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The Impact of Sexual Arousal on the Category Specificity of Women's Visual Attention to Erotic Stimuli

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THE IMPACT OF SEXUAL AROUSAL ON THE CATEGORY SPECIFICITY OF
WOMEN'S VISUAL ATTENTION TO EROTIC STIMULI

By

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Bachelor of Arts
University of Nevada, Las Vegas
2008

A thesis submitted in partial fulfillment
of the requirements for the

Master of Arts – Psychology

Department of Psychology
College of Liberal Arts
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University of Nevada, Las Vegas
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August 2013

ABSTRACT

The Impact of Sexual Arousal on the Category Specificity of Women's Visual Attention to Erotic Stimuli

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Research has shown that women have a much less category-specific pattern of visual attention to erotic stimuli than do men. That is, when simultaneously presented with male and female erotic stimuli, heterosexual women attend much more evenly to both male and female erotic stimuli than do heterosexual men, who attend almost exclusively to female stimuli. The present study investigated one proposed explanation for women's more diffuse visual attention patterns – that erotic female images have arousal value for heterosexual women. To test this hypothesis, heterosexual women were presented with either a 12-minute neutral, non-arousing video ($n = 19$) or a 12-minute erotic, sexually arousing video ($n = 21$). Both groups were then presented with 10 split-screen slides, each featuring an erotic photo of a nude man on one side of the screen and an erotic photo of a nude woman on the other side of the screen. Eye-tracking methodology was used to track participants' gaze patterns. Results indicated that arousal induction, as operationalized in this study, had no significant effect on the category specificity of women's visual attention to erotic stimuli. Their visual attention pattern was diffuse in both arousal and non-arousal conditions. Because of the difficulty in

interpreting results that support the null hypothesis, as well as certain methodological limitations, this study can only claim that increasing arousal did not appear to change women's viewing patterns. It could be that women look at female images for arousal reasons, but supposedly increasing arousal levels did not change women's viewing patterns. In other words, the purposeful induction of arousal does not make women's viewing patterns more category-specific. Interpretations of this result and future directions are discussed.

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CHAPTER 1

INTRODUCTION

Sexual arousal is one of the original phases of the sexual response cycle proposed by Masters and Johnson (1966). As a pre-requisite and precursor for the other three phases in their model (plateau, orgasm, and resolution), arousal has received much attention in the study of both normal populations and those with any number of sexual difficulties. Until Helen Kaplan (1974) later introduced the concept of desire in her tri-phasic model of the sexual response cycle, research on arousal had focused almost exclusively on the measurement of the physiological aspects of sexual excitement (primarily genital vasocongestion). Kaplan recognized that sexual arousal was not just a purely physical construct but that it also encompassed cognitions and emotions – a subjective experience of wanting sex and of feeling "turned on." The relationship between desire, which has yet to be empirically differentiated from subjective arousal, and genital arousal has thus become a focus of current research in an attempt to understand the complex nature of sexual motivational states (Meana, 2010).

Sexual arousal is measured both subjectively, through self-report, and physiologically. Physiological methods primarily rely on measurement of vasocongestion as an indicator of arousal. Given that both types of measurement (subjective and physiological) were assumed to be assessing the same underlying construct, it has been surprising that self-reported arousal and physiological indicators of arousal have been found to have only low correlations among women and moderate correlations among men (Chivers, Seto, Lalumière, Laan, & Grimbos, 2010). Several theories attempt to explain the sex difference in concordance rates between subjective

and physiological arousal as resulting simply from the effects of socially desirable responding, the lack of visual genital feedback for women, and measurement artifacts (see Chivers et al., 2010). However, socio-evolutionary theory suggests that this female discordance between subjective and physical arousal may be more than a methodological confound and could actually be adaptive – that it could serve an advantageous purpose for women.

In an attempt to further investigate the sex differences in concordance between subjective and physical arousal, an elegant series of studies was conducted showing that women, much more so than men, have a non-category-specific pattern of physiological arousal (Chivers & Bailey, 2005; Chivers, Rieger, Latty, & Bailey, 2004; Chivers, Seto, & Blanchard, 2007). That is, women became genitally aroused to erotic stimuli regardless of whether they reported being subjectively aroused by the stimuli. In order to address the possibility that the sex differences in concordance rates were attributable to different measures of genital arousal for men and women (vaginal photoplethysmography in women and penile strain gauge in men), Chivers et al. (2004) included post-operative male-to-female transsexuals in their study sample. Although these transsexuals' genital arousal was measured with the same device used for the females in the study, they showed concordance patterns similar to those of natal men. Essentially, natal men (heterosexual, homosexual and transsexual) evidenced significant genital vasocongestion primarily to stimuli that featured their erotic targets, while natal women evidenced significant genital vasocongestion to all manner of explicit visual stimuli, whether or not they claimed to be subjectively aroused by said stimuli.

Research measuring other potential objective indicators of sexual arousal is pointing in a similar direction. Recently, eye-tracking methodology has been used to examine the processing of sexual stimuli via visual attention. Visual attention invariably indicates interest in a stimulus, although the interest can range from sexual arousal to disgust or even fear. In any case, the pattern of female non-category-specificity recurs when investigating sex differences in visual attention to erotic stimuli. Heterosexual men visually attend more to their erotic target (i.e., women) than to their non-erotic target (i.e., men), while heterosexual women attend much more evenly to both men and women (Akhter, Meana, & Lykins, 2011; Lykins, Meana, & Strauss, 2008; Rupp & Wallen, 2007).

It is unclear, however, whether women's more diffuse visual attention pattern to erotic stimuli indicates their more indiscriminant arousal to both male and female stimuli or whether there is another possible explanation for their diffuse viewing patterns. It is possible that heterosexual women focus on women in erotic images as much as they do for reasons other than sexual arousal. They could be focusing on the woman in the image for reasons of social comparison. Alternately, their more evenly divided visual attention may be indicative of a greater female empathy, wherein all characters in an image are attended to regardless of sexual arousal. In an attempt to tease apart the reasons underlying this diffuse visual attention pattern of women viewing sexual stimuli, this study will instate sexual arousal prior to the exposure to erotic images to investigate the impact of arousal on the visual attention patterns of women. Although this manipulation does not, in and of itself, address all possible reasons for the visual attention patterns, it

will clarify the extent to which sexual arousal either magnifies or otherwise changes gaze patterns consistently found under non-arousal primed conditions.

CHAPTER 2

LITERATURE REVIEW

In the following section, literature relevant to the proposed study is reviewed.

This literature review will cover: 1) Measurement of Sexual Arousal, 2) Agreement of Subjective and Physiological Arousal, 3) Sex Differences in Category Specificity, 4) Sex Differences in Visual Attention to Erotic Stimuli.

Measurement of Sexual Arousal

Sexual arousal is measured both subjectively and objectively; through self-report measures of how exciting a stimulus is experienced to be and through measurement of the body's response to such stimuli. The measurement of subjective arousal in both men and women can be generally divided into two types: real-time and recall. Real-time measurement occurs during stimulus presentation. The first instrument used to continuously measure subjective sexual arousal was described by Wincze, Hoon, and Hoon (1977) and consisted of a lever that could be swung along a 90° arc; the lever changed resistance as it was moved along a 10 point metal scale indicating levels of arousal. Various adaptations of this mechanism have been used, including a slider that can be moved to illuminate the number of lights that reflect a participant's level of subjective arousal (Janssen, 2002). Recall measurement occurs post stimulus presentation. Typically, participants are administered Likert-type rating scales and/or questionnaires asking them to rate how stimulating they found a specific stimulus.

Each of these methods has advantages and disadvantages. Simultaneously measuring physiological and subjective levels of sexual arousal allows experimenters to observe how the relationship between the two varies over the course of stimulus

presentation (Janssen, 2002; Wincze, Hoon, & Hoon, 1977). However, the increased attention to one's arousal during testing required by continuous, real-time measures could lead to increases in spectating – a process by which the individual focuses on him/herself from a third person perspective, possibly interfering with arousal itself (Janssen, 2002). Wincze, Vendetti, Barlow, and Mavissakalian (1980) found that continuous measures led to decreased genital responses in men, but had no effect on genital responses in women. On the other hand, measuring subjective levels of arousal after the stimulus has been presented also has disadvantages. Responses may be less representative of how the participants were feeling during stimulus presentation. They may have a difficult time precisely recalling how they felt during presentation when asked to rate themselves after the fact (Chivers et al., 2010; Wincze, Hoon, & Hoon, 1977). Also, participants may be more likely to respond in socially desirable ways. On the other hand, some of these disadvantages of post-presentation measurement may be offset by the ability to ask multiple questions related to the experience (Janssen, 2002).

Physiological measurement of sexual arousal is considered an objective, less biased mechanism than self-report alone. Although many types of physiological changes purported to be associated with sexual arousal have been measured over the years, the most commonly used method is the measurement of genital vasocongestion. Due to differences in anatomy, genital vasocongestion is necessarily measured differently in men and women. In women, vasocongestion is measured using a vaginal photoplethysmograph. A vaginal photoplethysmograph is generally an acrylic plastic probe, shaped like a tampon, which measures light reflected from the wall of the vagina (Geer, Morokoff, & Greenwood, 1974; Sintchak & Geer, 1975). The more light reflected

back into the photoplethysmograph, the more vasocongestion is inferred. The photoplethysmograph records two pieces of information, vaginal blood volume (VBV) and vaginal pulse amplitude (VPA). As vasocongestion occurs, blood pools in the vaginal tissue; VBV reflects these changes (Beck, Sakheim, & Barlow, 1983). VPA measures changes in the vaginal pulse wave, which varies depending on the amount of pressure, or swelling, within vaginal blood vessels (Janssen, 2002).

Although both VBV and VPA have been reported in the literature, VPA is by far the most commonly used measure of female genital vasocongestion. Several studies have compared the sensitivity and specificity of these two measures, lending support to the use of VPA over VBV. Laan, Everaerd, and Evers (1995) exposed 49 women to sexual, sexually threatening, anxiety provoking, and neutral film clips. They found that VPA was sensitive only to the sexual and sexual threat videos, successfully differentiating between the sexual and nonsexual stimuli; VBV, however, was sensitive to only the sexual and anxiety videos, failing to differentiate between the sexual and nonsexual stimuli. Geer et al. (1974) found that although both VPA and VBV increased during sexual compared to neutral stimulus presentation, only VPA continued to increase as the film progressed. Osborn and Pollack (1977) found that VPA, but not VBV, differentiated between two stories differing in erotic valence. Finally, Heiman (1977) found that VPA was more highly correlated with subjective arousal and that it also accounted for more variance in genital responding than VBV.

Genital vasocongestion in men has generally been measured using penile plethysmography. Changes in penile blood volume can be measured volumetrically or circumferentially, however, the latter has been most commonly used. The penile strain

gauge records the maximum circumference (erection) a man reaches, which does not need to be a full erection, and any changes are reported as a percentage of his maximum response (Abel, Blanchard, Murphy, Becker, & Djenderedjian, 1981). There are several types of strain gauges including mercury-in-rubber, indium-gallium, and mechanical (Barlow) strain gauges as well as a device called the Rigiscan Plus, which also measures rigidity. In both the mercury-in-rubber and indium-gallium gauges, a rubber tube, filled with either substance, is placed over the shaft of the penis. As the penis becomes more erect, the liquid inside the tubing is displaced, causing changes in electrical resistance of the tube (Laws, 2009). The mechanical Barlow gauge produces the same type of output as the two previous devices, using instead a thin metal ring, open on the bottom of the penis, which is placed around the middle of the shaft (Barlow, Becker, Leitenberg, & Agras, 1970). The Rigiscan Plus, which is the most widely used of the strain gauges, consists of two loops; one loop is positioned at the base of the penis, the other just under the glans (Janssen, 2002). Each loop tightens and takes circumference and rigidity measurements at set time intervals.

One of the methodological limitations of plethysmography is that it provides different, and therefore difficult to compare, data outputs for each sex. Thermography has recently been investigated as a means to overcome this challenge. Thermography provides an absolute temperature reading of a target body region, and thus can be used with both men and women. A wide variety of other devices have been investigated including thermographic imaging cameras (Abramson, Perry, Seeley, Seeley, & Rothblatt, 1981; Kukkonen, Binik, Amsel, & Carrier, 2007, 2010); labial thermistor clips (Henson, Rubin, Henson, & Williams, 1977; Payne & Binik, 2006; Prause & Heiman,

2009); and penile thermistors (Webster & Hammer, 1983). Both early and recent findings support the ability of thermography to detect temperature differences contingent on arousal.

Abramson et al. (1981) found that male and female participants who read a sexually arousing story experienced an increase in pelvic temperature while those in a fear/anger or no story control experienced a decrease in temperature. Over 20 years later with the use of much more sophisticated thermography technology, Kukkonen et al. (2007) similarly found that men and women in an erotic film condition experienced a significant increase in genital specific temperature from baseline compared to participants in neutral or humor control conditions. Kukkonen et al. (2010) also found that men and women in an erotic film condition experienced a significant increase in genital specific temperature from baseline compared to participants in neutral, humor, or anxiety control conditions. These results suggest that thermographic imaging of the genitals can differentiate between sexual and other types of arousal.

Other methods of measuring physiological arousal have included ultrasonography (Kukkonen et al., 2006; Waxman & Pukall, 2009) and pelvic magnetic resonance imaging (Maravilla et al., 2003; Suh et al., 2004). However, research on these methods remains scarce and results inconsistent.

Agreement of Subjective and Physiological Arousal

The expectation has been that subjective and physiological sexual arousal would generally co-occur; however, the relationship appears to be much more complicated than intuited. Both men and women have reported subjectively feeling sexually aroused in the absence of physiological signs of sexual arousal (Brotto, Basson, & Gorzalka, 2004;

Rieger, Chivers, & Bailey, 2005). Conversely, men and women have shown physiological signs of sexual arousal without reporting any subjective feelings of sexual arousal (Chivers & Bailey, 2005; Chivers, Seto, & Blanchard, 2007; Delizonna, Wincze, Litz, Brown, & Barlow, 2001). This discordance appears to be much more pronounced for women than for men (Chivers et al., 2010; Laan & Janssen, 2007). Although a few studies have found concordance rates between subjective and genital measures of sexual arousal in women similar in magnitude to those of men (e.g., Abramson et al., 1981; Heiman, 1977; Henson & Rubin, 1978; Korff & Geer, 1983; Meuwissen & Over, 1992), the vast majority have found the correlation between subjective and physiological arousal to be much higher in men than in women (e.g., Peterson & Janssen, 2007; Steinman, Wincze, Sakheim, Barlow, & Mavissakalian, 1981; Suschinsky, Lalumière, & Chivers, 2009).

Chivers et al. (2010) conducted a meta-analysis to summarize and synthesize cross-study data on the nature of the relationship between subjective and physiological sexual arousal in men and women. They examined 132 studies reporting correlations of subjective and genital arousal and found that men had a significantly higher correlation at a cross independent sample average of .66 than did women, whose average correlation was .26. Although the concordance rates for each sex varied widely across individual studies, there was a marked overall sex difference in the level of agreement. Furthermore, it appears that the low concordance rates for women result from the common finding of their becoming genitally aroused to sexual stimuli in the absence of subjective arousal. In other words, women's bodies are physiologically reacting to a

wide variety of sexual stimuli, regardless of whether they subjectively find the stimuli sexually arousing (Chivers et al., 2010; Laan & Everaerd, 1995a).

A number of explanations have been offered to interpret this body of data. In particular, it has been posited that the difference may be the result of socially desirable responding, the lack of visual genital feedback for women, and the possibility that measurement artifacts account for the gender difference.

The social desirability hypothesis posits that low concordance rates for women may be attributable to the fact that women may be motivated to minimize or suppress subjective feelings of sexual arousal due to societal pressures. In contrast, men may also be motivated to exaggerate their feelings of arousal as a function of parallel though opposite social expectations. Whereas men have typically received positive and permissive messages about their genitals and sexuality, women have typically received more negative and prohibitive messages. Braun and Wilkinson (2001) describe a plethora of negative messages commonly associated with female genitals in Western societies. Stewart (1999) further describes a social climate of control in which women must constantly monitor or censure their behavior – behavior which is perfectly acceptable and even desirable in men – in order to avoid receiving an often unshakeable negative reputation. These associations and pressures to conform can lead women to feel shame and guilt, among other things, toward their bodies and their sexuality. Women may be reluctant to report the full extent of their arousal in order to conform to normative ideals for female sexual expression.

Furthermore, it is possible that internalization of these messages may lead to lower subjective feelings of sexual arousal. Mosher and O'Grady (1979) concluded that

sex-guilt in women could lead to reduced levels of subjective sexual arousal. Similarly, Morokoff (1985) found that women scoring high on sex-guilt reported lower levels of subjective sexual arousal than those who scored low on sex-guilt. However, as Laan and Janssen (2007) point out, underreporting subjective sexual arousal does not seem to be a likely cause of the discordance, as people who are willing to participate in sex research typically express more permissive and positive attitudes towards sex. In addition, these sex differences in concordance are consistently found in studies across decades and in different regions; it is likely that sexual attitudes varied across time and region, yet the discordance has persisted across these very dimensions.

Another theory posits that because women lack visual feedback of their genital arousal, they experience less subjective arousal (feelings of being "turned on"). When a man becomes physiologically aroused, he can clearly see and feel his erection as it forms, providing a source of feedback that women do not have to the same extent, as women's physiological arousal is not as evident as that of men. This feedback could augment subjective arousal. In other words, perceived genital arousal (e.g., "I think I am fully erect" or "I think I am lubricating") might be an important mediator of subjective arousal. If women have a tendency to underestimate their genital arousal, this may consequently impact their experience of subjective arousal. Indeed, Chivers et al.'s (2010) review of studies reporting correlations between participants' actual genital arousal and their perceived level of genital arousal suggests that women are much worse than men at detecting their own physiological arousal.

The data on the extent to which perception of genital arousal contributes to or augments subjective feelings of sexual arousal in men and women is mixed. Sakheim,

Barlow, Beck, and Abrahamson (1984) found that ratings of subjective sexual arousal did not significantly differ between men who were free to view their erections and those who were prevented from receiving visual or tactile feedback. van Lankveld, van den Hout, and Schouten (2004) found that sexually functional men rated their subjective sexual arousal higher in a self-focus condition, in which the participant's attention to his own physical responding was induced by leading the participant to believe they were being monitored via a TV camera that was pointed at them, than men in a non-self-focus condition. Stone, Clark, Sbrocco, and Lewis (2009) presented men with feedback about their level of genital arousal and found that when men received false positive feedback, subjective sexual arousal increased and when men received false negative feedback, subjective sexual arousal decreased.

However, there is also evidence indicating that genital feedback may not be as closely tied to subjective sexual arousal in men as one might think. Beck and Barlow (1986) found that sexually functional men rated their subjective sexual arousal to be lower when instructed to focus on their genital responding than when instructed to focus on internal feelings of arousal. Bach, Brown, and Barlow (1999) provided sexually functional men, whose genitals were blocked from view, with false negative genital feedback; although physiological arousal decreased after receiving feedback, there was no difference in the men's ratings of their subjective arousal to videos watched prior to or after receiving the feedback. Delizonna et al. (2001) found that feelings of subjective sexual arousal were nearly absent in men who achieved erection via a mechanical penis pump, even though they obtained a level of physiological arousal equal to that of men who achieved erection by masturbating while watching an erotic film. These studies

suggest that the reduction of physiological sexual arousal does not necessarily lead to a reduction in subjective feelings of sexual arousal in men. Nor is the presence of physiological arousal alone necessarily enough to produce subjective feelings of sexual arousal in men.

As is the case with men, evidence linking awareness of genital arousal to subjective sexual arousal in women is also mixed. Korff and Geer (1983) found that women in their study who were instructed to be mindful of their level of genital arousal had higher subjective/physiological arousal correlations than did women who did not receive such instructions. In contrast, Meston (2006) found that concordance between subjective and physiological arousal was lower when women were in a self-focus condition (induced by placing a reflective screen in front of the television) versus no self-focus condition. In this study, physiological arousal in functional women decreased in the self-focus condition while subjective sexual arousal remained the same in both conditions. van Lankveld and Bergh (2008) also found that subjective sexual arousal did not vary between a self-focus and no self-focus condition in women. Although self-focus does not specifically induce focus on the genitals, it was presumed in the Meston (2006) and van Lankveld and colleagues (2004, 2008) articles that any attention toward the body would lead to increases in bodily self-awareness, including genital self-awareness (see Carver & Scheier, 1978).

Data are also mixed in studies in which women have been given explicit feedback regarding their level of genital arousal. Sipski, Rosen, Alexander, and Hamer (2000) found that women who were presented with false positive feedback, leading them to believe that their genital arousal was high, reported higher subjective sexual arousal.

Similarly, McCall and Meston (2007) provided women with false positive and false negative feedback of their level of physiological arousal and found that positive feedback subsequently led to higher levels of subjective sexual arousal while negative feedback led to lower levels of subjective sexual arousal. However, contrary to these results, in a much older study in which accurate feedback of genital arousal was provided to women via biofeedback, it did not lead to a higher concordance between subjective and physiological sexual arousal (Cerny, 1978).

Although there is some evidence that genital cues may play a role in the determination of women's subjective sexual arousal, it seems likely that environmental cues are more robust predictors. Pennebaker and Roberts (1992) proposed that when deprived of emotionally relevant situational cues, women are much worse than men at detecting their own physiological responses; however, when environmental cues are present, women are equally skilled at detecting their own physiological responses. Furthermore, in his extensive review of the literature, Baumeister (2000) provided evidence that women's sexuality is more highly impacted by sociocultural and environmental factors than is men's.

Finally, the hypothesis that the pronounced sex difference in discordance between subjective and physiological sexual arousal may be attributable primarily to measurement artifacts is a reasonable one. Most correlations are measured using vaginal photoplethysmography in women and penile plethysmography in men. These two measurement devices cannot be directly compared as they yield two different outputs and have different reliability and validity profiles.

The reliability and validity of vaginal photoplethysmography has been a concern for some time. For example, Beck et al. (1983) placed three vaginal photoplethysmographs in a dark and temperature-controlled room for several hours and found that VBV signal output varied across time, even though input remained constant. This baseline drift was significant enough to potentially account for any differences in baseline measurements between stimulus presentations. Furthermore, this drift, which is unpredictable and therefore cannot be controlled for, leads to questions concerning the extent to which VBV measurements reflect actual changes in vasocongestion. However, correlations of subjective and physiological sexual arousal produced by VBV are similar to those produced by measurement of VPA (Chivers et al., 2010), suggesting that this drift may not have an effect on the overall correlations obtained. Rellini, McCall, Randall, and Meston (2005) have also suggested that low correlations obtained using measures of vaginal photoplethysmography may be a result of using suboptimal statistical analyses. They suggested that the use of hierarchical linear modeling may lead to increased concordance rates between subjective and physiological measures of sexual arousal.

The problem of comparing outputs across two different types of measures may be of greater concern. It is hard to argue that comparing erections to vaginal vasocongestion using completely different methods is not problematic. However, it is worth noting that in one clever study, Chivers et al. (2004) managed to compare subjective/genital arousal correlations across natal women and natal men using only vaginal plethysmography. They recruited male-to-female (MtF) transsexuals with surgically constructed vaginas. This allowed them to use a vaginal photoplethysmograph in both women and natal men.

The results mirrored the sex difference found when using two different methods. Women had lower concordance rates than the MtF's (natal men) despite the use of the very same measurement method.

Although data using methods of physiological arousal measurement other than plethysmography are scarce, lower correlations in women than in men continue to be found regardless of the method used (Heiman & Maravilla, 2007; Laan & Janssen, 2007). The only exception appears to be thermography which is directly comparable across sexes as the same instrument is used yielding the same type of output. Thermography has indeed produced similar correlations between subjective and physiological arousal in men and women (Chivers et al., 2010). However, more research needs to be conducted as only a few studies have examined the use of thermography with both men and women (Abramson et al., 1981; Kukkonen et al., 2007, 2010; Rubinsky, Hoon, Eckerman, & Amberson, 1985). Furthermore, studies using thermography have not compared correlations between subjective and physiological arousal when using non-preferred erotic stimuli, which is essential in the detection of physiological/subjective arousal discordance. In summary, the available data to date indicate that it is unlikely that measurement artifacts completely account for the lower concordance between subjective and physiological sexual arousal in women than in men.

A more comprehensive theoretical explanation for the discordance of subjective and physiological arousal in women rejects the idea that the discordance is a result of societal pressures, feedback deficits, and/or methods. Rather, this theory posits that the sex difference in concordance rates is real and is functionally adaptive from an evolutionary perspective. According to evolutionary theory, men increase their

reproductive success by mating with large numbers of women, while women are more successful when they choose a mate who can provide both quality genetic material and resources for her and her children (e.g., social, protective, or care-giving). Thus, it is beneficial for men to become subjectively aroused when they are physiologically aroused and to want to act on their physiological arousal. On the other hand, as Suschinsky et al. (2009) point out, it is more beneficial for women not to become subjectively aroused every time they are physiologically aroused so as to prevent them from engaging in intercourse indiscriminately and to allow them to choose a partner more wisely. Ponseti and Bosinski (2010) add that genital arousal to a wide array of stimuli may have ensured that women would be able to become physiologically aroused to whatever sexual stimulus might be advantageous at the time, regardless of whether it was subjectively arousing. That is, a general genital response would allow for selective mating with a wide variety of partners, depending on characteristics that are socially or biologically beneficial within a given context. Conversely, the mate characteristics important to men have remained relatively unchanging across contexts, namely that the partner is capable of reproduction.

It has even been suggested that automatic and indiscriminant genital arousal to a wide array of sexual stimuli may have had an important protective purpose. As a function of their disadvantage in terms of brute physical strength, women are and have always been at risk for unwanted vaginal penetration. Therefore, it may have been adaptive for women to become physiologically aroused in the presence of any sexual stimuli in case penetration were to occur. Regardless of subjective arousal, this genital

response would increase vaginal lubrication and vaginal tenting and consequently protect against potential injury (e.g., Chivers et al., 2010; Laan & Everaerd, 1995a).

In further support of the idea that genital arousal happens automatically in women (e.g., Chivers, 2005; Chivers & Bailey, 2005; Ponseti & Bosinski, 2010), genital vasocongestion has been found to occur in situations of actual sexual assault (Levin & van Berlo, 2004) and when women are exposed to sexually threatening stimuli in the lab (e.g., Laan, Everaerd, & Evers, 1995; Suschinsky & Lalumière, 2010). Spiering and Everaerd (2007) have shown that sexual stimuli presented subliminally, and therefore unable to be consciously evaluated as sexual, can elicit genital arousal in women.

Additionally, several studies have noted that genital vasocongestion increases very quickly after a sexual stimulus is presented, regardless of whether the stimulus is found to be subjectively arousing (e.g., Chivers & Bailey, 2005; Laan & Everaerd, 1995a). It thus seems that, discordance aside, women arouse genitally very easily (much more easily and indiscriminately than men) and that this automaticity of arousal begs an explanation that theories about the social suppression of female sexuality cannot seem to encompass.

Sex Differences in Category Specificity

The observed sex difference in concordance between physiological and subjective sexual arousal appears to be a corollary of the observed sex differences in the specificity of a stimulus necessary to induce physiological sexual arousal. Chivers and colleagues conducted a series of studies demonstrating that while men display a category-specific pattern of physiological sexual arousal, women display a non-category-specific pattern. That is, men typically become genitally aroused only when a visual sexual stimulus features their erotic target (i.e., women for heterosexual men and men for homosexual

men), whereas women typically become genitally aroused to any explicit visual sexual stimulus, relatively independent of whether their erotic target (i.e., men for heterosexual women and women for homosexual women) is featured. Therein lays the source of the discordance. Men's category-specific pattern of genital responding aligns with their subjective arousal whereas women's non-category-specific pattern of genital arousal disagrees with their subjective arousal.

As mentioned earlier, in the first study of the series, Chivers et al. (2004) sought to determine whether the differences in arousal patterns seen in men and women were due to measurement artifacts associated with the different methods used to measure physiological arousal (i.e., penile plethysmography in men and vaginal photoplethysmography in women). They showed videos of male-male, female-female, and male-female oral and penetrative sex to a group of male-to-female (MtF) transsexuals and heterosexual and homosexual men and women. The MtF transsexuals' genital arousal was measured using a vaginal photoplethysmograph inserted into surgically constructed neovaginas, the same instrument used to measure natal women's genital arousal. They found that, similar to the heterosexual and homosexual men, the MtF transsexuals showed a category-specific pattern of genital arousal – that is, they aroused genitally primarily in line with their erotic preferences. Women, however, evidenced similar levels of genital arousal when exposed to stimuli featuring and stimuli not featuring their erotic target. This study demonstrated both that women exhibit a non-category-specific pattern of physiological arousal, and that this discordance between what they subjectively prefer and their genital responses is unlikely to be a result of measurement artifacts.

Lawrence, Latty, Chivers, and Bailey (2005) described the pattern of results for the transsexual group in the Chivers et al. (2004) study in greater detail. Both homosexual transsexuals, who were attracted to men prior to sex reassignment surgery, and non-homosexual transsexuals displayed category-specific subjective and physiological arousal to their preferred erotic target. Some researchers, however, have questioned the reliability of vaginal photoplethysmography with MtF transsexuals. Brotto et al. (2005) also attempted to measure genital sexual arousal in MtF transsexuals; however, due to considerable movement artifacts in all of their participants, genital arousal could not be measured. They concluded that vaginal photoplethysmography was not a suitable device for measuring physiological sexual arousal in MtF transsexuals. It is unclear whether the transsexual participants in the Chivers and Brotto studies had undergone differing neovagina construction methods that could have affected the utility of the vaginal photoplethysmograph. However, Brotto et al.'s (2005) inability to get reliable measures does not nullify the clean results found by Chivers et al. (2004).

In an attempt to explore the extent of women's non-category-specificity of genital arousal, Chivers and Bailey (2005) added a video of bonobos (*Pan paniscus*) copulating to their visual stimulus protocol. Heterosexual men and women viewed videos of male-male, female-female, and male-female oral and penetrative sex, bonobos copulating, and neutral landscape or primate videos. Again, men showed a category-specific pattern of arousal, becoming subjectively and physiologically sexually aroused to the female-female and female-male videos. They did not respond, either subjectively or physiologically, to the neutral and bonobo videos. In contrast, women became physiologically aroused to all human sex videos and, although to a lesser extent, also to the bonobo videos. This

occurred despite reporting no subjective sexual arousal to the bonobo stimuli and greatest arousal to the male-female stimuli.

In 2007, Chivers, Seto, and Blanchard sought to further investigate specific stimulus features that result in gender-differentiated arousal by trying to tease apart effects of gender of the actors versus the sexual intensity of the activity they are engaging in. Heterosexual and homosexual men and women were shown videos of male-male, female-female, and male-female oral and penetrative sex, solitary male or female masturbation, a solitary man or woman exercising (to provide a stimulus containing an erotic target, but without the sexual activity), bonobos copulating (to provide a stimulus containing sexual activity, but without an erotic target), and a neutral landscape. Heterosexual and homosexual men had higher subjective and genital arousal to their preferred erotic target, and their sexual arousal increased as a function of the explicitness of the sexual activity their erotic target was engaged in. Their arousal thus varied as a function of the interaction between gender of the actor and explicitness of the activity portrayed. In women, the explicitness of the activity portrayed appeared to have more of an effect than who was engaging in it. In summary, activity was a stronger predictor of women's physiological sexual arousal, whereas gender was a stronger predictor of men's physiological sexual arousal.

Chivers et al. (2007) also found that non-heterosexual women had a more category-specific pattern of genital arousal to the videos of women and men engaging in solitary masturbation or exercise than did heterosexual women. Based on this finding, they concluded that videos depicting coupled sexual interactions were too intense and therefore overriding a category-specific response that would otherwise be found in non-

heterosexual women. Chivers and Timmers (2012) wanted to see if heterosexual women would also display a category-specific pattern of arousal to stimuli that were even less intense or explicit than audio-visual masturbation and exercise. They presented heterosexual men and women with audio-only narratives describing sexual or non-sexual encounters with men or women. Yet again, women displayed a non-category-specific pattern of sexual arousal in comparison to men.

Although subjective sexual arousal is typically found to be category-specific in both men and women, it is not uncommon for women to rate stimuli that do not feature their erotic target as subjectively more arousing than stimuli featuring their erotic target. In the Chivers and colleagues series of studies (2004, 2005, 2007), heterosexual women rated videos of heterosexual couples as being the most sexually arousing; however, the women also rated videos featuring female-female couples as more sexually arousing than videos featuring male-male couples. One explanation for this may be found in the work of Symons (1979) who posited that women may become aroused by identifying with and imagining themselves as being the erotic target, unlike men who generally become aroused by visual exposure to their erotic target. Indeed Rupp and Wallen (2009) found that while men showed no preference, women rated photos in which the female actor had an indirect gaze (as compared to directly looking at the camera) more sexually attractive, which may reflect a preference for photos allowing women to more easily envision themselves as the actress. Also consistent with this theory, much of the literature on sexual fantasies has supported the idea that men are more likely to fantasize about visual characteristics of the sexual encounter while women are more likely to fantasize about

contextual and emotional aspects of the encounter (e.g., Ellis & Symons, 1990; Leitenberg & Henning, 1995).

Further support emanates from a voluminous literature indicating a greater erotic plasticity in women than in men (Baumeister, 2000). Baumeister's systematic review yielded compelling evidence for the greater influence of context and environment on the sexual attitudes and behavior of women. At the individual level, it appears that while the amount and type of sexual activity men engage in remains relatively constant, in women it fluctuates over time and across circumstances (including sexual activity with same sex and opposite sex partners). Additionally, various sociocultural factors, such as culture, education, religion, and peer association, have more of an influence on women's sexual attitudes and behavior than on men's (Baumeister, 2000, 2004). Finally, Baumeister (2000) found a larger discrepancy between women's sexual attitudes and sexual behaviors than between those of men. That is, the literature appeared to indicate that women are more likely than men to engage in sexual behavior that runs counter to their stated beliefs, values, and/or desires.

Baumeister interpreted women's erotic flexibility to indicate one of three possibilities: that women basically had to submit to male power; that they acted as sexual gatekeepers which required them to be able to change their minds and/or; that they had a lower sex drive in which sexual substitutes were acceptable if some other more valued goal was at play. Baumeister finally settled on the third interpretation, offering up another systematic literature review of gender differences in sex drive (Baumeister, Catanese, & Vohs, 2001).

Kinnish, Strassberg, and Turner (2005) also found evidence for greater erotic plasticity and fluidity in women's sexuality. Across the lifespan, both heterosexual and homosexual women reported greater variation in their sexual fantasies and attractions than did men. Homosexual, but not heterosexual, women also reported greater variation in sexual behaviors than did men. Data from large scale surveys completed in 1994 (Laumann et al.) and more recently in 2006-2008 (Chandra et al., 2011) found that women were more likely to identify as bisexual rather than strictly homosexual, whereas the opposite was true for men. Baumeister (2000) also pointed out that homosexual women were far more likely than homosexual men to have had sexual interactions with members of the opposite sex. Survey data of individuals ages 18-44 from the National Survey of Family Growth (Chandra et al., 2011) indicated that 4.6% of women who identified as being sexually attracted only to the opposite sex reported having some same-sex sexual experience, compared to 2.8% of men. This pattern also held true for individuals who reported having some same-sex sexual experience, yet who identified as being sexually attracted mostly to the opposite sex (47.4% of women v. 20.6% of men) or who identified as being heterosexual (9% of women v. 3.2% of men).

Diamond (2000, 2003, 2005, 2008) found a similar pattern of female sexual fluidity in longitudinal studies examining the course of sexual attraction, behaviors, and identities in a sample of non-heterosexual (i.e., homosexual, bisexual, or unlabeled) women. In the series, some of the women who identified as lesbian reported engaging in sexual interactions with men. She also consistently found that while the women's attractions to the same or opposite sex (or more commonly both) remained relatively stable, their identities and behavior changed over time. Two years after an initial

interview was conducted, half of the women reported changing their sexual identity several times (Diamond, 2000). After a 10-year span, Diamond (2008) found that 67% of the women in her sample changed sexual identities at least once. Diamond's interpretation of the plasticity that Baumeister had chalked up to a lower sex drive was that women privilege relationships to a greater extent than men and, consequently, develop sexual feelings consequent to feelings of interpersonal connection. In this iteration, gender is relatively incidental to emotional connection. Of course, we do not know if a similarly variable course would be evidenced in an initially heterosexually identified sample.

In summary, the data collected by Chivers and Diamond, as well the literature reviewed by Baumeister, point to a more expansive sexuality in women and a more narrowly constrained one in men. Interpretations of this plasticity vary, but the pattern has remained the same, as measured by self-report, genital vasocongestion, and partner choice. Research using other objective methodologies such as brain imaging (e.g. Costa, Braun, & Birbaumer, 2003; Hu et al., 2011; Safron et al., 2007) and eye-tracking (e.g., Akhter et al., 2011; Lykins et al., 2008; Rupp & Wallen, 2007) have also found sex differences in category specificity, lending further support to the theory.

Sex Differences in Visual Attention to Erotic Stimuli

As Baumeister (2004) aptly phrased it, "I think we can safely say we know that women have higher erotic plasticity than men, but we do not really know why..." (pp. 138). It thus seems reasonable to investigate the cognitive processes underlying sexuality in further attempts to understand the related phenomena of female subjective-physical arousal discordance, non-specificity, and erotic plasticity/fluidity. Geer (1996) was the

first to apply a cognitive information processing model to the study of human sexuality. This model describes a very quick, sometimes automatic, progression in which attention is necessarily paid to information in order for that information to be processed. In processing information, humans quickly 'decide' (even if this happens below conscious awareness) whether the information they are attending to is relevant to the current situation and, consequently, whether it requires further attention. Logically then, processing visual information requires one to visually attend to that information and continued visual attention indicates some variety of interest in a stimulus.

Applying the study of visual attention to sex research provides a new mechanism for investigating sexual interest, or at least interest in visual sexual stimuli. Visual attention to sexual stimuli has primarily been assessed using viewing time or eye-tracking methodologies. Viewing time is a broader measure of visual attention in which participants are typically given the freedom to look at a set of pictures for as long as they choose while the amount of time spent looking at each picture is calculated. Longer viewing times are interpreted to indicate greater interest. In contrast, eye-tracking provides a more molecular measure of visual attention to sexual stimuli. It specifically demonstrates what part of the visual stimulus the participants are attending to, when they are doing so, how many times they fixate on it, and for how long.

Eye-tracking has many advantages over other traditional, widely used methodologies (e.g., self-report, plethysmography). First, visual attention can be measured objectively. It does not fall subject to the many limitations of self-report (e.g., delayed recall, response bias). Furthermore, the automatic nature of visual attention acts as a buffer, reducing participants' ability to purposefully alter their viewing patterns.

Second, visual attention is an objective measure of interest that is relatively unintrusive. Participants unwilling to participate in experimental paradigms that require genital measurements may be more open to participating in studies using less invasive procedures, possibly increasing generalizability of results. Finally, unlike most measures of genital arousal, the measurement of visual attention is directly comparable in men and women.

The first study linking viewing time to sexual interest was conducted by Rosenzweig in 1942. He found that male schizophrenic inpatients in a hypersexual group looked at sexual pictures longer than at non-sexual pictures while the men in the low sexual behavior group looked at sexual and non-sexual pictures equally.

In an attempt to develop a technique to distinguish homosexual men from heterosexual men, Zamansky (1956) used an apparatus similar to a tachistoscope (a device used to present visual stimuli) to measure heterosexual and homosexual men's viewing time to a set of paired images. Photos consisted of male-female, male-neutral, female-neutral, and neutral-neutral pairs. He found that heterosexual men viewed female images longer than male or neutral images; homosexual men viewed male images longer than female or neutral images. This study was the first to find category specificity in men at the level of visual attention.

In the 40 years between 1956 and 1996, only a few studies investigating the relationship between viewing time and sexual interest were published. Leckart, Keeling, and Bakan (1966) presented heterosexual men and women with photographs of a single woman or a single man. They found that women viewed photos of women longer than they viewed photos of men. However, contrary to more recent findings, they found that

men spent equal amounts of time viewing the photos of men and women. In 1973, Brown, Amoroso, Ware, Pruesse, and Pilkey found that heterosexual men spent more time viewing photos as the latter increased in explicitness. Landolt, Lalumière, and Quinsey (1995) showed heterosexual men and women photos depicting the head and shoulders of opposite sex individuals. They found that both men and women's viewing time increased linearly as attractiveness ratings increased. Ketsetzis, Earls, and Karamanoukian (1996) showed heterosexual men and women nude, frontal images of male and female adults, pubescents, and children; coinciding with their subjective ratings of arousal, men viewed images of adult women the longest, while women viewed adult males the longest. Also contrary to more recent findings, men viewed images of same-sex adults longer than women did.

Harris, Rice, Quinsey, and Chaplin (1996) later used viewing time, ratings of sexual attractiveness, and penile plethysmography to determine the validity of using viewing time as a measure of men's sexual interest. They found that the correlation between heterosexual men's viewing time and ratings of sexual attractiveness was .91, suggesting that men looked longer at photos of people they found more sexually attractive (in this case, nude adult women). Lending further validity to the use of viewing time as an objective measure of sexual interest in men, the pattern of viewing time mirrored that of penile responses such that photos that were looked at longer also produced increases in penile response. This was true for both the heterosexual, non-offending men in the study as well as for a group of child-molesting men. Both viewing times and penile responses were able to discriminate between the offending and non-offending groups of men. Similar results were obtained by Quinsey et al. (1996) who

also found that penile responses, sexual attractiveness ratings, and viewing times were positively correlated in a group of normal, heterosexual men.

With the intuitive connection between sexual interest/arousal and viewing time empirically supported, the study of visual attention became a useful adjunct to genital and self-report measures in attempts to understand the mechanisms governing sexual arousal. Mirroring results found in research using measures of subjective and physiological sexual arousal, studies examining visual attention to erotic stimuli have also consistently found sex differences in category specificity. This effect has been found using both viewing time paradigms and eye-tracking.

Israel and Strassberg (2009) asked heterosexual men and women to rate how sexually appealing they found individual photographs of partially clothed men, partially clothed women, or neutral landscapes, while their viewing times were simultaneously measured without their knowledge. Men had a category-specific pattern of responding, looking significantly longer at female stimuli than neutral or male stimuli. Women, however, had a non-category-specific pattern of responding, looking only slightly longer at male stimuli than at female stimuli. Sexual appeal ratings mirrored the viewing time patterns with stimuli viewed the longest receiving the highest ratings. Furthermore, women looked at same-sex photos significantly longer than men did, while men looked at opposite-sex photos significantly longer than women did (Israel & Strassberg, 2009). Interestingly, when examining opposite sex pictures only, sexual appeal ratings did not correlate with viewing time in either men or women.

Rupp and Wallen (2009) sought to investigate gender differences in preferences for viewing stimuli varying in activity, genital focus, and gender focus. Stimuli consisted

of photographs of heterosexual couples engaged in different sexual positions. Men and women did not differ in overall subjective ratings of the photos or their viewing times of the photos. Consistent with eye-tracking research described later, both men and women showed a preference for viewing photos in which the female image was more visible than the male.

Lippa, Patterson, and Marelich (2010) sought to more explicitly explore the relationship between model attractiveness and model sex. They showed heterosexual men and women photographs of men and women wearing swimsuits who varied in attractiveness. Viewing time increased as a function of attractiveness for both men and women. Men and women also spent more time viewing their erotic target than their non-erotic target, although this preference was much larger in men than women.

Studies using eye-tracking, as opposed to simply measuring the amount of time a participant looks at a picture, have been able to expand upon and specify findings emanating from viewing time research. Although the use of eye-tracking has been well-established in research on various topics, such as reading, driving, and marketing, Lykins, Meana, and Kambe (2006) were the first to apply this methodology specifically to sex research. They sought to investigate whether or not eye-tracking could capture differences in the way both men and women looked at erotic and non-erotic scenes. Heterosexual men and women viewed erotic and non-erotic photographs of the opposite sex while the location and duration of their gaze patterns were recorded. The photographs were divided into three scene regions: face, body, and context. Men and women spent more time looking at bodies than at faces or context and this effect was more pronounced in the erotic stimuli. The results suggested that eye-tracking

methodology could indeed detect differences in the way that individuals attend to erotic photos versus non-erotic photos.

In their 2008 study, Lykins, Meana, and Strauss had heterosexual men and women view photos of heterosexual couples engaged in foreplay, as well as matched non-erotic images. Again they found that bodies were attended to more than faces and context in the erotic stimuli as compared to the non-erotic stimuli. Of more pointed interest was their finding that women displayed a much more diffuse viewing pattern than men, in regards to the male and female images in the photos. That is, men looked significantly more at the opposite sex image in the photo than at the same sex image. Women, on the other hand, looked much more equally at the male and female images in the photos. In other words, men focused their attention primarily on their erotic target whereas women focused their attention more evenly on both their erotic and non-erotic targets.

Rupp and Wallen (2007) conducted a similar study while also considering the effect of hormonal status on women's viewing patterns. Heterosexual men, normally cycling heterosexual women (not taking oral contraceptives [OCT's]), and women taking OCT's viewed pictures of heterosexual couples engaging in either oral or penetrative sex while their visual attention patterns were measured via eye-tracking. These photos were also divided into various scene regions including: male and female face, male and female body, genitals, clothing, and background. Overall, men looked at female faces more than both groups of women and men looked at the female body as much as both groups of women did. Women not on OCT's appeared to look more at genital regions than women on OCT's, indicating that hormones may have an influence on visual attention to erotic

stimuli. Although women spent more time looking at male bodies than men, this region received very little attention overall. This may be due to the fact that the female body region includes female breasts, which are commonly seen as very sexualized, whereas the male body region does not have an equally sexualized component that has such a strong attentional draw. Nevertheless, we again see women dedicating much more attention than men to same sex figures.

Most of the sexual stimuli used in eye-tracking research to date have consisted of photographs of men and women in various states of undress and in various sexual positions. Tsujimura et al. (2009) were the first to track visual attention patterns to video. It makes sense that visual attention patterns may change when the stimulus is dynamic. Perhaps more contextual information is readily available or participants may become more easily engaged in the stimulus, both of which may logically narrow the participants' focus, presumably toward their erotic target. However, results were consistent with previous studies using static images. Men looked at the opposite sex significantly longer than did women, while women looked at the same sex significantly longer than did men. Women also looked at the same sex more than they looked at the opposite sex; the opposite was true for men.

Most recently, Akhter et al. (2011) presented heterosexual natal men and women as well as a group of androphilic (i.e., attracted to men) male-to-female transsexuals (MtF's) with split-screen photos, each screen containing a picture of a single nude man and a single nude woman side-by-side. Using eye-tracking, they found that although men, women, and MtF transsexuals looked more at their erotic target than at their non-erotic target, this effect was much stronger in men and MtF transsexuals. Both men and

MtF transsexuals looked longer at their erotic target than did women; women looked longer at their non-erotic target than did men or MtF transsexuals. The sex differences found in these results parallel those found in Chivers et al. (2004) whereby the visual pattern is markedly different for natal men and natal women, irrespective of sexual identity and gender.

A consistent and clear pattern has emerged in the literature, wherein natal men are responding in category-specific, non-plastic ways to sexual stimuli while natal women are responding in non-category-specific, plastic ways to sexual stimuli. Converging data from self-report measures, measures of genital vasocongestion, and measures of visual attention confirm this sex difference. However, the reasons behind this pattern remain unknown. It is also possible that explanations for non-specificity in one domain (e.g., vasocongestion) may be different than those in another (e.g., visual attention). In terms of visual attention, what might explain why heterosexual women attend so much more to same sex images than do men?

One potential explanation is that images of naked women have arousal value for heterosexual women, at the level of visual attention. We already know that they do at the level of genital arousal. Perhaps this is just a cognitive parallel to vasocongestion. Alternately, it could be that women are looking at women for the purpose of social comparison. Certainly, the societal pressure on women to achieve a certain bodily ideal has been shown to be ubiquitous in Western society (Rodin, Silberstein, & Striegel-Moore, 1984). It is thus possible that women are attending as much as they do to same-sex images in an attempt to assess how they measure up. Another possible explanation is that women are identifying with the woman in the photos and videos as they have a

greater relationship/empathy orientation than do men (this could also have arousal value) (e.g., Janssen, Carpenter, & Graham, 2003; Rupp & Wallen, 2009; Symons, 1979).

Finally, it could simply be that women have more diffuse visual patterns in general, regardless of whether the image is sexual or not. Lykins et al. (2008) did find the sex difference in visual attention with both erotic and non-erotic images. Alexander and Charles (2009) tracked men and women's visual attention to non-sexualized female and male faces, female and male typical toys, and female and male typical play styles, finding mixed results. In support of women's generally more diffuse pattern, they found that women showed no preference in looking at male/female faces or male/female typical play styles; however, they did find that women preferred to look at female typical toys.

Research has yet to parse out the reasons for these sex differences in visual attention but potential explanations are amenable to empirical investigation.

CHAPTER 3

AIMS OF THE STUDY

Much of the literature on sexual arousal has found a consistent sex difference in physiological arousal to sexual stimuli, whereby men become genitally aroused to their erotic target and women become genitally aroused to both their erotic and non-erotic targets. Erotic target refers to the sex of a person's preferred sexual partner. The erotic target for heterosexual men is a woman; the erotic target for heterosexual women is a man. A parallel finding has been that men attend visually almost exclusively to their erotic target while women divide their visual attention more so than men between erotic and non-erotic targets. There are a number of potential interpretations for women's more diffuse visual attention patterns to sexual stimuli, none of which have been tested empirically. One hypothesis is that heterosexual women may be looking more at women because they are engaging in social comparison. Another is that they are engaging in a type of empathic identification. Finally, there is the possibility that heterosexual women find the woman in the photo sufficiently sexually arousing to visually attend to her almost as much as they attend to their erotic target (men).

In an attempt to understand whether the sex difference in visual attention relates specifically to this latter arousal-related hypothesis, we designed a study to begin to tease apart the validity of hypothesized explanations for the sex difference. Specifically, we sought to investigate the theory that sexual images of women may contain arousal value for heterosexual women. Thus, the research question in this study was, "What is the effect of sexual arousal induction on the visual attention patterns of heterosexual-identified women viewing sexual photos of men and women?"

In order to examine the role of sexual arousal in visual attention to sexual stimuli, half of the women in the study (i.e., experimental group) viewed a previously validated heterosexual erotic video that is known to induce sexual arousal in women. Immediately after the video, their visual attention to a set of paired sexual images of a man and a woman were tracked. The other half of the sample of women (i.e., control group) were shown a non-erotic video prior to viewing the same set of paired sexual images of a man and a woman as their eye movements are tracked. The aim was to test whether women in the arousal induction condition would differ from women in the control condition in their visual attention to sexual stimuli.

There is insufficient empirical evidence or theoretical support to hypothesize the specific effect of sexual arousal on visual attention patterns in women. However, we can theorize about what different sets of results might indicate. Although we cannot ascertain from eye-tracking alone whether visual attention denotes subjective sexual arousal (it could signal disgust), it is reasonable to suggest that subjective arousal would usually be accompanied by visual attention to the sexual stimulus that gave rise to it. Thus, aroused women should attend more to what they find arousing than either non-aroused or less aroused women. Although analyses are covered in the method section, exploration of the meaning of results requires that we here indicate that the design was a 2 (Condition: Arousal Induction Video/Control Video) X 2 (Sex of Image: Male/Female) ANOVA.

There are 4 possible sets of results simplified in narrative and graphic form as follows:

1. Main effect for arousal condition. This result would likely be in the direction of women looking both at male and female images more in the arousal condition.

This could be interpreted to mean that arousal is in fact related to women's visual attention to women, as there is no theoretical reason to posit that arousal should increase social comparison or empathic identification. If the main effect for arousal favored the control condition, this would simply mean that our arousal manipulation did not have its intended effect.

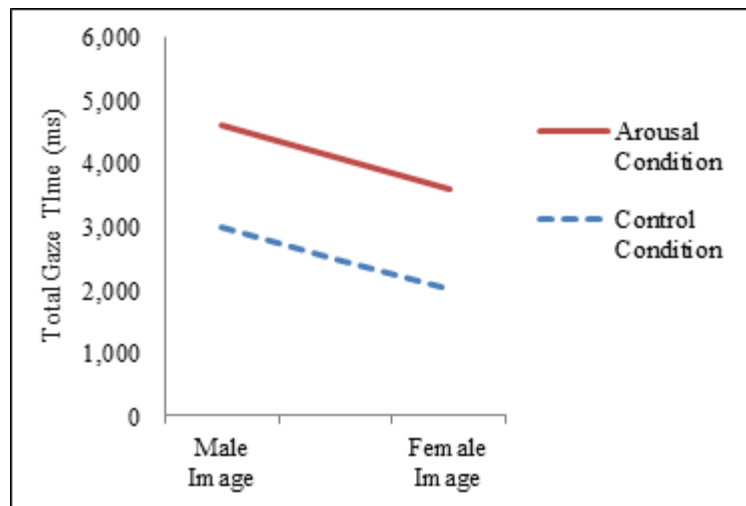


Figure 1. Possible Results – Main Effect For Arousal Condition

2. Main effect for sex of image. Both Lykins et al. (2008) and Akhter et al. (2011) found a main effect for sex of image such that all participants looked longer at the opposite sex image than at the same sex image (although women did much less so). If we also found this pattern, regardless of arousal condition, it could indicate that a) increasing arousal would not heighten the erotic value of either the male or female image, or b) heightened arousal does not distract women from social comparison or empathic identification with the female image.

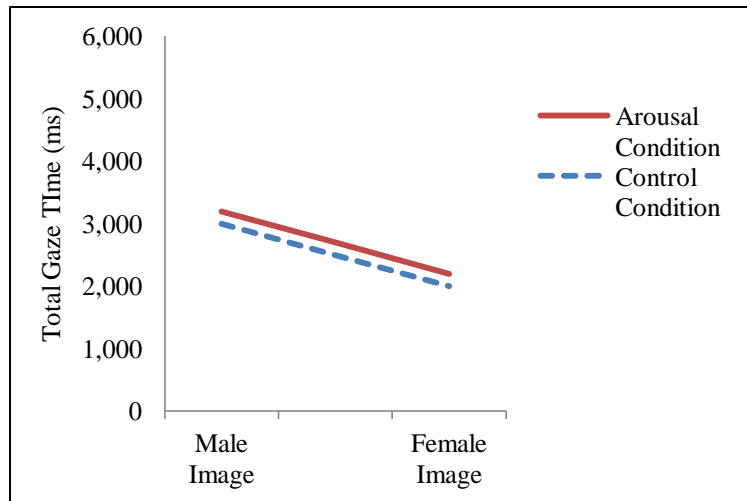


Figure 2. Possible Results – Main Effect For Sex of Image

3. Interaction #1. If in the arousal condition women spent more time looking at men and less time looking at women than in the control condition, this would indicate that given sufficient arousal, women do end up focusing on their erotic target (men). This would not negate that arousal was involved in gazing at women in the control condition but that, past a certain arousal threshold, their visual attention aligns with their stated erotic preference.

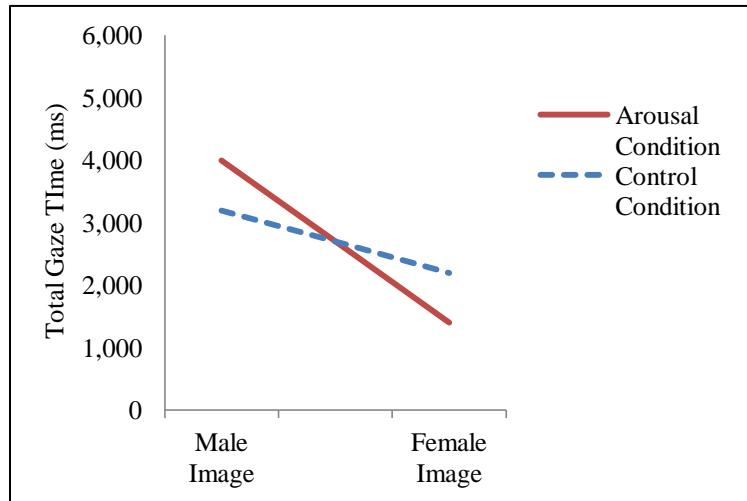


Figure 3. Possible Results – Interaction #1

4. Interaction # 2. If in the arousal condition women spent more time looking at women and less time looking at men than in the control condition, this would indicate that given sufficient arousal women end up focusing on their supposedly non-erotic target, strongly endorsing its arousal value regardless of stated sexual preferences.

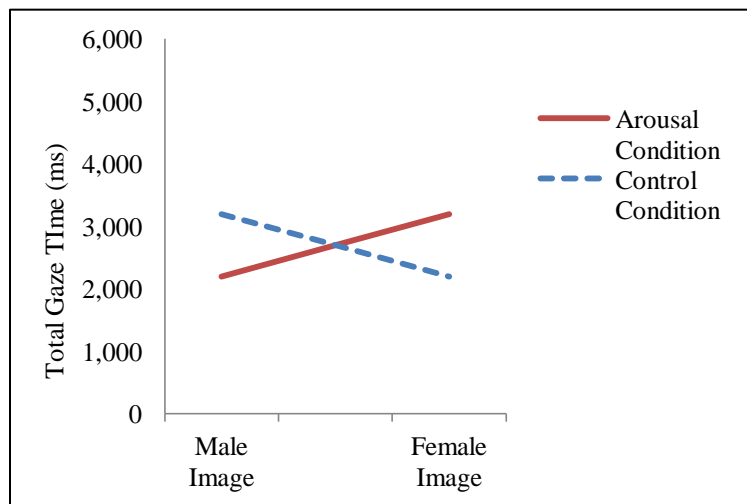


Figure 4. Possible Results – Interaction #2

CHAPTER 4

METHODOLOGY

Participants

Participants consisted of heterosexual women who were recruited via advertisement on the University of Nevada, Las Vegas SonaSystems website. Participants received one research credit for participation. All participants were required to be over 21-years-old, heterosexual, and have normal or corrected-to-normal vision (i.e., normal vision with contacts or glasses). The Kinsey Heterosexual-Homosexual Rating Scale (see Appendix A) was used to determine sexual orientation in all participants. Three versions of the Kinsey Scale were utilized, one each to determine participants' sexual orientation, sexual attraction to men and women, and sexual experience with men and women.

A total of 54 women participated in the study, yielding a final sample of 40 participants who met inclusion criteria and produced valid eye-tracking data. Due to either experimenter error, difficulty with calibration, or participants moving to such an extent that valid eye-tracking data could not be collected, a total of 12 participants were excluded. Additionally, two participants were excluded for endorsing a slightly bisexual orientation (i.e., a two on the Kinsey Heterosexual-Homosexual Rating Scale). All remaining participants endorsed exclusive or nearly exclusive heterosexual orientation, attraction, and experience (i.e., scores of 0 or 1).

Sociodemographic characteristics of the final sample ($N = 40$) are presented in Table 1. Analyses revealed no significant group differences among the control and experimental groups on age ($F(1, 38) = .70, p = .409$), ethnicity ($\chi^2(4, n = 40) = .703, p$

= .134), religious affiliation (χ^2 (4, n = 40) = 1.00, p = .910) and level of education (χ^2 (3, n = 40) = 1.98, p = .576).

TABLE 1

<i>Participant Sociodemographic Characteristics</i>						
	Control Group (n = 19)		Experimental Group (n = 21)		All Participants (N = 40)	
	M	SD	M	SD	M	SD
Age	24.3	5.5	26.1	7.9	25.3	6.9
Ethnicity	n	%	n	%	N	%
Caucasian	8	42.1	6	28.6	14	35.0
Asian	4	21.1	5	23.8	9	22.5
African American	3	15.8	4	19.0	7	17.5
Hispanic	1	5.3	6	28.6	7	17.5
Mixed/Other	3	15.8	0	0.0	3	7.5
Religious Affiliation						
None	8	42.1	10	47.6	18	45.0
Christian	6	31.5	4	19.0	10	25.0
Catholic	3	15.8	4	19.0	7	17.5
Buddhist	1	5.3	1	4.8	2	5.0
Jewish	1	5.3	1	4.8	2	5.0
Spiritual	0	0.0	1	4.8	1	2.5
Education						
High school diploma	0	0.0	1	4.8	1	2.5
Some college	11	57.9	11	52.3	22	55.0
Associate's degree	7	36.8	6	28.6	13	32.5
Bachelor's degree	1	5.3	3	14.3	4	10.0

Measures

Two types of measures were utilized and are described below: 1) eye-tracking methodology, which yields our dependent measures of visual attention and interest, and 2) self-report instruments, which yield information on sociodemographics and other variables of interest.

Dependent Measures

Total gaze time.

Eye-tracking methodology (see apparatus and procedure sections for technical details) was utilized to measure total gaze time. Total gaze time is a measure of the total amount of time a participant spends looking at each area of interest (in this case, the image of the man or of the woman). Total gaze time is commonly taken to be an indication of interest in eye-tracking research as it seems that we would logically spend more time attending to stimuli that capture our interest (Henderson & Hollingworth, 1999). Each participant's total gaze time was captured (in milliseconds) for each scene region (male image and female image) within each slide (a total of 10 slides). These data were then averaged across slides per participant, yielding a mean total gaze time per scene region for each participant.

Number of fixations.

Number of fixations is a measure of the total number of distinct fixations (or number of times) that a scene region has been attended to. Number of fixations is also commonly taken to be an indication of interest. Specifically, the number of fixations is related to the informativeness of the scene region, with more fixations indicating a greater level of relevant information (Henderson & Hollingworth, 1999). Each participant's

number of fixations were totaled for each scene region within each slide. These data were then averaged across slides per participant, yielding a mean total number of fixations per scene region for each participant.

Self-Report Measures

Post-experimental questionnaire.

A post-experimental questionnaire was administered to all participants to gather information on age, ethnicity, religious affiliation, and level of education as well as information regarding relationship status, sexual experience, sexual experience with a woman, exposure to pornography, any prior exposure to the photos and videos used in the study, and how sexually arousing the video and images were found to be (see Appendix A).

Kinsey Heterosexual-Homosexual Rating Scale (Kinsey, Pomeroy, & Martin, 1948).

Sexual orientation was determined using the Kinsey Scale. The scale consists of a seven-point continuum of sexual orientation ranging from 0, indicating an exclusively heterosexual orientation, to 6, indicating an exclusively homosexual orientation. The remaining points between 0 and 6 indicate varying degrees of co-occurring heterosexuality and homosexuality. Only the data of participants with a score of 0 or 1 were analyzed as these scores indicate a strong heterosexual orientation.

Stimuli

Participants in the control condition viewed a 12-minute neutral video of landscape scenery. Participants in the experimental condition viewed a 12-minute video of a heterosexual couple engaging in sexual intercourse. The erotic video, *Sweet Lady*,

has been validated at the Kinsey Institute and shown to induce sexual arousal in female participants (Janssen, Carpenter, & Graham, 2003). *Sweet Lady* was also piloted on a group of 13 women from the University of Nevada, Las Vegas psychology subject pool and shown to be highly arousing (on a 5-point scale: $M = 3.85$, $SD = .99$). The length of each video was chosen to be 12 minutes as female genital arousal to visual sexual stimuli has been shown to peak at 10-15 minutes after first exposure (Kukkonen et al., 2007, 2010). Habituation does not seem to be a concern within this time frame. Laan and Everaerd (1995b) assessed women's habituation to sexual videos that either varied in content or repeated the same content and found that there was a slight, but non-significant, decline in genital and subjective sexual arousal in the repeated content condition over the 21 one-minute film clips; genital arousal was higher overall when the women were presented with varied video clips and no decline in arousal was found. Thus, there is little reason to believe that subjective or physiological habituation to sexual stimuli will occur. To date, no time analysis studies have been conducted to determine if/how visual attention to sexual stimuli change over time.

All participants viewed ten split-screen slides, each featuring an erotic photo of a nude man on one side of the screen and an erotic photo of a nude woman on the other side. Within each slide, images were matched for size, amount of genital exposure, and body position of models (see Appendix B). These slides have been used in previous eye-tracking research by Akhter, et al. (2011). Slides were presented for 10 seconds each, in randomized order. Designated regions of interest were drawn around the body and head of each male and female actor; all data were collected from within these regions. Regions outside these designated areas are considered context and no gender differences

in viewing context have been found (Lykins et al., 2008). As context is not a gender-specific region of interest, data were not collected from this region. A calibration slide consisting of a small white square centered on a black screen was presented for five seconds between each erotic slide.

Apparatus

Stimuli were presented on an ASUS VW193T LCD monitor using an Intel® G41 Express Chip graphics card operating at a refresh rate of 60 Hz and a resolution of 1440 x 900 pixels x 16.7M colors. Eye movements were captured and recorded by an ASL D6 remote desktop eye-tracker. The system uses infra-red (870 nm) video-based technology to track the eyes. The Video Head Tracker utilizes ambient light to recognize facial features and track the position of the eye relative to the D6 optics. Eye positions are recorded at 120 Hz. Although viewing is binocular, only the position of the left eye will be tracked as is common in eye-tracking literature.

Procedure

A randomized participant group assignment sheet was created using computer-generated random numbers. All participants were assigned to either the control or experimental group based upon which group was next on the assignment sheet. Each session began with a brief description of the study procedures and participants were given an opportunity to ask questions. Participants read and signed the informed consent and were given a copy for their records. All participants were told they could end participation in the study at any time, without penalty. All participants were also informed that data would be numerically coded and not directly linked to any identifying information. Once any questions were answered, participants in the control group were

informed that they would be shown a 12-minute video. Participants in the experimental group were informed that they would be shown a 12-minute erotic video depicting a heterosexual couple engaging in oral and penetrative sex. Participants in both groups were then informed that immediately after the video presentation, a slideshow depicting images of nude men and women would begin. They were instructed to look at each picture as they normally would and, when a calibration slide appeared, to gaze at the white sign in the center of the slide until a new slide of images appeared, at which time they should resume natural viewing. Participants were informed that they would be notified via on-screen instructions when the eye-tracking portion of the study was complete, at which time they should fill out the Kinsey Scale and post-experimental questionnaire. Participants were instructed to insert the completed questionnaire into a provided manila envelope, seal the envelope, and slide the envelope into a box via a slot in the lid.

Next, participants were instructed to sit in a comfortable position that could be maintained for the duration of the study as they needed to remain as still as possible. Once the participant was positioned, the eye-tracker was calibrated. The calibration screen consisted of a white nine-dot matrix on a grey background. Participants were asked to fixate on each marker in succession in order to accurately capture each participant's unique gaze coordinates. This process was repeated until each of the nine markers was accurately calibrated. Once calibrated, participants were informed that calibration was complete and that they should continue to remain as still as possible for the duration of the eye-tracking study. The experimenter then left the room so that the participant could complete the study. Upon completion, participants were provided an

opportunity to ask question, were invited to contact the experimenter at any time with further questions, and were thanked for their participation.

Data Analyses

Descriptive analyses were computed for participant background variables and covariation was investigated. Eye-tracking results were analyzed in two 2 (Condition: Arousal Induction v. Control Video) x 2 (Image Sex: Male v. Female) mixed design ANCOVAs (one each for number of fixations and total gaze time).

CHAPTER 5

RESULTS

Overview

Data were collected and analyzed for two dependent measures: 1) number of fixations and 2) total fixation duration. Number of fixations and total fixation duration were significantly positively correlated across all scene regions (all p 's < .001). First, results of the manipulation check will be presented. Covariation results are then presented followed by results of the analyses of covariance for each dependent measure. Finally, power and effect size estimates will be discussed.

Manipulation Check

Subjective arousal ratings were obtained for both the neutral landscape video and *Sweet Lady*, the erotic video. *Sweet Lady* was rated as being significantly more sexually arousing than the neutral landscape video ($F(1, 38) = 12.41, p = .001$) (see Table 2), indicating the manipulation of the video had the intended effect.

TABLE 2

<i>Participant Ratings of Sexual Arousal</i>	Control Group (n = 19)		Experimental Group (n = 21)		All Participants (N = 40)	
	M	SD	M	SD	M	SD
How arousing was the video?	2.47	1.17	3.71	1.06	3.13	1.27
How arousing were the photos of men?	3.21	0.98	3.14	1.20	3.18	1.08
How arousing were the photos of women?	3.37	0.90	3.14	1.28	3.25	1.10
<i>Note.</i> Ratings were given on a 5-point scale ranging from Very Un-arousing (1) to Very Arousing (5).						

Covariation

We did not find group differences in hormonal contraceptive use, in whether participants had ever had sexual intercourse, age of first intercourse, current relationship status, ethnic preference for sexual partners, frequency with which they accessed sexual visual material, feelings toward sexual visual material, sexual orientation, or sexual attraction to men and women. Furthermore, there was no group difference in how sexually arousing the slideshow photos of men and women were found to be (see Table 2). However, we did find a group difference on sexual experience with men and women ($\chi^2 (2, n = 39) = 6.08, p = .048$) such that participants in the control group reported more sexual experiences with women than participants in the experimental group (see Table 3). Therefore, analyses were conducted using sexual experience with men and women as a covariate.

TABLE 3

	Control Group (n = 19)		Experimental Group (n = 21)		All Participants (N = 40)	
	n	%	n	%	n	%
Sexual Orientation						
Exclusively heterosexual	15	78.9	18	85.7	33	82.5
Predominantly heterosexual, incidentally homosexual	4	21.1	3	14.3	7	17.5
Sexual Attraction						
Only to men	11	57.9	9	42.9	20	50.0
Predominantly men, incidentally women	8	42.1	12	57.1	20	50.0
Sexual Experience						
Only had experiences with men	13	68.4	18	85.7	31	77.5
Mostly experiences with men, incidentally with women	6	31.6	1	4.8	7	17.5
Never had any sexual experiences	0	0.0	2	9.5	2	5.0

Main Analyses

Results were analyzed in two 2 (Condition: Arousal Induction v. Control Video) x 2 (Image Sex: Male v. Female) mixed design ANCOVAs (one each for number of fixations and total gaze time). Sexual experience with men and women was used as a covariate. The two-level between-subjects factor was Condition and the two-level within-subjects factor was Image Sex. Three outliers were identified, meaning their number of fixations and total gaze time were more than two standard deviations above or below the means. Analyses were run with and without the outliers, yielding no significant differences in the results. As such, results will be presented using the full data set.

Total Number of Fixations

Table 4 displays unadjusted means and standard deviations (SDs) of total number of fixations for women in the control and experimental group by image sex (male and female). Table 5 displays adjusted means and standard errors (SEs). ANCOVA results for total number of fixations appear in Table 6. After controlling for sexual experience with men and women, there was no significant main effect for Condition ($F(1, 37) = 0.40, p = .532$). There was a trend toward a significant main effect for Image Sex ($F(1, 37) = 3.82, p = .058$) such that there was a greater number of fixations on the male images than the female images, which likely would have reached significance with a larger sample. There was also no significant Condition X Image Sex interaction ($F(1, 37) = 1.09, p = .304$). The number of fixations on the female image violates the assumption of equality of error variances according to Levene's test ($F = 5.806, p = .021$). No other assumptions of ANCOVA were violated.

TABLE 4

Means and SDs for Total Number of Fixations

Image Sex	Control Group (n = 19)		Experimental Group (n = 21)		All Participants (N = 40)	
	M	SD	M	SD	M	SD
Male	8.53	3.38	9.61	2.77	9.10	3.09
Female	7.65	3.30	7.01	2.25	7.31	2.78

TABLE 5

Adjusted Means and Standard Errors for Total Number of Fixations

Image Sex	Control Group (n = 19)		Experimental Group (n = 21)	
	M	SE	M	SE
Male	8.51	0.72	9.63	0.68
Female	7.53	0.62	7.12	0.59

TABLE 6

Analysis of Covariance on Total Number of Fixations for 2-way Interaction (Condition x Image Sex)

Source	df	MS	F	Partial eta-squared	p
<i>Between subjects</i>					
Sexual Experience (SE)	1	22.146	3.536	.087	.068
Condition (C)	1	2.498	.399	.011	.532
Error	37	6.263			
<i>Within subjects</i>					
Image Sex (IS)	1	40.558	3.819	.094	.058
IS x SE	1	9.797	.922	.024	.343
IS x C	1	11.563	1.089	.029	.304
IS Error	37	10.620			

Total Fixation Duration

Table 7 displays unadjusted means and SDs of total fixation duration for women in the control and experimental group by image sex (male and female). Table 8 displays adjusted means and SEs. ANCOVA results for total fixation duration appear in Table 9. After controlling for sexual experience with men and women, there were no significant main effects for Condition ($F(1, 37) = 0.16, p = .70$). There was a trend toward a significant main effect for Image Sex ($F(1, 37) = 3.58, p = .066$) such that male images was attended to longer than female images, which likely would have reached significance with a larger sample. There was also no significant Condition X Image Sex interaction ($F(1, 37) = 1.00, p = .324$). Total fixation duration on the female image in the control group violates the assumption of normality ($S-W = .885, df = 19, p = .027$). No other assumptions of ANCOVA were violated.

TABLE 7

<i>Means and SDs for Total Fixation Duration (in Milliseconds)</i>						
Image Sex	Control Group (n = 19)		Experimental Group (n = 21)		All Participants (N = 40)	
	M	SD	M	SD	M	SD
Male	3284.65	1639.37	3785.64	1574.21	3547.67	1604.82
Female	2827.67	1523.04	2470.68	1026.20	2640.25	1281.89

TABLE 8

Adjusted Means and Standard Errors for Total Fixation Duration (in Milliseconds)

Image Sex	Control Group (n = 19)		Experimental Group (n = 21)	
	M	SE	M	SE
Male	3296.17	374.39	3775.22	355.96
Female	2777.27	287.16	2516.29	273.03

TABLE 9

Analysis of Covariance on Total Fixation Duration (in Milliseconds) for 2-way Interaction (Condition x Image Sex)

Source	df	MS	F	Partial eta-squared	p
<i>Between subjects</i>					
Sexual Experience (SE)	1	1595895.231	1.062	.028	.310
Condition (C)	1	233183.864	.155	.004	.696
Error	37	1503356.230			
<i>Within subjects</i>					
Image Sex (IS)	1	9631397.329	3.582	.088	.066
IS x SE	1	4046354.906	1.505	.039	.228
IS x C	1	2685361.112	.999	.026	.324
IS Error	37	2688843.975			

Power and Effect Size Estimates

Previous eye-tracking research examining visual attention patterns to erotic stimuli has found large effect sizes with group sample sizes of 19-20 (e.g., Akhter et al., 2011; Lykins et al., 2008). Based upon these findings, the sample size for the current study was set to detect a large effect. However, in these previous studies finding large effects, comparisons were between the viewing patterns of men and women. In this women only sample, a large effect was clearly not found. In order to have the power to find a medium effect, the current sample size would need to be doubled (Cohen, 1992). However, current effect size estimates are negligible (see Tables 6 and 9). As effect size estimates are not influenced by sample size (e.g., Berben, Sereika, & Engberg, 2012; Fritz, Morris, & Richler, 2012), there is no reason to believe that a medium effect size would be found even if the sample size was increased. Small effect sizes were deemed of little interest in the current study.

CHAPTER 6

DISCUSSION

Summary of Findings

The aim of this study was to investigate the extent to which arousal might impact the non-category-specific visual attention pattern that heterosexual women display when simultaneously presented with erotic images of men and women. We thought it likely that sexually aroused women would attend more to the stimulus that led to their arousal than would non-aroused or less-aroused women. Thus, changes in visual attention as a function of arousal would illuminate the extent to which arousal explains, at least partially, this gender specific viewing pattern.

There was no significant interaction between arousal condition and the sex of the image attended to for either of the dependent variables, total number of fixations or total fixation duration. The direction of the relationship was such that women in the arousal condition appeared to have a more category-specific visual attention pattern than women in the neutral condition: they looked slightly more at the images of men than did women in the neutral condition. However, variability within each condition was extremely large and no significant between group differences were found.

Although main effects for arousal condition or sex of the image were not found, they were not of specific interest to this study. The lack of main effect for the sex of the image is, however, worthy of note. Previous research has found a main effect for image sex such that all heterosexual participants (men and women) looked longer at the opposite sex image than at the same sex image (Akhter et al., 2011; Israel & Strassberg, 2009; Lykins et al., 2008). Although women in both of our conditions looked slightly

longer at the male image than at the female image, a main effect for sex of the image was not found for either of the dependent variables. This is almost certainly an issue of statistical power. Unlike in the case of the Condition X Image Sex interaction, it is likely that we would have found a main effect for Image Sex with a larger sample.

By and large, however, women in both conditions (arousal and neutral) had a relatively non-category-specific pattern of visual attention. The frequency distributions of amount of time (or number of fixations) spent looking at the male image minus the amount of time (or number of fixations) looking at the female image (see Figures 5 and 6) come closer to having a mean of 0 than any distribution found for men's visual patterns in similar studies (e.g., Akhter et al., 2011; Lykins et al., 2008; Rupp & Wallen, 2007; Tsujimura et al., 2009).

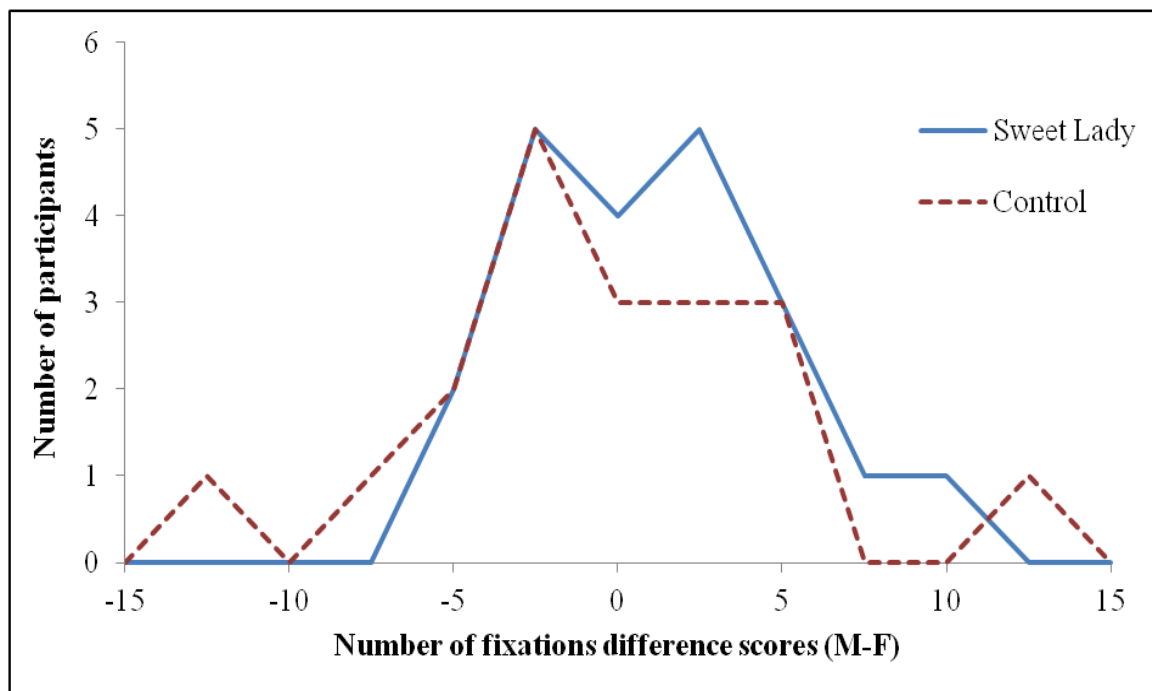


Figure 5. Male Minus Female Number of Fixations Difference Scores

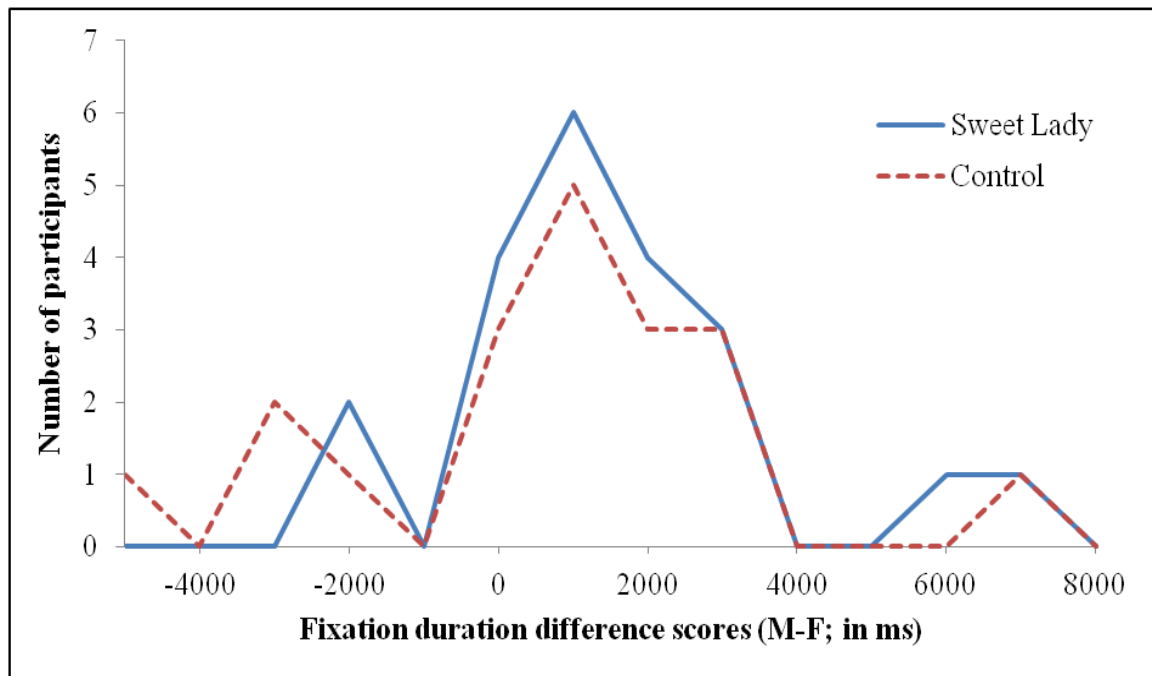


Figure 6. Male Minus Female Total Fixation Duration Difference Scores (in milliseconds)

Interpretation of Results

Was it a failure of arousal?

Overall, it appears that sexual arousal had no significant impact on the category-specificity of women's visual attention to erotic stimuli in our study. One possible explanation of these results is that the manipulation of sexual arousal did not work as expected – the women in the arousal condition may not have been sufficiently aroused by the erotic video. Although the sexual video was rated as significantly more arousing than the neutral video, perhaps absolute arousal was still low. The average rating of arousal to the erotic video was 3.71 on a 5-point scale, which places the average arousal rating about three-quarters of the way between “neither arousing nor un-arousing” and “somewhat arousing.” However, research has repeatedly shown that sexual videos reliably produce high levels of subjective and physiological arousal. There are also questions about the extent to which study participants truthfully report subjective sexual arousal, especially women. Oliver, Maykut, and Meana (in preparation) found that both men and women who falsely believed their responses were being monitored by a lie detector reported greater levels of subjective sexual arousal than did participants who did not believe their responses were being monitored. This effect was especially pronounced in women, who reported greater increases in subjective arousal than men. Our choice of video was predicated by Janssen et al.'s (2003) finding that *Sweet Lady* was rated by a sample of women as being the second most sexually arousing video out of 20 videos tested. Thus, it is likely that this video was at least as arousing as any other video we could have shown.

Another possible explanation in the failure-to-sufficiently-arouse category is the possibility that the static images of nude men and women shown after the videos (and during which the eye-tracking took place) were arousing in and of themselves, and that the erotic video did not increase arousal above and beyond that. This would mean that women in both conditions were equally aroused. However, the photos of men and women were rated as being only slightly more arousing than “neither arousing nor un-arousing,” which seems to indicate that the women in this study did not find the photos particularly sexually arousing. The arousal video was also rated as being more arousing than the photos, while the neutral video was rated as being less arousing than the photos. Finally, Laan and Everaerd (1995b) found that static sexual images led to such low levels of arousal that they could not determine whether habituation led to decreases in arousal. A sexual video produced higher levels of arousal than the images, leading them to conclude that video is superior to images, which alone may not be sufficient, in producing sexual arousal. It thus seems plausible that the images may have been arousing to an extent, but not to such a magnitude that the erotic video would not have provided additional arousal.

Was it an underestimation of arousal even when arousal is not induced?

On the other hand, heterosexual women's diffuse viewing pattern has been found both with erotic and non erotic images. The current finding that women displayed a non-category-specific visual attention pattern regardless of whether they had previously viewed an erotic or neutral video aligns with Lykins et al.'s (2008) finding that women have non-specific patterns of visual attention when viewing both erotic and non-erotic photos. That is, when shown non-erotic photos of men and women engaged in some

innocuous activity, heterosexual men focused almost exclusively on the women in the photo and heterosexual women displayed the same diffuse viewing pattern we evidence when they look at erotic images. Lykins et al. posited that, although the non-erotic photos were rated as being significantly less arousing than the erotic photos, it is possible that the non-erotic photos may still have been arousing for heterosexual women (and men) given that most people initially become aroused to their partners when that partner is fully dressed and not engaging in explicitly sexual behavior. Chivers and colleagues (2007, 2012) found that increases in the eroticism of stimuli which led to greater genital arousal did not lead to greater category specificity of women's genital arousal. Likewise, perhaps increases in arousal or eroticism do not lead to greater category specificity in the visual attention of women.

Do women have arousal value for heterosexual women?

A third possibility is that heterosexual women do indeed find women sexually arousing to an extent that heterosexual men do not find men sexually arousing, and this arousal to women results in a more diffuse viewing pattern, regardless of conditions. This would align with Chivers and colleagues (2004, 2005, 2007, 2012) findings that stimuli that are sexual in nature, regardless of whether or not a preferred erotic target is featured, leads to physiological arousal. Perhaps then women are as indiscriminant in visual attention as they are in genital arousal.

Evidence also suggests that women have greater erotic plasticity than do men, changing their sexual identity across time, as well as reporting a greater variation in sexual behaviors and attractions than men. In heterosexually identified women, identity appears to remain relatively stable, while attractions and sexual fantasies fluctuate across

time (Kinnish et al., 2005). In non-heterosexual women, attractions (commonly to both men and women) remain relatively stable, while identities and behavior fluctuate across time (Diamond, 2000, 2003, 2005, 2008). It thus seems identity is less related to attractions and behaviors for women than it is for men. So, although women may be identifying as heterosexual, they may still be attracted to and aroused by members of the same sex. Indeed, women in the current sample rated the photos of the women as being equally arousing as the photos of the men, which would align with their non-category-specific visual attention to those photos.

Are women's visual attention patterns unrelated to arousal?

Finally, it is possible that women's non-category-specific visual attention pattern is unrelated to sexual arousal. Increasing the arousal value of stimuli – from non-erotic photos, to erotic photos, to brief erotic video clips, to a full-length erotic video combined with erotic photos – does not seem to change women's visual attention category specificity. Using the least arousing visual stimuli, non-erotic photos, Lykins et al. (2008) found that women still had a diffuse visual attention pattern in comparison to men. They concluded that this result was more likely related to the non-specificity of female sexual arousal than to either a general, fundamental difference between men and women's visual attention patterns or to other gendered explanations for the difference.

One non-arousal explanation for the gender differences in visual attention patterns is that perhaps women are more contextual in their visual and other approaches to stimuli. Perhaps women look at all aspects of a scene more than men do. However, in the Lykins et al. (2008) study, men and women did not differ in the amount of time they attended to scene context (non human image components), which was relatively little compared to

time spent viewing the male or female actors, whether or not the stimuli were erotic in nature. One might expect that, if women's visual attention patterns were fundamentally diffuse, women would attend equally to all parts of the stimulus, and that this would remain unaffected by the level of eroticism in the photos. However, women do not pay equal attention to all stimulus characteristics. While category specificity remains relatively constant, attention is differentially paid to genitals, bodies, faces, or context depending on whether the photos are erotic or non-erotic or whether a woman is taking oral contraceptives or is normally cycling.

Lykins et al. (2006) found that women looked at bodies significantly more when the stimulus was erotic than when it was non-erotic; women looked at faces and context significantly less when the stimulus was erotic rather than non-erotic. Lykins et al. (2008) replicated this finding – women looked more at bodies, and less at faces, when viewing the erotic stimuli than when viewing the non-erotic stimuli. Rupp and Wallen (2007) found that normally cycling women looked more at genitals than did women taking hormonal contraceptives, while women taking hormonal contraceptives looked more at clothing and background than did normally cycling women. Finally, Alexander and Charles (2009) found that, although women preferred to look at female typical toys, they showed no preference for looking at male/female faces or male/female typical play styles.

Another potential explanation is that women are looking at other women in these images for reasons related to social comparison rather than arousal value. Perhaps women look at women in the images because they are intrigued by the variations in women's bodies and how those variations may be different than their own. Women may

be judging the extent to which their appearance and the model's appearance align or deviate from beauty ideals. This tendency toward comparison may have an evolutionary basis as physical appearance may be the primary domain in which women compete for a mate given its primary importance in male mate selection (Buss & Schackelford, 2008). According to Rodin et al. (1984), women commonly report automatically scanning their environment for other women and assessing how they measure up to these other women. Thus, as a precursor to female intrasexual competition, women may be looking at other women in the images to assess how they compare.

Alternately (although possibly relatedly), objectification theory posits that women are treated as a "collection of body parts" (pp. 174) whose primary purpose is for the use and pleasure of others (for a review see Fredrickson & Roberts, 1997). Women's bodies are sexualized and evaluated primarily through visual examination (Calogero, 2004; Fredrickson & Roberts, 1997). Thus, women may be socialized to objectify other women, via visual assessment, as well. If women are consistently portrayed as the objects of desire, they may have developed that gaze when seeing other women, even if they are not aroused by them.

Finally, some might explain these results by positing that women's diffuse viewing patterns reflect a more empathic orientation whereby they identify or empathize with the woman in the image. Symons (1979) posited that women may identify with and imagine themselves as being the sexual object, while men are more likely to become aroused by viewing their sexual object. Rupp and Wallen (2009) found that women rate photos in which the female actor had an indirect gaze as being more sexually attractive than photos in which the female actor had a direct gaze. This may reflect a preference for

photos allowing women to more easily imagine themselves as the actress. Laan, Everaerd, Bellen, and Hanewald (1994) found that women reported higher subjective sexual arousal to female centered erotic films. Heiman (1997) also found that heterosexual women became significantly more aroused when audiotapes described interactions in which the female was the initiator of and primary actor in the sexual activity and when the description focused more on female enjoyment and responsiveness than when tapes were more male-centered or male-initiated.

Overall, it appears that increasing women's sexual arousal does not significantly shift the category-specificity of visual attention patterns from those found when women are not aroused or less aroused. This does not rule out that arousal leads women to look at female images, but enhancing that arousal does not make them look at women or men any differently than when arousal is supposedly lower. Heterosexual women in our study may have been looking at images of women as much as they did because they find women sexually arousing, or because there is some fundamental difference in male and female viewing patterns, because they are engaging in social comparison, because women have a more empathic orientation, or as a function of some combination of these possibilities. Further studies will be necessary to tease apart all of these and other possible explanations.

Limitations

There are several limitations to the current study. First, the sample size was only large enough to detect large effect sizes. Given the large quantity of data points per participant and the large effect sizes found in eye-tracking research examining differences between men and women, sample sizes in eye-tracking research tend to be

small. It appears that differences within women are much smaller; a larger sample would have provided additional power to detect medium to small effects.

Second, previous eye-tracking research (Akhter et al., 2011; Lykins et al., 2006; Lykins et al., 2008) presented static erotic images for a period of 15 seconds each compared to 10 seconds each in the current study. This presentation time difference prevents direct comparison across studies. Although there has been no research on optimal stimulus presentation times in eye-tracking research, it is possible that those last 5 seconds are a critical time frame for any between group differences to arise. Perhaps more time is needed for group differences, such as those found in previous studies, to be flushed out. Conversely, it is also possible that, when given too much time to view the images, participants become indiscriminate in their attention. They may begin to attend to certain regions of the images not because they are particularly interested in those regions, but because they have already spent the desired amount of time looking at the regions that they *are* interested in. This was the rationale for presenting the images for 10 rather than 15 seconds.

Finally, although measures were taken to induce sexual arousal in the arousal condition and the erotic video was rated as more arousing than the neutral video, it is possible that women in the arousal condition were not sufficiently aroused. It is difficult to know how to do this better than through the use of a validated erotic video. Perhaps more testing is needed to determine which sexual stimuli are most arousing to any given population.

Future Directions

Future research could address some of the limitations of this study. It appears that intrasex differences in visual attention patterns are more subtle than are intersex differences. Future studies investigating intrasex differences may need larger sample sizes than those previously used.

Also, there has been no research to date on the optimal stimulus presentation times in eye-tracking research. Existing literature varies widely in stimulus presentation duration, with set times ranging from 15 seconds for static photos (Akhter et al., 2011; Lykins et al., 2006; Lykins et al., 2008) to 40 seconds for video (Tsujimura et al., 2009). Several studies also allow participants to self-advance images, providing them with unlimited time to view the erotic photos (e.g., Israel & Strassberg, 2009; Leckart et al., 1966; Rupp & Wallen, 2007, 2009). These studies found that women spent an average of about 5 to 8 seconds looking at each photo. Although findings remain consistent across studies in that women display a less category-specific pattern of visual attention than men, systematic investigation into the various presentation times and methods may reveal one that is more ideal. Standardization would allow for direct comparisons across studies.

Third, future research may benefit from analyzing visual attention to dynamic stimuli. Video analysis may capture a more authentic pattern of women's visual attention given that a dynamic stimulus is likely to be more representative of real-life human interaction. Furthermore, dynamic stimuli of a man and woman interacting may alleviate some potential homoerotic anxiety as it would eliminate an obvious forced choice paradigm in which participants must look at the man and woman separately. Finally,

video presentation would provide an optimal stimulus with which to explore changes in visual attention patterns across time, via time analysis.

A valuable adjunct to the video and time analysis would include examining other measures of sexual arousal concurrently with visual attention patterns in order to help elucidate the relationship between visual attention and sexual arousal. These methods include continuous measurement of subjective sexual arousal and/or physiological genital arousal as well as pupillometry. Recently, Rieger and Savin-Williams (2012) found that hetero-, homo-, and bisexual men as well as homosexual women exhibited greatest pupil dilation to their erotic target, whereas bisexual and heterosexual women exhibited less category-specific patterns of pupil dilation. They also found that, in women, pupil dilation correlated more strongly with self-reported sexual orientation than measures of genital arousal.

Finally, future research should address other theories of women's non-category-specific visual attention – that women are engaging in social comparison, that women may have a type of empathic orientation whereby they identify with the woman in the photos, or that women may generally have more diffuse gaze patterns, regardless of what or who is being depicted. In addition to experimental manipulation of and priming for these alternate explanations, it may be useful to ask women more directly about the thoughts and feelings they experience during stimulus presentation, either during or after collection of quantitative data. Collection of qualitative data via real-time, continuous methods or recall methods would be subject to the same advantages and pitfalls inherent in measurement of subjective arousal. Of primary concern would be that participants might become increasingly self-conscious of their viewing patterns and therefore alter

them, and that participants' verbal responses may be especially vulnerable to socially desirable responding. Regardless, a more qualitative approach may provide valuable insights.

APPENDIX A

POST-EXPERIMENTAL QUESTIONNAIRE

Date: _____

Participant Number: _____

Post-Experimental Questionnaire

1. How sexually arousing did you find the video in this study?
 - a. Very arousing
 - b. Somewhat arousing
 - c. Neither arousing nor un-arousing
 - d. Somewhat un-arousing
 - e. Very un-arousing

2. Have you seen the video before?
 - a. Yes
 - b. NoIf yes, how many times? _____

3. How sexually arousing did you find the photos of men that you were shown after the video?
 - a. Very arousing
 - b. Somewhat arousing
 - c. Neither arousing nor un-arousing
 - d. Somewhat un-arousing
 - e. Very un-arousing

4. How sexually arousing did you find the photos of women that you were shown after the video?
 - a. Very arousing
 - b. Somewhat arousing
 - c. Neither arousing nor un-arousing
 - d. Somewhat un-arousing
 - e. Very un-arousing

5. Have you seen any of the photos before?
 - a. Yes
 - b. NoIf yes, where? _____

6. How old are you? _____ yrs old

7. What is your ethnicity?
- a. African American
 - b. Asian
 - c. Caucasian
 - d. Hispanic
 - e. Native American
 - f. Pacific Islander
 - g. Other: (please specify) _____
8. What is your current religious affiliation?
- a. Catholic
 - b. Christian
 - c. Jewish
 - d. Mormon
 - e. Muslim
 - f. None
 - g. Other: (please specify) _____
9. What is your highest level of education?
- a. High school degree
 - b. Some college
 - c. Associate's Degree
 - d. Bachelor's Degree
 - e. Some graduate school
 - f. Master's Degree
 - g. Doctoral-level Degree
10. Are you using a hormonal contraceptive? (the pill, patch, ring)
- a. Yes
 - b. No
11. Do you have regular menstrual periods?
- a. Yes
 - b. No
12. What was the date of the first day of your last period? (Feel free to check your calendar if you marked it down or, if not, give us an approximation)

Day: _____ Month: _____

13. What is your sexual orientation?

- a. 0- Exclusively heterosexual
- b. 1- Predominantly heterosexual, only incidentally homosexual
- c. 2- Predominantly heterosexual, but more than incidentally homosexual
- d. 3- Equally heterosexual and homosexual
- e. 4- Predominantly homosexual, but more than incidentally heterosexual
- f. 5- Predominantly homosexual, only incidentally heterosexual
- g. 6- Exclusively homosexual
- h. 7- Asexual

14. Which of the following is most true of you?

- a. 0- Sexually attracted only to men
- b. 1- Predominantly sexually attracted to men, only incidentally attracted to women
- c. 2- Predominantly sexually attracted to men, but more than incidentally attracted to women
- d. 3- Equally sexually attracted to men and women
- e. 4- Predominantly attracted to women, but more than incidentally attracted to men
- f. 5- Predominantly attracted to women, only incidentally attracted to men
- g. 6- Sexually attracted only to women
- h. 7- Not sexually attracted to men or women

15. Which of the following is most true of you?

- a. 0- Have only had sexual experiences with men
- b. 1- Have mostly had sexual experiences with men, only incidentally with women
- c. 2- Have mostly had sexual experiences with men, but more than incidentally with women
- d. 3- Have had an equal number of sexual experiences with men and women
- e. 4- Have mostly had sexual experiences with women, but more than incidentally with men
- f. 5- Have mostly had sexual experiences with women, only incidentally with men
- g. 6- Have only had sexual experiences with women
- h. 7- Have never had any sexual experiences

16. Have you ever had sexual intercourse?

- a. Yes
- b. No

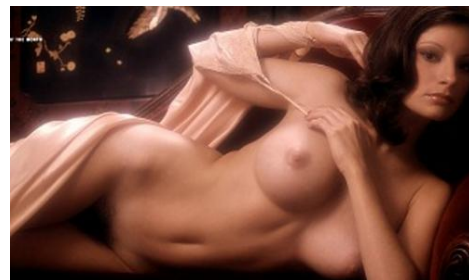
If yes, at what age did you first have sexual intercourse? _____yrs

17. What is your current relationship status?
- Single, not dating
 - Single, dating
 - Committed relationship
 - Married
 - Separated/Divorced
18. In the past year, how often have you intentionally accessed visual material (e.g., magazines, videos, internet) of a sexual nature (e.g., pornography or erotica)?
- Every day
 - A few times a week
 - Once a week
 - Once every two weeks
 - Once a month
 - Once every few months
 - Once every 6 months
 - Once a year
 - Never
19. Which of the following best describes your feelings toward visual material of a sexual nature (e.g., pornography or erotica)?
- Very much like
 - Like
 - Somewhat like
 - Undecided
 - Somewhat dislike
 - Dislike
 - Very much dislike
20. What ethnicity do you prefer your sexual partner(s) to be?
- African American
 - Asian
 - Caucasian
 - Hispanic
 - Native American
 - Pacific Islander
 - Other: (please specify) _____

APPENDIX B

STIMULUS IMAGES





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