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The Effect of Ovulation as a Male Mating Prime on Drinking and Other Mating Behaviors

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by

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ABSTRACT

A recent line of research grounded in evolutionary theory has shown that exposure to women's fertility cues affects men's mating cognition and behavior. This area of research has not yet been examined in relation to alcohol. As alcohol has also been shown to facilitate the formation of sexual connections for males, establishing the intersection between these two lines of research seems necessary to understand the impetus behind human behavior. Ninety-eight male participants were primed with either the scent of a fertile woman or the scent of nonfertile woman and then completed measures assessing their level of attraction to pictures of women, beer consumption, approach behavior, and alcohol expectancies. Results of the study indicated that males' mating behaviors are affected by women's ovulatory cues, as men exposed to an ovulation prime drank significantly more and exhibited significantly more approach behavior than men exposed to a control prime. Furthermore, an interaction was found between sexual enhancement expectancies and prime condition on beer consumption, which indicated that there was no effect for sexual enhancement expectancies for those in the control prime condition, but for those in the ovulation prime condition, increased drinking was associated with higher sexual facilitation expectancies. These findings were consistent with previous research and support evolutionary theories of mating behavior while taking an integrative approach in trying to explain factors behind human behavior.

INTRODUCTION

Emerging literature has demonstrated the impact of women's fertility on not only how women think and behave, but also on how men think and behave. When women ovulate and are at their most fertile, their psychology and behavior shift. According to evolutionary theory, during the brief window of time when women are fertile, women are more likely to be attracted to mates with strong genetic fitness and will engage in behaviors that will facilitate obtaining a desirable mate.

Research has also shown that women give off subtle cues of their ovulation status. Studies have shown fluctuations in scent, skin color, body symmetry, voice pitch, and waist-to-hip ratio in women while fertile. Consequently, it seems that men subconsciously receive these cues and behave in manners that promote the furtherance of their genes by engaging in behaviors that facilitate the occurrence of sexual activity, a finding that is in line with evolutionary theory. For example, men will engage in higher mate guarding behaviors when their partners are fertile, demonstrate increased cognitive accessibility to sexual concepts when exposed to the scent of an ovulating woman, and exhibit riskier decision-making in the presence of a woman at peak fertility. It seems, therefore, that, without awareness, men's reproductive behaviors and cognitions can be influenced by a woman's fertility status.

Similarly, alcohol has also been seen as a device to facilitate the occurrence of sexual activity. Alcohol has long been known as a social lubricant and has often been seen as a means to help both males and females make sexual connections. In particular, men experience greater

sexual arousal not only when they consume alcohol but also when they simply believe they have consumed alcohol. They often perceive greater chances of a sexual encounter in situations where drinking is present; that is, when either the males themselves are drinking or when targeted females are drinking or both.

As representations of alcohol effects stored in memory, alcohol expectancies have been shown to be a significant determinant of alcohol-related behavior; these expected psychological and physiological effects of alcohol can influence people's decisions about their alcohol consumption. Alcohol expectancies include not only outcomes but also the contexts in which these outcomes are anticipated. Building on this context-outcome relationship, we will focus on sexual enhancement expectancies and social facilitation expectancies, as these expectancies are relevant to helping males establish sexual connections. Based on the expectancy literature, it was thought that in the context of ovulatory cues, which provide information about sexual availability, sexual and social expectancies would be activated and result in increased alcohol consumption.

The present study tested whether the signals for receptivity from an ovulating female were part of a context that induced alcohol consumption. Increased alcohol consumption as a result of being exposed to ovulation cues might be due to the activation of sexual and social expectancies in relation to the sexual context. Specifically, the effect of exposing men to an ovulation prime on alcohol consumption and other mating behaviors was examined, and information on alcohol expectancies was collected after participants were exposed to the dependent variables The purpose of the current study, therefore, was to explore whether variations in alcohol use and cognitions and sexual behavior could be attributed to biological inductions and to explore if these variables were interconnected.

In subsequent sections, literature on women's ovulation cycles and their influence on mating behaviors in an evolutionary framework will be reviewed, as will the research on the effect of alcohol on mating behaviors and alcohol expectancy theory, particularly how expectancies operate in a sexual domain. The specific aims and hypotheses of the study will also be discussed, as well as a description of the procedure used to test the aims and hypotheses.

Women's Ovulation Cycles

Ovulation plays a very important role in human reproduction. For humans to reproduce, sexual intercourse is a necessary but not sufficient condition for reproduction. Any single act of sexual intercourse will, on average, lead to pregnancy only 3% of the time (Tietze, 1960). Many factors influence the possibility of pregnancy, such as sperm count, sperm mobility, and complications with the ovaries, fallopian tubes or uterus, but one of the most crucial factors is a woman's level of fertility. The only days in a woman's menstrual cycle when sexual intercourse can result in a chance of fertilization of the woman's egg are a few days before ovulation until the day of ovulation (Wilcox, Weinberg, & Baird, 1995). Therefore, the period of time surrounding ovulation is extremely crucial from a reproductive perspective, as it is when fertility is at its peak and when conception is most likely. Given fertility's significance in human reproduction, theories of evolution suggest that men and women have adapted strategies to promote mating behavior during this short window of time during which fertility is the highest (Gangestad, Thornhill, & Garver-Apgar, 2005).

Research has shown that there are many social psychological changes linked with women's level of fertility across the menstrual cycle, indicating that it may be possible that biological processes such as ovulation may influence mating behavior, even though the majority

of people are unaware of this influence. The effects that the different phases of ovulation has on women's psychological, cognitive and behavioral processes will be explored to demonstrate how females are affected by ovulation and also to review the various subtle cues that may be received by men, which as a result influences men's psychological, cognitive and behavioral processes, as well.

The Ovulatory-Shift Hypothesis

The ovulatory-shift hypothesis proposes that a woman's psychology shifts during the brief window of time of peak fertility, often without awareness (Gangestad & Thornhill, 1998; Gangestad & Thornhill, 2008). That is, during this time, women have stronger preferences for potential partners who show biological indicators of male genetic fitness. Women also show increased mating interest during this time of fertility, but they will be more selective in choosing a prospective mate. From an evolutionary perspective, poor mating choices have significantly higher consequences during peak fertility, so women will engage in behaviors that help to secure a desirable mate. Research on the ovulatory-shift hypothesis has shown that ovulation affects women's behaviors in a large variety of ways.

Female preferences for males seem to shift during mid-cycle. Studies have shown that women have stronger preferences for masculine facial and vocal qualities, intrasexual competitiveness, physical symmetry, and various forms of talent (Gangestad & Thornhill, 1998; Gangestad et al., 2005). In line with the ovulatory-shift hypothesis, these characteristics are all thought to be representative of male genetic fitness.

Women's sexual interests have also displayed a pattern of shifting according to their ovulation cycle. During this peak fertility period, women reported greater sexual attraction to and

higher levels of fantasizing about men who were not their primary partners, especially males who were indicative of good genetic fitness; that is, males who were physically attractive, muscular, socially respected and aggressive (Gangestad, Garver-Apgar, Simpson, & Cousins, 2007; Gangestad, Thornhill, & Garver, 2002). Furthermore, during this phase, women also rated the body odors of men with greater body symmetry as more pleasant and sexy (Gangestad & Thornhill, 1998). This pattern is in line with evolutionary theories that suggest that fertile women should seek out short-term mates with good genetic fitness, even when they are in long-term relationships. Being in a long-term relationship usually signifies that there is a male that could help support the offspring and help the woman nurture the offspring but having a short-term mate of good genetic fitness would increase chances of genetic survival. Women also reported increases in overall number of sexual fantasies, sexual self-stimulation, overall sexual desire, and initiation of sex with primary partners during this time of peak fertility (Bullivant et al., 2004; Gangestad et al., 2002; Regan, 1996).

During the ovulation phase of their menstrual cycle, women seem to feel and behave differently, as well. Haselton and Gangestad (2006) found that women in relationships reported greater flirtation with men with whom they were not in a relationship, especially when they were in relationships with men who they perceived as being low in genetic fitness. Single women reported greater interest in attending social activities where they could meet potential romantic partners. They also found that women reported feeling more attractive during the ovulatory phase of their menstrual cycle. Furthermore, women chose clothing products that enhanced appearance while shopping, wore more sexually provocative clothing, and engaged in more sexual signaling at social events (i.e. bars and clubs), such as exposing a greater amount of skin and wearing tighter and shorter skirts (Durante, Griskevicius, Hill, Perilloux, & Li, 2011; Durante, Li, &

Haselton, 2008). These differences in behavior are all adaptive in helping women to engage in activities that maximize the possibility of reproductive fitness benefits during periods of high fertility.

Cues of a Woman's Fertility

Human females differ from other species in that there are no overt physical signs that indicate when a woman is fertile, such as female chimpanzees and bonobo who have large female sexual skins when fertile or other primates who have sexual swellings on their hindquarters when fertile. For a long time, scientists thought that human females exhibited no signs during their ovulatory period, but many recent studies have produced results that suggest the presence of several subtle fertility cues, including body odor. Studies have shown that males rate odors from women during the ovulatory period of their menstrual cycle as more pleasant and sexier than odors from women not in the ovulatory period (Singh & Bronstad, 2001; Thornhill et al., 2003). Another study has also shown that scents from a woman near ovulation lead to increases in levels of testosterone in males (Miller & Maner, 2010), which is strongly related to male mating behavior and heightened mating interest (Roney, Lukaszewski, & Simmons, 2007). This reaction patterns signify that signs of a woman's reproductive fertility are associated with endocrinological responses in men.

Scent seems to be one of the most researched factors influencing male's behaviors and cognitions, which is not surprising given that in animals, scent is used as an important signal for female fertility and affects males' mating strategies (Ziegler, Schultz-Darken, Scott, Snowdon, & Ferris, 2005). Scents have also been used in psychology research to influence many different

psychological and behavioral processes, such as decision-making, accessibility and behavioral intent (Bone & Ellen, 1999; Holland, Hendriks, & Aarts, 2005).

In addition to scent, Van den Berghe & Frost (1986) found that skin color in females becomes lightest near the period for ovulation. Females also seem to exhibit more body symmetry in paired soft tissue traits while ovulating, such as breast and digit length, than during other phases of the menstrual cycle (Scutt & Manning, 1996). Both males and females rated females' voices as being more attractive during the ovulatory phase of their menstrual cycle, as well (Pipitone & Gallup, 2008). Research has also shown fluctuations in waist-to-hip ratio during various phases of the menstrual cycle (Kirchengast & Gartner, 2002).

Studies have shown that scent, skin color, body symmetry, voice pitch, and waist-to-hip ratio all fluctuate during a woman's menstrual cycle. Thus, it seems there are various characteristics that women exhibit during fertility that could influence a male's mating-primed behavior.

The Effect of Women's Ovulation Cycles on Men

Many studies have found that the stage of a woman's ovulation cycle can affect men's behavior and cognitions. A study by Miller, Tybur and Jordan (2007) found that female lap dancers who were in the ovulatory phase of their menstrual cycle earned significantly more tips than women in other phases of the menstrual cycle. This finding is especially significant when taking into account the revealed preference doctrine in behavioral decision theory that posits that actual consumer spending is more telling in accurately and reliably revealing preferences than using self-report items from participants (Hensher, Louviere, & Swait, 1999).

Women's ovulation cycles seem to affect males who are in relationships, as well. Male partners acted more jealously and possessively towards their significant other during periods of high female fertility, thus showing higher rates of mate guarding during this time of fertility (Haselton & Gangestad, 2006). This is in line with evolutionary theories because males would want to ensure that females with whom they are involved are not engaging in sexual activities with other males, especially while the female is fertile. Reproduction is the evolutionary goal and if a male's mate engaged in sexual activity with other males during periods of fertility, it would decrease the chances of his goal being met because another male may impregnate his mate. Furthermore, it may also be possible that near ovulation, women who are in relationships with men who they perceive to be low in genetic fitness report feeling more attracted to men outside their relationship and flirt more with men other than their significant other. This would also be in line with evolutionary theories because women want to reproduce with mates who have strong genetic fitness to ensure that their offspring will have the best chances of survival.

Miller and Maner (2011) conducted a series of studies that examined various cognitions and behaviors of men when primed with different cues of fertility. When male participants were exposed to scents of fertile women, these men showed an increased accessibility of sexual concepts compared to men exposed to scents of infertile women. Male participants exposed to scents of fertile women also resulted in a greater perception of women's sexual arousal than men exposed to scents of infertile women. Finally, in a study utilizing a female confederate, the experimenters found that when the confederate was more fertile, there was a greater tendency for the male participants to engage in risky decisions while the female was watching.

Male mating behaviors and cognitions, therefore, have been shown to vary throughout a woman's ovulation cycle. Other areas of research that have also been shown to influence male mating behaviors are studies on alcohol and alcohol expectancies.

Alcohol and Male Sexual Behavior

A significant amount of research has been conducted linking alcohol consumption and sexual behavior. Studies have suggested that alcohol consumption was perceived as having lowered sexual inhibitions (Wilsnack, Wilsnack, & Klassen, 1984), as well as having enhanced sexual enjoyment (Athanasiou, Saver, & Tavris, 1970). Results from other studies show that reported alcohol consumption was positively correlated with the likelihood that sexual intercourse had occurred during a first date using a sample of adolescents and college students (Cooper & Orcutt, 1997; Dermen & Cooper, 2000). A link between alcohol consumption and sexual aggression has also been found, as sexual assaults were associated with drinking by either one or both parties (Abbey, 1991; Koss, Gidycz, & Wisniewski, 1987; Muehlenhard & Linton, 1987).

Men, in particular, often drink in hopes that it will lead to a sexual encounter and because they think that alcohol will make this sexual connection easier. Male participants manifested significantly greater subjective sexual arousal and objective sexual arousal, as measured by penile tumescence, when they believed they had consumed alcohol, regardless of whether their drinks actually contained alcohol (George & Marlatt, 1986; Lansky & Wilson, 1981; Wilson & Lawson, 1976; Wilson, Niaura, & Adler, 1985). Also, men believe that the presence of alcohol leads to a more relaxed and less inhibited interpersonal setting (Wilson, 1977) and are also more

likely to approach women when intoxicated. They believe that women will feel less social anxiety when drinking, will be more open to sexual advances, and will be more sexually available and more willing to engage in foreplay and intercourse (George, Cue, Lopez, Crowe, & Norris, 1995; Gustafson, 1989; Wilson, Perold, & Abrams, 1981).

Not only do men expect more sexual experiences as a consequence of drinking, but drinking has also been shown to be a result of sexual stimuli and arousal. A meta-analysis by Hull and Bond (1986) found increased alcohol consumption and increased sexual arousal in response to erotic stimuli. In the current study, the sexual stimulus that will be utilized to elicit increased consumption of alcohol will be the scent of an ovulating woman.

Alcohol Expectancy Theory

An area of research that has emerged whilst examining alcohol consumption and drinking behavior posits that alcohol-related behavior is largely influenced by the beliefs or expectations regarding the effects of alcohol. Alcohol Expectancy Theory explains how future drinking behavior can be influenced based upon past and current memories and experiences related to alcohol (Goldman, Brown, & Christiansen, 1987; Smith & Goldman, 1994). Alcohol expectancies refer to the anticipated cognitive, behavioral or affective effects that can result from the consumption of alcohol (Goldman, Darkes, Reich, & Brandon, 2006). Alcohol expectancies can be measured and assessed in individuals long before drinking initiation (Dunn & Goldman, 1996) and are connected to the onset of drinking (Dunn & Goldman, 1998). Alcohol expectancies are important because of their association with abusive and non-abusive drinking patterns (Brown, Goldman, & Christiansen, 1985; Christiansen, Goldman, & Brown, 1985; Smith, Goldman, Greenbaum, & Christiansen, 1995), as well as their utility in predicting

behavior while drinking, predicting future drinking, and mediating decisions regarding alcohol consumption (Brown, Christiansen, & Goldman, 1987; Christiansen, Smith, Roehling, & Goldman, 1989; Goldman, Darkes, Reich, & Brandon, 2006). Furthermore, research has indicated that these expectancies mediate the relationship between genetic and environmental risk factors and drinking behavior (Darkes, Greenbaum, & Goldman, 2004; Goldman, Brown, & Christiansen, 1987; Goldman, Darkes, & Del Boca, 1999; McCarthy, Wall, Brown & Carr, 2000).

Research has demonstrated the importance of assessing for specific alcohol expectancies. Alcohol expectancies within different individuals vary greatly, and these specific expectancies have been shown to differentiate between drinking outcomes (Brown et al., 1980; Smith et al., 1995). Examples of commonly assessed areas of alcohol expectancies are the belief that drinking will reduce tension and have relaxing effects, enhance sexual experiences and increase aggression (Brown et al., 1987).

Alcohol expectancies cannot be discussed without including the context in which drinking occurs and in which outcomes are anticipated; that is, context is inextricably connected to the anticipated outcome. Certain types of alcohol expectancies may be activated in specific contexts, and these expectancies may also interact with specific environments to influence drinking behaviors and outcomes. For example, Birch and colleagues (2004) found that individuals who drink primarily to cope exhibited increased relief expectancies after a negative mood induction; meanwhile, individuals who drink primarily for enhancement purposes demonstrated higher reward expectancies after a positive mood induction. Another example is a study that found that women experienced stronger social and sexual enhancement expectancies after reading a hypothetical vignette describing a sexual situation (MacLatchy-Gaudet & Stewart,

2001). It seems, therefore, that certain alcohol expectancies can be influenced by contextual factors.

In particular, it is thought that when exposed to the context for the current study, ovulatory cues signaling sexual availability, sexual enhancement expectancies and social facilitation expectancies will be activated. The study will also examine whether these expectancies serve to moderate drinking in the context of ovulation cues.

Sexual Enhancement Expectancies

Sexual enhancement expectancies refer to the extent to which an individual believes that alcohol will facilitate sexual encounters; that is, whether alcohol makes people more sexually disinhibited, more interested in sex, and more sexually aggressive. Studies utilizing various expectancy instruments have shown that participants generally report the expectation that alcohol will enhance or disinhibit sexual experiences (Fromme, Stroot, & Kaplan, 1993; Leigh & Stacy, 1993). Research has demonstrated that sexual enhancement expectancies can mediate both alcohol ingestion and intoxicated behavior in certain samples and situations.

Carey (1995) found that sexual enhancement expectancies could predict the frequency of intoxication in college students. Furthermore, Leigh (1990) showed that individuals with stronger sexual enhancement expectancies were more likely to both consume alcohol in sexual situations and initiate sexual activity. Dermen and Cooper (1994) also found that in sexual situations, sexual enhancement expectancies were better predictors of drinking than general alcohol expectancies. Subjects who expected alcohol to lead to disinhibited sexual behavior reported drinking to intoxication at parties more frequently than those who did not hold those beliefs and reported a higher frequency of sexual intercourse at these parties, as well. In similar

fashion, subjects who expected alcohol to lead to impaired judgment reported drinking to intoxication on romantic dates more frequently than those who did not hold the same beliefs. Similarly, male subjects with strong sexual enhancement expectancies drank more in anticipation of watching an erotic video than males who had weaker expectancies (Skinner & George, 1988).

Social Facilitation Expectancies

Another type of alcohol expectancy is the belief that drinking will assist in social interactions. Individuals with high social facilitation expectancies might anticipate having increased interpersonal skills or less social anxiety. Social facilitation expectancies have been proven in research to be an important correlate and predictor in drinking behavior.

Results of a longitudinal study of adolescents indicated that social facilitation expectancies were the most powerful predictor out of all the alcohol expectancies for quantity and frequency of drinking, as well as problem drinking (Christiansen et. al, 1989). Furthermore, adolescents who are at a higher risk for alcohol use problems endorsed stronger expectancies of social facilitation. A longitudinal study by Smith and colleagues (1995) found that social facilitation expectancies could be used to predict alcohol use even before the onset of drinking. In subjects who had not yet begun to drink, initial social facilitation expectancies predicted differences in the rating of drinking increase over 2 years; that is, initial nondrinkers who had higher initial social facilitation expectancies drank more over 2 years than those nondrinkers with lower social facilitation expectancies. For all participants, initial social facilitation expectancies were correlated with the average rate of increase in alcohol use.

In the study by Smith and his colleagues (1995), the idea of reciprocal expectancy-drinking reinforcement was also proposed, which states that drinking experiences tend to

confirm the expectancies endorsed prior to the onset of drinking. These resulting experiences then influence subsequent alcohol expectancies. This study showed that social enhancement expectancies were found to predict subsequent drinking behavior over and above the influence of previous drinking history. Consequently, these experiences predicted later alcohol expectancies over and above the influence of previous expectancies.

Present Study

It has been established that exposure to women's ovulatory cues increases male mating behaviors, and alcohol is often used as a device that helps facilitate sexual connections. The primary aim of this study, therefore, was to examine the effect of an olfactory cue of fertility on males' alcohol consumption. It was hypothesized that males exposed to an ovulation prime would consume more alcohol than males exposed to a control prime as a result of being introduced to a sexual context.

The second goal of the study was to examine the effect of an ovulation prime on other male mating behaviors. Specifically, one a mating behavior of interest was male participants' approach behavior towards females. It was hypothesized that participants exposed to the ovulation prime would exhibit greater approach behavior than men exposed to the control prime as a result of viewing the situation as a sexual opportunity. Furthermore, as previous research has shown that men are more likely to approach women after drinking, it was hypothesized that alcohol consumption would moderate the relationship between ovulation exposure and approach behavior.

Another male mating behavior of interest was the level of attraction to photographs of females. After participants were exposed to either an ovulation prime or a control prime, they

completed a task where they viewed pictures of women, which served as a dependent variable and also served to help implicitly set the context for the study. Participants' ratings of attractiveness to the women were collected, as well as the time spent viewing each picture, which had been shown to be a valid measure of sexual attraction in previous studies. However, prior studies used full body pictures and either fully nude or partially nude pictures, and the task for the current study was modified to use only facial pictures, so results for the attraction ratings were exploratory in nature. It was hypothesized that the ovulation prime would elicit more attraction to the photographs of women (i.e., higher ratings of attraction and longer time spent viewing pictures) than men exposed to a control prime.

As it has been shown that particular contexts may activate certain alcohol expectancies, another area of interest was whether sexual enhancement expectancies and social facilitation expectancies were activated in the different prime contexts. However, these analyses were also exploratory in nature because alcohol expectancies were measured at the end of the study, so sequencing effects may have impacted participants' responses on the alcohol expectancy measure. For these exploratory analyses, it was hypothesized that men exposed to an ovulation prime would have increased sexual enhancement and social facilitation expectancies as compared to males exposed to a control prime. It was also hypothesized that there would be an interactive effect between ovulation exposure and expectancies on alcohol consumption; that is, there would be a significant positive relationship between alcohol consumption and alcohol expectancies in the ovulation condition and no relationship between the two in the control condition.

METHOD

Participants

Participants were recruited from an online participant pool of undergraduates from psychology classes that participated for extra credit in their psychology courses. To be eligible, participants had to be at least 21 years of age, beer drinkers, not allergic to beer and not current smokers (studies have shown that smoking leads to smell impairment; Vennemann, Hummel, & Berger, 2008). A total of 107 participants completed the study; of those participants, one was later found to be ineligible due to abstaining from alcohol and three were ineligible due to being under 21 years of age (those who were under 21 years old did not complete the taste-rating task portion of the study). In addition, as the study's main interest was to examine the effects of male attraction to females, five participants were excluded from the analyses of the study due to identifying themselves as homosexual with no sexual interest in females. The final sample was 98 undergraduate males between the ages of 21 and 37 years old (M = 23.67, SD = 3.52) who identified themselves as either White/Caucasian (55.1%), Hispanic/Latino (15.3%), Asian/Pacific Islander (13.3%), Black/African American (10.2%) or Other (6.1%).

Measures

Odor collection. Women who were not on hormonal contraceptives participated in the odor collection phase. For the ovulation prime condition, women wore a white cotton T-shirt during the nights of the late follicular phase of their menstrual cycle (typically Days 13-15), and

for the control condition, women wore a white cotton T-shirt during the nights of the luteal phase of their menstrual cycle (typically Days 20-22). Women were given ovulation tests to verify that they were either ovulating or not ovulating during the appropriate conditions. Women were given instructions to remain odor neutral, by a.) showering with unscented soap and shampoo, b.) refraining from using perfumes, deodorants and antiperspirants, c.) avoiding consumption of foods with pungent odors (i.e. garlic, vinegar, asparagus), d.) abstaining from smoking cigarettes, drinking alcohol, and using drugs, and e.) refraining from engaging in sexual activity and sleeping in the same bed as someone else. After each night, they were instructed to place the T-shirt in a sealed freezer bag, and after the three nights, the women returned the T-shirt to the experimenter and completed a questionnaire on whether she had followed the instructions from remaining odor neutral. The T-shirts were kept in a freezer when not in use, and all shirts were used within one week of being worn.

A total of 19 women were recruited to provide T-shirts for the study. Of those, 17 women provided a total of 38 T-shirts. One of the T-shirts was not used due to the participant not completing the protocol properly and the rest of the T-shirts were not used due to not having any male participants sign up for the study within a week of the T-shirt being returned. The final sample utilized a total of 30 T-shirts that were produced from 14 different women. The 14 women whose T-shirts were used in the study ranged in age from 20 to 29 years old and had an average age of 24.14 (SD = 2.54). They were 50% White/Caucasian, 28.6% Asian/Pacific Islander, and 21.4% Hispanic/Latino.

Ovulation prime. Each participant was assigned to either the ovulation prime group or the control group. T-shirts were only kept for one week at a time and it was not possible to have one of each type of T-shirt at all times, so group assignment was not truly random. During times

when there was only one type of T-shirt, participants were assigned to that condition. During times when there was at least one ovulation T-shirt and at least one non-ovulation T-shirt, participants were randomly assigned to a group. Participants in the ovulation prime group smelled a T-shirt worn by a woman in her late follicular phase, and participants in the control group smelled a T-shirt worn by a woman in her luteal phase.

Demographic questions. Participants were asked to report their age, ethnicity, gender, year in college, and sexual orientation. Sexual orientation was reported on a 7-point Likert scale, with one being exclusively heterosexual (straight) and seven being exclusively homosexual (gay). Those who reported a score of either 6 or 7 on the sexual orientation scale were excluded from data analysis, as the population of interest was males who were sexually attracted to females.

Visual Reaction Time (VRT). The Visual Reaction Time procedure was used to measure the participants' attraction to pictures of women's faces, as well as to help set the sexual context of the study. Participants completed this task via computer. For each slide to be rated, participants were instructed to rate the attractiveness of the woman on each screen on a Likert scale from 1 ("highly unattractive") to 7 ("highly attractive), with a rating of 4 indicating that the woman in the picture is neither unattractive nor attractive. The picture remained on the computer screen until the participant had entered his rating. Participants were in control the advancement of each slide, and the amount of time that the participant spent on each picture was measured by the computer and was used as a measure of attractiveness, along with the Likert scale ratings of attractiveness. Previous research has suggested that time spent looking at a person's picture is a valid and reliable measure of sexual attraction (Abel, Huffman, Warberg, & Holland, 1998). However, the procedure used for the study was a modified version of ones used in previous

studies, which featured full body pictures that were either fully nude or partially nude. The current procedure is similar to previous studies in that participants were allowed control over how long they viewed each picture, the current study only used pictures of faces.

Taste rating task. Procedures outlined in Marlatt et al. (1973) were followed for the taste-rating task. Participants were asked to taste and rate beers to unobtrusively measure levels of beer consumption. Participants were given two glasses of 12-ounce nonalcoholic beer and although nonalcoholic beer was used, the taste-rating task has been shown to be a valid measure of alcohol consumption. The first beer was given to the participant in a carafe marked A and the second beer was given to the participant in a carafe marked B. Participants were also given glasses marked A and B and were told to pour the beer from the corresponding carafes into the glasses before consuming the beers. All beers were chilled, and all identifying labels or containers were hidden. Participants were left with a glass of water to rinse their mouths in-between tastings.

Participants were given instructions verbally by the experimenter. Participants were told to take their time and to sample as much of each beverage as needed to arrive at a decision. The experimenter gave the participants rating sheets for each beer and then left the room, to reduce social constraints on drinking. Participants were not aware of the 10-minute time limit on the taste-rating period. Halfway through the 10-minute period, the experimenter returned to check on the participant's progress. At the end of the 10 minutes, the experimenter returned and had the participant continue to the next portion of the study.

Approach task. The approach task was used to measure participants' level of female approach behavior. Participants were led into a room by the experimenter. In the room, there were five chairs lined up in a row, with a woman's sweater hanging on the chair farthest to the

left, and a woman's purse and a clipboard on the chair. The four potential chairs available for the participant to sit on were coded from 1 to 4, with seat 1 being the chair located next to the chair with the jacket and purse or the "phantom woman". Lower number chairs are thought to reflect more approach behavior (Holland, Roeder, van Baaren, Brandt, & Hannover, 2004; Macrae, Bodenhausen, Milne, & Jetten, 1994; Smith & Bargh, 2008).

Quantity Frequency Variability Index (QFVI). The Quantity Frequency Variability Index is a 13-item questionnaire that asks participants about the amount of alcohol consumed per sitting, frequency of alcohol use, and the variability of alcohol consumption, including the modal amount of alcohol consumption and the highest amount of alcohol consumption (Cahalan, Cisin, & Crossley, 1969). QFVI ratings yield five types of drinker classifications: heavy drinker, moderate drinker, light drinker, infrequent drinker, and abstainer. Drinker information was collected to examine whether there were any baseline differences in drinker type between prime conditions.

Chemical Sensitivity Scale (CSS). The Chemical Sensitivity Scale is a measure containing 21 items that assess for individual differences in smell sensitivity (Nordin, Millqvist, Lowhagen, & Bende, 2003). The measure utilized a 6-point Likert scale ranging from 1 (*disagree strongly*) to 6 (*agree strongly*) to rate agreement to various statements (e.g., "I am easily alerted by odorous/pungent substances"). A high score on this measure indicated a greater awareness of odor cues in the individual's environment. Information on smell sensitivity was collected to examine whether there were any baseline differences between prime conditions.

Alcohol Expectancy Questionnaire (**AEQ**; Brown, Christiansen, & Goldman, 1987). The AEQ is a 68-item scale using a 2-point forced choice format ("agree" or "disagree") that measured the effects that respondents anticipate experiencing from consuming alcohol. The

participant was asked to respond about what he personally believed as true as a result of drinking alcohol (e.g., "I often feel sexier after I have had a couple of drinks"). The AEQ has good internal consistency (α = .84), an 8-week test-reliability coefficient of .64, and contains six subscales ranging in length from 7 to 24 items (a = .72-.92; Brown, Christiansen, & Goldman, 1987); of particular interest to the current study are the Sexual Enhancement (7 items) and Social Assertiveness (10 items) subscales. Each item is scored either 0 ("disagree") or 1 ("agree), and subscale and total scale scores are computed by averaging the appropriate items.

The AEQ was administered online before participation in the study as a baseline measure of expectancy so that differences in initial expectancies between groups could be examined. The AEQ was then administered again at the end of the study, following the approach task, but was modified so that the participant was instructed to answer how alcohol would make them feel in the moment. The AEQ administered at the end of the study was used to determine whether expectancies were activated during the study.

Procedure

Figure 1 shows an outline of the experimental procedure. Participants completed the AEQ online before the day of the experiment, as well as answered questions related to the amount of beer they typically consume, if they were allergic to beer, their smoking habits, and demographics to assess their eligibility for the study.

When participants arrived on the day of the experiment, they completed the informed consent for the study. An experimenter told the participants that the purpose of the study was to examine the effect of scents on consumer ratings. Participants first filled out a questionnaire on their demographics and then were asked to fill out the CSS. Then, participants were primed with

the scent of a woman who was ovulating or a woman who was not ovulating, depending upon the group to which they were assigned. Each participant was assigned to either the late follicular condition or the luteal condition. Participants were told that they would smell a T-shirt that had been washed with a laundry detergent and that they would be rating the laundry detergent product on various aspects. Instructions were given to each participant to put his nose into the plastic bag containing the T-shirt and to take three large inhalations. After smelling the T-shirt, participants were given a product rating form where they were asked to rate the product on its smell, how likely they would be to use the product and how likely they would be to buy the product. Participants and experimenters will be blind to the condition of the T-shirt.

Next, the participants participated in the Visual Reaction Time task. The participant was shown how to use the computer to rate each picture and how advance to the next picture using two test pictures. Twelve pictures of female faces were used for the actual task. Participants rated the attractiveness of each female and the computer also computed the time that each participant spent on each picture.

After the VRT task, the experimenter told the participant that they would taste beverages that might include sparkling water, sodas, coffee, or beer, and informed the participant that the type of beverage he would be rating would be new, low-calorie beers. The participants then completed the taste-rating task where they were asked to rate the beers on various aspects (e.g., taste, color).

The subsequent portion of the study was the approach task. Participants were led into a separate room by the experimenter where they were told they would be finishing the experiment by filling out a few more questionnaires. The room had five chairs lined up in a row, and the chair farthest left had a woman's sweater hanging on the back of it, as well as a woman's purse

and a clipboard on top of the chair. The participant was asked to take a seat and to complete the QFVI and the AEQ, with modified instructions to think about how they would expect alcohol to make them feel in that moment. Finally, participants were debriefed about the study and permitted to leave.

Timing. The informed consent process, demographics questionnaire and CSS questionnaire typically took participants 5-10 minutes to complete. The experimental prime, or smelling of the T-shirt, and then completing the fake product rating form usually took participants less than 1 minute. Next, the instructions and demonstration for the Visual Reaction Time task and the actual Visual Reaction Time task normally lasted between 5 and 10 minutes. Instructions to complete the taste-rating task were typically given in under 1 minute and participants were given exactly 10 minutes for the taste-rating task. Finally, participants usually completed the approach task, the QFVI and the AEQ in 7-15 minutes. It is unknown exactly how long it takes after a person is exposed to a scent before the smell begins to affect behavior and it is also unknown exactly how long the smell continues to affect behavior after a person is exposed, but the timing of the olfactory prime in the current study is similar to the timing other olfactory hormonal primes in previous studies.

Sequencing effects. As there were three dependent variables in the study (attractiveness ratings, alcohol consumption, approach behavior), the ideal study design would have involved a counterbalanced design to eliminate sequencing effects. However, due to limited resources, for the current study, only one sequence was used, with the visual reaction time task coming first after the exposure to the independent variable, then the taste rating task and finally the approach task. Although all participants viewed the same photographs of women in the same order, it is possible that some participants spent longer looking at the photographs or found some of the

photographs to be more or less attractive than other participants did, which may have influenced their responses on subsequent tasks. In order to account for potential sequencing effects, the time participants spent viewing each picture and attractiveness ratings were used as covariates when looking at the prime effect on the taste rating task and the approach task. Furthermore, the approach task followed the taste-rating task because we hypothesized that the amount of alcohol consumed would moderate the relationship between prime condition and approach behavior. Analyses using approach behavior as an outcome included amount of beer consumed as a covariate in order to account for potential sequencing effects.

RESULTS

Baseline Differences

Table 1 contains demographic information and baseline characteristics of the sample according to group condition. Baseline differences were examined to determine whether there were any systematic differences between groups initially to which results may have been attributed other than the independent variable. To explore whether there were baseline differences in demographics, sensitivity of smell, drinker type, and alcohol expectancies between the ovulation and control groups, t-tests for continuous variables and Chi-square tests for categorical variables were utilized.

There were no significant baseline differences between groups in age [$t(96) = -0.42$, $p = 0.68$], ethnicity [$\chi^2(4) = 3.63$, $p = 0.46$], year in college [$t(94) = -0.46$, $p = 0.65$], sexual orientation [$t(96) = -0.56$, $p = 0.58$], CSS total score [$t(96) = 0.14$, $p = 0.89$], and drinker type [$\chi^2(3) = 2.24$, $p = 0.52$). We were unable to examine differences in groups in alcohol expectancies due to missing data from the baseline measure of expectancies, as several participants did not complete the AEQ online before the study and, therefore, there was insufficient power to detect any differences in baseline expectancies.

A lack of significant baseline differences between the control group and the prime group indicated that these variables likely did not contribute to differences observed between groups after the independent variable was administered.

Beer Consumption

It was hypothesized that men who were in the ovulation prime condition would drink more during the taste-rating task due to being exposed to a sexual context and having their sexual and social expectancies activated. As can be seen in Figure 2, on average, participants in the ovulation prime group consumed more beer than participants in the control prime group. Analysis using a t-test confirmed this finding as statistically significant, $t(96) = 2.19$, $p = 0.031$ (see Table 2), in support of the main hypothesis of the study. To ensure that the visual reaction time task did not have an effect on beer consumption, participants' average attractiveness rating and visual reaction time were entered as covariates in the analysis, along with prime condition as a predictor. Table 3 shows that neither attractiveness ratings nor visual reaction time had a significant main effect on beer consumption, and even when controlling for the two variables, the effect of prime condition on beer consumption was still significant, $\beta = -0.22$, $t(93) = -2.23$, $p = 0.028$. This result is consistent with the thought that ovulatory cues provide men with a sexual context that results in increased drinking.

One participant reported that he was familiar with non-alcoholic beer and identified both beers in the taste-rating task as non-alcoholic beers. Three other participants identified one of the two beers in the taste-rating task as non-alcoholic beers. Even when excluding these four participants from the analysis, those in the ovulation prime condition still consumed significantly more alcohol than participants in the control group, $t(92) = 2.172$, $p = 0.032$, indicating that the group differences could not be attributed to participants' ability to discern that the beer was nonalcoholic.

Prime Effect on Other Male Mating Behaviors

Approach behavior. Differences in approach behavior between the ovulation group and the control group were examined to determine whether exposure to ovulatory cues would result in more approach behavior as a function of viewing the approach task as a potentially sexual opportunity. Figure 3 displays the average chair number that participants sat in during the approach task and shows that, on average, participants in the ovulation prime group chose lower number chairs than participants in the control prime group. Lower numbered chairs indicate that participants sat closer to the "phantom woman" and are reflective of more approach behavior. Results of a t-test confirmed that participants in the ovulation condition exhibited significantly more approach behavior than participants in the control condition, $t(95) = -2.28$, $p = 0.024$ (see Table 2). To ensure that prior tasks did not have an effect on approach task results, each participants' average attractiveness rating, average visual reaction time and total amount of beer consumed were included in a regression analysis as covariates. Table 4 shows that attractiveness ratings, visual reaction time and amount of beer consumed did not have a significant main effect on approach behavior, and even when controlling for these three variables, prime condition still significantly predicted approach behavior, $\beta = 0.23$, $t(92) = 2.21$, $p = 0.030$. These results were consistent with the initial theory that ovulation cues would create a sexual context, elicit increased mating behavior and, therefore, result in increased approach behavior towards females.

As prior research has shown men are more likely to approach women after consuming alcohol, it was hypothesized that beer consumption might moderate the effect between group condition and approach behavior. To determine whether alcohol consumption moderated the effect between group condition and approach behavior, a hierarchical linear regression with group condition, alcohol consumption, and the interaction effect between group condition and

alcohol consumption predicting approach behavior was conducted. Results of the analysis indicated that prime condition was a significant predictor of approach behavior, $\beta = 0.23$, $t(93) = 2.17$, $p = 0.033$, but the interaction effect between group condition and alcohol consumption was not significant, $\beta = 0.014$, $t(93) = 0.12$, $p = 0.90$ (see Table 5), suggesting that alcohol consumption did not moderate the effect between group condition and approach behavior. There was also no significant change in R^2 after adding the interaction effect to the regression model. This finding was not consistent with our hypothesis; however, the study used nonalcoholic beer, so it was possible that participants would have reacted differently due to intoxication effects.

Attractiveness ratings and Visual Reaction Time. Photographs of women were presented to participants to enhance the context of the study, as well as to assess their level of attraction to the photographs. Participants were asked to rate the pictures of women's faces on attractiveness and their time spent viewing each picture was recorded. Previous studies utilizing photographs of fully nude or partially nude women have shown that longer visual reaction time is indicative of more sexual attraction. However, since the current study utilized only photographs of women's faces, results were exploratory in nature.

The normality of the attractiveness ratings of the photographs of women was examined first to avoid floor or ceiling effects. Table 6 shows the skewness and kurtosis values for the attractiveness ratings for each photograph. Acceptable skewness and kurtosis values were between -1.0 and +1.0. One of the photographs was not used in analyses due to a non-normal distribution of responses. The photograph that was not included in analyses was negatively skewed, with the majority of participants rating the female as having a high level of attractiveness. The item had a skewness value of -1.17 ($SE = 0.24$) and a kurtosis value of 2.09 ($SE = 0.48$). All other photographs had absolute values of skewness and kurtosis under 1.

Overall, there was a significant positive correlation between ratings of attractiveness and time spent looking at each picture, indicating that participants spent longer looking at pictures of women who they thought were more attractive, $r = 0.14$, $p < 0.001$. This result is consistent with prior studies on Visual Reaction Time.

It was thought that participants would rate photographs of women as more attractive after being exposed to the ovulation prime and also spend more time viewing each photograph. Differences in attractiveness ratings and visual reaction time between the ovulation group and the control group were examined. Table 2 shows that the means of participants' attractiveness ratings and Visual Reaction Times in the ovulation group were marginally higher than participants' means in the control group. However, t-tests indicated that there were no significant differences between groups on ratings of attractiveness, $t(96) = 0.48$, $p = 0.63$, or Visual Reaction Time, $t(96) = 0.37$, $p = 0.71$ (see Table 2), indicating that the ovulation prime had no effect on participants' perceptions of physical and/or sexual attraction towards the photographs of women. Since the Visual Reaction Time task was presented before the other dependent variables, any differences between groups in attraction may have presented a potential confound on subsequent tasks. There were no significant differences between groups, so it can also be concluded that differences in attraction levels between groups were not responsible for differences observed on tasks following the Visual Reaction Time task, though participants' attractiveness ratings and visual reaction times were still used as a covariate for analyses of subsequent tasks.

Sexual Enhancement and Social Facilitation Expectancies

A secondary interest of the study was to examine whether the ovulatory cue would provide a sexual and/or social context for participants, thereby activating sexual and social expectancies. However, expectancies were measured after the taste-rating task, so it was possible that the taste-rating task might have influenced responses on the AEQ. Our aims in examining expectancies, therefore, are exploratory in nature.

Changes in sexual enhancement and social facilitation expectancies. Changes in sexual enhancement and social facilitation expectancies were unable to be examined due to missing data from the baseline expectancy measure, and therefore, there was insufficient power to detect differences.

Interaction between expectancies and group condition. For participants to drink more after the ovulation exposure, it would mean that the ovulation exposure acted as a sexual context for participants. However, for participants to drink more, they would need to have the expectation that alcohol would be useful tool in a social or sexual setting to help make those connections. Therefore, it was expected that there would be an interactive effect between sexual enhancement and social facilitation expectancies and ovulation exposure on alcohol consumption. To determine whether there was an interactive effect between sexual enhancement expectancies and social facilitation expectancies and group condition on alcohol consumption, hierarchical linear regression analyses were conducted.

A hierarchical linear regression with group condition, sexual enhancement expectancies and the interaction effect between group condition and sexual enhancement expectancies predicting alcohol consumption revealed that those in the control prime group drank significantly

less beer, β = -0.20, $t(93) = -2.07$, $p = 0.048$, and that those with sexual enhancement expectancies drank significantly more beer, $\beta = 0.35$, $t(93) = 2.66$, $p = 0.009$. There was also a significant interaction between group condition and sexual enhancement expectancies, β = -0.201, $t(93) = -2.046$, $p = 0.044$ (see Table 7), suggesting that the effect of group condition on beer consumption depended on sexual enhancement expectancies. Furthermore, there was a significant change in R^2 after adding the interaction term to the regression model, $\Delta R^2 = 0.040$, $p < .05$. The interaction effect is depicted in Figure 4, which shows that sexual enhancement expectancies had little effect on beer consumption for participants in the control prime group but that those who had high sexual enhancement expectancies in the ovulation prime group drank more beer than those with low sexual enhancement expectancies in the ovulation prime group. Simple slopes tests revealed a significant positive association between sexual enhancement expectancies and beer consumption for those in the ovulation prime condition ($b = 151.04$, $SE_b = 56.84$, $\beta = 0.35$, $p = 0.009$) and a nonsignificant relationship between sexual enhancement expectancies and beer consumption for those in the control prime condition ($b = -26.44$, $SE_b = 65.51$, $\beta = -0.061$, $p = 0.68$). These results indicated that there was no effect of sexual enhancement expectancies for participants in the control group, which was consistent with our theory because even if participants had high sexual enhancement expectancies, by being exposed to the control prime, they had not been exposed to a sexual opportunity and, therefore, had no reason to drink. Results also indicated that there for participants in the ovulation group, those who had higher sexual enhancement expectancies drank more than those with lower sexual enhancement expectancies, which was also consistent with our theory; after being exposed to the ovulation prime, which provides a sexual context for participants, participants who drank more needed to believe that alcohol would help them achieve sexual connections.

A hierarchical linear regression with group condition, social facilitation expectancies and the interaction effect between group condition and social facilitation expectancies predicting alcohol consumption revealed a significant main effect for group condition on alcohol consumption $\beta = -0.22$, $t(93) = -2.21$, $p = 0.030$, but no significant interaction between group condition and social facilitation expectancies, $\beta = -0.24$, $t(93) = -1.61$, $p = 0.11$ (see Table 8). There was also no significant change in R^2 when the interaction effect was added to the regression model. This finding indicated that there was no interaction effect between social facilitation expectancies and group condition on beer consumption. As there was an interactive effect for sexual enhancement expectancies and not for social facilitation expectancies, it was possible that men were primarily interested in establishing a sexual connection and not a social connection after being exposed to cues of fertility.

DISCUSSION

Humans are a complicated species whose thoughts and behaviors may be influenced by many different factors, some that are conscious and some that are subconscious. Consistent with evolutionary theory, research has shown that women's fertility cues can affect thinking and behavior in men. The goal of the present study was to examine the mating-related behavior of men when exposed to either an ovulation prime or a control prime. It was expected that men who were exposed to the ovulation prime would behave in ways that facilitate the formation of sexual connections, such as consuming more alcohol, exhibiting higher levels of attraction to females, and demonstrating greater approach behavior towards females.

The primary hypothesis that males exposed to an ovulation prime would consume more beer compared to those who were exposed to a control prime was supported by the study results, even when controlling for sequencing effects. This finding suggests that a female's ovulatory phase does in fact influence drinking behavior in men. The ovulation prime provides males with information of sexual availability, since the period of ovulation is the only time when it is possible for women to mate to reproduce. Fertility cues may present a sexual context for men that leads to increased drinking because of the belief that alcohol will facilitate the formation of sexual connections.

When examining other mating behavior, results revealed that participants in the ovulation prime condition exhibited more approach behavior than those in the control prime condition; that is, those exposed to the ovulation prime sat closer to the "phantom woman" than those exposed

to the control prime. Even when controlling for previous tasks, this finding was still significant, indicating that the visual reaction task and taste-rating task did not affect the results of the approach task. Further analyses indicated that consumption during the taste-rating task did not serve as a moderator between group condition and approach behavior. It was hypothesized that drinking would moderate the relationship between group condition and approach behavior because previous studies have shown that men are more likely to approach women after drinking, but it is possible that due to the use of non-alcoholic beer in the study, beer consumption did not have an effect on approach behavior due to the lack of alcohol intoxication. This finding suggests that regardless of the amount that participants drank, those in the ovulation prime condition picked up on fertility cues and engaged in more approach behavior. As a result of the ovulation exposure, these participants behaved in a way that would increase their chances of forming a sexual connection with a female, which is consistent with our evolutionary theory of behavior.

In addition to examining approach behavior, men's attraction to photographs of female faces using a modified visual reaction task was also examined. Participants' ratings of facial attractiveness were measured, as well as the time spent viewing each photograph. Although participants' ratings of attractiveness were significantly correlated with the amount of time spent viewing each photograph, neither measure was significantly different between the ovulation prime condition and the control prime condition. This lack of a difference may be due to the fact that participants were rating photographs of women's faces rather than their entire body. A past study utilizing the visual reaction task found that visual reaction time has similar validity to physiological measures of sexual attraction (e.g., plethysmography; Abel, Huffman, Warberg, & Holland, 1998); however, this study utilized full body pictures. Furthermore, other studies have

shown that characteristics of a female's body are important in the sexual selection of a female (e.g., waist-hip ratio, breast size) and that there is no direct evidence relating a woman's facial attractiveness to their reproductive success (Barber, 1995; Jackson, 1992). It is possible, therefore, that to properly investigate the effect of an ovulation prime on males' sexual attraction to females, they need to be exposed to the female's full body and not just a face.

It was also hypothesized that sexual enhancement and social facilitation expectancies would be activated in an ovulation context. Although we were unable to examine changes from pre- to post-experiment in sexual enhancement and social facilitation expectancies, results revealed that sexual enhancement expectancies had a main effect on beer consumption and there was an interaction between sexual enhancement expectancies and prime condition on beer consumption; however, there was no main effect for social facilitation expectancies on beer consumption and no interaction between social facilitation expectancies and prime condition on beer consumption. The interaction between sexual enhancement expectancies and prime condition indicated that for participants in the control prime condition, there was no effect of sexual enhancement expectancies on the amount they drank, but for participants in the ovulation prime condition, those with high sexual enhancement expectancies drank more than those with low sexual enhancement expectancies, suggesting that males exposed to the ovulation prime condition drank more when they viewed alcohol as a conduit for engaging in sexual interactions. This is consistent with our theory that ovulatory cues establish a sexual context, and for participants to drink more in this context, they must believe that alcohol will facilitate the establishment of sexual connections. As there was no main effect or interactive effect for social facilitation expectancies, it may be that males exposed to ovulation cues drink only to establish sexual relationships and not for social reasons.

Limitations

One limitation to the study was that there may have been sequencing effects of the dependent variables; that is, since there were three dependent variables, one of the earlier tasks may have had an effect on one of the later tasks, and so differences in the dependent variable may not be attributable to experimental condition. Due to limited resources, counterbalancing of the tasks was not possible. Although effects of prior tasks on subsequent tasks were controlled for statistically in analyses, in order to ensure no sequencing effects, future studies should aim to replicate findings using a counterbalanced design or only having one dependent variable per study.

An additional limitation to the study was that our sample was limited to an undergraduate psychology population at one institution in the southeastern United States. Future research should examine if the effects found in this study occur to the same extent in males of other age groups, in non-college populations and in different geographic areas.

An advantage to using nonalcoholic beer was that measures obtained after the taste rating task were not affected by a participant's intoxication level; however, even though the majority of participants did not report thinking that the beer was nonalcoholic, their drinking behavior may have been different than if alcoholic beer had been used. Furthermore, participants were asked to drink the beverages alone in a lab room, which is a very unnatural setting and much different than where drinking usually takes place, and although studies on the taste-rating task have shown that the lab environment does not influence the quantity of drinking, it is still possible that this unnatural environment influenced participants' drinking behavior.

Although there were no baseline differences found between groups, another limitation of the study was that there no true random assignment. There are no discernable differences between the two groups, but the experiment cannot be considered a true experiment and there may be some unidentified constant error associated with the lack of random assignment.

Future Directions

Future studies should aim to replicate the findings with different samples and also using alcoholic beer. The results of the current study indicated that the amount of nonalcoholic beer consumed did not influence a participant's approach behavior and also did not moderate the relationship between ovulation exposure and approach behavior. Since prior studies have shown that men are more likely to approach women after drinking, perhaps males needs to feel actual intoxication effects for alcohol consumption to influence approach behavior. If alcohol consumption does indeed influence approach behavior, it is possible that exposure to an ovulation cue along with high consumption of alcohol may create an interactive effect on approach behavior.

To our knowledge, no study to date has parsed out the effects of ovulation in relation to male sexual preference. Another avenue to explore further is examining effects of ovulation on homosexual males to see whether their evolutionary instincts influence their reactions to ovulation exposure or if a prerequisite to being affected by ovulatory cues is sexual attraction to females. If ovulatory cues do have an effect on homosexual males, it could signal that they still have an evolutionary drive to reproduce; conversely, if ovulation has no effect on homosexual males, it is possible that their sexual attraction towards other men overrides their evolutionary instincts.

Future research should also seek to examine if findings similar to the current study could be elicited when examining female mating behavior. Prior research has shown that in males of several different species, including humans, testosterone levels increase when exposed to potential mating opportunities and indicate mating interest (Batty, 1978; Miller & Maner, 2010; Roney, Lukaszewski, & Simmons, 2007). As it has been shown that the neuroendocrine system plays a crucial biological role in mating and that humans are able to detect subtle hormonal changes, it is possible that females may respond to males' differing testosterone levels similarly to how males respond to females' differing fertility levels.

Although there was an interactive effect found between sexual enhancement expectancies and prime condition on beer consumption, the expectancy measure was given to participants after they had completed the taste-rating task and consumed the beer. Our theory posits that the reason why people drink more after being exposed to an ovulation cue is so because they believe alcohol will help them achieve a desired sexual outcome. As the main purpose of the study was to determine the effect of the ovulation prime on beer consumption, we were unable to measure their alcohol expectancies before drinking because we did not want the expectancy measure to prime or alter drinking behavior. Future studies should look for a minimally reactive measure of alcohol expectancies to directly assess if expectancies can explain the relationship between group condition and alcohol consumption.

Conclusions

There are a variety of factors influencing human mating and attraction, many of which people are unaware. Consistent with previous studies, olfactory ovulation signals are detectable and can influence male mating behaviors. The current research helps to explain subconscious

influences on behavior and sheds light on the hidden determinants of human mating and attraction. This research demonstrates the value of examining mating behaviors through using evolutionary theories of human behavior. Future research should continue integrating cognitive, psychosocial and biological approaches with evolutionary approaches to further understanding of driving forces behind human behavior and social processes.

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APPENDIX A:

TABLES

Table 1

Participant Characteristics

	Total Sample (N = 98)		Ovulation (n = 48)		Control (n = 50)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Age	23.63	(3.52)	23.48	(3.43)	23.78	(3.64)
% Caucasian	55.1%		54.2%		56.0%	
Year in College	3.75	(0.99)	3.70	(0.97)	3.80	(1.02)
Sexual Orientation	1.15	(0.48)	1.13	(0.44)	1.18	(0.52)
CSS Total Score	2.67	(0.70)	2.68	(0.69)	2.66	(0.72)
% Heavy/Moderate Drinkers	68.4%		70.8%		66.0%	

Table 2

T-test Results of Dependent Variables

	Ovulation (n = 48)		Control (n = 50)		t (df)	p
	M	(SD)	M	(SD)		
Alcohol Consumption	214.58	(170.65)	154.08	(93.46)	2.19 (96)	0.031*
Approach Task	2.19	(0.71)	2.54	(0.79)	-2.29 (95)	0.024*
Attractiveness Ratings	3.88	(0.93)	3.80	(0.77)	0.48 (96)	0.64
Visual Reaction Time	4,671.80	(2,376.83)	4,521.20	(1,618.37)	0.37 (96)	0.71

Note: SE = Sexual Enhancement. SF = Social Facilitation. *$p < .05$ **$p < .01$

Table 3

Regression Table for Prime Condition Predicting Beer Consumption with Attractiveness Ratings and Visual Reaction Time as Covariates (n = 97)

Predictor	*b*	*SE*	β	*t*	*p*	*F*	ΔR^2
Model 1						0.37	0.0077
Attractiveness Rating	-13.53	16.82	-0.082	-0.80	0.42		
Visual Reaction Time	-0.0018	0.0071	-0.025	-0.25	0.81		
Model 2						1.92	0.058
Attractiveness Rating	-15.24	16.50	-0.093	-0.92	0.36		
Visual Reaction Time	-0.0023	.0069	-0.033	-0.33	0.74		
Group Condition	-62.10	27.84	-.22	-2.23	0.028*		

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

Table 4

Regression Table for Prime Condition Predicting Approach Behavior with Attractiveness Ratings, Visual Reaction Time, and Amount of Beer Consumed as Covariates (n = 96)

Predictor	*b*	*SE*	β	*t*	*p*	*F*	ΔR^2
Model 1						0.28	0.0089
Attractiveness Rating	0.062	0.094	0.069	0.66	0.51		
Visual Reaction Time	-0.0000044	0.000039	-0.012	-0.11	0.91		
Beer Consumption	-0.00033	0.00057	-0.059	-0.57	0.57		
Model 2						1.43	0.059
Attractiveness Rating	0.074	0.092	0.082	0.81	0.42		
Visual Reaction Time	-0.0000020	0.000039	-0.0054	-0.053	0.96		
Beer Consumption	-0.000036	0.00057	-0.0066	-0.063	0.95		
Group Condition	0.35	0.16	0.23	2.21	0.030*		

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

Table 5

Regression Table for Group Condition x Beer Consumed Predicting Approach Behavior (n = 96)

Predictor	*b*	*SE*	*β*	*t*	*p*	*F*	ΔR^2
Model 1						2.59	0.052
Group Condition	0.34	0.16	0.23	2.18	0.032*		
Amount of Beer	-0.000078	0.001	-.014	-0.14	0.89		
Model 2						1.71	0.00015
Group Condition	0.35	0.16	0.23	2.17	0.033*		
Amount of Beer	-0.00012	0.001	-0.021	-.18	0.86		
Condition x Beer	0.00016	0.001	0.014	0.12	0.90		

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

Table 6

Descriptive Statistics of Attractiveness Ratings

	M (*SD*)	Skewness	Kurtosis
VRT Picture 1	5.00 (1.16)	-0.54	0.12
VRT Picture 2	4.32 (1.11)	-0.10	0.92
VRT Picture 3	3.39 (1.33)	0.005	-0.30
VRT Picture 4	5.47 (1.19)	-1.17	2.09
VRT Picture 5	3.41 (1.43)	0.19	-0.61
VRT Picture 6	4.28 (1.270	-0.078	-0.40
VRT Picture 7	4.10 (1.24)	-0.33	.016
VRT Picture 8	3.27 (1.34)	-0.025	-0.56
VRT Picture 9	4.34 (1.44)	-0.12	-0.46
VRT Picture 10	3.07 (1.31)	0.32	-0.15
VRT Picture 11	4.51 (1.31)	-0.46	-0.039
VRT Picture 12	2.55 (1.15)	0.41	-0.16

Table 7

Regression Table for Group Condition x Sexual Enhancement Expectancies Predicting Amount of Beer Consumption (n = 96)

Predictor	*b*	*SE*	β	*t*	*p*	*F*	ΔR^2
Model 1						4.04*	0.079*
Group Condition	-55.77	27.87	-0.20	-2.00	0.048*		
AEQ SE	74.82	43.66	0.17	1.71	0.090		
Model 2						4.18**	0.040*
Group Condition	-56.65	27.41	-0.20	-2.07	0.042*		
AEQ SE	151.04	56.84	0.35	2.66	0.009**		
Condition x SE	-177.48	86.73	-0.20	-2.05	0.044*		

Note: SE = Sexual Enhancement. *$p < .05$ **$p < .01$

Table 8

Regression Table for Group Condition x Social Facilitation Expectancies Predicting Amount of Beer Consumption

Predictor	*b*	*SE*	β	*t*	*p*	*F*	ΔR^2
Model 1						2.49	0.050
Group Condition	-62.38	28.18	-0.22	-2.21	0.029*		
AEQ SF	2.10	41.59	0.005	0.050	0.96		
Model 2						2.55	0.026
Group Condition	-61.72	27.95	-0.22	-2.21	0.030*		
AEQ SF	75.94	61.97	0.19	1.23	0.22		
Condition x SF	-133.50	82.96	-0.24	-1.61	0.11		

Note: SF = Sexual Facilitation. *$p < .05$ **$p < .01$

APPENDIX B:

FIGURES

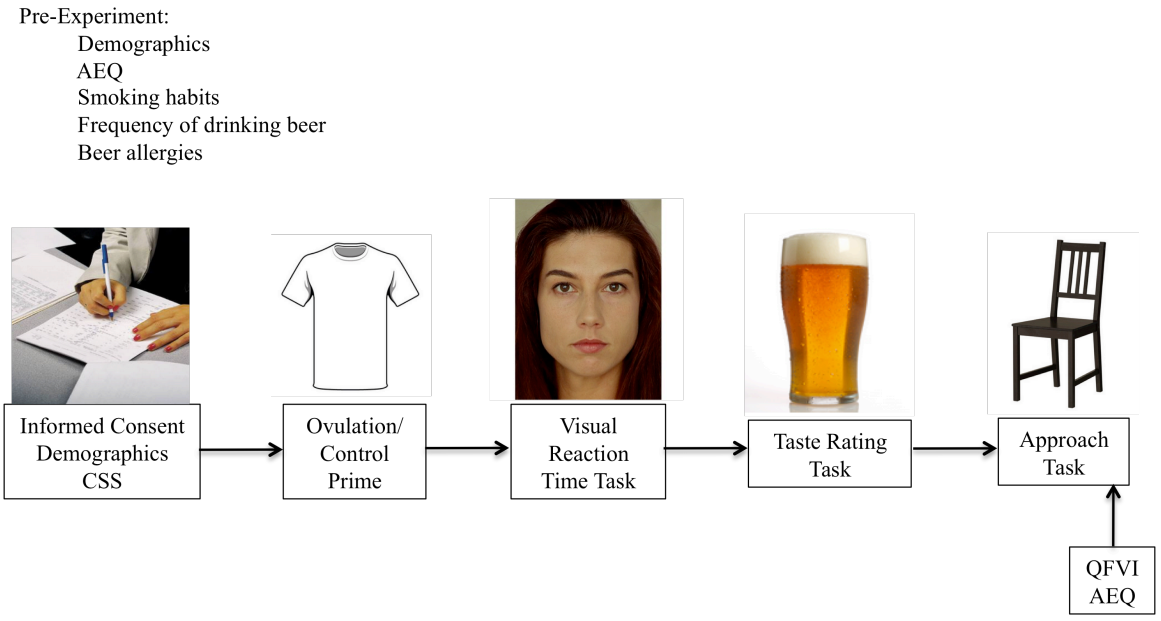

Figure 1. Outline of experimental procedure.

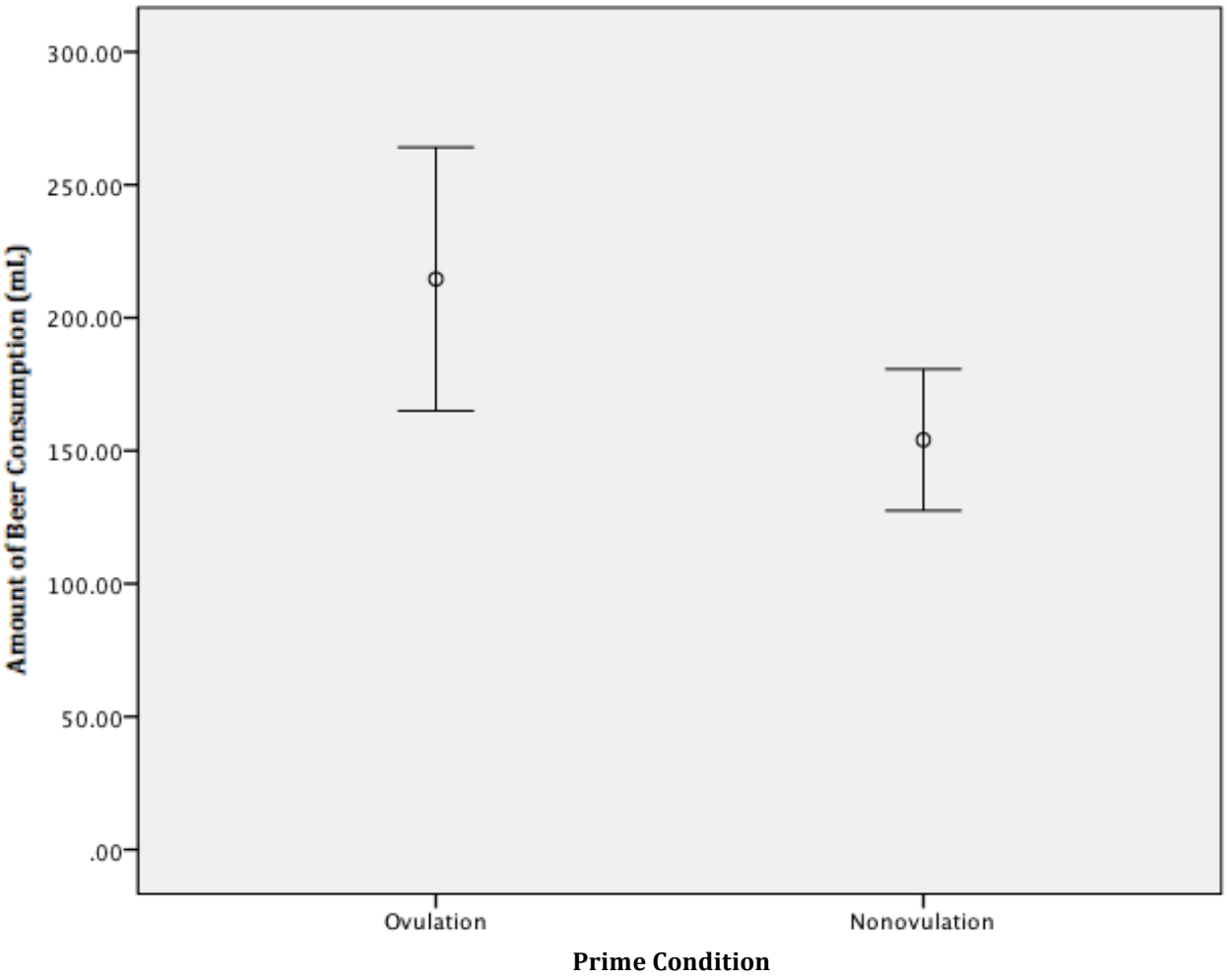

Figure 2. Graph of the 95% confidence interval of amount of beer consumed by group.

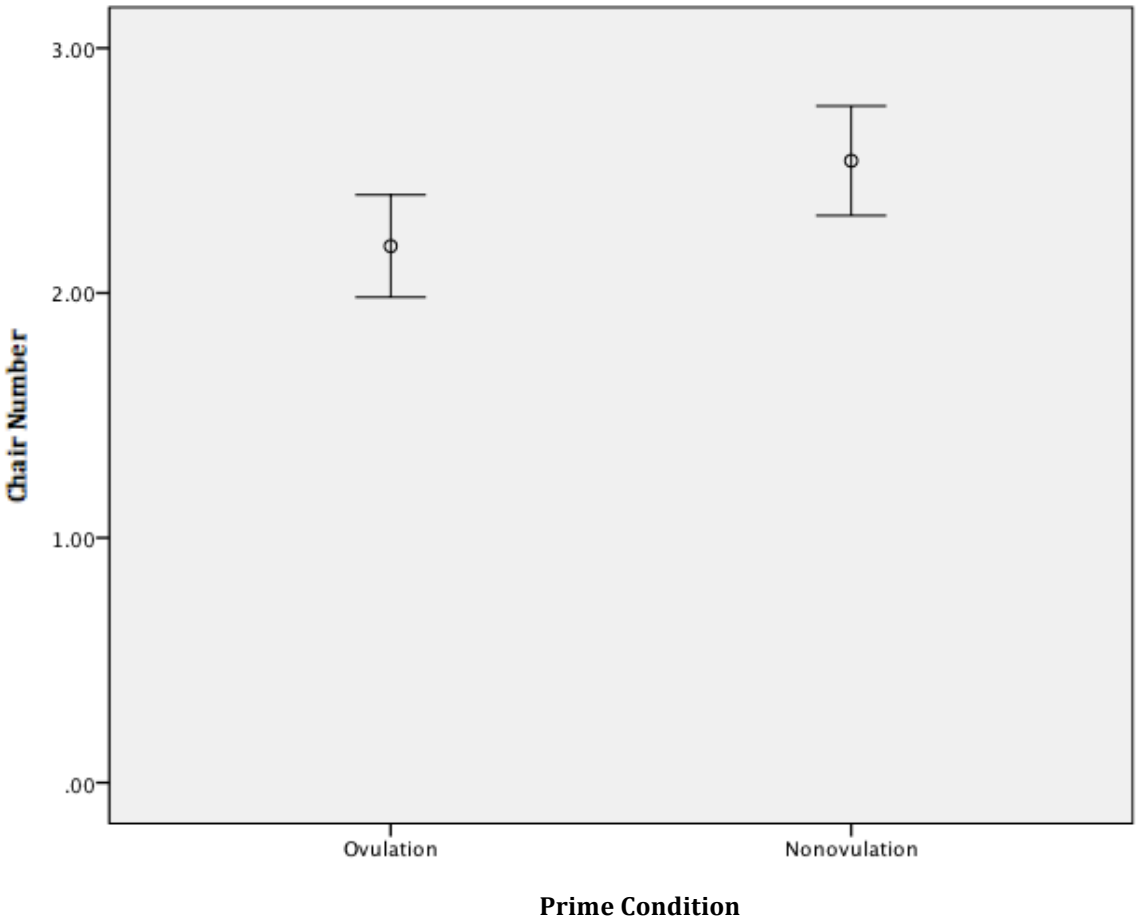

Figure 3. Graph of the 95% confidence interval of chair number by group.

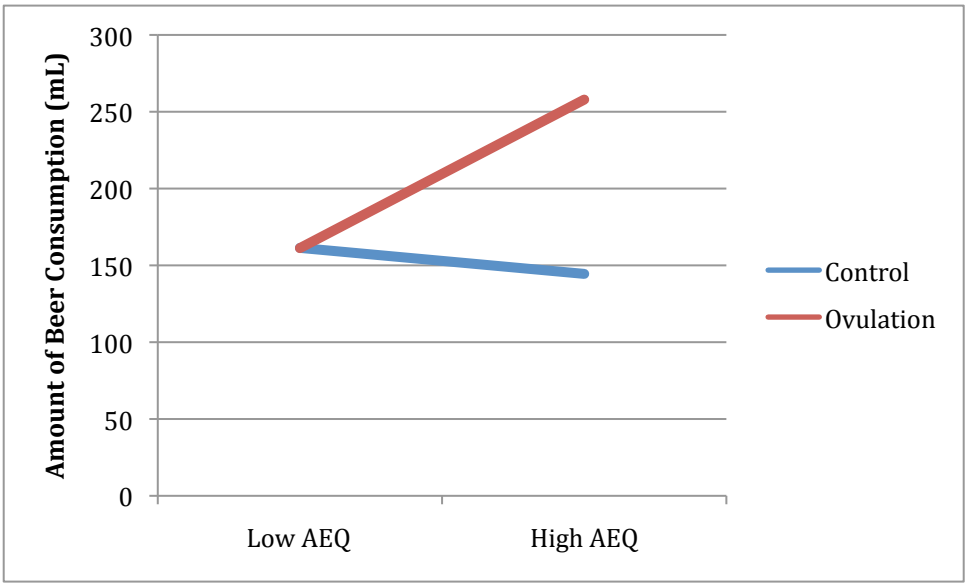

Figure 4. Plot of the interaction between prime condition and AEQ Sexual Enhancement. The interaction is significant at $p = .05$.