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Sex Differences in Response to Visual Sexual Stimuli: A Review

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Abstract

This article reviews what is currently known about how men and women respond to the presentation of visual sexual stimuli. While the assumption that men respond more to visual sexual stimuli is generally empirically supported, previous reports of sex differences are confounded by the variable content of the stimuli presented and measurement techniques. We propose that the cognitive processing stage of responding to sexual stimuli is the first stage in which sex differences occur. The divergence between men and women is proposed to occur at this time, reflected in differences in neural activation, and contribute to previously reported sex differences in downstream peripheral physiological responses and subjective reports of sexual arousal. Additionally, this review discusses factors that may contribute to the variability in sex differences observed in response to visual sexual stimuli. Factors include participant variables, such as hormonal state and socialized sexual attitudes, as well as variables specific to the content presented in the stimuli. Based on the literature reviewed, we conclude that content characteristics may differentially produce higher levels of sexual arousal in men and women. Specifically, men appear more influenced by the sex of the actors depicted in the stimuli while women's response may differ with the context presented. Sexual motivation, perceived gender role expectations, and sexual attitudes are possible influences. These differences are of practical importance to future research on sexual arousal that aims to use experimental stimuli comparably appealing to men and women and also for general understanding of cognitive sex differences.

Keywords

sexual stimuli; sex differences; sexual arousal

INTRODUCTION

Sex differences in response to visual sexual stimuli are widely acknowledged, although poorly documented. A common presumption in society and the media is that men respond more strongly to visual sexual stimuli than do women. Pornographic magazines and videos directed at men are a multi-billion dollar industry while similar products directed towards women are difficult to find. It is estimated that of the 40 million adults who visit pornography websites annually, 72% are male while only 28% are female (www.toptenREVIEWS.com, 2006). Although experimental studies support the idea that men generally respond more to sexual stimuli than women, there is not a complete understanding of this sex difference (Kinsey, Pomeroy, Martin, & Gebhard, 1953; Laan, Everaerd, van Bellen, & Hanewald, 1994; Money

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& Ehrhardt, 1972; Murnen & Stockton, 1997; Schmidt, 1975; Steinman, Wincze, Sakheim, Barlow, & Mavissakalian, 1981). The extent of sex differences and the exact mechanisms producing them are unclear. This review discusses what is known about human sex differences in response to visual sexual stimuli and possible influences contributing to this sex difference.

Sexual Arousal

To understand fully sex differences in response to visual sexual stimuli, it is first necessary to present the theoretical construct describing the multiple processes we believe to be involved in producing a response to sexual stimuli. We regard subjective sexual arousal, or the response to visual sexual stimuli, as an emergent product of the combined cognitive and peripheral physiological states of an individual (Basson, 2002; Heiman, 1980; Janssen, Everaerd, Spiering, & Janssen, 2000; Palace & Gorzalka, 1992). The cognitive contributions to sexual arousal are not completely known, but involve the appraisal and evaluation of the stimulus, categorization of the stimulus as sexual, and affective response (Basson, 2002; Janssen et al., 2000; Redoute et al., 2000; Stoleru et al., 1999). The physiological component of sexual arousal includes changes in cardiovascular function, respiration, and genital response, erection in men, and vasocongestion in women (Basson, 2002; Janssen et al., 2000; Korff & Geer, 1983; Laan, Everaerd, Van der Velde, & Geer, 1995). When subjects view sexual stimuli, physiological responses, such as heart rate, blood pressure, respiration, erection, and vaginal vasocongestion, are often discordant with self-reported subjective perception of sexual arousal, especially in women (Chivers, Reiger, Latty, & Bailey, 2004; Laan et al., 1994; Wincze, Hoon, & Hoon, 1977). The inconsistency between physiological measures and reports of subjective sexual arousal may suggest that physiological changes on their own are not the only events subjects use to assess sexual stimuli. Additionally, it is unclear whether this discordance is primarily limited to women, as men typically show a greater, although not complete, concordance between their genital responses and subjective assessments of arousal (Chivers et al. 2004; Hall, Binik, & Di Tomasso, 1985). Thus, we do not yet know the exact relationship between subjective and physical sexual arousal, which is a complex process emerging from multiple cognitive and physiological components. It is possible that these cognitive and physiological components operate through distinct mechanisms and circuitry, although they likely mutually affect each other (Janssen et al., 2000).

Our theoretical orientation supposes that the conscious and unconscious cognitive processing in the brain, including memory, attention, and emotion, set the internal context for which visual stimuli, as well as the subsequent peripheral physiological responses, are interpreted as sexual. The cognitive framework in which visual sexual stimuli are viewed thus mediates the specific response elicited to visual sexual stimuli. In a feedback process, subjective sexual arousal results from an interaction between cognitive and experiential factors, such as affective state, previous experience, and current social context, which set the conditions for the production of peripheral physiological reactions, which then feedback to affect cognitive reactions to the stimuli, resulting in feelings of sexual arousal, which in turn affect the extent of physiological arousal. This integrating process may go through several iterations, increasing arousal with each pass through the cognitive-physiological loop. Whether the initial cognitive mechanisms are conscious or unconscious is unresolved, with some investigators emphasizing the initial physiological response to sexual stimuli as being a primary determinant of psychological arousal (Basson, 2002; Laan et al., 1995). There is likely a sex difference in exactly how much cognitions influence subjective sexual arousal, but both men and women determine subjective sexual arousal as the product of physiological sexual arousal within the current cognitive state.

Previous investigations of sexual arousal have focused primarily on subjective or physiological end points, such as erection or genital vasocongestion, and have rarely quantitatively examined the cognitive processing of sexual arousal, including attention and stimulus evaluation. The

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cognitive component of sexual arousal in response to visual sexual stimuli is a critical aspect of the sexual arousal response in humans needing further investigation. Sex differences are likely to be observed in the factors influencing, and importance of, the cognitive state on overall sexual arousal. Therefore, it is necessary to examine both the physiological and cognitive aspects of sexual arousal to fully understand sex differences in response to visual sexual stimuli. This review discusses previous findings regarding sex differences in response to sexual stimuli, including studies measuring both subjective and peripheral physiological measurements of sexual arousal, as well as studies measuring neural activation in response to visual sexual stimuli. The examination of sex differences in response to visual sexual stimuli using different methodologies may further our understanding of the complex interaction between cognitive and physiological processes to produce subjective sexual arousal.

Sex Differences in Subjective Ratings of Sexual Stimuli

The best documented sex differences in response to sexual stimuli use subjective ratings of sexual arousal and interest in response to sexual stimuli. When presented with the same stimuli, men and women often report different levels of sexual and positive arousal, as well as ratings of sexual attractiveness of the actors, depending on characteristics of the stimuli. Most studies where men and women rate levels of attraction to sexual stimuli have not, however, systematically characterized details of the stimuli that may produce sex differences in sexual arousal or attraction (Bancroft, 1978).

The few studies that describe specific aspects of sexual stimuli that men and women differentially prefer find a range of attributes that can affect response in men and women. Whether men or women created the stimuli is one characteristic that influences subjects' respond to sexual stimuli. Women who viewed clips from erotic films made by women or men reported higher levels of sexual arousal to the woman-made films (Laan et al., 1994). However, their subjective response was not reflected in their physiological response as they showed similar genital response to both woman- and man-made films. This discordance may reflect that these women also reported more negative emotions, such as aversion, guilt, and shame, in response to the man-created compared to the woman-created films. These negative emotions may result from the fact that man-created films involved no foreplay and focused almost exclusively on intercourse while the woman-created film had four of 11-minutes devoted to foreplay. It is unclear whether this reflects a response by the women to male-and female-created films, or a greater comfort with depictions of foreplay than intercourse. This could only be resolved by using films of similar content, but made by men or women. The observed disconnect between psychological and physical arousal may be related to the negative emotions causing the female subjects to invoke other cognitive mechanisms, such as social acceptability of the portrayal of sexuality, resulting in an inhibition or censoring of subjective report, but leaving their physiological response unaffected. This discrepancy could also be explained by the fact that women report high levels of subjective arousal with positive affect but sometimes show increased genital arousal with negative affect (Peterson & Janssen, *in press*). Whether the subjective report or the genital response is the "true" measure of sexual arousal is unresolved.

In a related study by Janssen, Carpenter, and Graham (2003), when men and women were shown erotic films chosen by either a male or female research staff, they reported higher levels of subjective arousal to films chosen by members of the participants' own sex. Men had higher ratings compared to women for all of the videos, but had their highest ratings for male-chosen films. Women reported lower levels of sexual arousal across all of the films than did men, but reported higher levels of arousal to female- than male-selected films. This difference was comparatively small and men still had higher ratings than women even for women-selected films. Together, these data demonstrated that men responded more to visual sexual stimuli than

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did women, and this sex differences was strengthened if the stimuli were chosen by a male. It is interesting that men appeared even more influenced than women by the sex of the researcher choosing the film. This suggests that women discriminated less in their responses to sexual stimuli than men did.

While the study described above suggests that there is some aspect of male-selected films that affected the participants' responses to these films, the study provided no evidence of how films selected by men differed from films selected by women. Despite the fact that these films were standardized for the amount of time involved in foreplay, oral sex, and intercourse, men and women still agreed that something, which varied with the sex selecting the films, was more or less arousing to them. Women's ability to imagine themselves as the woman in the film was the only factor the strongly correlated with their reported arousal. Men, however, rated the attractiveness of the female actor and the ability to observe the woman important in their arousal to the film in addition to imagining themselves in the situation. These results suggest that although both men and women project themselves into the scenario, men may be more likely to objectify the actors within the stimuli (Money & Ehrhardt, 1972). Therefore, it appears that men and women have different strategies when viewing visual sexual stimuli (Symons, 1979); however, the specific characteristics of the stimuli that may enhance or detract from the ability of subjects to utilize their preferred strategies remain unknown.

A possible characteristic of sexual stimuli that men and women may attend to differently is the physical context or nonsexual details of the stimuli. This is supported by a recent eye tracking study demonstrating different gaze patterns for men and women viewing pictures of sexually explicit heterosexual activity (Rupp & Wallen, 2007). Although all participants spent the majority of their viewing time looking at the genitals, female faces, and female bodies in the photos, women using hormonal contraceptives looked more often at the background of the photos and clothing than did men. That study also found that men looked more often at the female actors' faces in the pictures than did women. Because the men and women in this study did not differ in their ratings of how sexually attractive they found the pictures, women's bias towards the contextual features of the stimuli, specifically the clothing and background, did not appear to be associated with less positive appraisal of the photos. This is consistent with another recent eye-tracking study in which men and women rated sexually explicit photos as equally arousing despite differences in their gaze patterns (Lykins et al., 2006). Inconsistent with the Rupp and Wallen study, however, this eye tracking study did not find a sex difference in attention to the contextual elements of erotic stimuli. However, the Lykins et al. study did not differentiate whether the women tested were using oral contraceptives although the findings from the previouis study found the sex difference in contextual attention was dependent on women's contraceptive use. Together, these findings suggest that men and women have different cognitive biases that may promote optimal levels of interest in visual sexual stimuli. However, until future eye tracking work uses simultaneous measurement of sexual arousal, it is not entirely clear what elements of visual sexual stimuli enhance sexual arousal in men and women.

Evidence from studies examining habituation to sexual stimuli offers further evidence that men and women evaluate sexual stimuli using different strategies. Repeated exposure to sexually explicit slides of men and women typically produces both physiological and subjective habituation of sexual arousal in men (Koukounas & Over, 2001; O'Donohue & Geer, 1985), but inconsistent results in women. In one study that found that women did not habituate when repeatedly viewing the same slides, indicated by both genital and subjective measures of arousal, post-experiment interviews discovered a unique strategy used by the women to maintain interest (Laan & Everaerd, 1995). Eighty-five percent of the female subjects said that as the trials repeated they paid more attention to both context-related and nonsexual details of the stimuli, such as background information or cues about the relationship of the actors. It is

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possible that, in general, women may pay more attention to contextual and nonsexual details of sexual stimuli than men do. The presence of contextual elements in visual sexual stimuli may even allow lead to heightened arousal in women, as supported by the fact that women reported more subjective erotic reactions to commercial movies that men did. (Kinsey et al., 1953).

In a study in which both men and women habituated to repeated presentation of sexual stimuli, a sex difference in subjective arousal was observed in the content of stimuli that reinstated the response to sexual stimuli after habituation (Kelley & Musialowski, 1986). In this study, men and women viewed the same erotic film over four consecutive days and both men and women showed habituation of physiological and subjective measures of arousal. On the fifth day, subjects were presented with either a film depicting the same actors engaged in novel sexual activities or a film of new actors engaged in the behaviors observed in the original films. Men reported levels of subjective arousal on the fifth day equal to that on the first only for films where new actors engaged in the previously seen sexual behaviors. Conversely, women's subjective arousal returned to first day levels only when viewing films in which the original actors engaged in new behaviors. These data were interpreted as suggesting that men show a preference for sexual stimuli with new people, whereas women respond better to stimuli suggesting the stability and security of a consistent partner. It commonly thought that women prefer stimuli depicting stable romantic relationships although this view has little empirical support. For example, when men and women were asked to read one of two stories of sexual experiences between a heterosexual couple, differing only in the level of affection expressed between the characters, both men and women rated the story comparably with higher levels of affection and as more sexually arousing (Schmidt, Sigusch, & Schafer, 1973). The Kelley and Musialowski (1986) study may also reflect that women are more likely then men to project themselves into the films and thus partner stability may be personally rewarding. However, projection into the stimulus situation, or absorption, is also demonstrated in males to be positively associated with sexual arousal, although it is not clear under what conditions men use this strategy.

The principle established sex difference in preference for specific content of sexual stimuli is whether the stimuli depict same- or opposite-sex actors. Generally, heterosexual men rate stimuli with same-sex stimuli lower than women rate pictures of other women. When undergraduate men and women were presented photos of men and women masturbating, men reported a significantly less favorable reaction to photos of men than of women (Schmidt, 1975). By contrast, women rated photos of both sexes comparably. Consistent with these findings, Costa, Braun, and Birbaumer (2003) reported equal levels of subjective arousal in women to photos of same sex nudes and opposite sex nudes, whereas men rated the opposite sex nudes higher. Similar patterns were observed when subjects were presented films of either heterosexual or homosexual sexual activity (Steinman et al., 1981). Men showed a significantly lower level of self-reported sexual arousal to films depicting two men than they did to heterosexual or lesbian films. Women, in contrast, did not show a difference in reported sexual arousal between heterosexual or female homosexual films. Subjective reports are consistent with recent eye tracking studies using attention to different regions of photos as implicit measures of interest (Lykins, Meana, & Strauss, 2007; Rupp & Wallen, 2007). In these studies, both men and women spent more time looking at the female compared to the male actor in photos depicting heterosexual intercourse.

Previous work suggests that heterosexual men's opposite-sex bias is dependent upon their sexuality, such that men have a specific bias towards the target of their sexual attraction, although women do not (Chivers et al., 2004). When men and women watched films of homosexual or heterosexual sex, male genital measures and subjective reports showed that men responded highest to films depicting sex with a member of the sex that they were attracted

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to. This stimulus specificity was true for all the subjects from a sample that included heterosexual men, homosexual men, and male-to-female transsexuals. For women, to the contrary, genital sexual arousal did not differentiate the sex of the actors engaged in sexual activity. Chivers et al. interpreted these findings to suggest that in men and women sexual arousal is organized differently in that men are category specific while women are not. This interpretation is supported by a follow-up study in which women, but not men, display a higher genital response to a nonhuman (male and female bonobos) sexual interaction compared to neutral stimulus, while men did not (Chivers & Bailey, 2005).

In summary, based on the literature described above, limited sex differences have been found in the contexts that evoke responses to sexual stimuli. Women seem to subjectively react positively to stimuli that allow them to project themselves into the situation while men prefer stimuli enabling objectification of the actors (Money & Ehrhardt, 1972). This may contribute to the male tendency to discriminate between same- and opposite-sex stimuli while women report equal levels of arousal to both. Specifically, if women project themselves into the stimuli to "be" the female actor in the stimuli, they would then be aroused by stimuli of same-sex actors. Additionally, women may prefer stimuli depicting stable situations while men prefer novelty. The underlying cause of the sex differences in stimulus preference is unclear. However, given the similarities across species in which many males demonstrate a preference for novel females to maximize reproductive success (Symons, 1979), one could hypothesize an evolutionary underpinning for this sex difference in novelty preference. Additionally, these sex differences may reflect biologically based reproductive strategies in which female reproductive success is increased if she has a reliable long term mate to help care for the young, sociological influences, or a combination of both. What is most important about these studies is the suggestion that men and women evaluate the same sexual stimuli differently. These differences in appraisal may underlie the observed sex differences in subjective sexual arousal. If men and women evaluate stimuli differently from the outset, ultimately, sex differences in sexual arousal would be expected and may simply reflect this initial difference in stimulus evaluation. The next section provides evidence that the sex differences observed from subjective reports of sexual arousal may be the product of sex differences in the cognitive processing of stimuli, reflected in differences in neural activity.

Sex Differences in Neural Response to Sexual Stimuli

Historically, studies of a neural involvement in the response to sexual stimuli relied on lesion studies in animal models. Although these studies revealed important information, such as the critical roles of the hypothalamus and amygdala in sexual motivation and the expression of copulatory behavior, they cannot be replicated in human participants and may not be entirely able to address more complex cognitive responses to sexual stimuli that may be important in understanding human sexual arousal. While animal models of sexual behavior and preferences have important ramifications for our understanding of human sexual behavior (Pfaus, Kippin, & Genaro, 2003), they are beyond the scope of this review. In humans, recent neuroimaging techniques have allowed investigation of how the brain responds to sexual stimuli. Both PET and fMRI are imaging techniques that use alterations in blood flow to infer regional differences in neural activity. PET, because it uses the accumulation of radioactive tracers, is more clearly linked to neural activity and, unlike fMRI, can detect both increased activation and deactivation of neural activity. With fMRI, it is only known that activity has changed, but not the direction of the change. Both techniques rely upon the assumption that a change in blood use by the brain implies increased neural activity although the exact mechanisms underlying this relationship are unclear.

Imaging studies show that, in response to sexual stimuli, both men and women show increased activation in many similar brain regions thought to be involved in the response to visual sexual

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stimuli, including the thalamus, amygdala, inferior frontal lobe, orbital prefrontal cortex, medial prefrontal cortex, cingulate cortex, insula, corpus callossum, inferior temporal lobe, fusiform gyrus, occipitotemporal lobe, striatum, caudate, and globus pallidus. Recent studies looking specifically for sex differences in response to the same set of sexual stimuli found that, in response to erotic films, men and women showed many areas of overlap in response to sexual stimuli in the anterior cingulate, medial prefrontal cortex, orbital prefrontal cortex, insula, amygdala, thalamus, and ventral striatum (Karama et al., 2002; Ponseti et al., 2006). However, only men showed increased activation in the hypothalamus during the presentation of sexual stimuli and its activation correlated significantly with the men's subjective reports of arousal. One possible explanation for this sex difference is that the hypothalamus may be involved in the physiological reaction to sexual stimuli, such as erection, or that sexual arousal activates the hypothalamic gonadal axis, resulting in the increased steroid secretion seen in men following sexual activity (Stoleru, Ennaji, Cournot, & Spira, 1993). A study by Hamann, Herman, Nolan, and Wallen (2004), using fMRI and still pictures, found a similar sex difference in hypothalamic activation in response to sexually explicit images of heterosexual activities. Men also showed higher general activation in response to sexual stimuli than women in the amygdale even though men and women did not report different subjective levels of arousal to the photos.

It is important to distinguish whether the sex differences observed in neural activation reflect differences in cognitive processing between men and women in response to sexual stimuli or simply differences due to inherent morphological or physiological sex differences. For example, the increased hypothalamic activation observed in men could be due to the fact that men can obtain erections and this alters hypothalamic activity. We do not think that this is the case, however, because sex differences in neural activity in the hypothalamus and amygdala are observed only in response to exposure to visual sexual stimuli and not during orgasm (Holstege & Georgiadis, 2004). In fact, with orgasm, there is amygdala deactivation and orgasm, particularly in men, is followed by a period of lessened interest in sexual stimuli. Therefore, the sexually differentiated neural activity during sexual arousal that precedes orgasm seems more likely to reflect the cognitive processing of sexual stimuli, such as motivation and desire, rather than physiological arousal.

Although the general neural networks underlying sexual arousal are the same in men and women, these circuits may be differentially activated based on the characteristics of the sexual stimuli presented. As described earlier, there are sex differences in what types of stimuli men and women report to be sexually attractive and arousing (Janssen et al., 2003; Kelley & Musialowski, 1986; Schmidt, 1975). Recent work supports the idea that the brains of men and women respond differently to sexual stimuli contingent upon the content of the stimuli. There are sex differences in neural activation between men and women depending upon the sex of the actor in the stimuli (Rupp, Herman, Hamann, & Wallen, 2004). While in the fMRI scanner, subjects viewed still photographs depicting male nudes, female nudes, a neutral condition, or fixation, presented in a block design. Activation to sexual stimuli was compared to activation during the neutral condition. Greater activation to opposite sex stimuli compared to same sex stimuli was seen in men in the inferior temporal and occipital lobes. Women did not show any areas of increased activation to opposite sex compared to same sex stimuli. Men showed more differential activation of brain areas related to sexual arousal than women, including the amygdala, hippocampus, basal ganglia, and some areas of the prefrontal cortex. Women did not show these differences, suggesting that women do not emotionally discriminate between opposite sex and same sex stimuli in the manner that men do. Women only showed increased activation to same sex compared to opposite sex stimuli in visual cortical areas. These differences may reflect different strategies for women in the cognitive processing of stimuli, specifically in how women focus their attention to sexual stimuli. Increased activation by women in these cortical areas may reflect a more complex approach to sexual stimuli that

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focuses not only on sexual aspects of a stimulus, but also on nonsexual and perhaps more contextual factors (Rupp & Wallen, 2007).

Studies constraining possible attentional targets of visual sexual stimuli address the possibility that men and women differ in their cognitive processing strategy when presented visual sexual stimuli to produce observed differences in neural activation. A recent neuroimaging study (Ponseti et al., 2006) found that when peripheral contextual elements of stimuli are unavailable, men and women, regardless of sexual preference, show identical patterns of neural activation in response to visual sexual stimuli. In this study, heterosexual and homosexual males and females passively viewed photographs of sexually aroused genitals without any other peripheral body parts or context. The authors demonstrate that men and women did not differ overall in their neuronal response to the sexual stimuli (as compared to IAPS control pictures of matched valence and arousal) in response to images without available context. What did differ, however, was the type of stimulus that produced increased activation in areas related to reward, specifically the ventral striatum and centromedian thalamus. For both heterosexual and homosexual men and women, the activation of the reward system was highest when viewing pictures of their preferred sex. This study supports our hypothesis that men and women do not differ in the neural pathways underlying sexual arousal, but only in the stimuli and strategies that activate the systems.

An investigation of the EEG response to same and opposite sex stimuli in men and women supports imaging findings and suggests that the women distinguish less between same and opposite sex stimuli than men do (Costell, Lunde, Kopell, & Wittner, 1972). Costell et al. measured the amplitude of the contingent negative variation (CNV) wave. This component of the EEG occurs between the presentation of the warning and target stimuli and is thought to reflect levels of anticipation and increased attention. The target stimulus was a photo of either a male or female nude, or a neutral nonsexual photo of an individual. The warning stimulus was a 500 msec preview of the following 10 sec target stimulus. Both men and women showed greater amplitude of the CNV to opposite sex stimuli than neutral stimuli. Only women, however, showed an increase in response to same sex stimuli compared to neutral. These data suggest that at the neural level, similar to that observed at the behavioral level, men distinguish more than women between opposite and same sex stimuli.

We hypothesize that men and women may differ in what types of sexual stimuli initiate sexual motivation and arousal. Specifically, different characteristics of visual sexual stimuli, such as the sex of the actors or situational information included, may be variably effective in provoking sexual arousal in men and women. Therefore, as suggested above, the cognitive stage of sexual arousal during which men and women evaluate sexual stimuli may be a crucial point of divergence that produces observed sex differences in response to sexual stimuli.

Sociological Influences

The literature reviewed above provides evidence that there are sex differences in response to visual sexual stimuli. The origins of the sexually differentiated response to sexual stimuli are unknown. Possible factors could be sociological, evolutionary, physiological, psychological, or most likely a combination. Sociological variables likely play a significant role in observed sex differences in reports of sexual arousal. Some researchers argue that sexuality is largely a socialized phenomenon (Reiss, 1986). Historically, Western culture has given men more sexual freedom and constrained women more in the display of sexual motivation or interest in sexual material, a double standard that exists even to some degree today (Crawford & Popp, 2003; Murnen & Stockton, 1997). A content analysis of popular television shows featuring characters aged 12–22 years found that there were more social and emotional negative consequences in scenes where women initiated sexual activities than when men did (Aubrey, 2004). Not only popular television, but also films used for sex education from 1990 to 2000 were found to

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portray a sexual double standard encouraging female passivity and caution (Hartley & Drew, 2001). The social teachings experienced by men and women throughout their lives may mediate their subjective feelings of sexual arousal in response to sexual stimuli. That there are cultural differences in sexual attitudes suggests that social influences contribute to observed differences in sexual attitudes and behavior (Reiss, 1986; Widmer, Treas, & Newcomb, 1998). Also, church attendance and identification with religion is correlated with decreased sexual permissiveness (Haerich, 1992; Jensen, Newell, & Holman, 1990). If religious teachings stigmatize sexuality in women, this may influence women' sexual attitudes and behaviors, and negatively bias their reported responses to sexual stimuli. In the lab, although men generally inferred more sexual intent from video tapes of opposite-sex social interactions than women did, this sex difference was minimized in men with more exposure to women, coeducational experience, and less masculine sex roles (Koukounas & Letch, 2001). Together, previous literature suggests that differences between men and women in experience, gender roles, and feelings about sexuality may produce different subjective levels of arousal.

Because women may feel more self-conscious in their response to sexual stimuli due to societal expectations, they may try to inhibit their responses to match socialized gender roles in which women do not display high levels of sexual response. A study examining biases in self-reporting of sexual behavior administered sexual attitudes and behavior questionnaires to undergraduates under three conditions and found that women, more than men, underreported their sexual behavior when there was less secured anonymity (Alexander & Fisher, 2003). Women may perform similar gender role congruent responding when presented with sexual stimuli. In contrast to women, who may often under-report their previous sexual experience to match their perceived societal expectations, men may over-report their previous sexual experience to also match their perceived gender role (Fisher, 2007). A recent study found that men characterized by high levels of hypermasculinity and ambivalent sexism reported more sexual partners when they had a female experimenter administering the anonymous survey, than if they had a male experimenter. This effect was only observed, however, when the cover page of the survey contained a statement saying that women were recently shown to be more sexually permissive and experienced than men. The findings that males who identify more strongly with traditionally masculine ideals alter their reporting when there is a message of dominant female sexuality, and that they do so only in the presence of a female experimenter, highlights the complex influence of socialized norms and attitudes on accurate reports of sexual behavior in men. These studies together emphasize the differential and polarizing effects that socialization appears to have on men and women in their reports of sexual behavior, which is important to consider when investigating sex differences in response to sexual stimuli.

This inhibition or enhancement of responding could have significant ramifications, not only for studies measuring subjective reports of sexual arousal, but also for studies of genital arousal or neural activation. According to this paper's theoretical model, the inhibition of women's subjective evaluations would diminish positive feedback on physiological arousal to produce lower levels of sexual arousal in women with inhibited subjective reporting. Inhibition also influences measures of neural activation, demonstrated by an fMRI study in which men were told to watch erotic films with or without inhibiting their reactions. Men without inhibition showed characteristic activation in the amygdala, anterior temporal lobes, and hypothalamus, but men inhibiting their responses did not (Beauregard, Levesque, & Bourgouin, 2001). Thus, if women are more likely to publically inhibit their sexual response their previously reported lower levels of genital and neural arousal in response to sexual stimuli might reflect greater subjective self-inhibition in women than men.

The impact of socialized sexual attitudes and subject's tendencies to match their perceived gender scripts to social expectations may explain much of the variability reported in the literature about reports of female sexual arousal. Women's subjective ratings of sexual arousal

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often do not match physiological measures or arousal (Heiman, 1977; Laan et al., 1995; Steinman et al., 1981). One moderator may be sexual attitudes, as there are significant relationships between these attitudes and reported levels of sexual arousal. For example, women with more negative sexual attitudes reported lower overall levels of sexual arousal in response to erotic films than did women with more positive sex attitudes (Kelly & Musialowski, 1986). Similarly, another study found that although physiological arousal was the same in response to two different types of erotic films, the film that elicited feelings of shame, anger, or guilt received lower subjective ratings of sexual arousal (Laan et al., 1994). This disconnect between subjective and physiological arousal is not limited to sexual attitudes, but is also related to sexual orientation. Chivers et al. (2004) found that women had the same genital arousal to films of homosexual and heterosexual intercourse regardless of their own sexual orientation. By contrast, their subjectively reported sexual arousal differed between stimuli depending on the sex of the actors in the films and was congruent with their self-declared sexual preferences. Men did not show a similar incongruence. Extreme examples of the female incongruence between cognitive and physiological arousal in women are clinical reports of sexual assault victims describing genital arousal during the incident.

The impact of socialization on women's inhibitions of certain aspects of sexual responding, but not on others, highlights the complexity of women's sexual response. There are multiple cognitive and physiological processes which social influences can differentially influence, altering subjective and genital response. Paradoxically, although women have a less specific peripheral genital response than men (Chivers et al, 2004; Chivers & Bailey, 2005), their subjective reporting may be more socially influenced and thus appear more restricted. Women exhibit genital arousal to a variety of stimuli that they would not necessarily report as subjectively sexually arousing, such as the depiction of sexual intercourse between two members of the non-preferred sex or even nonhumans (Chivers et al., 2004; Chivers & Bailey, 2005). Women's relatively nonspecific genital arousal likely reflects the importance of subjective arousal in women's sexuality. If genital arousal occurs to stimuli that women find subjectively unarousing, they are unlikely to engage in sex with those stimuli, even though they are physically capable of doing so. By contrast, few sexual stimuli are likely to not result in genital arousal, thus subjective, not genital, arousal becomes the critical factor in modulating women's sexual behavior. This is markedly different from men's sexuality where subjective arousal without genital arousal would preclude most sexual behavior thus making genital arousal a crucial regulatory aspect of men's sexuality.

Together, these studies demonstrate in women a disconnect between physiological and subjective reports of sexual arousal. Whether these differences result from social factors that bias women's reporting and feelings of sexual arousal is unresolved. Whatever their cause, such bias may alter female perception of their physiological arousal such that they do not subjectively experience psychological arousal congruent with their genital response. Alternatively, as a result of perceived social expectations, women may actively inhibit the level of arousal they report, such that it does not reflect the level of arousal they actually experience. Which of these mechanisms is operative, or whether some other process produces this disconnect, is difficult to determine because we do not yet know how important genital arousal is for women's subjective feelings of sexual arousal. An important area of future research is the role that socialization plays in the shaping of sexual attitudes and how it moderates subjective and physiological responses to sexual stimuli.

Biological Influences

In addition to social pressures, biological differences between men and women likely contribute to the sex differences in response to sexual stimuli. Although social factors may strongly modulate men and women's reactions to sexual stimuli, biological factors may

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determine the extent to which social factors can modulate subjective and physiological arousal. Gonadal steroid hormones are likely candidates for biological influences on the cognitive component of sexual arousal, including stimulus evaluation, attention, and sexual motivation. Hormones may act by altering the attention to and the valence of sexual stimuli. Previous work demonstrates that men have more subjective and physiological arousal to sexual stimuli with higher attention and positive emotion (Koukounas & McCabe, 2001). Attention and other cognitive processes may be influenced by testosterone levels in men. A PET study found that activation in the right middle occipital gyrus and right inferior frontal gyrus, areas linked to emotion and motivation, in response to viewing erotic film clips was positively correlated with testosterone levels in men (Stoleru et al., 1999). Additionally, hypogonadal men, who have chronically low levels of testosterone, do not show neural activation patterns typical of men with normal testosterone levels in response to viewing sexual films (Park et al., 2001). However, following three months of testosterone supplementation, hypogonadal men show increased activation in the inferior frontal lobe, cingulate, insula, corpus callossum, thalamus, and globus pallidus, as observed in normal men in response to sexual stimuli. Because untreated hypogonadal men are capable of obtaining erections when viewing sexual stimuli at rates equal to normal men (Kwan, Greenleaf, Mann, Crapo, & Davidson, 1983), these findings implicate testosterone in the nonphysiological response to sexual stimuli. That they did not find any difference in activation in the amygdala may be a consequence of methodology. Only recently have fMRI scanners developed the resolution to accurately scan this deeply embedded region.

Previous studies suggest that testosterone also influences sexual attention in women. Alexander and Sherwin (1993) found that attention to auditory sexual stimuli in a subgroup of women, with low levels of testosterone, was correlated with their endogenous levels of testosterone. Subjects were asked to repeat a target auditory message that played into one ear while a distracter message, of either a sexual or nonsexual nature, was presented after a small delay into the subjects' other ear. All women made more errors in repeating the target message when the distracter was sexual than when it was neutral stimuli. In the 12 women with lowest testosterone increased, but not in the sample overall, errors to the sexual stimuli was correlated with testosterone, suggesting that there is a threshold for hormone action. Although the results are difficult to interpret because the phenomenon was observed only in women at the extremely low testosterone levels, they do suggest that testosterone may increase attention to sexual stimuli. This notion is supported by a study that administered exogenous testosterone to normal women and changed their response to sexual stimuli (Tuiten et al., 2000). Women receiving a single dose of testosterone reported, four hours following administration, increased sexual "lust" and perceived arousal to erotic videos. While this study needs to be replicated, it does suggest an activational effect of testosterone on cognitive perception of sexual stimuli.

Testosterone metabolites, particularly estrogen, may also influence the perception of sexual stimuli in men and women. On a basic level, hormones receptors in the eyes (Suzuki et al., 2001) may actually how one sees their environment to bias attention towards bright sexual cues, for example. Perception of, and attention to, the environment can also be influenced by hormones, possibly indirectly through hormonal influence on sexual motivation (Rupp & Wallen, 2007; Wallen, 1990, 2001). Many studies in women find increased sexual desire, masturbation, and sexual initiation during the ovulatory period that fluctuate over the cycle (Harvey, 1987; Tarin & Gomez-Piquer, 2002; Wallen, 2001). However these menstrual cycle effects are often subtle (Tarin & Gomez-Piquer, 2002) and some studies do not show any change in subjective levels of arousal across the cycle or increases in arousal outside ovulation (Schreiner-Engel, Schiavi, Smith, & White, 1981). The incongruent findings investigating hormonal influences on women's interest in visual sexual stimuli may be due, in part, to methodological issues. The first common methodological problem is that many studies use subjective units of measurement as indicators of interest in stimuli. The use of subjective measurement may not accurately portray hormone effects because subjective questionnaires

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often suffer from subject bias and inhibition (Alexander & Fisher, 2003) and do not tap into more subtle menstrual cycle effects on women's attractiveness and proceptivity (Travin & Gomez-Piquer, 2002). For example, women report a greater desire to go out to parties and meet men around ovulation (Haselton & Gangestad, 2006) and demonstrate more self-grooming and ornamentation (Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2006). A second common methodological issue in the investigation of menstrual cycle effects on women's interest in visual sexual stimuli is the use of a within subjects design. Using within subject comparisons across a woman's menstrual cycle may be problematic considering the results of a previous study demonstrating that physiological sexual arousal in response to visual sexual stimuli did not depend on the hormonal state at the time of testing, but rather on the hormonal state of females during their first exposure (Slob, Bax, Hop, Rowland, & van der Werff ten Bosch, 1983). In that study, hormonal state at first test session was shown to mediate subsequent levels of genital response to visual sexual stimuli. Females first exposed to visual sexual stimuli during their luteal phase had lower levels of physiological arousal when subsequently tested across other phases of their menstrual cycle than females whose initial exposure occurred at another phase. In this way, hormones may have primed or conditioned females to have increased responses to stimuli that they were exposed to when they had higher levels of sexual desire. Therefore, previous work investigating fluctuations in women's interest in visual sexual stimuli across the menstrual cycle may suffer from this confound of hormonal state at first exposure.

In addition to hormonal influences on overall sexual interest and arousal, female perception of male attractiveness varies with their ovarian cycle. What women find attractive in relation to the masculinity of a males' face fluctuates across the menstrual cycle (Gangestad & Simpson, 2000). Women show a preference for masculine male traits during their ovulatory phase of the cycle that is not observed during other phases (Feinberg et al., 2006; Gangestad, Simpson, Cousins, Garver-Apgar, & Christensen, 2004; Penton-Voak & Perrett, 2000). In fact, when tested during the luteal phase, women find feminine male faces more attractive than masculine faces (Jones et al., 2005). The fluctuation in preferences may reflect variability in reproductive priorities across the menstrual cycle (Gangestad & Simpson, 2000). Although males with more masculine features may provide genes with higher fitness, masculine males are less likely to invest in offspring (Waynforth, Delwadia, & Camm, 2005) and enter partnered relationships (van Anders & Watson, 2006). At ovulation, when conception is likely, women may prioritize acquiring fit genes and be more attracted to masculine men. During the luteal phase, in contrast, when hormones are preparing for potential pregnancy, the priority may shift from mating with masculine males to finding a stable partner who can provide more parental investment and resources. A mate choice is a complex decision balancing the potential reward of high genetic quality with the risks of low paternal care or sexually transmitted infection and disease. It is currently unknown how the hormonal states correlated with fluctuating mate preferences modulate females' preferences for male traits. It is possible that this is a central cognitive effect and that the hormonal state of an individual sets a cyclically fluctuating context in which potential mates are evaluated.

Changes in overall sexual arousal and desire and mate preferences with fluctuations in hormone levels across the menstrual cycle may be due to variability in the cognitive processing of sexual stimuli across the cycle. This hypothesis is supported by a recent neuroimaging study that found differences in neural activation in women looking at visual sexual stimuli depending on their menstrual phase at the time of testing (Gizewski et al., 2006). Specifically, women had more activation in the anterior cingulate, left insula, and left orbitofrontal cortex when tested during their mid-luteal compared to menstrual phase. Evidence for this also comes from ERP studies of women viewing sexual stimuli where ERP activity changes with the phase of the menstrual cycle (Krug, Plihal, Fehm, & Born, 2000). Eleven women viewed still photos of nude men, neutral photos of people, and babies during their menstrual, ovulatory, and luteal phases. Only

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during the ovulatory phase, when estrogen levels were elevated, did women show an increase in the late positive component (LPC) to sexual compared to neutral stimuli. The LPC is thought to be sensitive to valance and levels of emotional processing. Concurrent with measured changes in the LPC, women reported greater subjective positive valence in response to the sexual stimuli during the ovulatory period. It is possible that the variability that is observed in the literature regarding sex differences in response to sexual stimuli may be partially a result from cyclic variations in sensitivity in women. Possibly high levels of estrogen during the periovulatory phase increase women' attention and positive perception of sexual stimuli to levels similar to those observed in men whose gonadal hormone levels fluctuate over a smaller range than those of women.

Although relevant data are comparatively limited at this time, it is apparent that the hormonal state of the subjects is likely an important variable to consider when investigating sex differences in the cognitive response to sexual stimuli. Previous studies have used women taking oral contraceptives (Hamann et al., 2004), or did not even assess where subjects were in their menstrual cycles (Chivers & Bailey, 2005; Hamann et al., 2004; Koukounas & McCabe, 2001; Ponseti et al., 2006). These design problems have obscured a factor likely to be of significant importance and have increased variability in the results. Future studies need to more precisely investigate the impact of hormonal status on the perception of sexual stimuli and how this relates to differences in men and women.

CONCLUSIONS

The currently available data strongly support the idea that men and women differ in the sorts of stimuli that they find sexually attractive and arousing. We still do not know the relationship between these sex differences in preference and differences in physiological arousal as there is not yet a common metric to compare physiological arousal in men and women. A variety of factors clearly moderate responses to sexual stimuli in men and women. Evidence supports that some previously observed sex differences in response to sexual stimuli may, in part, reflect a differential response to the content of the stimuli used. Men are influenced by the sex of the actor portrayed in the stimulus while contextual factors, possibly allowing for the creation of a social scenario, may be more important to women. Additionally, men generally prefer stimuli that allow objectification of the actor and projection of themselves into the scenario, while women are aroused primarily by stimuli allowing projection, although men also use the projection strategy which is positively associated with sexual arousal (Koukounas & Over, 2001). Whether these preferences are learned or innate is unknown. Work by Chivers and Bailey (2005) suggests that women are less specific in their arousal patterns then men, possibly as a protective mechanism. Future work would benefit from the quantification of the characteristics that are differentially appealing to men and women. Understanding these differences is of practical importance to future research on sexual arousal that aims to use experimental stimuli comparably appealing to men and women.

The sex differences observed in subjective sexual arousal to visual sexual stimuli are possibly the combined product of social and biological influences on cognitive processes that direct the perception and assessment of these stimuli. Based on how men and women differently regard these stimuli as positive and arousing, there will result in apparent differences in physiological and psychological responses. Sexual motivation, perceived gender role expectations, and sexual attitudes are cognitive factors that likely influence participant's response to sexual stimuli, especially in women. Strong support for this notion is evident in the common finding that subjective and physiological measures of sexual arousal in women are often uncorrelated.

Further investigation of the cognitive aspect of sexual arousal is very important in our understanding of the sexual arousal process, not only in how participants respond in

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experimental conditions, but especially in understanding sexual arousal outside of the laboratory. Current therapy for sexual dysfunction in men and women primarily addresses the physiological component of sexual arousal, such as the ability to maintain an erection or produce vaginal lubrication. We argue that despite recent pharmacological scientific advancement, the most appropriate treatment is cognitive therapy. Women, especially, may be better served by sexual therapy targeting cognitive components of sexual arousal, rather than pursuing pharmaceutical relief, which may be ineffective. Finally, while the current review focuses on sex differences in the cognitive processing of visual sexual stimuli, differences in attention and preferences for different contextual element s of pictures may not be unique to sexual stimuli. Rather, differences in response to visual sexual stimuli could be one example supporting the idea that the brains of men and women differ functionally in their environmental assessment to produce sexually differentiated behavioral response patterns.

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