

**APPETITIVE RESPONDING AND THE FEMALE MENSTRUAL CYCLE:
AN INVESTIGATION INTO THE POST-AURICULAR REFLEX**

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ABSTRACT

A multitude of research supports that fluctuations in fertility and hormonal shifts in normally cycling females influence changes in female sexual strategies, preferences, and desires across the menstrual cycle. Evolutionary theory posits that in order to maximize reproductive benefits, near ovulation female responses to sexual stimuli alter and cues of sex are more appealing. The post-auricular reflex (PAR) is a psychophysiological reaction that has been linked to motivation and reward, emotion, and appetitive responding. The PAR responds to pleasant stimuli, including stimuli that are relevant to evolutionary themes. The purpose of the current study was to explore the nature of the post-auricular reflex, and in particular, to examine potential shifts in motivation and reward processing of sexual and emotional stimuli across the female menstrual cycle. Ovulation blunted PAR responses to non-erotic categories in normally cycling females, while responses to erotica did not significantly decrease across phases of the menstrual cycle. Ovulation was also found to affect female self-report of sexual desire. These shifts were not seen in females using hormonal birth control. The study results suggest that ovulation shifts female priorities towards reproduction by increasing desire and also decreasing motivations for non-mate-relevant activities. The study also demonstrates the need for greater investigation of the PAR and the appetitive responding system.

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CHAPTER ONE

OVERVIEW OF EVOLUTIONARY PSYCHOLOGY

Evolutionary psychology aims to understand human behavior through a lens that focuses on adaptations for survival and drives for passing on genes to future generations. Primarily, evolutionary psychologists hypothesize about how particular patterns of thoughts, feelings and behaviors functioned to optimize human survival and reproduction. For instance, universal preferences for finding certain foods more palatable or finding certain faces more beautiful may reflect hardwired cognitive adaptations that provided survival and reproductive advantages during the course of human ancestry. Because it is not possible to recreate the course of human ancestry, evolutionary explanations have frequently drawn criticism as being “just so” stories, untestable hypotheses about past life as a means to explain a present-day behavior (e.g. Gould & Lewontin, 1979; Schlinger Jr., 1996). Although evolutionary approaches do seek to find more “ultimate” explanations for patterns of human behavior, they are not meant to compete with or to replace proximate explanations. In combination with proximate explanations, evolutionary approaches add information to gain a fuller understanding of human behavior (Confer et al., 2010). Evolutionary psychology has made significant contributions by highlighting aspects of human behavior that were originally overlooked by other areas of psychology.

Daly and Wilson’s (1988) examination of homicide within families is a seminal example of how evolutionary approaches can inform other areas of psychology. From an

evolutionary perspective, familial homicide initially would seem to contradict a basic tenet of evolution by destroying opportunities to have one's genes and related genes survive. Using archival data of homicide rates, Daly and Wilson discovered that genetically related homicides within a family were relatively rare. Homicides within a family were more commonly males killing female spouses or step-children. Violence and homicide are extreme and unjustifiable acts, but Daly and Wilson explained that the emotions behind such events are likely related to evolutionary motives in reproduction and parental investment. From an evolutionary standpoint, it only makes reproductive sense to invest in genetically related children. In contrast to females, males cannot be fully certain of their paternity and may risk investing resources in children sired by another male. As such, jealousy and perceived infidelities contribute to violence against spouses. Similarly, care of stepchildren does not enhance one's own genetic survival, which may result in greater anger and hostility towards stepchildren. In fact, Daly and Wilson found that fathers in the U.S. were 100 times more likely to kill stepchildren than their own biological children. Daly and Wilson's work is notable because it substantiates how evolutionary theories can offer novel insights into human behaviors and motivations. Without testable hypotheses drawn from evolutionary approaches, the extreme disparity between homicide rates for stepchildren and biological children may not have been fully examined or discovered.

Natural Selection, Parental Investment, and Female Sexual Strategies

Darwin's theory of natural selection (1859) dictates that certain traits will be more beneficial than others in a given environment. Those in possession of genes best suited

for an environment have a survival and reproductive advantage, ensuring that those genes are more present in future generations. Traits, preferences, and behaviors can also be passed on for their benefits. For instance, in general people find foods high in sugars and fats to be palatable, and find foods that may be spoiled or rancid to be revolting. These taste preferences are universal in human societies and serve a clear adaptive function. Human ancestors who preferred the taste of fats and sugars in foods sought out foods rich in nutrition and calories, enhancing their chances of survival. Ancestors who may have preferred the taste of spoiled food would not receive the same nutritional benefit, and would likely have not been healthy enough to be able to reproduce and pass on genes to a future generation.

Certain genes and traits will be advantageous in a given environment, but these genes and traits must also survive through future generations via reproduction. Although reproduction can be costly and effortful, the drive to reproduce is a basic motivator and spurs procreation. Darwin's theory of natural selection also expanded into sexual selection and mate choice. Just as preferences for certain kind of foods may provide survival advantages, preferences for certain kinds of mates may yield reproductive advantages.

Parental Investment Theory

Parental investment theory (Trivers, 1972) posits that basic biological differences between males and females of a species affect mate selection strategies and tactics. Parental investment includes any time, effort, or costs to the self that are needed to produce offspring successfully. Greater minimum investment results in higher mating

selectivity, as there is greater risk in the act. Similar to the pattern in many species, in humans, females provide the greater minimum investment. Human females are limited in their ability to reproduce, as they are born with a limited number of eggs containing genetic material for reproduction, cannot reproduce further during their nine months of pregnancy, and experience menopause in later years after which they can no longer reproduce. Females often also are affected post-pregnancy by nursing and nurturance of offspring.

In contrast, at its minimum, male parental investment is much less. Though males often do invest in their offspring, their ability to reproduce does not require them to contribute more than the relatively short time of copulation and a small amount of sperm. Unlike eggs, sperm are replenished over a male's lifetime, and human males thus experience a greater number of reproductive years than females. Male reproductive success is thus more limited by finding potential partners than it is by biological constraints, and parental investment theory predicts a pattern of female selectivity and male competition in humans.

Sexual strategies theory (Buss & Schmitt, 1993) further expands upon parental investment theory. A male benefits most from seeking short-term relationships with multiple fertile females to increase the likelihood that he will pass on genes. This strategy limits his investment in any particular offspring, but allows for a greater potential quantity of offspring. Males often place high value on physical characteristics in females because qualities such as youth, attractiveness, and waist-to-hip ratios are strongly associated with a female's ability to conceive (Buss & Schmitt, 1993; Singh, 1993).

Relative to males, females benefit from seeking long-term investment from a partner that will enhance her and her offspring's survival and help to offset the loss of resources incurred during pregnancy. Because a female can produce fewer offspring overall compared to a male, her energies and resources are better devoted to heavy investment in fewer offspring. Female sexual strategies tend to emphasize long-term cues of investment, commitment, and resource acquisition.

Female Mate Selection Preferences

Personality characteristics that indicate long-term partner potential and parenting qualities, such as wealth, social status, intelligence, and kindness tend to be more important to females (Brase, 2006; Buss & Schmitt, 1993). Such cues are consistently valued in a long-term mating context (Gangestad, Garver-Apgar, Simpson, & Cousins, 2007; Penton-Voak & Perrett, 2000, Penton-Voak et al., 1999). Perception of these cues may sometimes be more attractive to females than a male's actual physical appearance. Women rated males dressed as white-collar professionals as more attractive than males depicted in low-status fast food uniforms. When the male model was unattractive, status cues also predicted likelihood of any form of relationship (Townsend & Levy, 1990a). Such characteristics are important for the benefit they provide to females: men with status and resources plus a willingness to invest those resources in a female will better ensure the survival of any potential offspring.

Although females frequently place more importance on cues to resources and investment, male physical features and characteristics are also valuable sources of information. Just as males discern fitness information from female physical features, the

male physique also displays information of genetic fitness. Testosterone levels in males are associated with health and virility: higher levels of testosterone in a male contribute to sexually dimorphic features such as hirsuteness, strong brow and jaw lines, and vocal pitch. Because testosterone can also act as an immunosuppressant (Folstad & Karter, 1992), a male who is able to display both health and sexual dimorphism is providing an honest signaling of good genetic quality (Gangestad & Thornhill, 2003; Grammer & Thornhill, 1998; Zahavi, 1975).

Female reproductive benefits would be maximized by obtaining a male who is willing and able to provide both high-quality genetic material and resources and investment into offspring. However, such males are in high demand, and most females will need to prioritize either high quality or high investment from a partner (Buss & Schmitt, 1993; Gangestad & Simpson, 2000). While certain testosterone markers signal high genetic quality, they also correspond to poor long-term partner potential. Males with higher testosterone levels are perceived as less warm and less of a good parent by females (Penton-Voak & Perrett, 2000; Perrett et al., 1998). They also cause greater risks to the pair bond through a greater likelihood to commit infidelities, divorce their spouse, or engage in aggressive/destructive behavior such as physical violence (Booth & Dabbs, 1993). Males with lower testosterone levels have less strong sexual dimorphism, but appeal to females through perceived personality characteristics such as honesty and warmth (Cunningham, Barbee, & Pike, 1990; Perrett et al., 1998).

Ovulatory Effects on Sexual Strategies

Human reproduction is unusual in that females give no outward signs of ovulation. Unlike other primates and animals, human females do not exhibit visible estrus through sexual swellings, coloration, or other conspicuous or conscious cues of ovulation (Burt, 1992). “Concealed ovulation” has been posited as an adaptive method of obtaining male investment: if ovulation is hidden, a male must be consistently present in order to reproduce with a particular female. Although females provide no obvious visual cues of ovulating, research suggests that fertility status may be revealed through subtle changes in behavior and preferences. The fertile window for human females is brief (6-7 days), but during this time mating-related preferences and behaviors increase to take advantage of the reproductive opportunity.

Several lines of research have shown that ovulation influences female sexual behavior. Ovulating females report greater sexual desire, more sexual fantasies, more interest in sex and more frequent sexual activity, and find sexual stimuli more rewarding (Bullivant et al., 2004; Pillsworth, Haselton, & Buss, 2004; Stanislaw & Rice, 1998). Ovulating females also self-report more instances of infidelity and short-term relationships (Baker & Bellis, 1995; Pillsworth et al., 2004) and a greater interest in mate-relevant contexts such as clubs or parties (Haselton & Gangestad, 2006). Increases in sexual desire and activity are not limited to opposite-sex attraction; females that self-identify as lesbian or bisexual also report greater sexual interest near ovulation (Brown, Calibuso, & Roedl, 2011; Matteo & Rissman, 1984). For heterosexual females, an increased interest in mating-related activity at times of high fertility would help to

optimize their reproductive success. Females who sought out sexual partners at times of high conception risk would be more likely to reproduce, conceive, and pass on their genes. Females who sought out high genetic-quality males in particular would reap an even greater reproductive benefit.

Ovulation has also been shown to influence female preferences for selecting potential mates. During the majority of the menstrual cycle, the risk of conception is low and females benefit by selecting partners who would make good long-term mates. At times of low fertility, females prefer cues that signal a male's status, commitment, and parenting qualities. But near ovulation when the risk of conception is high, females can benefit by adopting a more short-term strategy (Gangestad, Thornhill, & Garver-Apgar, 2005; Gangestad et al., 2007). At times of high fertility, females pay greater attention to cues that signal a male's physical health and genetic quality, and place less importance on a male's resource potential and parenting qualities (Penton-Voak & Perrett, 2000). When evaluating potential mates, ovulating females prefer males with cues that signal higher testosterone levels and better physical health. Ovulating females prefer the faces of males with higher testosterone as opposed to the faces of males with lower testosterone levels (Roney & Simmons, 2008). Ovulating females prefer images of males with more masculinized faces (Little, Jones & DeBruine, 2008; Penton-Voak & Perrett, 2000) and more masculinized bodies (Little, Jones, & Burriss, 2007). Ovulating females are also more attentive to cues of physical health like symmetry. Ovulating females prefer the faces, bodies, and the scents of more symmetrical males (Little, Jones, Burt, & Perrett, 2007; Gangestad & Thornhill, 1998; 2003). Ovulating females also prefer masculine

characteristics including deeper vocal pitch (Collins, 2000), taller height (Pawlowski & Jasienska, 2005), and greater displays of dominance (Gangestad, Simpsons, Cousins, Garver-Apgar, & Christensen, 2004).

Female strategies to attract mates may also shift with ovulation. Females place greater emphasis on their appearance near ovulation, perhaps in efforts to attract a mate. Females near ovulation were judged by both male and female raters to make a greater effort to appear attractive by choosing more fashionable clothing and/or ornamentation such as jewelry or by revealing more skin (Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007). Fertile females also chose more revealing outfits for themselves in hypothetical scenarios (Durante, Li, & Haselton, 2008). Schwarz & Hassebrauck (2008) tracked females across their cycles in a diary study and found that women closer to ovulation felt they dressed more provocatively. In addition to manner of dress, fertile females also display a greater willingness to purchase expensive items to enhance appearance (Hill & Durante, 2009).

Although evolutionary approaches may provide an ultimate explanation for shifts in female sexual strategies, the most proximate explanation is that the shifting preferences are linked to fluctuations in reproductive hormones throughout the menstrual cycle. Shifts in female sexual strategies have typically been found only in normally cycling women (e.g. those who experience regular menstrual cycles and are not on any form of hormonal birth control). These women experience fluctuations in fertility due to ovulation. The human female menstrual cycle is often divided into phases based upon estimated conception risk and/or fluctuating hormonal levels (Regan, 1996). During the

follicular phase (days 1-14 based on a standard 28-day cycle), which begins with menstruation (days 1-6), the body has low amounts of progesterone relative to estrogen (estradiol). Estrogen and luteinizing hormones increase near the late follicular phase and decline after ovulation, which occurs approximately 14 days prior to menstruation regardless of cycle length (Baker & Bellis, 1995). Female conception risk is heightened near ovulation, although the exact fertile window varies from cycle to cycle and among individuals (Fehring, 2005). In contrast, women on hormonal forms of birth control do not experience any fluctuations in fertility. Hormonal birth control mimics a state of pregnancy in women which prevents ovulation. Hormonal birth control provides steady levels of progesterone and/or estrogen. Luteinizing hormone is not stimulated and no egg is released (Alvergne & Lummaa, 2009; Regan, 1996). As a consequence, women who use hormonal forms of birth control show lesser to no shifts in mating preferences throughout the menstrual cycle (Alvergne & Lummaa, 2009).

The effects of ovulation are not limited to female behavior and preferences; ovulation can have impacts on males as well. Evolutionarily, males benefit by seeking out and attending to females when the chance of a female conceiving is at its peak. Research shows that a female's fertility status can alter male preferences and behaviors. Men show an unconscious preference for fertile females, supporting that human ovulation is not fully concealed (e.g. Burt, 1992). Male raters in Schwarz & Hassebrauck's diary study (2008) rated females near ovulation as wearing sexier and more revealing outfits, and judged their pictures to be more attractive relative to the same females at low fertility. Males engage in more protective and mate-guarding behaviors when their female

partner is near ovulation (Gangestad et al., 2002; Haselton & Gangestad, 2006), particularly if the male is less sexually attractive (Pillsworth & Haselton, 2006). Males perceive greater value in fertile females, as evidenced by women in a gentlemen's club earning more tips near the fertile point of their cycle (Miller, Tyburn, & Jordan, 2007). Female fertility is also detected by males in non-visible cues: men prefer the scents (Singh & Bronstad, 2001) and voices (Pipitone & Gallup, 2008) of females at high as opposed to low-fertility points in their cycle. Female ovulation thus encourages mating-related behaviors in both males and females.

Ovulatory Effects on Cognitive and Emotional Processing

In addition to generating shifts in females' mate selection preferences, fertility status also impacts the cognitive and emotional processing of mate-relevant stimuli. At times of high fertility, mate-relevant stimuli may command greater attentional resources. Using a dichotic listening task, Rosen & López (2009) found that fertile females showed greater attentional bias towards flirtatious (mate-relevant) messages and made more errors in shadowing flirtatious messages relative to neutral content. Females on hormonal birth control did not show a change in errors based upon condition. For normally cycling fertile females, cues related to mating and courtship have greater attentional salience.

Fertility status can also impact categorization processes when exposed to mate-relevant stimuli. Normally cycling females categorize male faces faster at peak compared to low conception risk; ovulation did not affect categorization of female faces (Johnston, Arden, Macrae, & Grace, 2003; Macrae, Alnwick, Milne, & Schloerscheidt, 2002). Macrae et al. (2002) also found that fertile females verbally categorize information about

males more quickly. Near ovulation, females primed with a male face more quickly categorized stereotypical male words (e.g. “strong”, “reckless”) as opposed to stereotypical female words. Quicker reaction times to mate-relevant stimuli indicate that males have greater reproductive relevance for females at times of high conception risk. Females at high conception risk also more accurately recognized sexual stimuli and made more false recognitions of other stimuli as sexual stimuli in a verbal categorization task (Krug, Psych, Pietrowsky, Fehm, & Born, 1994). Furthermore, Krug et al. demonstrated that fertile females are specifically attentive to relationship and mate-based stimuli. They included pictures of babies as a biologically relevant stimulus, indirectly related to sex and mating as a product of reproduction. Recognition of babies did not increase with conception risk. Increased attention and perception with fertility is thus specific to mate-related stimuli.

Mate-relevant stimuli may also invoke different types of emotional processing depending on a female’s fertility status. Mate-relevant stimuli may be more rewarding at high conception risk. Laeng & Falkenberg (2007) used pupillometry as a correlate of interest and sexual arousal to track female responses to pictures of attractive individuals. Autonomic responses of increased pupil diameter were seen specifically for males that females had rated as personally attractive, such as their own boyfriends or favorite actors.

Further evidence that mate-relevant stimuli may be more rewarding for ovulating females comes from a study of female olfactory perception. Hummel, Gollisch, Wildt, & Kobal (1991) tested normally cycling females in an olfactory dilution series threshold test for chemical compounds. Females rated androstenone, a musky odorant found in male

sweat. Although their detection threshold for the hormone did not change, females rated the scent of androstenone as more pleasant around the time of ovulation. Female sensitivity and evaluation of other odorants was not affected by cycle phase, indicating that shifts in reward value were limited only to sexually relevant stimuli.

Use of Psychophysiological Measures to Examine Sexual Strategies

Sexual strategies theory predicts that mate-relevant stimuli will have different reward values as a function of fertility status. The use of psychophysiological measures has proven very useful for examining the emotional processing of mate-relevant stimuli. An increased reward value for sexually relevant stimuli near ovulation has been confirmed with studies utilizing evoked response potentials (ERP). Females showed greater emotional processing of specifically sexual stimuli near ovulation as measured through greater late positive components (LPC; modulated by valence and emotional intensity of content) of an electroencephalogram (Krug, Plihal, Krehm, & Born, 2000). Similar to previous research (e.g. Krug et al., 1994), responses were specific to sexual stimuli (e.g. nude males) rather than reproductive but not sexual stimuli (e.g. babies). Females in the ovulatory cycle phase show increased brain activation to erotic videos relative to normally cycling women in other phases (Gizewski et al., 2006). Women also experienced greater subjective sexual arousal during the ovulatory phase, showing no difference compared to males, despite males generally showing stronger responses to erotica and finding it more pleasing and arousing (Bradley, Codispoti, Sabatinelli, & Lang, 2001). Ovulating females also show increased brain activation in reward

processing areas, especially to specifically sexual stimuli (Rupp et al., 2009a) and to masculinized relative to feminized male faces (Rupp et al., 2009b).

Other psychophysiological measures have demonstrated that ovulation makes mate-relevant stimuli more rewarding. Mass, Hölldorfer, Moll, Bauer, & Wolf (2009) used facial EMG to study activity of the zygomatic muscle (a muscle that pulls the lip upward while smiling) in normally cycling females while viewing different types of images. Females in the follicular phase (more fertile) of their cycle smiled more in response to pictures of nude males, while responses for neutral stimuli did not alter with phase. Because emotional evaluations can often occur without conscious awareness (Devine, 1989; Vanman, Paul, Ito, & Miller, 1997), the use of psychophysiological measures can provide insights into emotional processing that would be unavailable through self-reports alone (Berridge & Winkielman, 2003).

Psychophysiological measures may be particularly useful for testing, and potentially revising, evolutionary theories. For instance, evolutionary theories of parental investment predict that males should find the sexual infidelity of their mates more upsetting than their emotional infidelity while females should show the opposite pattern (e.g. Buss, Larsen, Westen, & Semmelroth, 1992). Harris (2000) analyzed psychophysiological reactions of males and females who imagined sexual infidelities, emotional infidelities, or sexual scenarios without infidelity. Males responded more to sexual scenarios, regardless of whether they contained the infidelity component. In contrast to previous thought, psychophysiological reactions of females did not differ

across infidelity scenarios. Harris' work demonstrates that psychophysiological measures to supplemental self-report can help test and potentially refute evolutionary theories.

CHAPTER TWO

THE POST-AURICULAR REFLEX AND APPETITIVE RESPONDING

Particular emotional states or expressions often have specific patterns of arousal and muscle activity (Lang, Greenwald, Bradley, & Hamm, 1993). Changes in psychophysiological reactions in response to visual or auditory stimuli can therefore be analyzed as a correlate for emotions (Bradley & Lang, 2000). Lang and colleagues (Lang, Bradley, & Cuthbert, 1990; 1992) posited the existence of two basic motivational systems: the defensive motivational system and the appetitive motivational system. These two motivational systems are the foundation for emotional responding. Each motivational system corresponds to specific action patterns that encourage survival. Organisms faced with an external stimulus prepare for appropriate and corresponding action. Threat-related stimuli place the organism in a defensive state, where it prepares to attack or escape from the aversive stimulus. Appetitive stimuli spur positive survival tactics, such as ingestion, reproduction, or nurturance. Processing negative emotion primes an organism for defensive responding, whereas processing positive emotion primes forms of appetitive responding (Lang, 1995). These reflexive actions are strongest when motivational state and emotional information are similar, e.g. defensive states and unpleasant affect produce stronger defensive responses than defensive states and pleasant affect.

The eyeblink startle reflex, or measurement of orbicularis oculi muscle activity, reliably measures defensive motivational responding to negative or aversive stimuli

(Grillon & Baas, 2003). In traditional tests of the startle response, participants view different picture stimuli while they hear an occasional sudden burst of white noise intended to provoke a startle response (Lang, 1995). Eye-blinking is a first defensive reflex to being startled, and intensity of the response can be analyzed through EMG recordings of the orbicularis activity. Both current motivational state and type of picture affect the response. Aversive or threatening picture stimuli potentiate or intensify the response, and pleasant picture stimuli diminish eyeblink (Bradley, Codispoti, Cuthbert, & Lang, 2001; Bradley, Cuthbert, & Lang, 1990; Lang et al., 1990; Lang, 1995; Vrana, Spence, & Lang, 1988). High-intensity negative pictures (e.g. death) evoke highest potentiation (Bradley, Codispoti, Cuthbert, et al., 2001). The eyeblink response is also a specific function of the emotional stimuli, rather than orientation to the probe (Bradley et al., 1990). Eyeblink startle reliably measures defensive responding, as it potentiates to a variety of negative pictures (e.g. fear, disgust). However, eyeblink is not reliable enough to measure appetitive responding systems, as it is not reliably inhibited by positive stimuli (Grillon & Baas, 2003).

Although not as widely studied, the post-auricular reflex (PAR) has been identified as a reliable index of appetitive responding. In what is thought to be a vestigial mammalian response, the post-auricular muscle (a muscle behind the ear) pulls back the pinna of the ear (Gray 1901/1955). The PAR may be more recognizable as an index of appetitive responding in non-human mammals such as rabbits or dogs, whose ears “perk” in response to the sight of another animal or to food. The PAR has been tested in studies of attention and orienting (Sollers & Hackley, 1997) and hearing impairment (O’Bierne

& Patuzzi, 1999), but can also be measured in conjunction with other EMG activity such as eyeblink startle. The PAR consistently and reliably responds to pleasant stimuli, including those related to reproduction, nurturance, or ingestion. It also shows a pattern opposite to defensive eyeblink responding. Unpleasant stimuli that increase eyeblink startle decrease the PAR, and pleasant stimuli that decrease eyeblink startle increase the PAR (Benning et al., 2004).

The PAR has been linked to reward anticipation, motivation, and appetitive responding. Hackley, Muñoz, Hebert, Valle-Inclán, & Vila (2009) found that anticipation for rewarding chocolate potentiated larger PAR responses relative to anticipated punishments of bitter banana peel in a learning task. As ingestion is an appetitive action, eating foods can be rewarding, and chocolate was especially rewarding for the participants, self-described chocoholics who were deprived prior to sessions. Since PAR indexes reward value, it is also influenced by diminished motivation and anticipation systems, such as those seen in individuals with depressive symptoms. Sloan & Sandt (2010) found that individuals who self-reported higher depressive symptoms had lowered PAR responses across all categories. The reduced magnitude reflects lowered motivational responding in these individuals.

The PAR consistently responds more to pleasant images than to unpleasant ones. Benning, Patrick, & Lang (2004) reported that males showed greater potentiation of the PAR response to images of erotica and adventure scenes. Hess, Sabourin, & Kleck (2007) showed that the PAR potentiates to happy faces and is inhibited by angry faces. Gable and Harmon-Jones (2009) found that the PAR reliably potentiated to pleasant pictures of

both high and low-arousal content. Recent research suggests that within pleasant categories, the PAR may be more specifically attuned to appetitive stimuli – items that are both pleasant and biologically relevant.

Sandt, Sloan, and Johnson (2009) found that within specific thematic categories, the PAR responded most specifically to appetitive items (e.g. erotica, families, food) relative to non-appetitive pleasant items (e.g. adventure, nature scenes). As both erotica and adventure scenes were of high arousal, they theorized that PAR is influenced more by motivation than by arousal. Pictures of food, families, and erotica depict the evolutionary motivations for ingestion, nurturance, and reproduction. Johnson, Sandt, and Izbicki (2008) also tested the PAR response specifically within social categories, and found that both males and females potentiated more to appetitive stimuli (erotica, babies) relative to attractive pleasant stimuli (opposite-sex individuals, couples). The exact pattern of responding within pleasant categories has not been fully verified. One PAR study found stronger responses to erotica and babies, but not to food, within pleasant categories (Benning, 2011). Other studies have not reported differences between erotica relative to pleasant categories such as nature or adventure (Benning et al., 2004; Sloan & Sandt, 2010) or between appetitive and attractive categories such as couples or opposite-sex individuals (Quevedo, Benning, Gunnar, & Dahl, 2009). Although the findings on specifically appetitive responding are less conclusive, the PAR consistently shows a pattern of responding to pleasant stimuli.

Because the PAR is specifically attuned to stimuli that are both rewarding and biologically relevant, the PAR may be particularly useful for testing evolutionary

motivations. For instance, sexual strategies theory predicts that males and females should differ in which types of social cues have the most reward value. Prior studies using psychophysiological measures have confirmed some sex differences in responses to the evolutionarily relevant themes of sex versus nurturance. Nurturance-related stimuli, such as babies, produce more positive affect in females than males (Bradley, Codispoti, Sabatinelli, et al., 2001) as measured through psychophysiological responses of smiling as well as self-report. Males tend to respond more positively to erotica than females in self-reports of affect and arousal, and also show higher skin conductance responses to depictions of nude couples (Bradley, Codispoti, Sabatinelli, et al., 2001). As an index of appetitive responding, the PAR has also captured sex differences in responding to evolutionarily relevant themes. Overall, the PAR consistently potentiates to biologically relevant stimuli; both males and females show strong activation to images of food and erotica (Sandt et al., 2009). Within appetitive categories, however, males show a larger potentiation to erotic stimuli, and females show greater potentiation to pictures of babies (Johnson et al., 2008).

New Directions: PAR as an Index of Shifting Sexual Strategies

The PAR may be particularly applicable for examining shifts in female sexual strategies, because it may have associations with reproductive ability. Evidence from Quevedo, Benning, Gunnar, & Dahl (2009) suggests the PAR is linked to the onset of fertility in females. In a study of adolescent females, only those who had reached puberty and begun menstruation showed PAR activation to rewarding stimuli. Although their

study did not specifically test sexual strategies theory, it provides reason to examine PAR in conjunction with fertility shifts across the menstrual cycle.

Sexual strategies theory argues that ovulation causes shifts in females' sexual interest and preferences for mates. When conception risk is low, females emphasize long-term mating strategies and cues that signal a male's potential resource investment. Near ovulation, females show more motivation towards short-term mating strategies and emphasize cues that signal a male's genetic quality. Changes in female responding and preferences are shown in both self-report and psychophysiological activation. As the reward value of sexual stimuli increases with ovulation (e.g. Mass et al., 2009; Rupp et al., 2009a, 2009b) so should the appetitiveness of such stimuli. As an index of appetitive responding, the PAR to mate-relevant stimuli might also increase as females approach ovulation.

Despite its links to appetitive responding, the PAR has yet to be used to examine shifts in female preferences across the menstrual cycle. Part of the reason for this may be that PAR has only been recently identified and there has been relatively little exploratory research into its applications for other facets of psychology. Recently, researchers have branched out from investigating the nature of the PAR response itself to studying how it can be utilized in applied settings such as communications and advertising (Sparks & Lang, 2010). It has also been used for some clinical applications such as exploring the nature of disorders such as autism (Dichter, Benning, Holtzclaw, & Bodfish, 2010). At this point, a full understanding of the mechanisms behind the PAR and the factors influencing its responding are still relatively unknown.

However, because the PAR is a reflexive response, it could be a useful tool for measuring motivations outside of conscious control. As it responds to items linked to human survival and reproduction, study of the PAR could assist in testing evolutionary theories regarding human preferences and motivations. The PAR responds to appetitive items that match evolutionary motivations and goals; families and babies reflect a goal of nurturance, whereas erotica reflects a goal of reproduction. As of yet, no research has attempted to utilize PAR to test the predictions of sexual strategies theory, although it seems a strong candidate for that purpose. A common criticism of studies based on evolutionary theory is their lack of testable hypotheses (Gould & Lewontin, 1979; Schlinger Jr., 1996). Use of the PAR at fertile and non-fertile points in a female's cycle provides an opportunity to use a reflexive measure, rather than solely self-report, to examine a priori predictions about female motivations and preferences from evolutionary theories. Changes in PAR responses in accordance with fertility would indicate that shifts in female sexual strategies are linked to shifts in basic motivational drives. The overarching goal of this research is to examine whether ovulation generates shifts in appetitive responding to reproductively relevant categories. As the PAR is still a relatively unknown measure, a secondary objective of this research is to further explore individual factors that could influence PAR responding.

CHAPTER THREE

STUDY OVERVIEW

Ovulation has been shown to alter females' interest in sex and their preferences when selecting mates. A consequence of the hormonal fluctuations that accompany ovulation may be that mating-relevant stimuli become more appetitive. The PAR has demonstrated that it can be used to index appetitive responding (Benning et al., 2004), and PAR consistently responds to themes that depict ingestion (food), reproduction (sex), and nurturance (babies and families). The PAR may have links to female reproductive hormones, as Quevedo and colleagues (2009) demonstrated that the PAR in females is related to the onset of puberty. The goals of the present research studies were to explore further the links between ovulation, shifts in female sexual strategies, and the PAR.

Hypotheses

The present research was designed to examine the following four hypotheses.

Hypothesis 1: Females will report greater sexual interest and rate sexual themes more favorably at times of high fertility.

Sexual strategies theory predicts that females should shift towards more short-term mating strategies at times of high conception risk. Prior research has established that ovulating females report greater sexual desire and sexual interest (Bullivant et al., 2004; Pillsworth et al., 2004; Stanislaw & Rice, 1998), find sexual themes more rewarding (Gizewski et al., 2006; Krug et al., 1994; Mass et al., 2009; Rupp et al., 2009a, 2009b), and may dress in a more provocative fashion (Durante et al., 2008; Haselton et

al., 2007; Schwarz & Hassebrauck, 2008). The present research seeks to extend upon these findings by examining shifts in females' self-concepts and evaluation of reproductively related social categories.

Shifts in self-concepts were examined with the "Sexy Seven" scale (Schmitt & Buss, 2000). The Sexy Seven asks participants to describe themselves in relation to 67 different adjectives relating to sexual attitudes and preferences. Previous research indicates that self-endorsement of sexual self-concepts on the Sexy Seven is predictive of behaviors such as infidelity (Schmitt & Buss, 2001). It was predicted that females at times of high fertility would give higher ratings to adjectives indicative of greater sexual interest (e.g. horny, lustful, provocative). The present research is the first to examine fertility effects on shifts in females' sexual self-concepts using the Sexy Seven.

Evolutionarily, reproductive interests involve three main themes, 1) mate selection, 2) sexual activity, and 3) nurturance of offspring. In accordance with sexual strategies theory, it was predicted that at times of high fertility, females would shift their relative evaluation of these three themes. Previous research has shown that although females generally rate nurturance-related images (i.e. babies) very favorably, ovulation only increases the reward value of sexual images (Krug et al., 1994). It was predicted that females at times of high fertility would give higher ratings to erotic images, but that ratings of nurturance-related images would remain constant. Previous research has also established that females generally rate high status males more favorably (Buss, 1989; Townsend & Levy, 1990a; 1990b), especially for long-term relationships. An emphasis on long-term mateship strategies is particularly important for females at times of low

fertility. But near ovulation, females may switch to more short-term mating strategies, placing more value on a male's physical characteristics and less value on a male's resource potential (Gangestad et al., 2005). It was predicted that females would only evaluate high status males more favorably at times of low conception risk. The present research is the first to examine fertility effects simultaneously for the three reproductive themes of sex, nurturance, and status as a component of partner selection.

Hypothesis 2: Females will show greater PAR responding to sexual themes at times of high fertility.

In normally cycling females, sexual stimuli are judged to be more interesting and rewarding near ovulation (Mass et al., 2009; Pillsworth et al., 2004; Rupp et al., 2009a; 2009b). Although the PAR is commonly potentiated by sexual images (Benning et al., 2004), to date, no study has examined the PAR specifically in conjunction with ovulation. Extrapolating from these previous findings, it was predicted that erotic images would elicit larger PAR magnitudes for females at points of high conception risk.

Hypothesis 3: Females would show greater PAR responding to nurturance themes at times of low fertility.

Among social categories, the PAR has been shown to be responsive to themes related to reproduction (Johnson et al., 2008; Sandt et al., 2009), including images of sexual activity (i.e. erotica) and images that depict nurturance (i.e. babies and families). However, the appetitive value of sexual themes versus nurturance themes may differ across sexes. Females show greater PAR potentiation to images of babies relative to males, while males show greater PAR responses to erotic images relative to females

(Johnson et al., 2008). This pattern may reflect sex differences predicted by parental investment theory with females placing higher value on investing in and caring for potential offspring. But, as previously discussed, ovulation increases the reward value of sexual themes but not nurturance themes. Therefore, it was predicted that females would show heightened PAR responses to images of babies at times of low conception risk.

Hypothesis 4: Females will show greater PAR responses to high status males only at times of low fertility.

Due to greater minimum investment in females (Trivers, 1972), females benefit from focusing on long-term mating strategies (Buss & Schmitt, 1993). When females are evaluating potential long-term mates, cues of investment and status in male partners are valued consistently (Buss, 1989; Gangestad et al., 2007; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999). Although a male's social status is often appealing to females, it is unclear whether social status can be categorized as an appetitive stimulus. Although the PAR is generally more responsive to pleasant categories than unpleasant categories, it is most responsive to categories that are both pleasant and biologically relevant (i.e. food and reproduction). Up to this point, no studies have examined whether a potential mate's social status should be considered a biologically appetitive stimulus. However, to the extent that males with high social status are considered to be a more pleasant stimulus (Townsend & Levy, 1990a; 1990b), greater PAR magnitudes to high status males over low status males is expected only for females at low conception risk.

Exploratory Analyses of Individual Differences

Although not directly related to the primary goals of the present research, several exploratory lines of inquiry were pursued in order to gain a fuller understanding of how individual differences between participants may mediate or moderate the effects of fertility or the activation of the PAR. For instance, participants with higher levels of depressive symptoms exhibit reduced PAR magnitudes relative to individuals with fewer depressive symptoms (Sloan & Sandt, 2010). Although yet to be explored, it is possible that depressive symptoms might also blunt ovulatory shifts in sexual strategies as well. To this end, several personality and clinical assessments were also included in the study. In addition to examining the primary hypotheses, the present research explored how individual differences in depression, anxiety, behavioral inhibition, and behavioral activation might modify fertility effects and the PAR.

Goals of Present Research

To summarize, the main goal of the research was to explore female PAR responses to pleasant social categories as a function of fertility risk across the menstrual cycle, with specific interest in categories of sex, nurturance, and status. Based upon previous findings on the PAR potentiation and the predictions of sexual strategies theory, it was hypothesized that females would show increased PAR potentiation to erotica at high fertility and increased PAR potentiation to babies and families at low fertility. It was also predicted that PAR responses would be potentiated more for males displaying cues of high status, but that this pattern would only be present at times of low fertility. Related study goals included further expansion of prior research that females report greater sexual

interest and more short-term sexual strategies at times of high fertility. It was predicted that females would self-endorse decreased interest in relationships and increased sexual descriptions relating to desire and attractiveness at times of high fertility.

Methodological Note

The present research was designed as a two-part study aimed at capturing how within-subjects shifts in fertility status alter sexual strategies and PAR responding in normally cycling women. Due to the two-part format of the study, a high attrition rate was expected due to participants not returning for the second session; however, the rates of attrition were much higher than anticipated. Nearly one-third of all participants did not complete the second session. In addition, although originally aimed at studying normally cycling women, a small group of participants reported using some form of hormonal birth control. In order to utilize the collected data most effectively, subsamples were created from the overall sample and analyzed separately. Study 1 reports the results from the subsample of normally cycling female participants that completed both sessions of the study. Study 2 reports the results from the subsample of females who reported using a form of hormonal birth control and completed both sessions of the study. Based upon prior research (Alvergne & Lummaa, 2009; Regan, 1996), females using hormonal birth control were not expected to show any shifts in sexual interest, sexual strategies, or PAR responding across time points.

CHAPTER FOUR

STUDY 1

Methods

Study Design

Study 1 employed a within-subjects repeated-measures design to investigate potential differences in psychophysiological and self-report responses of females at an estimated time-point of high fertility versus a point of low fertility.

Participants

Participants were 79 female undergraduate students at Temple University who were enrolled in a psychology course. Participants were recruited through the online psychology recruitment website and received either research course credit or extra credit in exchange for their participation. A high attrition rate was anticipated due to the two-part format of the study. Of the 79 students who participated, a total of 25 did not return to complete a second session, so that I had data from only one point in the cycle. Six participants reported missing cycles, cycles of irregular length, or did not report cycle information so that estimation of menstrual cycle phase, a pivotal component of the study, could not be performed. Four participants' data were lost due to computer error or malfunction. Study 1 used a subsample from 37 normally cycling women ($M_{age} = 20.22$, $SD = 2.71$) who provided two data points across their cycle. The sample was predominantly white (41.7%) and African-American (30.6%) (Table 1).

Table 1. Demographic Characteristics of Participants

Characteristic	Study 1 ⁱ		Study 2 ⁱⁱ		Withdrawn ⁱⁱⁱ	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age	20.22	2.71	19.57	0.79	21.32	4.03
Education (years)	13.65	2.43	13.86	0.69	13.95	3.42
BDI Score	10.75	7.66	7.64	5.81	12.12	8.35
BAS-Reward	18.19	1.64	17.86	1.35	18.4	1.66
BAS-Fun Seeking	11.87	2.08	13.57	1.24	12.8	2.36
BAS-Drive	10.84	2.3	12.29	2.69	12.72	2.21
BIS	21.82	2.59	19.0	2.82	21.84	3.58
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
	37	100	7	100	25	100
In a relationship	15	40.5	2	28.6	16	40
Race/ethnicity						
White	15	40.5	5	71.4	7	29.2
African-American	11	29.7	2	28.6	7	29.2
Asian	6	16.2	0	0.0	7	29.2
Other	4	10.8	0	0.0	2	8.3

Power analysis. As previous research has not investigated whether the PAR is moderated by fertility effects, it was necessary to look at existing findings in the literature for estimated effect sizes. Research indicates a small to medium effect size in differences to responses across PAR categories ($r = .34-.37$; Sandt et al., 2009) ($\eta_p^2 = .05$; Johnson et al., 2008). Research also indicates small to medium effect sizes for fertility differences ($d = .24$; Durante et al., 2008). Based upon power = .8, a G-Power analysis (Faul, Erdfelder, Lang, & Buchner, 2007) indicated that approximately 35 subjects would be needed to detect effects of that size.

Materials

Demographics and Related Information

Demographic questionnaire. Participants completed this basic information form only once at the first session. Participants were asked about dominant hand use, which affects where heart rate and skin conductance sensors are placed to collect physiological responses. Participants also were asked about potential visual or auditory issues that might prevent accurate responding. Participants also reported age, sex, ethnicity, religion, and education.

Menstrual questionnaire. Participants completed a menstrual cycle information questionnaire asking about estimated last date of menstruation, average cycle length, and next estimated date of menstruation and use of birth control. Similar questionnaires have been used in previous research to determine menstrual cycle phase (Gangestad et al., 2004; Johnston et al., 2003; Puts, 2006; Thornhill & Gangestad, 1999). Participants were provided with a daily calendar (Timeline Followback Calendar; Sobell & Sobell, 1992) in

the questionnaire and also allowed to consult personal calendars to aid with remembering cycle information.

Rating Social Pictures Task

Visual stimuli. Procedures for facial EMG and psychophysiology measures followed previous research that utilizes the PAR as a measure of appetitive responding. Participants viewed a series of pictures presented on a computer screen. A visual fixation cross was presented for 6 seconds, followed by a picture presented for 6 seconds. Picture presentation was followed by self-report ratings.

A total of seven picture categories were included in the study. The PAR has previously been shown to respond reliably to themes related to sex (Benning et al., 2004; Johnson et al., 2008; Sandt et al., 2009). Two picture categories were used to examine PAR responses to sexual imagery. The *erotic males* category depicted nude or nearly-nude males and the *erotic couples* category depicted nude or nearly-nude heterosexual couples engaging in sexual acts. The PAR reliably responds to themes related to nurturance (Johnson et al., 2008; Sandt et al., 2009). Two picture categories were used to examine PAR responses to nurturance themes. The *babies* category depicted either one or two babies without an adult depicted. The *families* category depicted a heterosexual couple with very young children. One goal of the present research is to examine whether females find male social status as an appetitive stimulus. Two picture categories were used to examine PAR responses to status cues. The category *high-status males* depicted fashionably dressed men and/or in professional contexts. The category *low-status males* depicted men dressed in average clothes and/or in a working-class context. The final

picture category was related to more general mate-selection themes. The category *couples* depicted clothed heterosexual couples interacting in a romantic but non-erotic manner.

A total of thirty-five pictures, five pictures in each category, were included in the experimental portion of the picture presentation. Eleven pictures were used from the International Affective Picture Stimuli Set (Lang, Bradley, & Cuthbert, 2005). An additional twenty-four pictures were collected through the internet in order to represent the categories. All pictures with erotic content depicted models over the age of 18, and all internet pictures had accompanying copyright permission for use. All stimulus images had been approved by the Temple University Review Board for inclusion in the study.

Auditory stimuli. Consistent with previous emotional picture rating and psychophysiology studies (Benning et al., 2004; Lang, 1995), a startle probe burst of white noise (50 ms, 95 dB) was presented binaurally through headphones on critical picture trials. Startle probes were randomly assigned to 3 of the 5 pictures within each theme category to prevent habituation to the probe. Probes also varied in start time, occurring at 3, 4, or 5 seconds into the picture presentation.

Self-report measures during picture presentation. Participants self-reported valence and arousal elicited by each picture using a modified version of the Self-Assessment Manikin (SAM; Lang, 1980). The SAM pictorially represents valence corresponding to a 1-5 scale, with 1 indicating low levels of pleasantness (sad, upset; a frowning figure) and 5 indicating high levels of pleasantness (happy, joyful; a smiling figure). A similar scale for arousal was also completed, with 1 indicating low levels of arousal (calm, dull; a figure at rest) and 5 indicating high levels of arousal (excited,

jittery; a figure with numerous sparks and bolts). Category averages of valence and arousal were computed by taking the average response for all pictures in a category (probed and non-probed).

Psychophysiological measures. Physiological responses were recorded using a Dell PC computer running Acknowledge data acquisition software (Biopac systems, Goleta, CA). A second Dell PC computer controlled picture and acoustic startle probe presentations using E-Prime 2.0 software (Psychology Software Tools, Sharpsburg, PA). Psychophysiological data were recorded continuously throughout the procedure, beginning with a trial block of pictures, random startle probes, and self-report ratings. We included heart rate and skin conductance as indicators of general arousal. Facial EMG activity from the corrugator, zygomatic, orbicularis oculi and post-auricular muscles was also collected. The corrugator and zygomatic activity reflected general negative and positive affect respectively, and orbicularis activity measured eyeblink startle reflexes.

The primary psychophysiological measure of interest was the PAR. The PAR was recorded by pulling the left pinna (outer ear) forward and placing two 4-mm Ag/AgCl electrodes immediately above and below the tendon for insertion. Raw PAR signals were sampled at a rate of 1000 Hz, amplified and band-pass filtered (8-1000 Hz) using a model M150 bioamplifier and EMG 100c modules, and band-stop filtered for 60 Hz noise (Biopac systems, Goleta, CA). Responses were not smoothed, and reflex magnitudes were scored after individual waveforms were rectified.

Access of the PAR presents methodological concerns. Due to its being controlled by a vestigial muscle, it is not present in all individuals (Guerra et al., 2004). The muscle

is also weak compared to other muscles commonly used in EMG such as the orbicularis oculi activity measured in eyeblink startle reflex, and measurable signals may be lower as a result. In addition, not all participants will show measurable PAR responses to a startle probe (Hess, 2009). The PAR is defined by activation of the post-auricular muscle within a given time window following an auditory probe (see Figure 1).

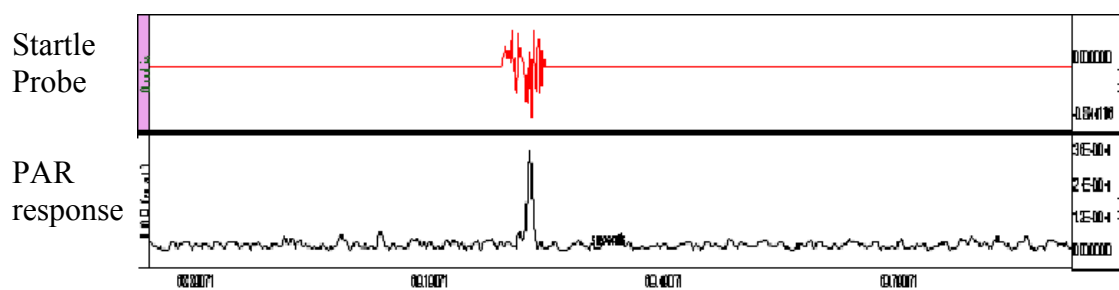


Figure 1. Sample PAR Response After Startle Probe.

Only pictures that had an accompanying startle probe were analyzed. PAR activity 50 milliseconds prior to probe onset was measured as a baseline average. However, disagreement exists in the research literature about the optimal time window for scoring PAR responses. The time window for the PAR was originally defined as 8 - 30 milliseconds following the probe (Benning et al, 2004). Other researchers have viewed the original recommendations as too restrictive and have since used an expanded time window (e.g. Hess et al, 2007; Sloan & Sandt, 2010). In order to gain a more inclusive representation of PAR responding, I used the expanded window of 2.5 - 75 milliseconds after the probe as my scoring window. For each picture accompanied by an auditory

probe, the peak activity of the post-auricular muscle during the scoring window was assessed. The PAR magnitude for each picture was measured by subtracting the baseline activity prior to the probe from the peak response. Responses with no observable magnitude were scored as a value of 0. Category magnitudes were computed by taking the average response across probed pictures in each category.

Measures of Sexual Interest

Kinsey Scale (Heterosexual-Homosexual Scale). At each session, participants completed the Kinsey Scale (Kinsey, Pomeroy, & Martin, 1948) by self-selecting one of seven options that best described their sexual interaction, activities, and desires, ranging from “exclusively heterosexual” to “exclusively homosexual”.

Sexy Seven^{iv}. The “Sexy Seven” (Schmitt & Buss, 2000) scale captures self-ratings of sexual dimensions in personality. Participants were asked to rate themselves on a 1-9 Likert-type scale ranging from “inaccurate – extremely” to “accurate – extremely” on 67 descriptive items. The dimensions include sexual attractiveness, relationship exclusivity ($r = .97$), gender orientation, sexual restraint, erotophilic disposition, emotional investment ($r = .86$), and sexual orientation.

Assessments of Trait Affectivity

Beck Depression Inventory II (BDI-II). Participants completed the Beck Depression Inventory II (Beck, Steer, & Brown, 1996). Participants responded to 21 groups of statements by selecting the most accurate self-description of four options. The statements reflect severity and intensity of feelings and behavior over the past two weeks.

Higher scores reflect greater symptoms of depression in both normal and clinical populations ($r = .96$; Sprinkle et al., 2002).

State-Trait Anxiety Inventory (STA-Y/TAI-Y). The State-Trait Anxiety Inventory (Spielberger & Sydeman, 1994) distinguishes between specific emotion in temporary or state anxiety (STA-Y; $r = 0.4$) and general emotion in long-lasting or trait anxiety (TAI-Y; $r = .86$ (Rule & Traver, 1983)). Participants completed two scales, each consisting of 20 questions, on a Likert-type scale of four options. Higher scores indicate greater anxiety in current intensity (STA-Y) or in frequency (TAI-Y).

Behavioral Inhibition System/Behavioral Activation System Scales (BIS/BAS). The BIS/BAS scales (Carver & White, 1994) measure levels of two general motivational systems. The BIS ($r = .66$) measures tendencies of behavioral avoidance, or movement away from unpleasantness, whereas the BAS ($r = .59-.69$ depending on subscale) measures tendencies of approach motivation and movement toward something desired or appetitive. Participants rated how well 24 statements described their behavior on a 1-4 Likert scale ranging from “very true for me” to “very false for me”. Items on the BIS/BAS were scored and summed to receive a score for each subscale.

Procedure

Participants were recruited to participate in a two-part study about rating social pictures. No specific mention of types of pictures (e.g. erotica) was used in the study description for recruitment.

Session One

Participants were greeted by a female experimenter and seated in a cubicle containing a desk and a computer. Participants were instructed that the experiment was about emotional responses to different types of social images. Participants were informed that during the experiments they would be shown a series of images and asked to rate their mood in response to each image. Participants were also informed that some pictures they viewed would be interrupted by a sudden noise and sensors placed on their hands and face would be used to record their emotional responses. After providing informed consent, participants then completed brief demographics questionnaires including questions about their menstrual cycle. The menstrual cycle questionnaire was later used by the experimenter for scheduling the second session at an alternate point of fertility. After completing the demographics questionnaire, the participants were prepped for physiological recording by cleaning electrode placement sites with rubbing alcohol and a mild abrasive gel to reduce impedances. Sensors were filled with conductive gel and adhered to placement sites using small adhesive strips. Participants were then instructed on the Rating Social Pictures Task and allowed to complete a few practice trials. After ensuring that participants understood the Rating Social Pictures task, the experimenter left the room so that the participants could complete the study. Continuous recordings of the post-auricular muscle were collected throughout the Rating Social Pictures task using equipment in an adjacent room. Upon completing the Rating Social Pictures Task, participants answered clinical and personality assessments including questions about their sensitivity to reward and punishment, symptoms of depression, state-anxiety, trait-

anxiety, sexual orientation, and sexual self-concept. After completion of all tasks, participants were thanked for their time and asked if they wished to continue the study. Participants who declined to participate further were debriefed fully at this time. Participants who indicated a willingness to participate in a second session were scheduled according to the procedures below.

Determination of Conception Risk and Scheduling of Second Session

While participants were completing the computer-based tasks, researchers used the Reverse Counting Method (as in Adams, Gold, & Burt, 1978; Regan, 1996), or Calendar Method (Fehring, 2005) to estimate fertility phase. There is no standard accepted measure for calculating fertility risk (Regan, 1996), but reverse counting has been used in previous research (Gangestad et al., 2004; Johnston et al., 2003; Matteo & Rissman, 1984; Thornhill & Gangestad, 1999; Thornhill et al., 2003). Since ovulation is assumed to occur approximately 14 days prior to menstruation regardless of cycle length (Baker & Bellis, 1995), reverse counting allows for an estimation of ovulation in shorter and longer cycles that do not exactly match a 28-day cycle. The fertile portion of the cycle is considered to be approximately Reverse Cycle Days (RCD) 13-18 (Adams et al., 1978); all other cycle days (RCD 0-12 and 19-28) are considered to be non-fertile. On a 28-day cycle, this would correspond to the early and part of the mid-follicular phases, and most of the luteal phase as non-fertile period, with the fertile period of RCD 13-18 through the mid- to late follicular phase and including presumed ovulation and increase in luteinizing hormone (Regan, 1996). Participant data from the menstrual information questionnaire were used to estimate RCD of each participant and her cycle status (fertile

or non-fertile). Participant cycle status was noted in each subject folder. The menstrual questionnaire and current RCD was used to schedule the participant for the opposite status in her next session, such that participants who were non-fertile during their initial session were asked to return on a day that corresponded with an RCD 13-18 ($M = 15.76$, $SD = 1.94$). Each participant was coded and provided with a unique subject number so that her data could be matched at a follow-up session. Participants were scheduled at least 5 days apart ($M = 14.38$, $SD = 6.92$). Average cycle length of participants was 27.24 days ($SD = 5.63$).

Session Two

At the beginning of the second session, participants were again greeted by a female experimenter. Each participant then confirmed her identity by verifying her subject number and initials, so that her second session data could be subject-matched. The procedure for the second session was virtually identical to that of the first session. Participants were prepped for physiological recordings and once again completed the Rating Social Pictures task. After the Rating Social Pictures Task, participants completed the same personality and clinical assessments used in the first session. After completion of all tasks, participants were thanked for their time and debriefed fully at this time.

Results

Fertility Effects on Category Ratings

Thirty-five participants returned complete data for picture ratings at both time points.

Valence. A mixed factors 2 (Cycle phase: non-fertile, fertile) x 7 (Picture category: erotic males, erotic couples, babies, couples, families, high-status males, low-status males) ANOVA conducted on the valence ratings with normally cycling females revealed only a significant main effect of picture category, $F(6,204) = 65.75, p = 0.0, \eta_p^2 = .66$ (Table 2). There was no significant interaction of fertility status and category ratings, $F(6,204) = .7, p = .65, ns, \eta_p^2 = .02$, nor was there a main effect of fertility status, $F(1,34) = .07, p = 0.8, ns, \eta_p^2 = .002$. Pairwise comparisons of the category ratings revealed that babies ($M = 4.21, SD = .52$) were rated as significantly more pleasant than all categories (at $p = 0.0$) except for couples ($M = 4.13, SD = .53$) from which they did not differ ($p = 0.3, ns$). Couples were also rated as significantly more pleasant ($p = 0.0$) than all categories except babies, and families ($M = 3.78, SD = .53$) were rated as significantly less pleasant than babies and couples, $p = 0.0$, but more pleasant than all other categories, $p = 0.0$. Females trended to rate erotic couples ($M = 3.26, SD = .63$) as more pleasant than erotic males ($M = 3.07, SD = .52$), $p = .056$. Low-status males were also rated significantly less pleasant relative to all other categories, $M = 2.54, SD = .46, p = 0.0$ (Figure 2).

Arousal. A mixed factors 2 (Cycle phase: non-fertile, fertile) x 7 (Picture category: erotic males, erotic couples, babies, couples, families, high-status males, low-status males) ANOVA conducted on the arousal ratings with normally cycling females revealed only a significant main effect of picture category, $F(6,204) = 24.42, p = 0.0, \eta_p^2 = .42$ (Table 2). There was no significant interaction of fertility status and category ratings, $F(6,204) = .73, p = .62, ns, \eta_p^2 = .021$, nor was there a main effect of fertility

Table 2. Low- and High-Fertility Responses to Social Picture Categories

Category	PAR (μV)			Arousal	Valence
	<i>M (SD)</i>	<i>Skew</i>	<i>Kurt</i>	<i>M (SD)</i>	<i>M (SD)</i>
Low fertility ^v					
Erotic Males	70.04 (72.02)	1.68	1.5	2.56 (.73)	3.09 (.47)
Erotic Couples	58.88 (47.23)	1.17	.74	3.10 (.94)	3.27 (.68)
Babies	68.45 (36.57)*	-.1	-1.48	2.72 (1.05)	4.17 (.57)
Families	84.05 (72.62) ⁺	2.5	7.4	2.59 (.75)	3.77 (.57)
Couples	76.67 (50.20)*	.56	-.63	2.63 (.94)	4.11 (.62)
High-Status Males	55.87 (31.85)*	.88	.20	2.21 (.70)	3.09 (.40)
Low-Status Males	61.70 (36.02)*	.18	-1.23	1.71 (.67)	2.57 (.46)
High fertility ^{vi}					
Erotic Males	37.67 (35.27)	1.42	.97	2.63 (.76)	3.04 (.64)
Erotic Couples	33.05 (24.11)	1.18	1.21	3.11 (.87)	3.25 (.67)
Babies	30.01 (23.70)*	1.64	2.92	2.78 (1.04)	4.26 (.56)
Families	41.52 (28.83) ⁺	.47	-1.45	2.61 (.85)	3.79 (.63)
Couples	25.67 (31.85)*	.84	-.20	2.74 (1.07)	4.15 (.55)
High-Status Males	24.27 (16.81)*	1.62	2.84	2.10 (.61)	3.01 (.33)
Low-Status Males	26.05 (19.49)*	1.25	.62	1.64 (.61)	2.50 (.56)

* Significantly different at $p < .05$.

⁺ Different at $p = .088$.

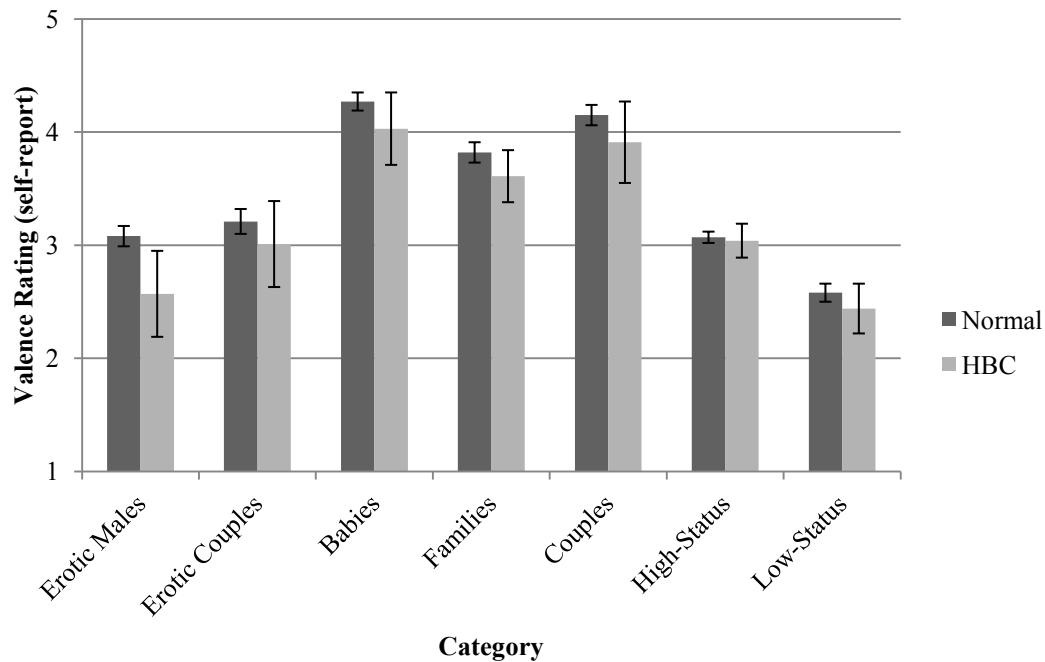


Figure 2. Self-Report of Valence across Social Picture Categories.

status, $F(1,34) = .022, p = .88, ns, \eta_p^2 = .001$. Pairwise comparisons of the category ratings revealed that females rated erotic couples ($M = 3.11, SD = .85$) as more arousing than other categories, including erotic males ($M = 2.6, SD = .69, p = 0.0$), couples ($M = 2.69, SD = .9, p = .029$), and families ($M = 2.6, SD = .75, p = .002$). Erotic couples also trended to be more arousing than babies ($M = 2.75, SD = .94; p = .077, marginal$). High-status and low-status males ($M = 2.15, SD = .62$ and $M = 1.67, SD = .59$ respectively) were rated as significantly less arousing than all other categories, $p = 0.0$ (Figure 3).

Fertility Effects on Sexual Interest

Shifts in female sexual interest were assessed by their endorsement of adjectives listed on the Sexy Seven scale. Seventeen normally cycling participants completed the

Sexy Seven (Schmitt & Buss, 2000) at both time points. Of the 67 listed adjectives, paired samples t-tests revealed that females reported feeling more *horny* during fertile days ($M = 5.19, SD = 1.56$) than they did on non-fertile days ($M = 4.31, SD = 1.89$), $t(15) = -2.49, p = .025, d = .64$ (Figure 4). Females also reported feeling significantly less *effeminate* when fertile ($M = 4.31, SD = 1.3$) than when non-fertile ($M = 5.06, SD = 1.34$), $t(15) = 2.82, p = .013, d = .71$.

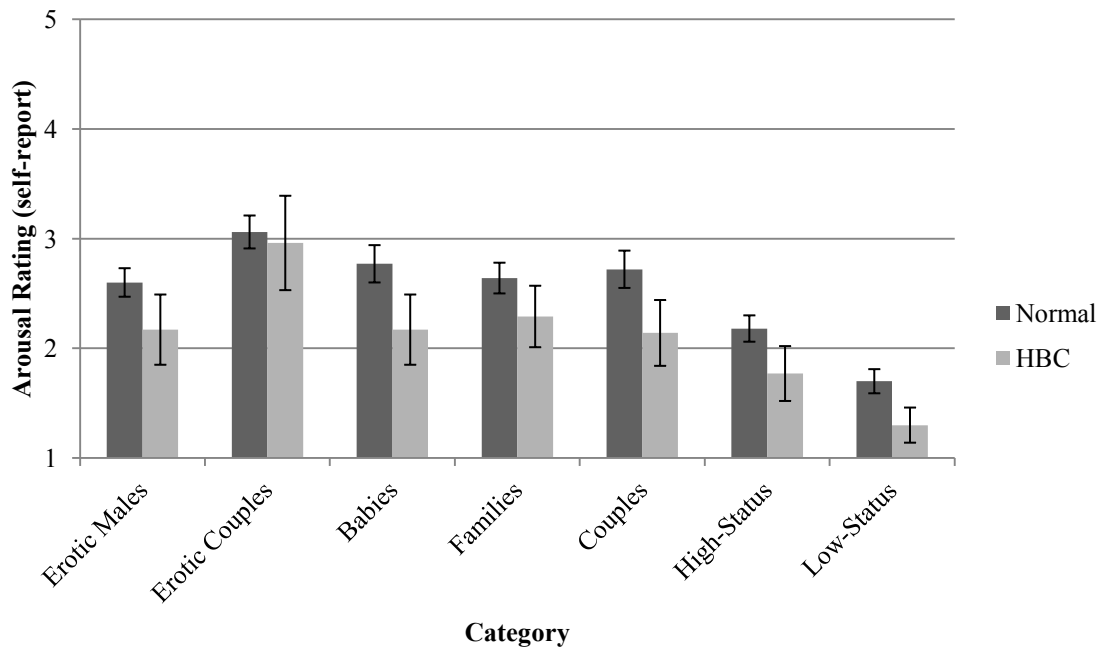


Figure 3. Self-Report of Arousal across Social Picture Categories.

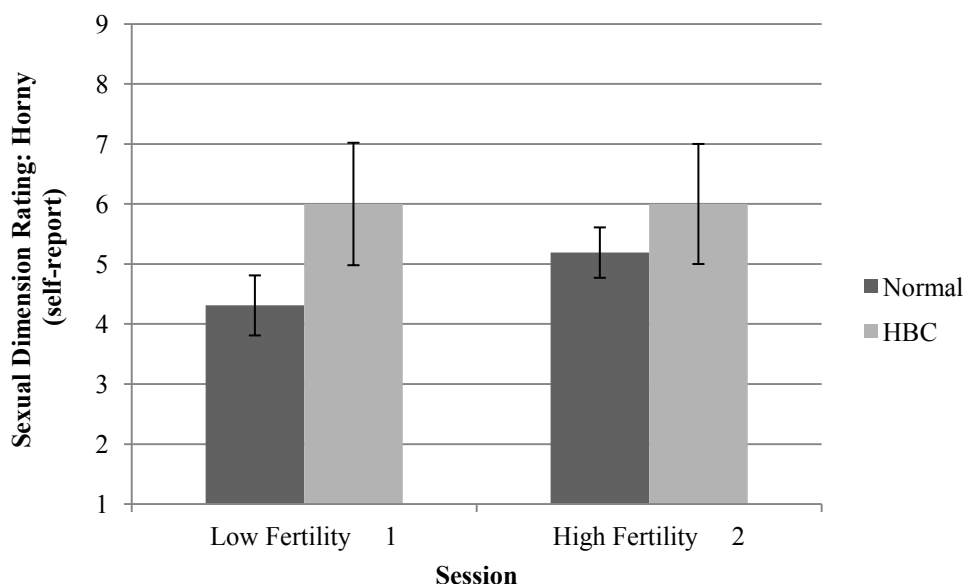


Figure 4. Self-Endorsement Differences between Normally Cycling Females and Females on Hormonal Birth Control in the Sexual Dimension of Horny.

For normally cycling females, $p = .025$, $d = .64$ (large effect).

Fertility Effects on PAR Responding

Due to the nature of physiological recordings, some amount of missing data was anticipated. It is common to lose data due to technical errors such as a sensor becoming detached, an equipment malfunction, or an unreliable signal. Of the 37 normally cycling females who completed both parts of the study, physiological data from seven females were lost due to technical errors. Measures of the PAR present an additional challenge because it is not present in all individuals (Guerra et al., 2004) and the signal is weak compared to other EMG measures (Hess, 2009). Of the remaining 30 females, only eleven participants reliably showed the PAR for all picture categories at both time points.

In order to examine within-subject changes in PAR, all analyses of the PAR were limited to these eleven participants.

I first performed a mixed factors 2 (Cycle phase: non-fertile, fertile) x 7 (Picture category: erotic males, erotic couples, babies, couples, families, high-status males, low-status males) ANOVA on the magnitude of PAR responses with normally cycling females. The ANOVA revealed no main effect of category ($F(6,60) = 1.64, p = .15, ns$) and no significant interaction ($F(6,60) = .50, p = .81, ns$), but found a main effect of fertility ($F(1,10) = 6.65, p = .038, \eta_p^2 = .399$) (Table 2). Although the ANOVA did not reveal overall category differences at traditional significance, pairwise comparisons revealed that families did potentiate higher PAR responses compared to erotic couples, $p = .042$. Low-status and high-status males also trended to elicit lower responding relative to families, $p = .051$ and $p = .061$ respectively.

In order to examine further the significant decrease in PAR due to fertility status, a repeated-measures (Cycle phase: non-fertile, fertile) ANOVA was then conducted separately for each category. In comparison to a point of low fertility, females at a point of high fertility showed significantly lower PAR responses to all categories except for the erotic categories.

Ovulation decreased PAR responses to pictures of babies ($F(1,10) = 7.29, p = .022, \eta_p^2 = .42$), couples ($F(1,10) = 10.96, p = .008, \eta_p^2 = .52$), high-status males ($F(1,10) = 9.65, p = .011, \eta_p^2 = .49$), and low-status males ($F(1,10) = 6.221, p = .032, \eta_p^2 = .38$). A trend was also seen for ovulation to reduce PAR responses to pictures of families ($F(1,10) = 3.57, p = .088, \eta_p^2 = .26$). However, ovulation did not significantly decrease

PAR responses to pictures of erotic males ($F(1,10) = 1.46, p = .25, ns$) or to pictures of erotic couples ($F(1,10) = 2.48, p = .15, ns$) (Figure 5).

Fertility Effects on Trait Affectivity

In order to examine whether fertility status can generate shifts in affective responding, paired samples t-tests were employed to compare participants' reports of depression, trait anxiety, state anxiety, behavioral inhibition (BIS), and behavioral activation (BAS) at a point of low fertility to a point of high fertility.

Depression. Thirty-four females returned complete information for the BDI-II. A paired samples t-tests concluded that normally cycling females did not differ as a function of fertility risk for scores of depressive symptoms ($t(33) = 1.52, p = .14, ns$).

Trait Anxiety. Thirty-three females returned complete information for the TAI-Y. A paired samples t-tests concluded that normally cycling females did not differ as a function of fertility risk for trait anxiety level ($t(32) = .77, p = .45, ns$).

State Anxiety. Thirty-four females returned complete information for the STA-Y. A paired samples t-tests concluded that normally cycling females did not differ as a function of fertility risk for state anxiety level ($t(33) = 1.03, p = .31, ns$).

BIS/BAS. Thirty-four females returned complete information for the BIS/BAS. A paired samples t-test concluded that normally cycling fertile females reported lower levels of BAS Fun Seeking ($M = 11.3, SD = 2.54$) than non-fertile females ($M = 12.41, SD = 2.03$), $t(33) = 3.19, p = .003, d = .575$. A trend also emerged for normally cycling females to report lower scores on the BAS Drive scale ($t(33) = 1.79, p = .083, marginal$). Scores did not differ as a function of fertility status on the Behavioral Inhibition Scale

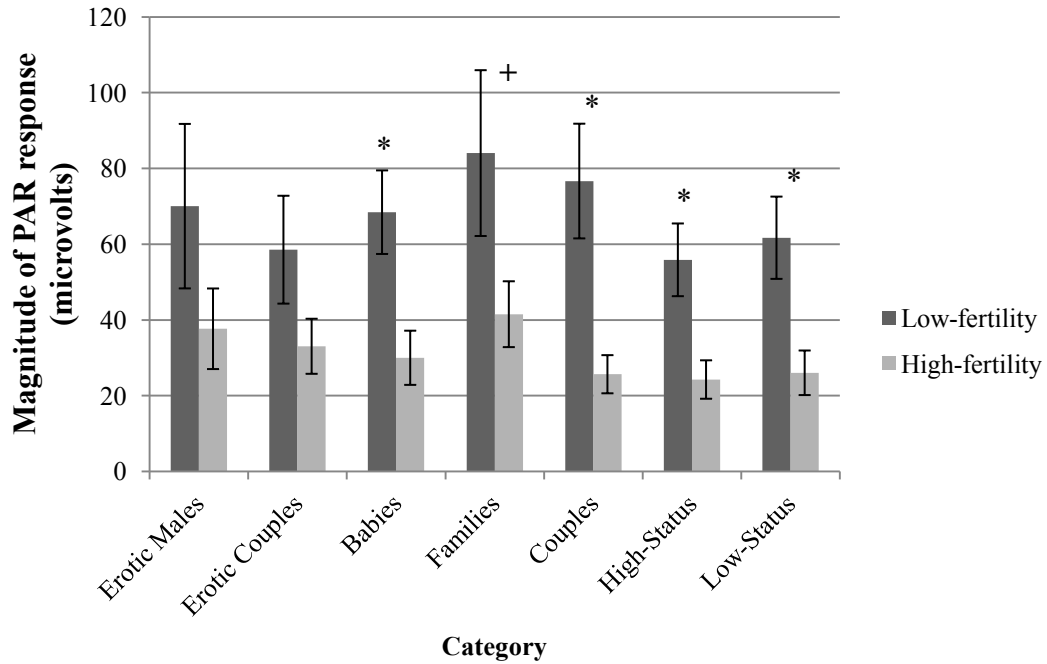


Figure 5. Average PAR Responses to Erotic and Social Categories in Normally Cycling Females as a Function of Fertility.

* $p < .05$.

+ $p = .088$.

($t(33) = -.94, p = .36, ns$) or the BAS Reward scale ($t(33) = .082, p = .94, ns$). BAS overall decreased with ovulation; a paired samples t-test concluded that normally cycling fertile females reported lower levels of BAS ($M = 41.76, SD = 3.95$) than non-fertile females ($M = 40.03, SD = 5.41$), $t(33) = 3.19, p = .05, d = .36$.

Correlations of BAS scales and PAR

In comparison to points of low fertility, points of high fertility reduced the overall magnitude of PAR responses and also decreased reports of Fun Seeking and Drive on the BIS/BAS scale. In order to examine potential relationships between self-reports of

behavioral activation and PAR responding, correlations were calculated between changes on each of the BIS/BAS subscales and changes in overall PAR magnitude. Change in overall PAR magnitude trended to correlated with change in BAS Drive, $r = 0.6$, $p = .068$, *marginal*.

Interactions between Fertility and Trait Affectivity

I investigated depression as a between-subjects factor, as depression has been linked to diminished PAR responding (Sloan & Sandt, 2010). The Beck Depression Inventory was scored according to the suggested cut-offs (0-13 indicating minimal depressive symptoms, 14-19 mild, 20-28 moderate, and 29-63 severe depression; Beck et al., 1996). As previously mentioned, depression level between sessions did not differ, and scores between sessions were averaged to compute a general factor of depressive symptoms.

Category Ratings: Twenty-one participants scored as having minimal depression symptoms; thirteen participants scored for mild to severe symptoms. A 2 (Cycle phase: non-fertile, fertile) x 2 (Depression: minimal, mild to severe) x 7 (Picture category: erotic males, erotic couples, babies, couples, families, high-status males, low-status males) ANOVA conducted on the valence ratings with normally cycling females indicated no significant three-way interaction ($F(6,192) = .71$, $p = .64$, *ns*, $\eta_p^2 = .022$) or significant interaction between fertility status and depression ($F(1,32) = .003$, $p = .96$, *ns*, $\eta_p^2 < .01$). However, the interaction of depression and picture category was significant, ($F(6,192) = 2.57$, $p = .02$, $\eta_p^2 = .074$). Females with minimal depression trended to rate babies as more pleasant than females with mild to severe depression ($M = 4.34$, $SD = .56$, as

opposed to $M = 4.01$, $SD = .43$; $t(32) = 1.85$, $p = .07$, *marginal*). Females with minimal depression also trended to rate erotic couples as less pleasant than females with mild to severe depression ($M = 3.14$, $SD = .55$, as opposed to $M = 3.53$, $SD = .64$; $t(32) = -1.878$, $p = .069$, *marginal*).

A 2 (Cycle phase: non-fertile, fertile) x 2 (Depression: minimal, mild to severe) x 7 (Picture category: erotic males, erotic couples, babies, couples, families, high-status males, low-status males) ANOVA conducted on the arousal ratings with normally cycling females indicated no significant three-way interaction ($F(6,192) = .64$, $p = 0.7$, *ns*, $\eta_p^2 = .012$) or significant interaction between fertility status and depression ($F(1,32) = .001$, $p = .98$, *ns*, $\eta_p^2 < .01$). However, the interaction of depression and picture category was significant, ($F(6,192) = 2.37$, $p = .031$, $\eta_p^2 = .07$). Females with mild to severe depression trended to rate erotic couples ($M = 3.48$, $SD = .91$) as more arousing than females with minimal depression ($M = 2.93$, $SD = .74$), $t(32) = -1.9$, $p = .067$.

PAR: Five participants scored as having minimal depression symptoms; five participants scored for mild to severe symptoms. A mixed factors 2 (Cycle phase: non-fertile, fertile) x 2 (Depression: minimal, mild to severe) x 7 (Picture category: erotic males, erotic couples, babies, couples, families, high-status males, low-status males) ANOVA conducted on the magnitude of PAR responses with normally cycling females concluded that there was no main effect of depression on PAR responding ($F(1,8) = 1.62$, $p = .24$, *ns*). Depression also did not interact with category ($F(6,48) = .72$, $p = .64$, *ns*), fertility ($F(1,8) = 2.81$, $p = .13$, *ns*), or with category and fertility ($F(6,48) = .72$, $p = .64$, *ns*). A 2 (Cycle phase: non-fertile, fertile) x 2 (Depression: minimal, mild to severe)

repeated-measures ANOVA for individual categories revealed that there was a main effect for depression to blunt PAR responses to pictures of babies, $F(1,8) = 7.0, p = .029, \eta_p^2 = .47$ (Figure 6). For pictures of couples, there was a trend to interaction of depression and fertility status ($F(1,8) = 4.11, p = .077, \eta_p^2 = .34$). At low conception risk, depression trended to blunt PAR responses to couples (Figure 7).

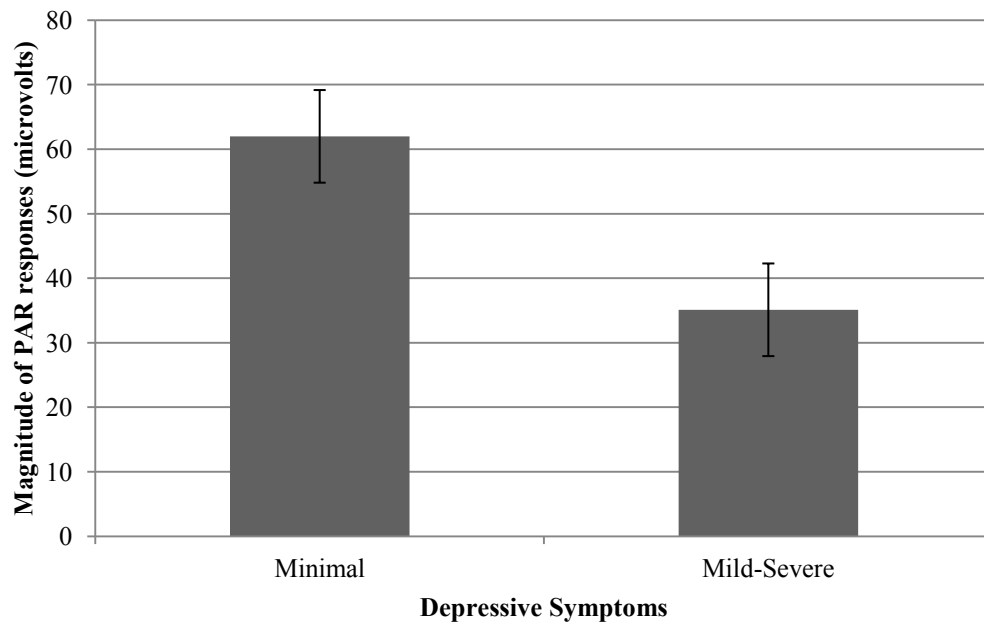


Figure 6. Average PAR Responses to Babies in Normally Cycling Females by Depression Symptoms.

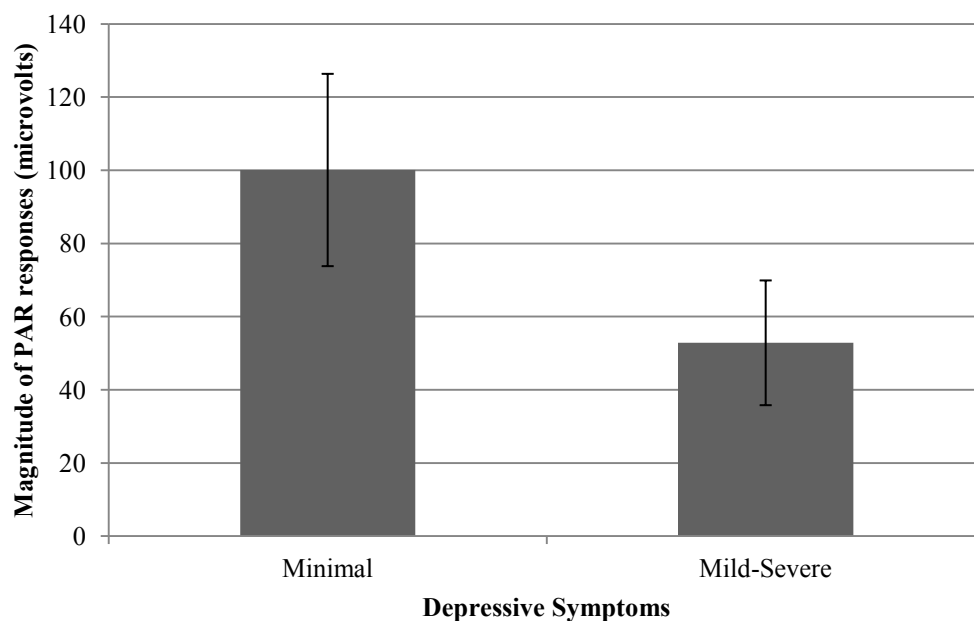


Figure 7. Average PAR Responses to Couples in Normally Cycling Females at Low Conception Risk by Depression Symptoms.

Test of Order Effects

In order to verify that the reported changes in PAR responses were due to fertility status and not to order effects, an additional series of analyses were conducted using session order as a within-subjects factor.

PAR: Of the eleven participants who had complete PAR data available, seven were first tested in their non-fertile phase, and four first tested in the ovulatory phase. A mixed factors 2 (Cycle phase: non-fertile, fertile) x 2 (Session 1: non-fertile, fertile) x 7 (Picture category: erotic males, erotic couples, babies, couples, families, high-status males, low-status males) ANOVA revealed that although the effect of fertility remained significant ($F(1,9) = 5.22, p = .048, ns, \eta_p^2 = .367$), there was no main effect of Session 1 fertility status on the magnitude of PAR responses in normally cycling females ($F(1,9) =$

1.74, $p = .22$, *ns*). Session 1 status also did not interact with category ($F(6,54) = 1.03$, $p = .42$, *ns*), fertility ($F(1,9) = .09$, $p = .78$, *ns*), or with category and fertility ($F(6,54) = .88$, $p = .52$, *ns*).

Discussion

In this study, I tested whether fertility status would affect females' evaluation of reproductively relevant social categories through use of participant self-reports and the psychophysiological measure of the post-auricular reflex. I had predicted that females would report sexual imagery as more pleasant or rewarding at times of high fertility versus low fertility. I also expected that the pattern of PAR responses would mirror self-reports. I predicted that PAR responses to specifically sexual stimuli would increase near ovulation, and that PAR responses to stimuli of nurturance and/or commitment would be greater at non-fertile times. I also predicted that females would rate images of high-status males as more pleasant and show greater PAR responses to high-status males relative to low-status males at times of low fertility. Consistent with prior research, I had predicted that females would indicate greater sexual interest at times of high fertility. Support for these hypotheses was mixed.

Fertility Effects on Category Ratings

Contrary to expectations, fertility status did not influence self-reported ratings of valence or arousal for any of the picture categories. However, the overall pattern of picture ratings was consistent with previous research. Females gave the most favorable ratings to images that depicted themes related to long-term sexual strategies. Depictions of babies, romantic couples, and families were rated the most pleasant. Although erotic

images were rated as the most arousing, within the erotic category females rated images of erotic couple both more pleasant and more arousing than the images of erotic males. However, the evaluation of sexual motivations relative to nurturing motivations was not impacted by fertility status.

Fertility Effects on PAR

The hypotheses about PAR responding were partially supported. Although PAR responses to sexual stimuli showed a non-significant decrease across cycle phases, PAR responses to all non-erotic categories were significantly reduced near ovulation. The significant reduction in PAR magnitudes at times of high fertility was contrary to expectations. The reductions in PAR response could not be attributed to habituation of the response from across experimental sessions. The order of experimental sessions did not affect the pattern of PAR responses, indicating that cyclical shifts in fertility were influencing PAR responses.

Although contrary to expectations, the finding that ovulation blunts appetitive responding to non-erotic, reproductively relevant categories is consistent with sexual strategies theory. The shift in PAR responses across the cycle may correspond with a re-prioritization of female motivations. I had predicted increased responses to erotica near ovulation, based on findings that sexual stimuli may become more rewarding to females at this time (e.g. Mass et al., 2009; Pillsworth et al., 2004; Rupp et al., 2009a, 2009b). However, Fessler (2003) notes that re-prioritization may also take place in females by a decrease in salience of other stimuli and motivations that are not mating-specific. Fessler reviewed evidence from animal and human studies that found a decrease in caloric intake,

as well as decreased satiation points for water, in females near ovulation. He posited that decreased hunger and thirst allowed females to spend greater amounts of energy on finding a suitable mate near the time that they would be most likely to conceive. By doing so, females receive a maximum benefit of good genes from partners. Decreased PAR responding to social categories appears to operate in a similar manner by decreasing the appetitiveness of non-erotic relevant stimuli, including those of nurturance and commitment.

Evaluation of Status Cues

I also predicted that females would prefer images depicting high-status males as opposed to low-status males at low conception risk. It was expected that high-status males would consistently be rated more favorably than low-status males and PAR magnitudes would consistently be larger for high-status males compared to low-status males. Those hypotheses were not supported. Although females did consistently rate images of high-status males as more pleasant than low-status males, PAR responses did not mirror their self-report. Unexpectedly, females showed greater PAR potentiation to pictures of low-status males, although this difference was not significant. The fact that females did not differ in PAR responses to status cues may indicate that status cues are not prioritized over other cues of mate-selection. Pictures of low-status males may depict information such as masculinity or strength (e.g. ability to do physical labor), whereas high-status males depict cues of power or wealth. It is possible that females' PAR responses did not differentiate between high- and low-status males because the general category of non-nude males was as rewarding as the other reproductively related

categories. The lack of concordance between PAR and self-reports might indicate that females may be responding to different cues at the conscious (self-report) and unconscious (reflexive PAR) levels. At the level of conscious responding, however, social desirability issues and awareness of status may have affected females' self-report ratings.

Fertility Effects on Sexual Interest

It was predicted that females during times of high fertility would report greater interest in sex; this hypothesis was partially supported. Normally cycling females that completed the Sexy Seven gave higher endorsements of feeling *horny* near ovulation, indicating greater sexual desire at this time. This finding illustrates that fertility did affect some measure of female desire, and is consistent with previous research showing female sexual desire increasing near ovulation (Brown et al., 2011; Bullivant et al., 2004; Gangestad et al., 2002; Matteo & Rissman, 1984). The effect size is large, even given the small sample of participants who were able to complete the Sexy Seven.

The Sexy Seven list numerous adjectives related to sexual motivations, so it is interesting that the only term that increased in endorsement was *horny*. While females may be more interested in sexual activities near ovulation, this may not translate into endorsing words that may connote negativity towards those actions or desires (e.g. *provocative, promiscuous, perverted*). Females at times of high fertility were less likely to endorse feeling *effeminate*. As the word typically refers to feminine characteristics in males and thus is more often used to describe males, this was an unexpected finding. Since females did not report feeling more *feminine* or *womanly*, it is possible the lowered

endorsement reflects a stronger rejection of gender-atypical description near ovulation. It is also possible that undergraduate females did not understand all word choices, and a lack of comprehension contributed to confusion in ratings. Although endorsement of *effeminate* did shift, it also hovered in the neutral range, rather than reflecting disagreement with the term as was shown in other gender-atypical descriptions such as *manly* or *masculine*.

No shifts were seen for items on the Sexy Seven indicating an interest in relationships (e.g. *faithful*, *loose*) or emotional investment (e.g. *loving*, *lovable*, *cuddlesome*). Though females did not show shifts in endorsing items related to relationship exclusivity or emotional investment, the significant finding of greater self-endorsement of *horny* near ovulation supports that ovulation may specifically cause shifts in female sexual desire.

Fertility Effects on Behavioral Activation

Analyses of trait affectivity were included for exploratory purposes, so no specific predictions were made about the relationship of behavioral activation or inhibition in females as a function of menstrual phase. Unexpectedly, I found that near ovulation, females reported a general decrease in BAS. BAS overall describes a person's general tendencies to respond to reward and to experience positive emotion from reward cues (Carver & White, 1994). The BAS also assesses impulsivity and a tendency to approach novel stimuli. Some research supports the idea that females may engage in protective behaviors against rape and victimization near ovulation by taking fewer risks (Bröder & Hohmann, 2003; Chavanne & Gallup, 1998). The shift for ovulating females to be less

willing to approach novel stimuli or act on impulse may be seen as evidence of fewer risk-taking behaviors. At points of high fertility, females showed decreases in both general BAS and overall PAR responding. The decreases in both BAS and PAR bolsters the suggestion that ovulation may blunt general motivations for rewarding and appetitive stimuli.

Depression and Sexual Strategies

Research also suggests that depression may affect PAR responses (Sloan & Sandt, 2010). Higher levels of depressive symptoms have been previously associated with blunted PAR responding, but I was unable to replicate that finding in the current study. Depression may have some impact on female sexual strategies, making females less responsive to cues of nurturance. Females with depression also showed a tendency to self-report babies as less pleasant, compared to non-depressed females. This pattern was mirrored in the PAR responses of females with higher depressive symptoms. I was able to show specifically that females with higher depressive symptoms showed blunted PAR to pictures of babies. The results of this study also hint at possible interactions between fertility status and depression on responses to mate-selection themes. During low conception risk, females with depression trended to show lowered responding to romantic couples.

Although tentative, these results may lead to new insights about how depression impacts female reproductive behavior. They may be especially relevant to understand post-partum depression. Female post-partum depression also affects emotional responses to and interactions with infants (Field, 2010). Research using fMRI has found that

mothers with depression show less activation in reward areas of the brain when exposed to their own infant's cries, and showed different patterns of activation in response to other infant cries compared to non-depressed mothers (Laurent & Ablow, 2012).

Evidence that reduced PAR responses and less pleasant affect to pictures of babies in females with greater depressive symptoms supports the idea that depression lowers reward value and motivations towards babies and cues of nurturance in females.

Summary

The current study found mixed support for ovulation to shift female priorities and desires. Although females near ovulation showed reduced appetitive responding overall, appetitive responding to sexual stimuli was not significantly diminished and self-reported sexual interest increased. Taken together, the results suggest a possible dual mechanism for emphasizing sexual opportunities at times of heightened conception risk. Females appear more inclined to pursue sex due to increased desires, while also finding non-mate-relevant stimuli less rewarding overall. Females who were thus motivated would be more likely to attend to sexual opportunities, reaping the maximum benefit from copulation at heightened conception risk. The findings of Study 1 are consistent with goals in sexual strategies theory (Buss & Schmitt, 1993) and evolutionary literature suggesting that ovulatory shifts affect female motivations and interests.

CHAPTER FIVE

STUDY 2

Literature (e.g. Alvergne & Lummaa, 2009; Regan, 1996) suggests that females on hormonal birth control do not show cyclical shifts. The purpose of Study 2 was to utilize data from a small subsample of participants who reported taking hormonal birth control.

Methods

Study Design

Study 2 employed a within-subjects, repeated measures design to investigate potential differences in psychophysiological and self-report responses of females on hormonal birth control who provided data from two separate time-points.

Participants

Study 2 used a subsample of participants collected from the overall sample detailed in Study 1. Participants were 7 female undergraduate students ($M_{age} = 19.57$, $SD = .79$) who reported using a form of hormonal birth control. The sample was white (71.4%) and African-American (28.6%) (Table 1).

Procedure

Study 2 employed the same methodology as Study 1. Efforts were made to keep scheduling of participants as consistent in methodology as possible. For scheduling purposes only, females were treated as if they were normally cycling and the Reverse Counting Method was used to estimate an RCD of 13-18. Participants were asked to

return on a day that would correspond to the opposite cycle phase. However, as conception risk would not vary due to participants taking hormonal birth control, participants were considered non-fertile regardless of session. Sessions were scheduled at least 6 days apart ($M = 12.33$, $SD = 4.76$).

Materials

Participants completed the same materials outlined in Study 1.

Results

Self Report Ratings: Self-Assessment Manikin

Valence. A mixed factors 2 (Session: one, two) x 7 (Picture category: erotic males, erotic couples, babies, couples, families, high-status males, low-status males) ANOVA conducted on the valence ratings with females taking hormonal birth control revealed differences in picture category, $F(6,36) = 6.32$, $p = 0.0$, $\eta_p^2 = .513$. Babies ($M = 4.03$, $SD = .84$) were rated as more pleasant than erotic males ($M = 2.57$, $SD = 1.0$), high-status males, ($M = 3.04$, $SD = .39$), and low-status males ($M = 2.44$, $SD = .59$). Babies did not differ in pleasantness from erotic couples ($M = 3.01$, $SD = 1.0$), families ($M = 3.6$, $SD = 0.6$), and couples ($M = 3.91$, $SD = .94$). As predicted, scores did not differ between sessions, $F(1,6) = 1.05$, $p = .35$, ns , $\eta_p^2 = .149$, and there was no significant interaction of session and category ratings, $F(6,36) = .57$, $p = .75$, ns , $\eta_p^2 = .087$.

A series of Mann-Whitney U-tests revealed no differences between normally cycling females and females on hormonal birth control in average valence ratings for picture categories (Figure 2).

Arousal. A mixed factors 2 (Session: one, two) x 7 (Picture category: erotic males, erotic couples, babies, couples, families, high-status males, low-status males) ANOVA conducted on the arousal ratings with females taking hormonal birth control revealed only differences in picture category, $F(6,36) = 5.91, p = 0.0, \eta_p^2 = .496$. Females rated erotic couples ($M = 2.96, SD = 1.14$) as more arousing than erotic males ($M = 2.17, SD = .85$). Erotic couples did not differ in arousal ratings from babies ($M = 2.17, SD = .85$). As predicted, scores did not differ between sessions $F(1,6) = .279, p = .62, ns, \eta_p^2 = .044$, and there was no significant interaction of session and category ratings, $F(6,36) = .929, p = .49, ns, \eta_p^2 = .134$.

A series of Mann-Whitney U-tests revealed no differences between normally cycling females and females on hormonal birth control in average arousal ratings for picture categories (Figure 3).

Ratings of Sexual Interest

Sexy Seven. Given that both normally cycling participants did not report arousal and valence rating differences as a function of fertility status, but did differ in endorsement on the Sexy Seven, I also analyzed the Sexy Seven in females on hormonal birth control. Females reported no differences in endorsement of adjectives across sessions. Unlike normally cycling females, females on hormonal forms of birth control showed no differences in self-endorsement of *horny* from session 1 ($M = 6.0, SD = 2.71$) to session 2 ($M = 6, SD = 2.65$). An independent samples Mann-Whitney U-test indicated that normally cycling females in the non-fertile phase trended in differing from females on hormonal birth control in the endorsement of *horny*, $p = .089, marginal$, but

that normally cycling fertile females did not differ from females on hormonal birth control, $p = .49$, *ns* (Figure 4).

Hormonal birth control females did not exhibit a difference between session timepoints, but did exhibit a somewhat higher endorsement of *horny* relative to normally cycling non-fertile females. Endorsement for other words did not differ across sessions, so an average endorsement of Sexy Seven adjectives was calculated for normally cycling females (all words except *horny* and *effeminate*) and females on birth control.

Independent samples Mann-Whitney U-tests revealed that relative to normally cycling females, females on birth control also endorsed themselves as more *coy* ($M = 6.43$, $SD = 1.2$ for normal versus $M = 4.84$, $SD = 1.78$ for birth control) and more *sultry* ($M = 4.5$, $SD = 2.04$ versus $M = 4.63$, $SD = 1.14$).

Psychophysiological Data

Because of the small number of available participants, there was insufficient power to conduct reliable inferential statistics. As a result, the following analyses have been limited to descriptive analyses. Missing data were expected due to the nature of psychophysiological data collection and the PAR response in particular. A visual inspection of the means and SDs reveals that there were no differences in PAR responses for different categories, and that there were no shifts in PAR responding across session for females on hormonal birth control (Table 3).

Independent-samples Mann-Whitney U-tests revealed that females on hormonal birth control did not differ in overall PAR responses relative to normally cycling females

at low-fertility ($p = .33$), but trended to differ in overall PAR responses relative to normally cycling females at high-fertility ($p = 0.9$).

Table 3. PAR Responses across Sessions for Females on Hormonal Birth Control

Category	Session 1	Session 2
	<i>M (SD)</i>	<i>M (SD)</i>
Erotic Males	68.59 (84.17)	45.6 (20.9)
Erotic Couples	64.65 (20.12)	75.53 (93.15)
Babies	85.25 (52.85)	109.69 (93.5)
Families	97.94 (67.22)	49.78 (16.83)
Couples	68.7 (43.12)	57.65 (36.24)
High-Status Males	40.75 (20.0)	35.37 (11.89)
Low-Status Males	44.59 (35.87)	76.0 (103.34)

Discussion

For females using hormonal forms of birth control, no shifts were found in ratings of reproductively relevant categories or for PAR responses across sessions. In contrast to normally cycling females, females on hormonal birth control also exhibited no shift in sexual desire, consistent with research that suggests females on hormonal birth control do not exhibit cyclical shifts in preferences and desires (Alvergne & Lummaa, 2009). Greater numbers of females in both groups may be needed in order to make more

concrete statements about self-perceptions of sexual adjectives across cycle points. However, even with small sample sizes in both groups, the within-subjects design strengthens the data points, and the shift is evident only in normally cycling females. The absence of a cyclical shift in females on hormonal birth control supports the hypothesis and is consistent with prior research demonstrating differences between normally cycling and hormonal birth control females.

Consistent with predictions, neither category nor session affected PAR responses for Study 2 participants. This lack of change is understandable given that in normally cycling participants, ovulation blunted PAR responses to non-erotic social categories but did not significantly reduce responses to erotica. Females on birth control have consistent low conception risk from a steady influx of hormones, and differences in responses would only be seen with ovulation or high conception risk. Thus although the subsample is small, the findings of Study 2 also bolster the findings of Study 1 in that ovulatory motivational shifts, including a de-emphasis of non-mate-relevant social information, are limited to normally cycling females.

While no other specific predictions were made about females on hormonal birth control, their self-report indicated some subtle differences in self-perception of sexual adjectives. These females perceived themselves as more coy and sultry than normally cycling females, and hornier compared to normally cycling females in the non-fertile phase. Undergraduate females taking oral contraceptives have been shown to have more active sex lives and less restrictive expressions of sexual morality (Bancroft, Sherwin, Alexander, & Davidson, 1991). The group studied here, though small, may also be more

comfortable with aspects of their sexuality as seen from the greater self-endorsement of these terms. However, females also take oral contraceptives for reasons other than preventing pregnancy, and so taking oral contraception should not be seen as necessarily indicative of sexual activity in a female. Effects of hormonal birth control in females' general sexual desire are unclear, due to the differing types of hormones in contraception and other social and psychological variables (Schaffir, 2006). Future research would need to take into account more specific motivations and reasons for use of birth control before interpreting these differences.

CHAPTER SIX

GENERAL DISCUSSION

The overall findings of Studies 1 and 2 show limited support for my original hypotheses, although they do offer some general support for sexual strategies theory. It was hypothesized that ovulation should increase motivations towards sexual cues while possibly decreasing motivations towards nurturance cues. Ovulation did not significantly change the appetitiveness of erotic stimuli as assessed by PAR responding, but did blunt responses for non-erotic social categories, including those depicting other motivations such as nurturance and commitment. However, no shifts were seen in self-reported ratings of the different social categories. Ovulatory shifts were also seen in increased reports of sexual desire in normally cycling females. These ovulatory shifts were present only in females who did not report a use of hormonal birth control, matching previous patterns in literature and providing support for mechanisms linked specifically to fertility as a cause of female motivational shifts. The results suggest that ovulation may have a two-fold purpose to increase female motivations toward sex, both by increasing desire while simultaneously decreasing the appetitiveness associated with non-mate-relevant stimuli.

Implications for Sexual Strategies Theory

Although it was expected that the effect of ovulation would be to increase sexual motivation, the pattern of PAR responses suggests that instead the effect is for ovulation to diminish social motivations not directly related to sex (e.g. Fessler, 2003). The

possibility that ovulation can blunt appetitive responding is also supported by the decrease in behavioral activation at points of high fertility. This pattern of results suggests that the effect of ovulation on female social motivations is complex.

Evolutionarily, females should be motivated to take advantage of the brief reproductive window available near times of ovulation; however, females may also be motivated to avoid unnecessary risk at that time. Past research has shown that females may show greater sexual interest at times of high fertility, but other work has shown that females may also become more risk-averse (Bröder & Hohmann, 2003; Chavanne & Gallup; 1998). While risk-avoidance has been interpreted as a mechanism for ovulating females to reduce the threat of rape when the risk of conception is highest, the present study suggests that reductions in risky behavior may be related to a general decrease in reward seeking and appetitive motivation near ovulation.

Reduced appetitive responding to non-erotic social cues could also impact female mate-selection strategies at times of high versus low fertility. By blunting responses to social cues that are not related to sex, ovulation may lead to a decreased ability to distinguish cues that signal a male's quality as a long term mate. Literature documents a cyclical shift in females to prefer cues of genetics and testosterone in males (e.g. Little, Jones, & Burriss, 2007; Little, Jones & DeBruine, 2008; Penton-Voak & Perrett, 2000; Roney & Simmons, 2008). However, as testosterone also relates to negative personality traits, this preference shift frequently comes at the expense of likely partner investment from these males. Recently, Durante, Griskevicius, Simpson, Cantú, & Li (in press) examined perceived parental characteristics of males by females, finding that ovulating

females expect a greater likelihood of parental investment and positive long-term partner traits in highly attractive males, relative to their perceptions about male investment at times of low fertility. The effect is specific to personal interests; females remain objective about highly attractive males' parenting qualities when asked about investment with other females. For females asked about the attractive males' investment with them specifically, though, ovulation leads women to increase perceptions of investment. Durante et al.'s findings suggest that ovulating females have a diminished ability to discern important social information. The finding that social categories elicit lower PAR responses near ovulation also suggests that ovulation decreases female sensitivity to non-erotic social cues.

Inconsistencies between self-report and PAR

Although activity of the PAR was expected to mirror self-reports of valence and arousal, in most instances there was no concordance between explicit ratings and PAR responding. However, this pattern of results was not inconsistent with past research. Physiological arousal does not always correspond with self-reported arousal (Basson, 2002). Conscious reports of sexual arousal and general enjoyment involve interpreting physiological responses, and for females this interpretation may include mixed or contrasting emotions. Females also have been found to respond less to visual sexual stimuli than men do, and often bodily and subjective levels of arousal and pleasantness of the stimuli do not converge in females (e.g. Rupp & Wallen, 2007a).

In the present studies, females' self-report ratings of the picture categories reflected some past research of how females react when viewing social pictures,

specifically erotica. Bradley, Codispoti, Sabatinelli, & Lang (2001) found that females, relative to males, were more likely to report more positive emotions elicited by pictures of babies or families than for pictures of erotica. Females, relative to males, were less consistent in their ratings of positive emotions elicited by opposite-sex erotic stimuli. Females were more likely to report feelings such as embarrassment when viewing erotic images (2001). An understanding of general female patterns in feelings elicited by erotica may help to explain why PAR responses to erotica did not significantly differ throughout the cycle, but females did not report that erotic stimuli were more pleasing near ovulation.

Variability of the PAR Response

Based upon past research, the PAR was thought to be a suitable candidate to capture shifts in evolutionary motivations that result from fluctuations in fertility. The present studies question that assumption. Several methodological challenges were revealed in attempting to use PAR to track the effects of ovulation across different time points. Across participants, there was a high degree of variability in PAR responses. Although ovulation was found to decrease PAR responding to non-erotic social categories in normally cycling females, this shift was only seen in participants who could be tracked across the cycle. However, a large portion of participants could not be used in the within-subjects analyses because they failed to evidence a PAR response to at least one of the categories at one or more time points.

In general, participants exhibited similar PAR responses across categories, contradicting my original hypotheses that PAR responses to erotica overall would be

higher near ovulation. My hypothesis that PAR responses to high-status males would be higher than responses to low-status males at low conception risk was also not supported. As the research was exploratory in nature and little is known about the PAR regarding ovulation other than that it is linked to the onset of puberty and menses in females (e.g. Quevedo et al., 2009), the present study highlights the need for future research into the effects of fertility and appetitive responding.

Limitations and Considerations for Future PAR Research

Sample. PAR responses for the overall sample showed a wide range of responding. Female average responses across categories were markedly higher than other samples previously reported. Quevedo et al. (2009) reported PAR magnitudes ranging from 22-25 μV for appetitive categories in post-pubertal adolescents, compared to lower magnitudes in previous literature from single digits into the teens (e.g. Benning et al., 2004; Sandt et al., 2009). Given that the sample differs from previous findings in overall magnitude of response, they may not be a representative sample.

Social factors. Wallen (2001) notes that an interaction of factors influence human female sexual interest, desire, and activities, including partner interests and desires, orientation, and desires to achieve or avoid conception. Depending on the interaction of hormonal and social desires, varying patterns of female interest (increase, decrease, or no change) may emerge with the menstrual cycle. The current study attempted to control for factors such as sexual orientation and use of hormonal birth control. I did not take into additional potential variables such as desires of the individual or couple (if the female was in a relationship), interest in children, whether the female was sexually active (with

self, partner, or not active), relationship satisfaction, and type of relationship sought. As social factors may mediate female interests, future research should take into consideration these nuanced variables.

Trait affectivity. Levels of depressive symptoms have previously been associated with blunted PAR responses (Sloan & Sandt, 2010). In the present research, higher levels of depression lowered PAR responses to pictures of babies; a similar trend was also seen for depression to lower self-reported valence of babies. This is the first PAR study to investigate specifically females and reproductively relevant social themes, but the pattern suggests depression levels in females may impact emotional responding to themes of nurturance. Further investigations into the PAR should include measures of trait affectivity, as depression may affect reward value and motivation in females to specific categories.

Picture categories. In the present research, the magnitude of PAR responses did not differ between categories. However, because all categories were reproductively relevant social categories, they may not have elicited distinct differences in motivation. A lack of contrasting categories (negative, neutral, positive same-sex or positive non-social pictures) in the picture viewing may have eliminated additional response differences between categories.

Although the PAR definitively potentiates to pleasant relative to unpleasant stimuli, there have been mixed findings of how specifically PAR responds to particular types of pleasant categories. Benning et al. (2004) reported only a trend for pleasant over neutral PAR responses. In addition, findings of PAR vary across types of pleasant

pictures. Benning et al. (2004) found that PAR responses to erotica did not differ from responses to adventure scenes, while subsequent work (Quevedo et al., 2009; Sandt et al., 2009) has found that within pleasant categories, adventure potentiates lower PAR. Sandt et al. (2009) found greater PAR for appetitive pictures of food, erotica, and families; however, Benning (2011) found that within pleasant pictures, the PAR was not potentiated more by food relative to erotica and babies. Although the PAR does respond specifically to pleasant pictures, a more exact response pattern is unclear.

Johnson et al. (2008) was the first PAR study to utilize solely social picture categories, and found that both males and females showed greater PAR to appetitive (e.g. erotica and babies) relative to attractive, pleasant stimuli (attractive males, females, and couples). However, not all work has supported this distinction of PAR responses. Within pleasant categories, Quevedo et al. (2009) found no differences in post-pubertal adolescents' PAR responses to pictures of food, romantic couples, babies and families, and attractive males and females. Sandt et al. (2009) found greater PAR responses to categories of food, erotica, and families relative to nature and adventure. In contrast, Sloan & Sandt (2010) report that PAR potentiated more to pleasant images, but did not report distinctions across pleasant categories of erotica, food, adventure, nature, and families. Thus, the pattern in the current study of no strong differences between categories as assessed through PAR responses supports that PAR responds to pleasant pictures, but cannot add more nuanced distinctions.

In addition to being the first PAR study utilizing solely pleasant social categories, this is also the first PAR study to investigate responses solely in females. As there have

been unclear distinctions in female responses across pleasant categories such as attractive males (Quevedo et al., 2009), erotic images, romantic couples, families, or babies (Johnson et al., 2008; Sandt et al., 2009), females may have found *all* of the current social categories to be pleasant enough not to warrant physiological distinctions across categories. Families (which included a baby or young child) and couples may be pleasing to females for displaying cues of commitment, nurturance, or investment. Pictures of non-erotic males may similarly still display useful information to females about status, but also masculinity.

Hormonal influences. Ovulation status may also be able to explain why there have been mixed results previously regarding a pattern of PAR responses. In the present study, the PAR responded to all tested social categories. Based upon Johnson et al. (2008) and Sandt et al. (2009) I expected to find distinctions in female responses to erotica and babies relative to other pleasant categories, but the research was not able to support a distinction between appetitive relative to attractive categories at times of low fertility.

A lack of shifts in females using forms of hormonal birth control, both for PAR responses and for self-reported sexual desire, confirmed the prediction that shifts in sexual strategies would only be present in normally cycling females. The results suggest that sexual strategies are influenced by a proximate shift in hormones; females not experiencing this shift are less likely to experience the accompanying shifts in desires and motivations. An exclusive use of females in this PAR research allowed for an exploration of these nuances that affect female responding. Future research also should consider examining females' method of birth control, as hormones will affect motivations and

therefore appetitive responding. Reasons for use of hormonal birth control should also be considered to explore potential differences in sexuality or other motivations.

Conclusions

The current research supports theories that female sexual strategies are altered by fertility shifts, as evidenced from differences in self-report and patterns in PAR responses between females on hormonal birth control and normally-cycling females who could be tracked across the cycle. These findings also represent the first efforts to link appetitive responding with evolutionary motivations and sexual strategies, and extend research into the post-auricular reflex. In addition, the study contributes to an understanding of potential issues in psychophysiological research that may be of use to future researchers. An expanded use of social and contrast categories and consideration of factors such as additional female motivations, sexual activity, and levels of trait affectivity will likely be of use to understand better the mechanisms behind the post-auricular reflex in humans and especially in human females. The PAR has not been previously tested exclusively in human females or across the menstrual cycle. The PAR was responsive to all tested social categories, but the present research indicates that ovulation in females may diminish PAR responding across categories. The hypothesis that PAR would be affected by cyclical shifts showed limited support; cyclical shifts were seen only in females providing complete within-subjects data. PAR responses indicated that while responses to all social pictures decreased with conception risk, only responses to sexual stimuli did not decrease significantly near ovulation. Taken together, the findings replicate previous reports in shifts of desire with ovulation that are limited to normally cycling females and

differences in self-report ratings about pleasantness elicited in females by visual stimuli, and support the idea that female desires are a product of conception risk. Further research is needed into the post-auricular reflex, as is continued research into the complexity of factors that influence women's physiological and subjective responding.

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APPENDIX

Menstrual Information Questionnaire with Sample Calendar

This questionnaire will ask you to report some information about your menstrual cycle. We ask that you try to be as accurate as possible, but if you are not certain, please give us your best estimate. A calendar is provided below to help you remember dates.

A menstrual cycle is defined as the number of days from the onset of menstruation to the onset of the next menstruation. We are **not** asking for the number of days that your period lasts during the cycle. For most people, the cycle ranges from 25-35 days, though individuals may have shorter or longer cycles. Please keep this definition in mind when you answer the questions below.

What was the date of your last menstruation (the start of your period)? _____

How many days does your cycle (not your period: **the number of days from the onset of menstruation to the onset of the next menstruation**) usually last? _____

What is the estimated date of your next menstruation (the start of your next period)?

Please describe the type of birth control you use.

2012	SUN	MON	TUES	WED	THURS	FRI	SAT
	1 New Year's	2	3	4	5	6	7
J	8	9	10	11	12	13	14
A	15	16 M. L. King	17	18	19	20	21
N	22	23	24	25	26	27	28
	29	30	31	1	2	3	4
F	5	6	7	8	9	10	11
E	12	13	14 Valentine's Day	15	16	17	18
B	19	20 Presidents' Day	21	22	23	24	25
	26	27	28	29	1 Ash Wednesday	2	3
M	4	5	6	7	8	9	10
A	11	12	13	14	15	16	17 St. Patrick's Day
R	18	19	20	21	22	23	24

ⁱ Missing data for Study 1 participants: age ($N = 1$), BDI ($N = 3$), BIS/BAS ($N = 3$), relationship ($N = 2$) and race ($N = 1$).

ⁱⁱ Missing data for Study 2 participants: relationship ($N = 1$).

ⁱⁱⁱ Missing data for withdrawn participants: age ($N = 3$), race ($N = 2$), relationship ($N = 15$) and education ($N = 3$).

^{iv} This measure was not completed by all participants, due to approval date by the Institutional Review Board. Thus, the measure is included as exploratory.

^v Shapiro-Wilk tests of normality indicate the categories of erotic males ($p = 0.0$), erotic couples ($p = .035$), and families ($p = 0.0$) are not normally distributed.

^{vi} Shapiro-Wilk tests of normality indicate the categories of erotic males ($p = 0.007$), babies ($p = .032$), high-status males ($p = .033$) and low-status males ($p = .033$) are not normally distributed.