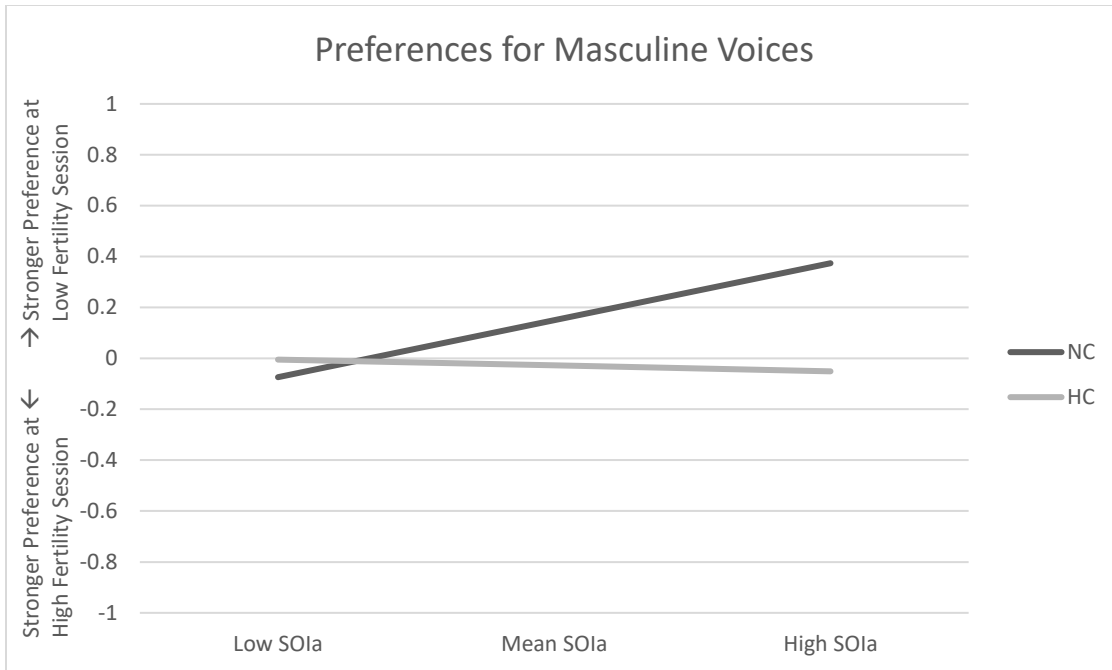
First, a mixed model, 2 (within-subjects: high fertility vs. low fertility) X 3 (within-subjects: lower pitch vs. middle pitch vs. higher pitch) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed on preferences for different pitched vocal clips. Greenhouse-Geisser corrections are reported as they sufficiently correct violations of the assumption of sphericity. Results should, however, be interpreted with caution as a Levene's test revealed that, for two groups, the assumption of homogeneity of variance was also not met,  $ps \geq .007$ . Results revealed a main effect of pitch on masculine vocal pitch preferences,  $F(1.85, 367.46) = 301.37, p \leq .001, \eta_p^2 = .60$ , with women showing a stronger

preference for the more masculine vocal pitch when pitches were the highest ( $M = 1.45$ ) compared to when pitches were intermediate ( $M = 1.00$ )  $p = .077$ , or the lowest ( $M = .206$ ),  $ps \leq .001$ , and preferring the more masculine vocal pitch when pitches were intermediate compared to when they were the lowest,  $p \leq .001$ . See Table 7 for descriptive statistics.

Next, potential moderators of the relationships between condition, fertility status, and preferences for more masculine vocal clips were tested across different pitches. Results revealed similar patterns for SOI at high pitches, SOId at high pitches, and SOIa at middle pitches, as such, only the results for SOIa at middle pitches will be reported in detail here. Similarly, results revealed similar patterns for SOI and SOIa at the sum. As such, only SOIa at the sum will be reported here.

Results revealed a main effect of SOIa on preferences for masculine vocal clips at middle pitches,  $b = 0.41$ ,  $SE = 0.18$ ,  $t = 2.38$ ,  $p = .019$ , where more positive attitudes about short term sex were associated with a stronger preference for more masculine vocal clips at low fertility compared to high fertility than those with less positive attitudes about short term sex, which was qualified by a two-way interaction between condition and SOIa on preferences for masculine vocal pitches,  $b = -0.22$ ,  $SE = 0.11$ ,  $t = 1.94$ ,  $p = .054$ . See Figure 9 for interaction effect. Results revealed that naturally cycling women with high levels of SOIa showed a significantly stronger preference for more masculine vocal pitches at low fertility compared to high fertility,  $b = 0.37$ ,  $SE = 0.15$ ,  $t = 2.46$ ,  $p = .015$ , and naturally cycling women at mean SOIa were trending in the same direction,  $b = 0.15$ ,  $SE = 0.10$ ,  $t = 1.47$ ,  $p = .142$ . There were no differences between preferences for masculine voices between high and low fertility sessions at low levels of SOIa or for women taking HCs,  $ps \geq .517$ .



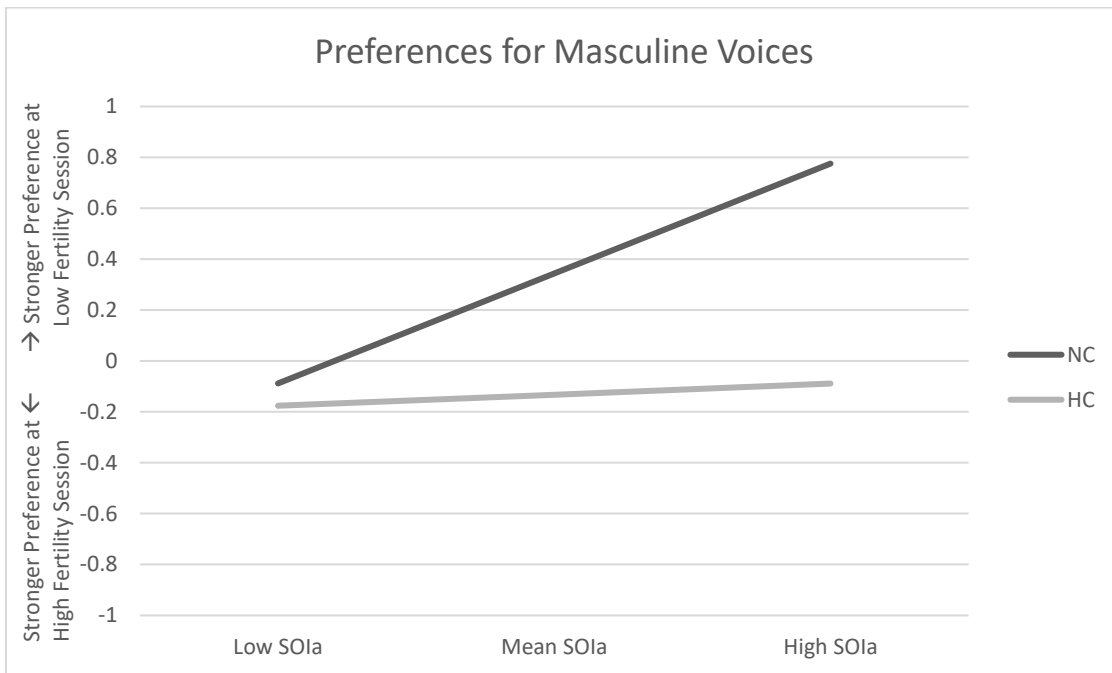


*Note.* NC = naturally cycling group; HC = hormonal contraceptives group; SOIa = sociosexual attitudes.

**Figure 9.** The difference between low fertility preferences and high fertility preferences for the middle pitched vocal preferences as a function of condition (naturally cycling vs. HC) and SOIa. Positive values indicate a stronger preference for masculine vocal pitches at the low vs. high fertility session. Negative values indicate a stronger preference for masculine vocal pitches at the high vs. low fertility session.

Results revealed a main effect of SOIa on preferences for masculine vocal clips across all difference types,  $b = 0.72$ ,  $SE = 0.27$ ,  $t = 2.67$ ,  $p = .008$ , where those with high SOIa had with a stronger preference for more masculine vocal clips at low fertility than high fertility compared to those with lower SOIa. This effect was, however, qualified by a two-way interaction between condition and SOIa on preferences for masculine vocal clips,  $b = -0.34$ ,  $SE = 0.17$ ,  $t = 1.96$ ,  $p = .051$ . See Figure 10 for interaction effect. Results revealed that

naturally cycling women with high levels,  $b = 0.78$ ,  $SE = 0.24$ ,  $t = 3.30$ ,  $p = .001$ , and mean levels,  $b = 0.34$ ,  $SE = 0.16$ ,  $t = 2.19$ ,  $p = .030$ , of SOIa showed a significantly stronger preference for more masculine vocal pitches at low fertility compared to high fertility. There were no differences between preferences for masculine voices between high and low fertility sessions at low levels of SOIa or for women taking HCs,  $ps \geq .294$ .



*Note.* NC = naturally cycling group; HC = hormonal contraceptives group; SOIa = sociosexual attitudes.

**Figure 10.** The difference between low fertility preferences and high fertility preferences for the masculine vocal preferences across pitches as a function of condition (naturally cycling vs. HC) and SOIa. Positive values indicate a stronger preference for masculine vocal pitches at the low vs. high fertility session. Negative values indicate a stronger preference for masculine vocal pitches at the high vs. low fertility session.

No further significant interactions emerged when investigating the relationships between short term mating motivations or relationship status and condition, fertility, and preferences for masculine vocal clips,  $ps \geq .121$ .

**Table 7.** Marginal means and (standard errors) for the vocal preference task.

		<b>Fertility Status</b>	
		<b>High</b>	<b>Low</b>
<b>Naturally Cycling</b>			
	Sum	2.59 (0.15)	2.79 (0.16)
	Lower Pitch	0.24 (0.06)	0.29 (0.06)
	Middle Pitch	0.96 (0.08)	1.04 (0.08)
	Higher Pitch	1.38 (0.09)	1.45 (0.08)
<b>Hormonal Contraceptive</b>			
	Sum	2.80 (0.12)	2.67 (0.13)
	Lower Pitch	0.25 (0.05)	0.26 (0.05)
	Middle Pitch	1.02 (0.06)	0.98 (0.06)
	Higher Pitch	1.53 (0.07)	1.43 (0.07)

***Tone Preference Task (Control Task)***

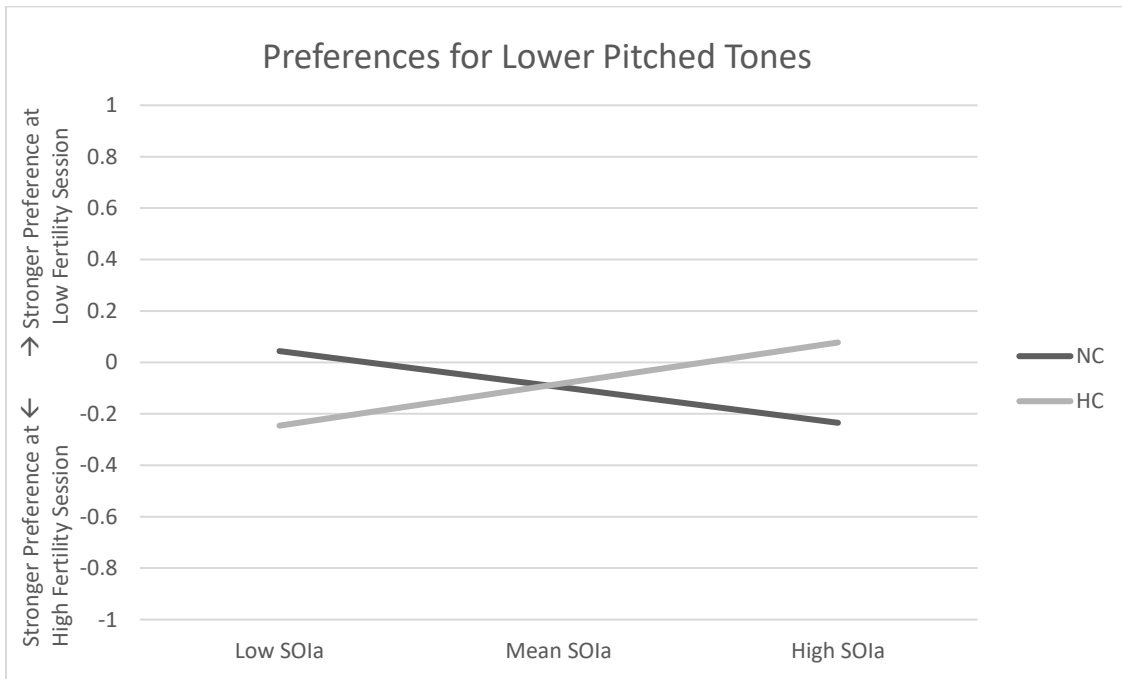
First, a mixed model, 2 (within-subjects: high fertility vs. low fertility) X 3 (within-subjects: lower pitch vs. middle pitch vs. higher pitch) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed on preferences for different pitched tones. Greenhouse-Geisser corrections are reported as they sufficiently correct violations of the assumption of sphericity. Results should, however, be interpreted with caution as a Levene’s test revealed that, for two groups, the assumption of homogeneity of variance was also not met,  $ps \geq .012$ . Results revealed a main effect of pitch on preferences for lower pitched tones,  $F(1.82, 356.56) = 63.78, p \leq .001, \eta_p^2 = .25$ , with women showing a stronger preference for lower pitched tones when tones were higher pitched tones ( $M = 1.35$ ) compared to both middle pitched tones ( $M = 1.07$ ) and lower pitched tones ( $M = 0.70$ ), and showing a stronger

preference for lower pitched tones when tones were middle pitched compared to lower pitched,  $ps \leq .001$ . No other significant effects emerged,  $ps \geq .114$ . See Table 8 for marginal means.

Next, relationship status and short-term mating motivations were tested as potential moderators of the relationships between condition, fertility status, and preferences for lower pitched tones across different pitches. At middle pitches, results revealed a significant main effect of SOIa on preferences for lower pitched tones,  $b = -0.39$ ,  $SE = 0.19$ ,  $t = 2.06$ ,  $p = .041$ , where higher SOIa, or more positive attitudes about short-term sex, was associated with a stronger preference for more masculine vocal clips at women's high fertility session compared to their low fertility session compared to those with lower SOIa. A significant main effect of condition on preferences for lower pitched tones also emerged,  $b = -1.26$ ,  $SE = 0.60$ ,  $t = 2.11$ ,  $p = .036$ , where naturally cycling women showed a stronger preference for the lower pitched tone at their high fertility session than their low fertility session, compared to women taking HCs. Both of these main effects were, however, qualified by a significant two-way interaction between the two variables on preferences for lower pitched tones,  $b = 0.27$ ,  $SE = 0.12$ ,  $t = 2.18$ ,  $p = .031$ . See Figure 11 for interaction effect. Within women taking HCs, those with low levels of SOIa displayed a marginally stronger preference for the lower pitched tones at high fertility compared to low fertility,  $b = -0.25$ ,  $SE = 0.15$ ,  $t = 1.64$ ,  $p = .102$ . There were no other differences between low fertility and high fertility sessions within women taking HCs,  $ps \geq .341$ . Within naturally cycling women, women with high levels of SOIa were trending towards showing a stronger preference for lower pitched tones at their high fertility, compared to their low fertility session,  $b = -0.24$ ,  $SE = 0.16$ ,  $t = 1.44$ ,  $p = .152$ .

There were no other differences between low fertility and high fertility sessions within naturally cycling women,  $ps \geq .386$ .

No other potential moderating variables tested produced significant interaction effects on tone preferences,  $ps \geq .058$ .



*Note.* NC = naturally cycling group; HC = hormonal contraceptives group; SOIa = sociosexual attitudes.

**Figure 11.** The difference between low fertility preferences and high fertility preferences for the lower pitched tones within the middle pitches as a function of condition (naturally cycling vs. HC) and SOIa. Positive values indicate a stronger preference for lower pitched tones at the low vs. the high fertility session. Negative values indicate a stronger preference for lower pitched tones at high vs. low fertility session.

**Table 8.** Marginal means and (standard errors) for the tone preference task.

		<b>Fertility Status</b>	
		<b>High</b>	<b>Low</b>
<b>Naturally Cycling</b>			
Sum		3.18 (0.17)	3.01 (0.16)
Lower Pitch		0.77 (0.09)	0.67 (0.09)
Middle Pitch		1.09 (0.09)	1.04 (0.09)
Higher Pitch		1.35 (0.08)	1.34 (0.08)
<b>Hormonal Contraceptive</b>			
Sum		3.19 (0.14)	3.01 (0.13)
Lower Pitch		0.77 (0.07)	0.61 (0.07)
Middle Pitch		1.10 (0.07)	1.04 (0.07)
Higher Pitch		1.33 (0.07)	1.37 (0.07)

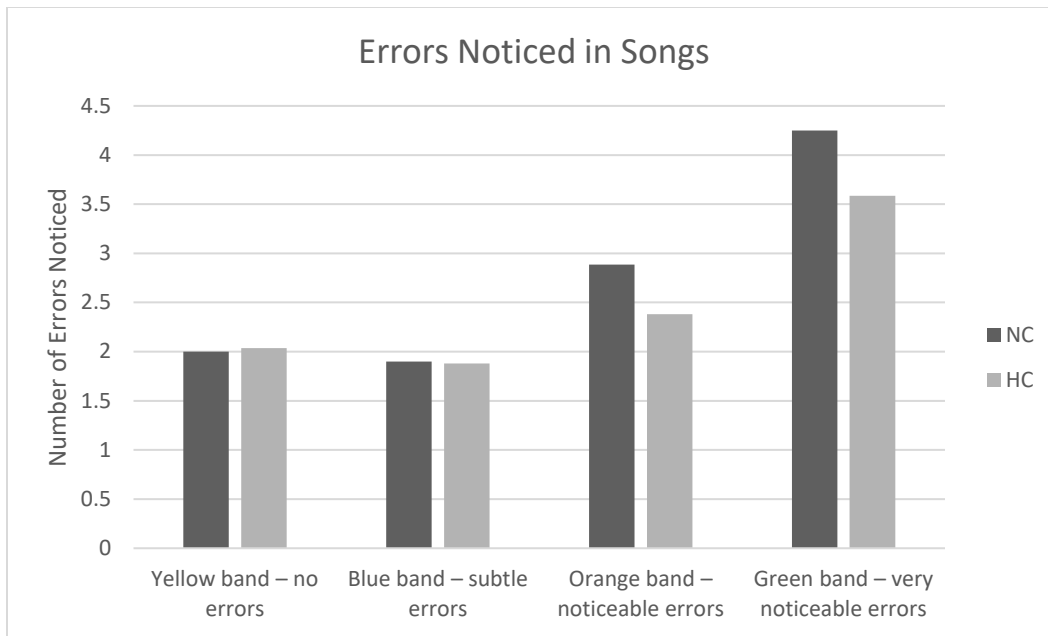
***Interim Summary of Auditory Preference Results***

Results of the auditory preference tasks revealed fewer clear patterns than the previous tasks. Contrary to predictions, few differences emerged between naturally cycling women and women taking HCs, and few differences emerged between high and low fertility sessions in preferences for the lower pitched voices.

For naturally cycling women, those with higher short-term mating motivations, and specifically, more positive attitudes about short term mating, show a stronger preference for the lower pitched vocal clips at low fertility, compared to high fertility, specifically at middle pitched tones, which is where the differences were the smallest between the stimuli. The opposite pattern of results was observed for preferences for lower pitched tones, with naturally cycling women with more positive attitudes about short term sex preferring the lower pitched tones at high, compared to low, fertility.

### ***Music Preference Task***

First, a mixed model, 2 (within-subjects: high fertility vs. low fertility) X 4 (within-subjects: blue band vs. yellow band vs. orange band vs. green band) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed on number of errors heard in song clips. Greenhouse-Geisser corrections are reported as they sufficiently correct violations of the assumption of sphericity. Results should, however, be interpreted with caution as a Levene's test revealed that, for two groups, the assumption of homogeneity of variance was also not met,  $ps \geq .008$ . Results revealed a main effect of band on number of errors heard,  $F(2.47, 226.77) = 80.67, p \leq .001, \eta_p^2 = .47$ . There were no differences in errors noticed between the blue (subtle errors;  $M = 1.89$ ) and the yellow (no errors;  $M = 2.02$ ) bands' renditions of the song,  $p = .424$ , however women noticed fewer errors in both of these compared to both the orange (noticeable errors;  $M = 2.63$ ) and the green (very noticeable errors;  $M = 3.92$ ) bands' rendition of the song, and noticed more errors in the green band's rendition of the song than the orange band's rendition of the song,  $ps \leq .001$ . However, this effect was qualified by a significant two-way interaction between condition and band on number of errors heard,  $F(2.47, 226.77) = 2.87, p = .047, \eta_p^2 = .03$ . See Table 9 for descriptive statistics and Figure 12 for interaction effect.



Note. NC = naturally cycling group; HC = hormonal contraceptives group

**Figure 12.** Number of errors noticed as a function of condition (naturally cycling vs. HC) for each band’s rendition of the song. Positive values indicate more errors noticed.

Follow up tests revealed that naturally cycling women were trending towards rating the yellow band’s song as having more errors at low compared to high fertility,  $p = .116$ , while women taking HCs rated the orange band’s song as having marginally more errors at high compared to low fertility,  $p = .071$ . There were no other differences between high and low fertility status within conditions,  $ps \geq .419$ . Looked at differently, within the low fertility session, naturally cycling women rated the orange band’s song as having significantly more errors,  $p = .013$ , and were trending towards rating the green band’s song as having more errors,  $p = .105$ , than women taking HCs. At high fertility, NC women were also trending towards rating the green band’s song as having more errors than women taking HCs,  $p = .082$ . There were no other differences between conditions within fertility status,  $ps \geq .302$ .



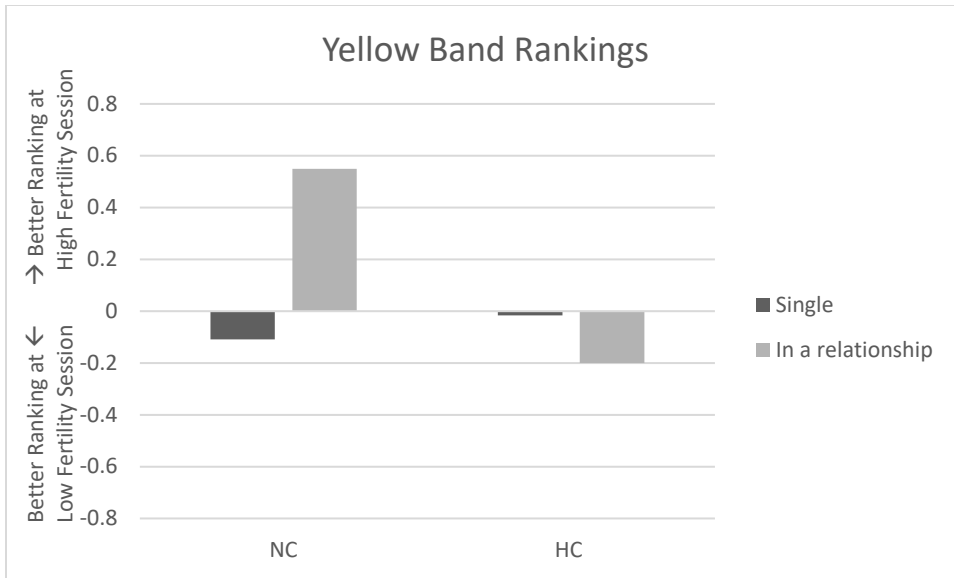
Next, the moderating impact of short-term mating motivations and relationship status was tested on the relationships between condition, fertility status, and number of errors noticed in each rendition of the song. No significant interaction effects emerged,  $ps \geq .162$ .

**Table 9.** Marginal means and (standard errors) for number of errors noticed in each song.

	Fertility Status		Condition
	High	Low	
<b>Naturally Cycling</b>	2.64 (0.14)	2.88 (0.21)	2.76 (0.18)
Yellow band – no errors	1.80 (0.11)	2.20 (0.25)	
Blue band – subtle errors	1.90 (0.21)	1.90 (0.20)	
Orange band – noticeable errors	2.77 (0.29)	3.00 (0.26)	
Green band – very noticeable errors	4.10 (0.35)	4.40 (0.38)	
<b>Hormonal Contraceptive</b>	2.54 (0.13)	2.41 (0.14)	2.47 (0.12)
Yellow band – no errors	2.09 (0.16)	1.98 (0.17)	
Blue band – subtle errors	1.95 (0.15)	1.81 (0.14)	
Orange band – noticeable errors	2.56 (0.20)	2.20 (0.18)	
Green band – very noticeable errors	3.53 (0.24)	3.64 (0.26)	
<b>Fertility Status</b>	2.59 (0.12)	2.64 (0.13)	

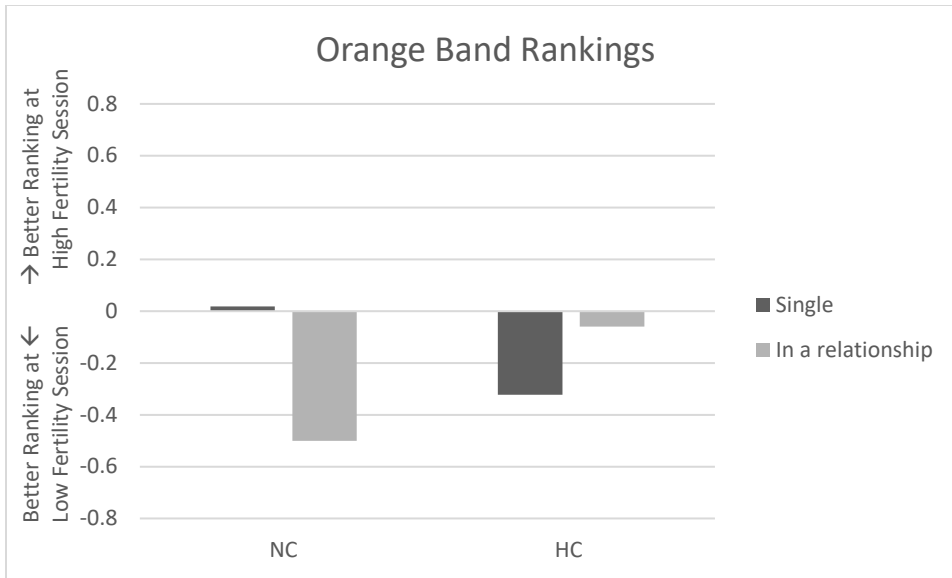
To examine the rankings of song clips, a mixed model, 2 (within-subjects: high fertility vs. low fertility) X 4 (within-subjects: blue band vs. yellow band vs. orange band vs. green band) X 2 (between-subjects condition: naturally cycling vs. HC) ANOVA was performed rankings of the different song clips. Greenhouse-Geisser corrections are reported as they sufficiently correct violations of the assumption of sphericity. Results should, however, be interpreted with caution as a Levene’s test revealed that, for one group, the assumption of homogeneity of variance was also not met,  $p = .026$ . Results revealed a main effect of band on rankings,  $F(2.58, 175.40) = 28.61, p \leq .001, \eta_p^2 = .30$ . Results followed the same pattern as ratings of errors, such that women ranked the blue band and yellow band as equally good, and the orange band and green band were ranked worse than both, with the orange band being ranked better than the green band.

Next, the moderating impact of short-term mating motivations and relationship status was tested on the relationships between condition, fertility status, and song rankings for each band. Results revealed that relationship status had a similar, but not identical, impact on these relationships in both the yellow and orange band rankings. In each case, results revealed a significant main effect of relationship status, albeit in opposite directions. Women in relationships ranked the yellow band lower (better) at their high fertility compared to low fertility session,  $b = 1.50$ ,  $SE = 0.72$ ,  $t = 2.10$ ,  $p = .03$ , while women in relationships ranked the orange band lower (better) at their low fertility compared to high fertility session,  $b = -1.30$ ,  $SE = 0.64$ ,  $t = 2.02$ ,  $p = .045$ . Both of these effects, however, were qualified by significant two-way interaction between the two variables on song rankings (yellow band:  $b = -0.84$ ,  $SE = 0.42$ ,  $t = 2.03$ ,  $p = .044$ ; orange band:  $b = 0.78$ ,  $SE = 0.37$ ,  $t = 2.09$ ,  $p = .038$ ). See Figures 13 and 14 for interaction effects. Follow-up tests revealed that naturally cycling women in relationships rated the yellow band marginally lower (better) in their high fertility session compared to their low fertility session,  $b = 0.55$ ,  $SE = 0.29$ ,  $t = 1.91$ ,  $p = .058$ , while naturally cycling women in relationships rated the orange band marginally higher (worse) in their high fertility session compared to their low fertility session,  $b = -0.50$ ,  $SE = 0.26$ ,  $t = 1.94$ ,  $p = .055$ . Additionally, single women taking HCs rated the orange band higher (worse) in their high fertility session compared to their low fertility session,  $b = -0.32$ ,  $SE = 0.15$ ,  $t = 2.20$ ,  $p = .029$ . There were no other differences between high and low fertility sessions for either groups of women ranking either band,  $ps \geq .273$ .



*Note.* NC = naturally cycling group; HC = hormonal contraceptives group

**Figure 13.** The difference between rankings at low fertility and high fertility for the yellow band’s version of the song (no errors) as a function of condition (naturally cycling vs. HC) and relationship status. Positive values indicate lower (better) rankings at the high vs. low fertility session. Negative values indicate lower (better) rankings at the low vs. high fertility session.

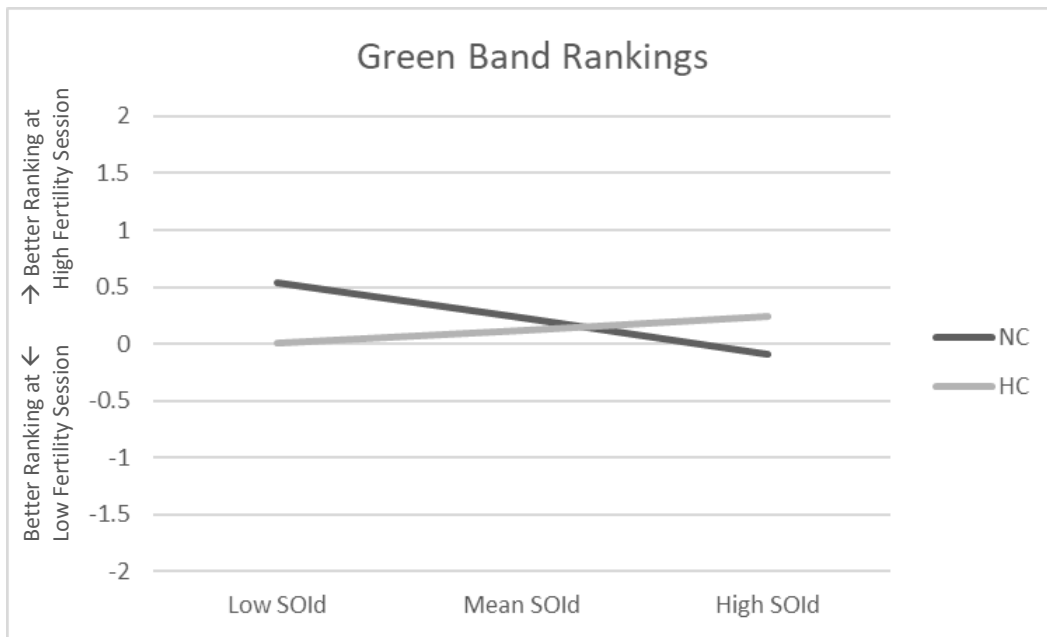


Note. NC = naturally cycling group; HC = hormonal contraceptives group

**Figure 14.** The difference between rankings at low fertility and high fertility for the orange band’s version of the song (noticeable errors) as a function of condition (naturally cycling vs. HC) and relationship status. Positive values indicate lower (better) rankings at the high vs. low fertility session. Negative values indicate lower (better) rankings at the low vs. high fertility session.

Short-term mating motivations were also found to influence the relationships between condition, fertility status, and song rankings for the green and blue bands. When ranking the green band, there emerged significant main effects of both condition,  $b = -0.52$ ,  $SE = 0.39$ ,  $t = 2.20$ ,  $p = .029$ , such that naturally cycling women ranked the green band’s rendition of the song lower (better) at their low fertility session than their high fertility session, compared to women taking HCs, and SOId,  $b = -0.43$ ,  $SE = 0.19$ ,  $t = 2.26$ ,  $p = .025$ , such that those with higher SOId ranked the green band’s rendition of the song lower (better) at their low fertility session compared to their high fertility session compared to those with lower SOId, both of which were qualified by a significant two-way interaction between the two on song rankings,

$b = 0.25$ ,  $SE = 0.11$ ,  $t = 2.21$ ,  $p = .028$ . See Figure 15 for the interaction effect. Follow up tests revealed that naturally cycling women with high levels of SOId ranked the green band's song as significantly higher (worse) at their high fertility session than their low fertility session,  $b = 0.53$ ,  $SE = 0.21$ ,  $t = 2.56$ ,  $p = .011$ . There were no other differences between high and low fertility sessions for either group of women at other levels of SOId,  $ps \geq .123$ .

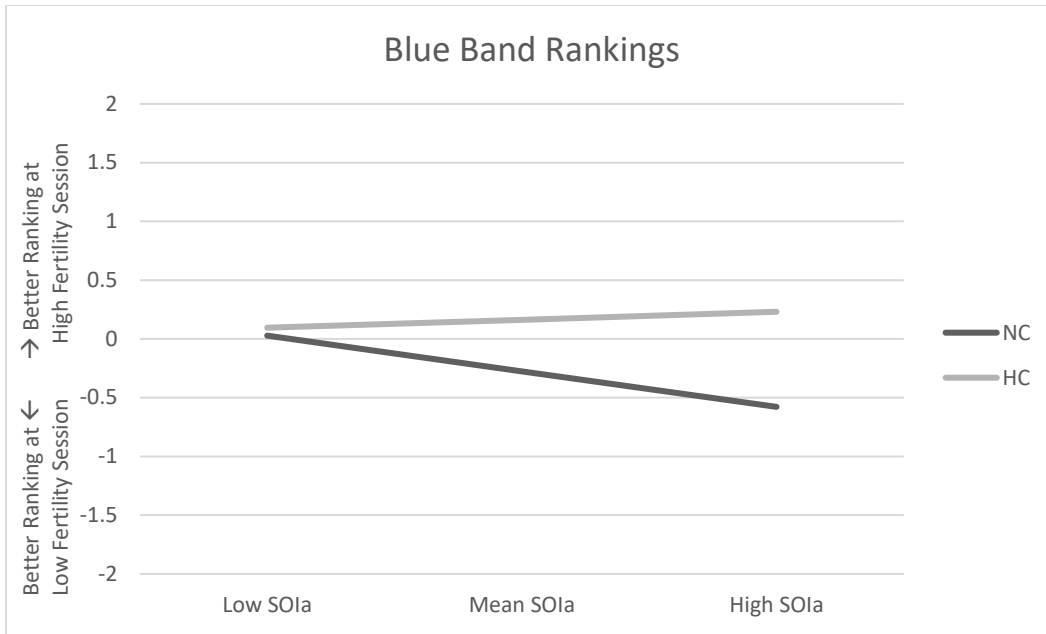


Note. NC = naturally cycling group; HC = hormonal contraceptives group

**Figure 15.** The difference between rankings at low fertility and high fertility for the green band's version of the song (very noticeable errors) as a function of condition (naturally cycling vs. HC) and SOId. Positive values indicate lower (better) rankings at the high vs. low fertility session. Negative values indicate lower (better) rankings at the low vs. high fertility session.

When ranking the blue band, there emerged a significant main effect SOIa,  $b = -0.59$ ,  $SE = 0.25$ ,  $t = 2.36$ ,  $p = .020$ , where those with higher SOIa ranked the blue band's rendition of the song lower (better) at their low fertility session compared to their high fertility session compared to those with lower SOIa, which was qualified by a significant two-way interaction between SOIa and condition on song rankings,  $b = 0.32$ ,  $SE = 0.16$ ,  $t = 1.99$ ,  $p = .048$ . See Figure 16 for the interaction effect. Follow up tests revealed that naturally cycling women with both mean and high levels of SOIa ranked the blue band's song as lower (better) at their low fertility session than their high fertility session, (mean:  $b = -0.28$ ,  $SE = 0.15$ ,  $t = 1.88$ ,  $p = .062$ ; high:  $b = -0.58$ ,  $SE = 0.22$ ,  $t = 2.65$ ,  $p = .009$ ). There were no other differences between high and low fertility sessions for either group of women at other levels of SOIa,  $ps \geq .142$ .

No further significant interactions emerged,  $ps \geq .102$ .



Note. NC = naturally cycling group; HC = hormonal contraceptives group

**Figure 16.** The difference between rankings at low fertility and high fertility for the blue band’s version of the song (subtle errors) as a function of condition (naturally cycling vs. HC) and SOIa. Positive values indicate lower (better) rankings at the high vs. low fertility session. Negative values indicate lower (better) rankings at the low vs. high fertility session.

**Table 10.** Marginal means and (standard errors) for song rankings.

	Fertility Status	
	High	Low
<b>Naturally Cycling</b>		
Yellow band – no errors	1.50 (0.34)	2.05 (0.24)
Blue band – subtle errors	2.10 (0.21)	1.80 (0.22)
Orange band – noticeable errors	3.35 (0.18)	2.85 (0.22)
Green band – very noticeable errors	3.05 (0.24)	3.30 (0.23)
<b>Hormonal Contraceptive</b>		
Yellow band – no errors	2.38 (0.15)	2.18 (0.15)
Blue band – subtle errors	1.78 (0.13)	1.98 (0.14)
Orange band – noticeable errors	2.82 (0.12)	2.76 (0.14)
Green band – very noticeable errors	3.02 (0.15)	3.08 (0.15)

**Participants Without Musical Training.** The pattern of results did not change when excluding women with prior musical training for either task.

### **Interim Summary of Music Preference Results**

Results of the musical preference task were somewhat in line with our predictions, specifically, results revealed that naturally cycling women noticed more errors in songs without (manipulated) errors at their low fertility session than their high fertility, and that they ranked this song as better at their high fertility session than their low fertility session. When ranking the rendition of the song with noticeable errors, women taking HCs noticed more errors at their low fertility session than their high fertility session and ranked the song better at their high fertility session than their low fertility session. At high fertility, naturally cycling women ranked the song without errors as better and the song with noticeable errors as worse than did women taking HCs. They also noticed less errors on the rendition with very noticeable errors than did women taking HCs. At low fertility, naturally cycling women noticed more errors in the renditions with noticeable and very noticeable errors than women taking HCs did. This indicates that naturally cycling women prefer well performed songs when conception is possible, and dislike poorly performed songs when conception is not possible.

Relationship status impacted song rankings and noticing of errors, such that naturally cycling women in relationships ranked the rendition of the song without errors as better in their high fertility session than their low fertility session, and ranked the rendition with noticeable errors better at their low fertility session than their high fertility session.

Additionally, single women taking HCs ranked the rendition of the song with noticeable



differences better at their low fertility session than they ranked it at their high fertility session as well.

Finally, short-term mating motivations impacted song rankings as well. When errors were very noticeable, naturally cycling women with high levels of SOId ranked them worse at high fertility than they did at low fertility. When errors were subtle, naturally cycling women with higher levels of SOIa ranked songs better at low fertility compared to high fertility.

### **Discussion**

The current research sought to a) replicate effects of previous research which finds that naturally cycling women prefer men with more symmetrical faces and more masculine faces, voices, and body stature (here investigated using gait) utilizing a larger sample size and more rigorous methods and b) extend this research by investigating if these shifts in preferences are driven by an increased perceptual acuity to subtle mating related cues. To test these predictions, a large sample of naturally cycling women and women using HCs was collected and tested on tasks at both high and low fertility points in their ovulatory cycles, with high fertility being confirmed utilizing urinary LH testing. Tasks included a facial discrimination task assessing reaction time to notice changes in facial morph videos, facial preference, gait preference, and vocal preference tasks which assessed preferences for stimuli ranging in masculinity (and symmetry for the facial preference task), and a music preference task in which women listened to various versions of the same song and ranked renditions (and indicated the number of errors they heard) according to their preferences.

I predicted that naturally cycling women and women at high fertility would have faster reaction times to notice changes in symmetrical and masculine male faces, stronger preferences for more symmetrical male faces, stronger preferences for more masculine male faces, gaits, and vocal clips, and stronger preferences for music without errors than women taking HCs and women at low fertility. I also predicted that these preferences may be the result of an increased ability to notice subtle differences, specifically subtle differences in mating related stimuli. As such, I predicted that naturally cycling women at high fertility may show stronger preferences when the differences between the stimuli were small as opposed to when they were large, compared to women taking HCs. Further, I predicted that these changes might be more pronounced in women with stronger short-term mating motivations and women in relationships, specifically those who were less committed to their partners or who found their partners less attractive. I found supporting evidence for some of these predictions, however, I also failed to find support for others (see Table 11 for a summary of results). Below, I interpret the findings of the current research in light of past literature on this topic, describe important limitations, and suggest key directions for future research.

**Table 11.** Dependent measures and results of predictions.

<b>Task</b>	<b>Construct Assessed</b>	<b>High vs. low fertility</b>	<b>NC vs HC</b>	<b>Moderation</b>
<b>Facial discrimination</b>	Perceptual attunement to facial differences	Low fertility = faster response time than high fertility	NC = somewhat faster response time than HC; (non-significant effects)*	High SOIb = faster response time for NC women at high fertility compared to low fertility (some trials)*
<b>Facial preference</b>	Perceptual preference of facial differences	No effect of fertility found	NC = stronger preference for symmetrical faces than HC*  HC = stronger preference for masculine faces than NC	Low SOIa = HC: stronger preference for masculine faces at low compared to high fertility  High SOId = NC: stronger preference for masculine faces high compared to low fertility*
<b>Gait preference</b>	Perceptual preference of gait differences	Mixed Findings	Mixed findings	No significant moderating effects
<b>Vocal preference</b>	Perceptual preference of vocal differences	Low fertility = somewhat stronger preference for masculine voices than high fertility	HC = stronger preference for masculine voices than NC	High SOIa = NC: stronger preference for more masculine vocal pitch at middle pitches and sum at low compared to high fertility (same pattern for SOI and SOId at high pitches; SOI at sum)

<b>Music preference</b>	Perceptual acuity to quality of courtship cues	High fertility = stronger preference for music without errors than low fertility*	NC = stronger preference for music without errors than HC*	Relationship status = NC in relationship rated error-free song better and song with noticeable errors worse at high compared to low fertility*  High SOId = NC rated song with most errors better at low compared to high fertility*  High SOIa = NC rated song with subtle errors better at low compared to high fertility*
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*Note.* NC = naturally cycling group; HC = hormonal contraceptives group; SOIa = sociosexual attitudes; SOIb = sociosexual behavior; SOId = sociosexual desires; SOI = sociosexual inventory. \*Prediction supported.

## **Facial Tasks**

### ***Main Effects***

In line with our predictions, the results of the facial discrimination task revealed that naturally cycling women were somewhat faster to notice changes in the facial discrimination tasks than were women taking HCs, although not significantly so. Surprisingly, this was mainly driven by naturally cycling women responding faster at their low fertility session compared to their high fertility session. This latter finding is at odds with what theory and past research predicts (Gangestad & Simpson, 2000; Pillsworth & Haselton, 2006) and could be an indication that other factors, such as short-term mating motivations or levels of estradiol (the latter of which is addressed in the Limitations and Future Directions section below), may influence the impact of fertility status on discrimination ability or speed.

Additionally, I found little evidence that the ability to notice subtle changes was specific to mating related stimuli, as similar patterns emerged across both mating related and non-mating related trials. That is, unlike Renfro and Hoffman (2013), who found naturally cycling women at high fertility to be better able to discriminate between mating related scents (but not other scents) compared to naturally cycling women at low fertility, I found no evidence that differences in discrimination ability were specific to mating related stimuli.

Compared to women taking HCs, naturally cycling women displayed a stronger preference for more symmetrical male faces, replicating results of previous studies (e.g. Little et al., 2007b), specifically when the differences were the smallest between the faces presented. This finding supported one prediction; however, again, there was no influence of fertility status on preferences for more symmetrical male faces. That differences were observed when the differences between the stimuli were the smallest, here, indicates that that naturally cycling women's preferences for symmetrical faces may be associated with noticing subtle differences in cues of symmetry.

Contrary to my predictions, women taking HCs displayed a stronger preference for the more masculine faces than did naturally cycling women, specifically at low fertility. This was an unexpected result as others have found women prefer more feminized faces after beginning to take HCs (Little et al., 2013). One explanation for this discrepancy may lie in how the tasks in the current study were presented to participants. That is, previous work finding preferences for symmetry and masculinity in naturally cycling women at high fertility have assessed these preferences specifically in the context of mate preferences, or, even more specifically, in the context of short term mate preferences (Gildersleeve, 2014). Ovulatory shift effects frequently do not emerge when assessing women's long-term mate preferences

or when the mating context is not specified. Perhaps by not inducing a short-term mating mindset prior to tasks in the current study, mechanisms which would facilitate preferences and attunement to mating related stimuli were not engaged.

### ***Moderating Effects of Short-Term Mating Motivations***

The possibility that engaging short term mating motivations is necessary to elicit ovulatory shift effects in women's mate preferences and perceptual capabilities towards mating related stimuli is supported by theory. For example, Maner and colleagues (2005) argue that motivational states which are associated with survival and reproductive success should be key in directing the brain's selective processing of social stimuli. The researchers tested this theory by priming participants with self-protection and mate-searching goals in two separate studies and then asking participants to rate levels of emotional expressions that they perceived on photographs of targets with neutral expressions. Results revealed that activating these motivational states, which were directly related to survival and reproduction, led to increased perception of functionally relevant emotions in goal-relevant targets. For example, when primed with a mate-searching goal, men perceived more sexual arousal in neutral female faces.

Given this past research, it seems possible that activation of women's short-term mating motivations may be necessary in order for ovulatory shift effects to emerge. This concept is also supported by the pattern of findings that emerged when including women's short term mating motivations in models as a moderator of the impact of fertility status and condition (naturally cycling vs. HC) on discrimination ability. In the current study, increased short-term mating motivations, specifically short-term sexual behavioral experience, in naturally cycling women were associated with faster response times in the high compared to

low fertility sessions, or better attunement to subtle differences in stimuli. This finding is consistent with the hypothesis that perceptual acuity maybe influenced by both hormonal and motivational factors and is in line with recent research. For example, Kim and colleagues (2018), find that naturally cycling women who have heightened short term mating motivations also have increased desire for short term mating at ovulation, a pattern which the researchers did not observe in women without increased short term mating motivations.

Short term mating motivations were specifically found to influence women's reactions times in the current study on the trials in which the stimuli changed from more masculine to feminine and more feminine to masculine (and in the fruit change control trial as well). This could indicate that naturally cycling women do have increased perceptual acuity to notice differences in stimuli at high fertility compared to low fertility when short-term mating motivations are activated, although perhaps these differences are more pronounced when the stimuli varies in levels of masculinity than when the stimuli varies in levels of symmetry.

In line with this finding, naturally cycling women with higher short-term mating motivations – in this case, high short-term mating desires – displayed a stronger preference for more masculine faces at high compared to low fertility when the differences between the faces were intermediate. It should be noted, however, that the same pattern of results did not emerge when investigating the impact of short-term mating motivations on preferences for masculine faces at the smallest differences, specifically with positive attitudes towards short term sex. In this case, women taking HCs with less positive attitudes towards short-term sex showed a somewhat stronger preference for the more masculine faces at low fertility compared to high fertility. While one pattern of results was not found consistently throughout

tasks, it appears that short term mating motivations does account for some of the unexpected findings in the current work. That is, while some of my predictions were not confirmed (i.e. I found that naturally cycling women prefer less masculine faces than women taking HCs, and that this preference for masculine faces is not impacted by fertility status), naturally cycling women at high fertility with higher mating motivations did display the expected preferences on some of the tasks.

### **Gait and Auditory Preference Tasks**

#### ***Main Effects***

As a further test of naturally cycling women's preferences for and attunement to cues of masculinity at high fertility, preferences for masculine gaits and masculine tones were also investigated. The results of these tasks followed similar patterns of those observed in the masculine face preference task, with a few key differences. First, I found that when the differences between the gaits were the smallest, naturally cycling women displayed a stronger preference for the more masculine gaits than did women taking HCs, but only at low fertility. The opposite was true when the differences were the largest. In this case, I found that women taking HCs displayed a stronger preference for more masculine gaits than did naturally cycling women, but again, this was only at low fertility.

Similarly, in the vocal pitch preference task, naturally cycling women again showed a stronger preference for the more masculine vocal clips at low fertility compared to high fertility. Further, across fertility sessions, I found that women taking HCs displayed a stronger preference for the more masculine vocal clips than did naturally cycling women. This difference was strongest at high fertility and when the differences were intermediate and at the higher pitch. These results do not support the predictions that naturally cycling women



at high fertility would show the strongest preferences for more masculine gaits and vocal clips, as has been found in other studies (Feinberg et al., 2006, Little et al., 2007a, Puts, 2005;). However, recent studies, which have included large sample sizes and rigorous methodology more similar to the current research, have also failed to replicate previous studies which find increased preferences for masculinity at high fertility compared to low fertility (Jünger et al., 2018a, Jünger et al., 2018b).

### ***Moderating Effects of Short-Term Mating Motivations***

While short term mating motivations did not impact preferences for more masculine gaits, they did influence naturally cycling women's preferences for more masculine vocal pitches, although, not in the predicted direction. That is, naturally cycling women with increased short-term mating motivations had a stronger preference for the more masculine vocal pitches at their low fertility compared to their high fertility sessions. This pattern of results was observed when considering women's positive attitudes towards short term sex (and the full SOI scale) at middle pitches, and their desires for short term sex (and the full SOI scale) at the highest pitches. In this case, short term mating motivations are associated with naturally cycling women preferring more masculine voices at low fertility compared to high fertility.

While differences were observed at middle pitches, where differences between the stimuli were the smallest, they were also observed at the highest pitches, where differences were intermediate, preventing any strong conclusions from being drawn in regard to my predictions regarding discrimination ability in response to subtle differences. It is noteworthy, however, that the opposite pattern of effects was observed when investigating the impact of short-term mating motivations on preferences for a lower pitched tone in the

auditory control task. While this could be an arbitrary outcome produced as the result of utilizing an evolutionary irrelevant stimuli (tone), it does lend some support that the results here are specific to mating related auditory cues, despite results not emerging in the predicted direction.

## **Music Preference Tasks**

### ***Main Effects***

In the music preference tasks, I found that naturally cycling women did rank the song without errors as better in their high fertility session compared to their low fertility session and compared to women taking HCs. They also ranked the song with noticeable errors as worse than did women taking HCs at high fertility. Further, naturally cycling women also tended to notice somewhat more errors at high compared to low fertility, while this was not the case for women taking HCs. These results are in line with my predictions, specifically that naturally cycling women at high fertility are more attuned to mistakes in musical performances than women taking HCs or naturally cycling women at low fertility. If musical performances are indeed a courtship cue (Miller, 2000), noticing errors and preferring performances without errors when conception is possible could help women to select more skilled and intelligent mates.

### ***Moderating Effects of Relationship Status***

Across some studies, researchers have found that only women in relationships, and not those that are single, to show increased sexual desire during ovulation (Pillsworth, Haselton, & Buss, 2004; Roney & Simmons, 2016). This shift in desire when conception is possible and when a long-term partner is present is theorized to occur because only under these circumstances does the benefits of becoming pregnancy outweigh its costs (Pillsworth

et al., 2004). Consistent with this theory, naturally cycling women in relationships rated the error-free version of the song better at high fertility compared to low fertility, and the version of the song with noticeable errors as worse at high fertility compared to low fertility. In this case, it appears naturally cycling women in relationships show stronger preferences for courtship cues that are well executed when fertile, and weaker preferences for courtship cues that are executed poorly.

### ***Moderating Effects of Short-Term Mating Motivations***

Further, naturally cycling women with increased short-term mating motivations rated the version of the song with subtle errors better at low fertility than they did at high fertility, and the version of the song with the most noticeable errors as better at low fertility than they did at high fertility as well. Extending previous research which finds that women are more influenced by music at high fertility compared to low fertility (Sanders & Wenmoth, 1998), these results, taken with those from the previous section, suggest a pattern in which naturally cycling women at high fertility with heightened short-term mating motivations enjoy and like music that is performed well, and dislike music which is not performed well. Further studies should aim to replicate and clarify this novel result, however these findings are in line with my predictions that naturally cycling women at high fertility would prefer the music clips without errors, notice more errors in in music clips with errors, and that increased short-term mating motivations would attenuate these effects.

### **Moderating Effects of Partner Attractiveness and Commitment to Partner**

I sought to investigate the impact partner attractiveness and commitment to partner within women in relationships, however, these results are not reported here. It should be noted that these variables did not significantly impact relationships between fertility status,

condition, and preferences for or perceptual acuity to mating related stimuli across any of the target tasks. While this could indicate that these relationship factors do not influence preferences for and acuity to mating related stimuli, it could also have resulted from being underpowered to detect such relationships, as less than half of the current sample reported being in a relationship across both sessions. Additionally, as is true in nature, there were less naturally cycling women in relationships than women taking HCs in relationships. This frequently occurs, as one of the many reasons that college aged women decide to take HCs is because they are in a committed relationship but do not wish to become pregnant (Upadhyay, Raifman, & Raine-Bennett, 2016). These skewed sample sizes may have further prevented any meaningful relationships from emerging from these analyses. Future research should address this limitation by collecting samples with equal sized groups of naturally cycling women and women taking HCs who are in relationships.

### **Summary of Results**

While I found some evidence to support my predictions, I did not find overwhelming support across all of the different tasks. I did find naturally cycling women to prefer more symmetrical faces, but not masculine faces, voices, or gaits, although some of these relationships were influenced by short-term mating motivations. While there was some evidence in the discrimination task, music task, and in some of the tasks assessing masculinity that naturally cycling women did show stronger preferences for better performed music and more masculine and symmetrical stimuli when the differences were subtle, indicating that heightened perceptual acuity at high fertility could drive ovulatory shift effects, this was also not found consistently across tasks.

## **Limitations and Future Directions**

Although the current work has many strengths in comparison to the extant studies investigating ovulatory shift effects, it is not without limitations. While nonsignificant findings could be evidence that no effect exists, nonsignificant findings could have arisen, in part, due to a few limitations of the current work. One such limitation includes that the sample size of naturally cycling women and women taking HCs was skewed, with far less naturally cycling women completing both sessions than women taking HCs. This was likely the result of increased difficulty scheduling naturally cycling women at the correct times in their cycles. As cycle lengths vary from month to month, some women were required to come into the lab quite a few times before completing their high (and even occasionally their low) fertility sessions. This added inconvenience may have dissuaded some naturally cycling women from completing both sessions. While the regression procedures utilized to estimate models that included moderating variables are robust to differences in group sizes (Kline, 1998), ANOVA procedures are less so (Wilcox, 1993). As such, some results may be disproportionately skewed due to unequal group sizes. Further, more naturally cycling women completed their high fertility session prior to their low fertility session than did women taking HCs. This confounded session order with fertility somewhat in the naturally cycling group. As such, results could be somewhat (although not significantly) influenced by session order.

It should also be noted that the sample of women in the current work was comprised of college-aged women, mainly from a high socioeconomic background who are somewhat unique from the population in ways that could have impacted the results of the current study. For example, women in this sample, coming from a private, Christian university in the

southern United States, are likely to be more sexually restricted than the general population. If short-term mating motivations must be activated in order for ovulatory shift effects to emerge, women in this sample are less likely to display these effects compared to women in the general population. Future research investigating women's perceptual acuity to mating related stimuli at ovulation should be done using a more representative sample to ensure that null effects reported here are not specific to the sample being studied.

Additionally, across the tasks, I found a consistent lack of evidence that fertility status influenced shifts in preferences and discrimination abilities in the predicted directions. If it is the case that increased estradiol at ovulation enhances perceptual capabilities, these unanticipated findings could be due to a second rise in estradiol that occurs in the luteal phase of the cycle. It could also be the case that progesterone levels relative to estradiol levels impact perceptual abilities in ways which have yet to be explored. The possibility that the timing of each high fertility session was suboptimal should also be considered, as estradiol may already have begun to drop by the time women confirmed ovulation via LH surge. Future research incorporating the salivary hormone samples collected during this study will allow these explanations to be further elucidated.

Further, while only women taking first through third generation HCs were included in the current study, it could be that certain HCs with different levels and different types of synthetic progestins may have influenced responses in this group. Future research should investigate the impacts of different HCs and progestin types, along with how the duration of HC use impacts perceptual abilities. It is possible that some of the differences between naturally cycling women and those taking HCs would be more prominent if the women taking HCs were more homogeneous in their HC use. Further, it could be that and increased

duration of HC use amplifies differences between women taking HCs and naturally cycling women. Future research should seek to understand the cognitive, perceptual, and motivational influences of HC use, paying careful attention to differences that may emerge between women using different types of HCs (specifically with differing types of progestin) and differences that may emerge as a function of each woman's duration of HC use.

## **Conclusions**

Despite the limitations of the current study, this work adds valuable new insights to the literature investigating how (and if) women's preferences shift at ovulation. I sought to discover if women's increased preferences for symmetry and masculinity at ovulation were driven by an increased perceptual acuity to subtle changes in mating related stimuli when conception was possible. I also sought to replicate previously reported ovulatory shift effects using more rigorous methods and larger sample sizes than previous studies have employed. I was able to replicate some effects (e.g. naturally cycling women preferred more symmetrical male faces than did women taking HCs), however I was unable to replicate most other previously effects of preferences for masculinity or symmetry based upon fertility status. I also did not find overwhelming evidence that naturally cycling women at high fertility displayed greater acuity to mating related changes, specifically in regard to facial cues or gait patterns. I did, however, find that naturally cycling women at high fertility with increased mating motivations show somewhat stronger preferences for mating cues that could signal good genes, specifically preferring better performed music, which could indicate increased perceptual acuity to this specific cue of mate quality. Despite mixed findings, the current study provides directions for future research, along with new insights into women's mating psychologies.

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## VITA

Summer Mengelkoch was born in Phoenix, Arizona on December 3<sup>rd</sup>, 1992. She is the daughter of Richard and Gail Mengelkoch. After graduating from St. Francis Senior High School in 2011, she received a Bachelor of Arts degree from the University of Minnesota in 2013, where she majored in Psychology. In 2017 she began graduate study at Texas Christian University, where she is currently pursuing a Doctor of Philosophy degree in Experimental Psychology under the tutelage of Dr. Sarah E. Hill.

## **ABSTRACT**

### **MECHANISIM BEHIND THE MADNESS: INCREASED PERCEPTUAL ACUTIY FOR MATING RELATED STIMULI AT OVULATION**

by Summer Mengelkoch, M.S., 2020  
Department of Psychology  
Texas Christian University

Thesis Advisor: Sarah E. Hill, Associate Professor of Psychology

Researchers find that, near ovulation, women exhibit a heightened preference for men who have indicators of good genes – such as facial symmetry, facial masculinity, body masculinity, and vocal masculinity – particularly in the context of their short-term partners. Here, I sought to conceptually replicate these patterns and examine whether they are driven by changes in women’s perceptual acuity near ovulation. Ninety-seven naturally cycling women and 145 women taking hormonal contraceptives were tested on their preferences for and their perceptual acuity to mating related stimuli that indicate high quality genes at both high fertility and low fertility across the ovulatory cycle. Tasks assessed preferences for and acuity to subtle differences in faces, gaits, voices, and music. Results reveal that while women’s preferences for and acuity to subtle differences in mating related stimuli are impacted by hormonal contraceptive use and short-term mating motivations, that patterns of results differed across different types of tasks.