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RESEARCH ARTICLE

Sex Differences in the Motivation for Viewing Sexually Arousing Images

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Abstract

Sexual motivation strongly influences mate choice and dating behavior and can be triggered by merely viewing sexually arousing visual images, such as erotic pictures and movies. Previous studies suggested that men, more than women, tend to search for sexual cues that signal promiscuity in short-term mates. However, it remains to be tested whether sex differences in the motivation to view sexual cues can be observed by using robust and well-controlled behavioral measures. To this end, we employed a pay-per-view key-pressing task. Japanese self-identified heterosexual male and female participants viewed images of men, women, or couples with two levels of sexual arousal (sexual vs. less sexual). Participants could alter the viewing time of a presented image according to their willingness to keep viewing it. Male participants were the most eager to view sexually arousing images of the opposite sex, whereas female participants were more strongly motivated to view less sexual images of couples. Such sex differences may reflect differentiated reproductive strategies between men and women in terms of men's motivation toward promiscuity and women's motivation toward long-term relationships.

Keywords Sexual motivation · Sex differences · Sexual strategies theory · Mate selection · Pay-per-view key-pressing task

Introduction

Sexual motivation has substantial impacts on our mate choice and dating behaviors and is therefore central to an understanding of human evolution (Fisher et al., 2006). From an evolutionary psychology perspective, men and women should be equipped with specialized psychological adaptations for mate choice, which lead to sex-differentiated reproductive strategies (Buss & Schmitt, 1993). Men are more likely to report greater interest than women in seeking short-term mates and to consent to have sex after briefer periods of time across cultures (Dawson & Chivers, 2016; but see also Schmitt et al., 2003). In contrast, women are more selective in choosing short-term mates and have stricter criteria for a mate's physical attractiveness (Kenrick et al., 1993).

The sexual strategies theory (SST; Buss & Schmitt, 1993) provides a plausible explanation for sex differences in psychological reactions to sexual cues. The SST posits that sex differences in mate preferences and mating decisions result from different mating problems that men and women have faced (Buss & Schmitt, 1993). According to the SST, humans possess psychological adaptations designed for both short-term and long-term mating strategies. Short-term mating strategies are characterized by a desire for sexual variety and multiple sex partners over brief time intervals (Schmitt, 2015). Long-term mating strategies are characterized by monogamous relationships and long-term pair bonding (Buss & Schmitt, 1993). For reproductive success, both men and women have to devote their parental investment to their offspring in order to increase the survival chances of their offspring, but the minimal parental investment requirements differ between men and women (Trivers, 1972). In terms of human reproduction, females tend to be the more heavily investing sex, as is the

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case for most mammals (e.g., fertilization, gestation, and placentation) because women are constrained by the number of offspring they can produce. Thus, pursuing short-term mating strategies is thought to be more advantageous for men than for women in terms of reproduction and genetic dissemination. Men's reproductive success accrues from obtaining sexual access to a larger number of female partners, which may in part explain why men are sexually aroused more easily than women (Baumeister et al., 2001; Peplau, 2003). In contrast, pursuing long-term mating strategies is thought to help foster and maintain long-term pair-bonding, enabling high levels of investment and commitment to one's offspring. Thus, women often pursue long-term mating strategies to secure the quantity and quality of external resources for themselves and their offspring from men (e.g., good earning capacity, wealth, and so on; see Buss & Schmitt, 1993 for more details).

Such sex differences in mating strategies are also reflected in the psychological reactions to sexual cues. In general, men are more eager than women to access visual sexual cues (Bailey et al., 1994; Baumeister et al., 2001; Buss & Schmitt, 1993; Schmitt, 2014; Symons, 1979). The core brain regions for sexual desire, including the amygdala and hypothalamus, are more strongly activated in men than women when viewing identical sexual images (Hamann et al., 2004). Furthermore, men's stronger preference for sexual visual cues can lead to greater motivation to view sexually arousing images (Murnen & Stockton, 1997), perhaps because such visual images are cues for sexual gratification from the actual act (Kimmel & Plante, 2002; Zurbriggen & Yost, 2004). One survey revealed that 46% of the American male population accesses pornography at least once a week, compared to only 16% of the American female population (Regnerus et al., 2016). Also, men prefer to watch explicit pornography (Hald, 2006) and are willing to pay for pornography and prostitution (Pitts et al., 2004; Regnerus et al., 2016). Conversely, women are likely to experience higher levels of subjective sexual arousal when fantasizing about romantic relationships (Carvalho et al., 2013). Laan et al. (1994) pointed out that women feel more intense subjective sexual arousal for women-made pornography, while they often experience negative affective reactions toward man-made pornography and describe such content as awful and unaesthetic. Women-made pornography delineates romantic elements more (e.g., glancing at each other or kissing) as well as sexual intercourse, while man-made pornography is less focused on romantic details (Laan et al., 1994). Furthermore, women experience higher levels of subjective sexual arousal when exposed to sexual content in films, especially when they fantasize about their partner (Carvalho et al., 2013). These findings indicate that romantic elements (e.g., marriage, intimate couples) are essential for female subjective sexual arousal, possibly reflecting stronger preferences for long-term relationships and long-term pair-bonding (Chivers & Timmers, 2012). Taken together, these findings suggest that men generally tend to search for sexual cues that signal immediate sexual access and promiscuity in short-term mates as opposed to women, who seek long-term relationships (Buss & Schmitt, 1993).

Evidence of sex differences in response to visual sexual cues has been accumulated from self-report surveys and physiological studies. Sexual arousal is multifaceted and includes physical, subjective, emotional, and behavioral responses (Bancroft et al., 2009). Subjective sexual arousal (e.g., self-reported perception of arousal) and physiological sexual arousal (i.e., genital responses) can be seen as distinct constructs, even though they are correlational (Carvalho et al., 2013; Chivers et al., 2010; Laan et al., 1994). There is a sex difference in the degree of correlation between subjective and physiological sexual arousal, where men's genital responses correlate more strongly with subjective arousal than women's (Chivers et al., 2010). This makes it more difficult to investigate sex differences related to sexual interests and motivation to view sexual cues.

To quantify sex differences in terms of willingness to view visual sexual cues using direct behavioral measurements, we adopted a pay-per-view key-pressing task in the current study, which provides a measure of the incentive salience held by visually presented stimuli (Aharon et al., 2001). The pay-per-view task constitutes an effort-based behavioral measurement of willingness to view a given stimulus as indexed by the number of key presses (Sprengelmeyer et al., 2013). Participants are able to alter the viewing time of a presented picture according to their willingness to view the picture by pressing a predetermined key to increase the viewing time of images if they are willing to watch the images for longer. In contrast, participants press an alternate key to decrease the viewing time. The key-press task is assumed to reflect the psychologically rewarding value (such as "wanting") of viewing visual images, rather than the subjective likability of the images (Aharon et al., 2001). The task provides a quantitative indication of whether or not the behavior is actually affected, which in turn provides a more accurate representation of our daily behavior (Ferrey et al., 2012). Indeed, Aharon et al. (2001) reported that men's attractiveness rating scores of opposite-sex faces were comparable in a self-report measurement, and men, more than women, spent more time viewing attractive faces of the opposite sex. Similarly, Hahn and colleagues (2013) replicated the finding that men tend to spend more time looking at attractive faces of the opposite sex than women. Thus, we expected that the pay-per-view key-pressing task for sexual images would provide a valid behavioral measure for participants' eagerness and motivation to search for sexual cues.

The present study aimed to investigate sex differences in the motivation to view several types of sexual images by using the pay-per-view key-press task. Based on the sexual strategies theory, we predicted that both heterosexual men and women would increase their viewing time of opposite-sex images compared to same-sex images because opposite-sex images are associated with reproduction, copulation, and personal bonds (Carvalho et al., 2013; Chivers & Bailey, 2005; Hahn et al., 2013; Laan et al., 1994). In addition, we anticipated that men would be more eager than women to view sexual images, such as opposite-sex nude images because sexually explicit opposite-sex images suggest sexual accessibility (i.e., looseness or promiscuity), which can provide direct benefits for men seeking short-term relationships. In contrast, women would be less likely to view sexually explicit images because women are expected to be relatively selective and discriminating when choosing a sexual partner, in keeping with their preference for long-term strategies. In addition, long-term strategies may enhance the motivation for women to view images of couples because they imply emotional and romantic bonding. We tested a set of hypotheses by presenting three types of images (i.e., males, females, and couples). Some previous studies used sexual images depicting only a nude man or a nude woman (Morrison et al., 2017; Ponseti & Bosinski, 2010), while others employed images of opposite-sex couples depicting relationship contexts or physical contact (Dewitte, 2015; Hamann et al., 2004; Laan et al., 1994; Spiering et al., 2010). We included images of couples in this study because images of couples evoking romantic emotions would be essential for women's sexual interest (Laan et al., 1994; Rupp & Wallen, 2007) and women are more sensitive to contextual and nonsexual details of sexual stimuli than are men. Although the main purpose of this study was to examine whether there are differences between men and women in terms of their motivation to view sexual images, we also included subjective likability and arousal rating measurements to test whether the motivation measured with the pay-per-view key-presses (i.e., "wanting") correlate with the subjective aspects of likability (i.e., "liking") and arousal. This was because the previous studies showed that wanting and liking are different (Aharon et al., 2001), and examining the subjective evaluations would add further information to elucidate the relationships between motivation to view sexual images versus subjective likability and subjective arousal rating.

Methods

Participants

Thirty-one Japanese men (M_{age} = 20.43 years, SD = 1.81 years) and 27 Japanese women (M_{age} = 19.96 years, SD = 1.53 years) were recruited for this experiment. All participants self-identified as heterosexual, had normal or corrected-to-normal vision, and were naive to the purpose of the study. They provided written informed consent before participating and were individually tested. This study was approved by the local ethics committee of the university with which the authors are affiliated. The sample size was determined based on a previous study examining the gender differences in affective responses to visual sexual cues (Carvalho et al., 2013).

Apparatus and Stimuli

The experimental stimuli were a set of 36 colored images selected from the NAPS ERO (Wierzba et al., 2015) and OASIS (Kurdi et al., 2017) image databases. From the NAPS ERO, images of opposite-sex couples (N = 5, male and female explicitly engaged in sexual intercourse or sexual interaction), a single male (N = 6), and a single female (N = 5, individuals engaged in an erotic or sexual setting) were selected. Some images from the OASIS were also selected from couple (N = 5), nude couple (N = 2), nude male (N = 6), and nude female categories (N = 7). The images were selected according to the mean rating score of sexuality and arousal provided by 34 heterosexual Japanese participants (18 females; M_{age} = 20.94, SD = 1.71) in a preliminary experiment. Participants in the preliminary experiment rated the sexuality and emotional arousal of the 231 images collected from the NAPS ERO and OASIS on a scale ranging from 1 (not sexual at all/not emotionally arousing at all) to 9 (highly sexual/highly emotionally arousing). Inter-rater reliabilities of the rating scores were high (Cronbach's alphas > 0.95), and thus, the two rating scores were averaged across participants for each. As the sexuality and emotional arousal ratings were highly interrelated (r = 0.92), the two ratings were synthesized via a principal component analysis (PCA); thus, the synthesized score (referred to as "sexual arousal") accounted for 83.7% of the variance. Then, we selected 18 low sexual arousal (referred to as "less sexual") and 18 high sexual arousal image stimuli (referred to as "sexual") according to the sexual arousal scores. Each image set consisted of pictures depicting a single male (N = 6, sexual; mean rating score = 0.69, SD = 0.66, less sexual; mean rating score = -2.07, SD = 0.11), a single female (N = 6, sexual; mean rating score = 2.57, SD = 0.46, less sexual; mean rating score = − 0.19, SD = 0.37), and a male–female couple (N = 6, sexual; mean rating score = 2.13, SD = 0.52, less sexual; mean rating score = − 2.64, SD = 0.44). The selection of images was validated by statistical tests in advance. A two (sexual *vs.* less sexual) × within-subjects there-level (photo category: male vs. female vs. couple) repeated measures analysis of variance (ANOVA) revealed a significant main effect of photo category [F (1.36,

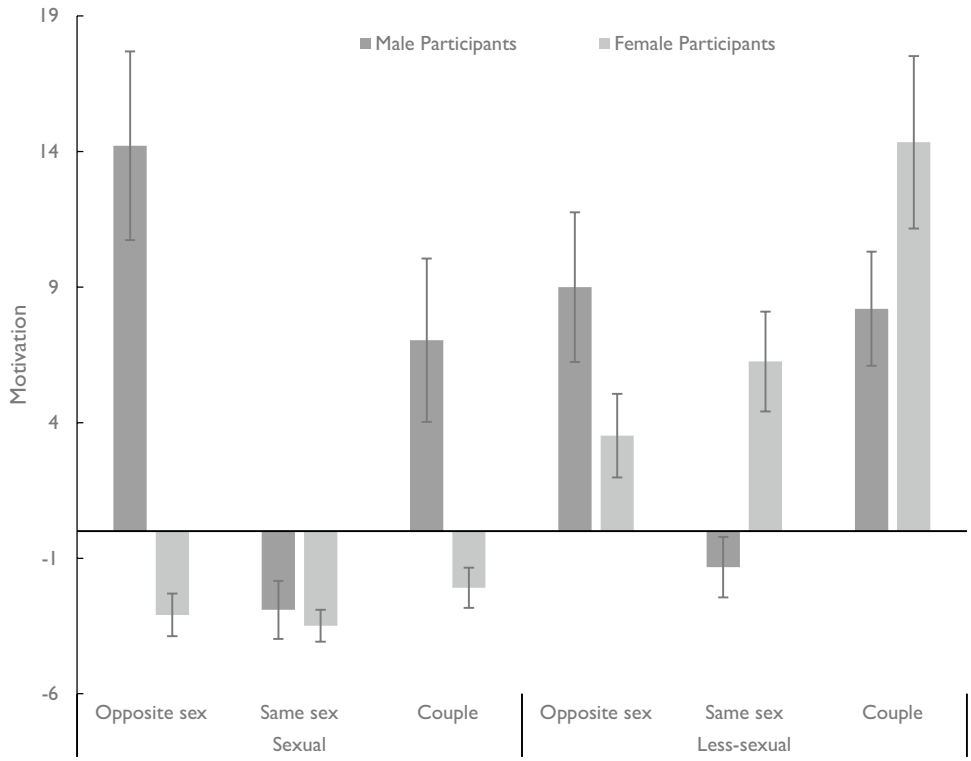

Fig. 1 Motivation in the pay perview task. The data for male participants are presented in the left panel and for female participants are presented in the right panel. Error bars present standard errors (SEs) of the mean

6.78) = 570.21, $\eta_{p2} = 0.99$, $p < 0.001$] and of sexual arousal [F (1, 5) = 712.24, $\eta_{p2} = 0.99$, $p < 0.001$]. There were significant interactions between photo category and sexual arousal [F (1.68, 8.42) = 65.12, $\eta_{p2} = 0.93$, $p < 0.001$]. A simple main effects analysis and subsequent multiple comparison tests (Shaffer's modified sequentially rejective Bonferroni method) revealed that all the images were rated higher in the sexual condition than the less sexual condition [male images: F (1, 5) = 117.21, $\eta_{p2} = 0.96$, $p < 0.001$, female images: F (1, 5) = 555.60, $\eta_{p2} = 0.99$, $p < 0.001$, couple images: F (1, 5) = 1901.62, $\eta_{p2} = 1.00$, $p < 0.001$]. Furthermore, in both the sexual and less sexual conditions, the sexual arousal score was the highest for the female images, followed in order by the couple images and male images ($ps < 0.05$).

Procedure

The experiment consisted of a pay-per-view key-pressing task and a subjective rating task. Upon arriving at the experimental room, participants were taken to a dark room designed for visual experiments and were seated in front of a computer display. All of the participants received a short briefing explaining that sexually explicit images would be presented in the experiment and that they could quit the task if they felt uncomfortable. The participants took part in the task only if they agreed to the above-mentioned explanation.

Pay-Per-View Key-Pressing Task

Participants were then asked to complete the pay-per-view key-pressing task. In the task, participants were able to alter the viewing time of a presented picture according to their willingness to view it. We measured the total number of key presses and the total amount of time participants spent on viewing in the pay-per-view task for the analysis. Each trial began with the presentation of a fixation point for 500 ms, followed by a target picture presentation. The default presentation time was 4000 ms, and participants could either increase the viewing time by alternating between the "N" and "M" keys or decrease the viewing time by alternating between the "Z" and "X" keys. A vertical timer-bar appeared next to each image to indicate the remaining time before image progression. One key-press unit was coded each time a key-pair was pressed alternately. Viewing time was altered by 200 ms per one key-press unit. In each trial, a randomly selected picture was presented once; 36 trials were conducted in total. All participants completed a brief training task designed to familiarize them with the key-press procedure prior to the experiment by using sample pictures never presented in the main task. Participants were instructed that a picture would be displayed on the screen, and they had to press assigned keys according to their willingness to view the picture. Also, they were told that the entire duration of the experiment would not change even if they finished each trial early.

Subjective Rating Task

After completing the pay-per-view key-pressing task, participants were asked to provide ratings for arousal (1, not arousing at all; 9, highly arousing) and likability (1, dislike; 9, very like) for all 36 images presented in the pay-per-view key-pressing task by using a nine-point Likert scale. The presentation order of the images was randomized, and the order of the rating types was counterbalanced across participants.

Data Analysis

We calculated the total amount of time participants spent on viewing each category of images. Data from one male and two female participants were excluded from the analysis because the total number of their total key-presses in the pay-per-view task was less than 55.6 times (i.e., less than the 5th percentile of the total number of the key presses); then, the final analysis included the data for 55 participants (25 female). The motivation in the pay-per-view task and the two types of rating scores (likability and arousal) were analyzed with a linear regression model.

Our designs comprised one between-subject (i.e., sex of participants) and two within-subjects factors (i.e., photo category and sexual arousal). Similar to the approach taken in the previous studies (Judd, 2000; Hsu et al., 2017), we created weighted difference scores to be used as dependent variables, namely, "within-groups contrasts." The within-groups contrasts are contrasted to be orthogonal to each other. Thus, we created six orthogonal within-groups contrasts as weighted differences of the repeated measures. The first contrasted the key-pressing responses to the opposite-sex images with those to the other photo categories for sexually arousing images (i.e., the halving of the differences ensures that the regression coefficient is interpretable as the relevant difference). In a similar vein, the second and the third contrasted the same-sex images with those the other photo categories, and the couple images with those the other photo categories, respectively. The analogous three more contrasts were created for less sexually arousing images.

To test the sex differences in the responses to the images from each photo categories, we regressed each within-groups contrast on the complete set of a between-groups contrast (sex of participants: male vs. female), thus performing six linear regressions. The resulting regression coefficients indicate the degree of sex differences, where the positive value means the stronger effect in male participants, and the negative value means the stronger effect in female participants.

The precisely analogous regression analysis described above was performed for the likability and arousal ratings in order to assess how observers' sexual interests are reflected to both effort-based behavioral measure and self-report measures.

Results

Figure 1 shows the number of pay-per view key presses. The associated regression coefficients for analysis of the pay-per-view key-pressing, subjective likeability, and subjective arousal ratings are shown in Tables 1, 2, and 3, respectively. The pay-per-view key-pressing task, subjective likeability, and subjective arousal results showed simultaneously different and similar trends, especially in terms of the characteristics of responses to opposite-sex and couples images. In the following sections, we describe the gender differences and differences in the response characteristics of results of the pay-per-view key-pressing task, subjective likeability, and subjective arousal.

Pay-Per-View Key-Pressing Task

When examining the differences between men and women in the sexual condition using opposite sex images (i.e., the first within-subjects comparison), male participants made significantly more key presses to view images than female participants. For the less sexual condition, there were no significant differences between male and female participants in terms of pay-per-view key presses (i.e., the second within-subjects comparison). When presented with same-sex images in the sexual condition, there were no significant differences between male and female participants; in the less sexual condition, however, female participants made significantly more key presses to view same-sex images than male participants. Male participants made significantly more key presses to view couples images in the sexual condition than female participants, while female participants made significantly more key presses to view couples images in the less sexual condition, than males.

Subjective Rating Task

In terms of subjective likeability, in both the sexual and less sexual conditions, male participants had significantly higher scores for images of the opposite sex than female participants. Similarly, in both conditions, female participants rated their subjective likeability of same-sex images significantly higher for images than male participants. When presented with sexual images of couples, male participants rated their subjective likeability significantly higher than female participants, whereas female participants rated less sexual images of couples significantly higher than male participants.

In terms of subjective arousal rating, for both the sexual and less sexual conditions, male participants had significantly higher scores for images of the opposite sex than female participants. Similarly, in both conditions,

Table 1 Pay-per-view key pressing task

Between-subjects contrast	Within-subjects contrast					
	Sexual condition			Less sexual condition		
Male *vs.* female participants	Opposite sex images *vs.* other sexual images			Opposite sex images *vs.* other images		
	Regression coefficient	95% CI	T(1,54)	Regression coefficient	95% CI	T(1,54)
	8.51***	[5.10, 11.9]	5.01	1.4	[− 0.45, 3.27]	1.52
Male *vs.* female participants	Same sex images *vs.* other sexual images			Same sex images *vs.* other images		
	Regression coefficient	95% CI	T(1,54)	Regression coefficient	95% CI	T(1,54)
	−1.53	[− 3.96, 0.91]	−1.26	− 6.43***	[− 8.79, − 4.06]	−5.45
Male *vs.* female participants	Couple images *vs.* other sexual images			Couple images *vs.* other images		
	Regression coefficient	95% CI	T(1,54)	Regression coefficient	95% CI	T(1,54)
	− 3.60**	[− 1.40, − 5.81]	3.27	5.56***	[− 8.38, − 2.74]	− 3.96

N = *55* (female participants: *n* = 25)

***$p < .00l$; **$p < .01$

female participants rated their subjective arousal related to same-sex images significantly higher than male participants. When presented with sexual images of couples, female participants rated their subjective arousal significantly higher than male participants. On the other hand, when presented with less sexual images of couples, male participants rated their subjective arousal significantly higher than female participants.

Discussion

The purpose of this study was to examine whether there are differences between men and women in terms of their motivation to view sexual images. Drawing on SST (Buss & Schmitt, 1993), we hypothesized that our self-identified heterosexual male and female participants would view the opposite-sex images longer than the same-sex images because opposite-sex images can evoke sexual arousal (Chivers & Bailey, 2005; Hahn et al., 2013), and that men would be more eager than women to view the highly sexual images because sexually explicit opposite-sex images suggest sexual accessibility (Buss & Schmitt, 1993). Our results indicate that the motivational salience of sexual images differed between male and female participants. Here, we summarize the main findings and interpret such differences in light of the SST (Buss & Schmitt, 1993).

First, as predicted, our male participants viewed the opposite sex images and couple images longer than the same sex images, irrespective of the sexual arousal of the images. These results confirm that heterosexual males are strongly motivated to view opposite sex images (Baumeister et al., 2001; Hamann et al., 2004). Furthermore, the number of key-presses by the male participants for the opposite sex images in the sexual condition was higher compared to that for the other image. Such prioritized motivational responses

Table 2 Subjective likeability rating task

Between-subjects contrast	Within-subjects contrast					
	Sexual condition			Less sexual condition		
Male *vs.* female participants	Opposite sex images *vs.* other sexual images			Opposite sex images *vs.* other images		
	Regression coefficient	95% CI	T(1,54)	Regression coefficient	95% CI	T(1,54)
	1.65***	[1.29, 2.00]	9.18	0.55***	[0.24, 0.85]	3.59
Male *vs.* female participants	Same sex images *vs.* other sexual images			Same sex images *vs.* other images		
	Regression coefficient	95% CI	T(1,54)	Regression coefficient	95% CI	T(1,54)
	− 0.50***	[− 0.74, − 0.25]	− 4.08	− 1.50***	[− 1.84, − 1.16]	− 8.87
Male *vs.* female participants	Couple images *vs.* other sexual images			Couple images *vs.* other images		
	Regression coefficient	95% CI	T(1,54)	Regression coefficient	95% CI	T(1,54)
	1.02***	[0.67, 1.37]	5.83	− 1.21***	[− 1.60, − 0.82]	− 6.21

N = *55* (female participants: *n* = 25)

***$p < .00l$; **$p < .0l$

Table 3 Subjective arousal rating task

Between-subjects contrast	Within-subjects contrast					
	Sexual condition			Less sexual condition		
Male *vs.* female participants	Opposite sex images *vs.* other sexual images			Opposite sex images *vs.* other images		
	Regression coefficient	95% CI	T(1,54)	Regression coefficient	95% CI	T(1,54)
	0.91***	[0.56, 1.25]	5.30	1.69***	[1.44, 1.95]	13.42
Male *vs.* female participants	Same sex images *vs.* other sexual images			Same sex images *vs.* other images		
	Regression coefficient	95% CI	T(1,54)	Regression coefficient	95% CI	T(1,54)
	− 1.79***	[− 2.19, − 1.37]	− 8.75	− 0.89***	[− 1.22, − 0.57]	− 5.51
Male *vs.* female participants	Couple images *vs.* other sexual images			Couple images *vs.* other images		
	Regression coefficient	95% CI	T(1,54)	Regression coefficient	95% CI	T(1,54)
	− 0.39**	[− 0.64, − 0.13]	− 3.04	0.46*	[0.11, 0.82]	2.61

N = *55* (female participants: *n* = 25)

***$p < .001$; **$p < .01$

to the opposite sex images were also evident in likability and sexual arousal ratings. In the less sexual condition of the opposite-sex images, there were no significant differences in the pay-per-view key pressing, but there were significant differences in subjective likeability and arousal ratings. This result was not reflected in the behavior of opposite sex images with less sexual condition, even though male participants reported higher levels of subjective sexual arousal and preference than female participants. This suggests that the pay-per-view responses reflect sexual motivation to view the images, not merely the subjective evaluations of them (Aharon et al., 2001). These observations of the male participants' behavior are consistent with the behavioral predictions provided by the SST (i.e., prediction 6: *cues to immediately available sex will be valued by men in short-term mates more than in long-term mates because they provide cues to sexual accessibility*). Previous studies also suggest that men are likely to prefer visual sexual cues than women, and are thus eager to view nude images of women (Baumeister et al., 2001; Regnerus et al., 2016). Also, recent studies reveal that heterosexual men prefer to view opposite-sex images in both erotic and non-erotic contexts more than heterosexual women do (Lykins et al., 2006; Lykins et al., 2008; Rupp & Wallen, 2007). Taken together, these findings suggest that men tend to value cues to immediately available sex (e.g., promiscuity) in short-term mates (Buss & Schmitt, 1993), possibly leading to men's greater attraction to sexually arousing visual images (Symons, 1979). Our results support these previous findings by using a behavioral measurement that reflects sexual motivation.

In contrast to the male participants, the female participants displayed different patterns of pay-per-view responses depending on the sexual arousal of the images. From the standpoint of mate choice, the female participants would have also viewed the male images longer than the female images (Chivers & Bailey, 2005; Hahn et al., 2013). However, the female participants in this experiment viewed the couple images longer than the other images, while they decreased the viewing time for all types of images in the sexual condition. Female participants in this study were less responsive than male participants to opposite sex images in all pay-per view key-pressing, subjective likeability and arousal. Previous studies indicate that women react to men's physical attractiveness as strongly as men react to women's physical attractiveness (Hahn et al., 2013; Hamann et al., 2004; Wiederman & Dubois, 1998). This indicates that men and women are equally able to identify sexual cues from the opposite sex (Kowalski, 1993). It is noteworthy that many previous findings were based on participants from Western cultures; so, the inconsistency between previous findings and our results may be partially derived from cultural and social differences in sexual attitudes (Thomas et al., 2015). Our results that women decreased viewing time for both sexual and less sexual same sex images ostensibly seem to be inconsistent with some previous findings (e.g., Women react to men's physical attractiveness as strongly as men react to women's physical attractiveness (Hahn et al., 2013; Hamann et al., 2004; Wiederman & Dubois, 1998). One possible explanation for the inconsistent results can be provided by cultural differences in expression and social expectations of female sexuality. Indeed, Western women tend to explicitly report higher sexual desire, arousal, and pleasure when experiencing orgasm compared to East Asian women (Brotto et al., 2005; Cain et al., 2003). Also, East Asian women are likely to have automatic thoughts related to sexual guilt (e.g., "I am an immoral person for wanting sex," or "It is wrong for a woman to initiate sexual activity?"), which may originate from implicit social expectations of female sexuality and thereby motivate them to avoid sexual scenarios they believe immoral (Woo et al., 2011). Although such cultural differences

are also found in men, they are reflected in women more strongly (Abramson & Imai-Marquez, 1982). It would be interesting to address this question by conducting a cross-cultural study with East-Asian and Western populations.

Of particular interest is that our female participants viewed the couple images longer than the male and female images in the less sexual condition. Such patterns were also observed in the subjective likeability rating task but not in the subjective arousal task. These results are consistent with previous findings that women are highly motivated to view couple images depicting relationship contexts and emotional bonds (Laan et al., 1994; Carvalgho, 2013). According to the behavioral prediction of the sexual strategies theory, women place more emphasis on romantic relationships than men's physical attractiveness (Rupp & Wallen, 2007). Indeed, Dewitte (2015) showed that women feel greater sexual desire when primed with visual cues conjuring up romantic relationships. Correspondingly, women experience more intense sexual arousal when viewing pornography with romantic elements (e.g., glancing at each other, kissing, or marriage) than pornography with actual sexual intercourse (Laan et al., 1994). In our study, the female participants displayed prolonged viewing of less sexual couple images compared to the highly sexual couple images. The less sexual couple images often include romantic elements as described above. The female preference for romantic or relational elements likely derives from psychological adaptations for long-term relationship and pair-bonding signals (Buss & Schmitt, 1993; Chivers & Timmers, 2012). Long-term relationships are more advantageous for women than for men (Trivers, 1972), because women tend to be the more heavily investing sex (e.g., fertilization, gestation, placentation, and maternal care). Thus, women's strong preference for long-term mating cues might reflect the motivation to secure the quantity and quality of external resources for themselves and their offspring from men (Buss & Schmitt, 1993). At the same time, our female participants made key-press responses to reduce the viewing time for images with high sexual arousal (sexual condition), regardless of the image category. This response pattern may be related to an adaptive behavior such as preventing the initiation of sexual intercourse after only brief intervals of time (Buss & Schmitt, 1993) and/or women's sexual attitudes are influenced by societal norms that place them in a dilemma regarding sexuality, such that female sexuality has historically been suppressed and deemed as immoral (Lemer et al., 2013).

The present study has been based on the sexual strategies theory and has discussed considerations related to reproductive success, such as opposite-sex and couple images, but it is necessary to discuss the results for same-sex sexual images, which are not thought to contribute to reproduction according to the sexual strategies theories. Our female participants were more motivated, more preferred, and more aroused by the same sex images with less sexual condition than male participants. This result may be due to a greater intra-individual variation in female preferences, behavior, attitudes, and responsiveness to cultural influences drives. Greater flexibility in female sexual preferences may also be reflected in a less specific pattern of sexual arousal (Baumeister et al., 2001; Chivers et al., 2004). These response characteristics to same-sex sexual stimuli are important in examining various genders, including LGBT, and can provide valuable insights for discussions that go beyond sexual strategies theory.

Limitations and Directions for Future Research

While the findings of the current study are novel, there exist several limitations to be considered. As mentioned in the introduction, sexual arousal is a multifaceted concept that includes physical, subjective, emotional, and behavioral aspects (Bancroft et al., 2009). Among them, this study focused on the motivation to view sexual images in an experimental setting as indexed by the pay-per-view key-pressing responses. It is important to keep in mind that the pay-per-view responses are not the direct measures of actual sexual behaviors and physiological arousal. Sex differences in psychological reactions to sexual cues await further validation with physiological and subjective measurements. In addition, the visual stimuli we used were limited to images from Western models, while the participants in this study were Japanese. Some studies demonstrate that people are susceptible to recognition errors or biased emotional evaluation when target images are from an unfamiliar group rather than their own group (e.g., other-race-effect; Feng et al., 2012; Herrmann et al., 2007; Hugenberg et al., 2010). Although we confirmed in the preliminary experiment that Japanese viewers were able to evaluate sexual arousal consistently, it may be more appropriate to use sexually arousing images from the same cultural group. However, to the best of our knowledge, the image database including a Japanese erotic category is not publicly available yet. Our findings await validation from future studies by using images from the same and different groups. Lastly, we could not rule out the possibility that unidentified factors other than sexual arousal and the image categories of our image stimuli affected the viewing time in the pay-per-view task because of the lack of experimental control for the components constituting each image, such as the presence of faces, the number of persons, and so on. More detailed analysis is needed for a deeper understanding of what triggers the sex differences in the motivation to view sexual images.

Conclusions

In conclusion, the present study investigated sex differences in willingness to view sexual images by using the pay-per-view task. Although Asians have more conservative attitudes toward sex than other races (Ahrold & Meston, 2010), our Japanese male participants were motivated to view sexually arousing female images, whereas female participants were motivated to view less sexually arousing couple images. Such sex differences may reflect differentiated reproductive strategies between men and women, as predicted by the sexual strategies theory. The sex differences based on psychological adaptation may help solve our dating problems and sexual harassment problems. Our findings contribute to a better understanding of differentiated sexual motivation between men and women, which underlies a wide range of sex-related social matters including pornography consumption, sexual consent, and sexual crimes.

Author Contribution All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by M. K. and K. N. The first draft of the manuscript was written by M. K. and K. N, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data Availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Code Availability The codes that support the findings of this study are available from the corresponding author, M. K., upon reasonable request.

Declarations

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and were approved by the local ethics committee of the university that the authors are affiliated with. All procedures were carried out in accordance with the 1964 Helsinki declaration and its later amendments.

Consent to Participate Informed consent was obtained from all individual participants included in the studies. Before starting the experiment, each participant in all studies provided informed consent and signed a written consent form.

Consent for Publication All authors, M. K., K. N, and K.W, have consented to the publication of this manuscript.

Informed Consent Informed consent was obtained from all individual participants included in the study. Before starting the experiment, each participant provided informed consent and signed a written consent form.

Conflicts of Interest The authors declare that they have no conflict of interest.

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References

Abramson, P. R., & Imai-Marquez, J. (1982). The Japanese-American: A cross-cultural, cross-sectional study of sex guilt. *Journal of Research in Personality, 16*(2), 227–237. https://doi.org/10.1016/0092-6566(82)90078-2

Aharon, I., Etcoff, N., Ariely, D., Chabris, C. F., O'Connor, E., & Breiter, H. C. (2001). Beautiful faces have variable reward value: fMRI and behavioral evidence. *Neuron, 32*(3), 537–551. https://doi.org/10.1016/S0896-6273(01)00491-3

Ahrold, T. K., & Meston, Æ. C. M. (2010). Ethnic differences in sexual attitudes of U.S. college students: Gender, acculturation, and religiosity factors. *Archives of Sexual Behavior*, *39*(1), 190–202. https://doi.org/10.1007/s10508-008-9406-1

Bailey, J. M., Gaulin, S., Agyei, Y., & Gladue, B. A. (1994). Effects of gender and sexual orientation on evolutionarily relevant aspects of human mating psychology. *Journal of personality and social psychology, 66*(6), 1081. https://doi.org/10.1037/0022-3514.66.6.1081

Bancroft, J., Graham, C. A., Janssen, E., & Sanders, S. A. (2009). The dual control model: Current status and future directions. *Journal of Sex Research, 46*(2–3), 121–142. https://doi.org/10.1080/00224490902747222

Baumeister, R. F., Catanese, K. R., & Vohs, K. D. (2001). Is there a gender difference in strength of sex drive ? Theoretical views, conceptual distinctions, and a review of relevant evidence. *Personality and Social Psychology Review, 5*(3), 242–273.

Brotto, L. A., Chik, H. M., Ryder, A. G., Gorzalka, B. B., & Seal, B. N. (2005). Acculturation and sexual function in Asian women. *Archives of Sexual Behavior, 34*(6), 613–626. https://doi.org/10.1007/s10508-005-7909-6

Buss, D. M., & Schmitt, D. P. (1993). Sexual strategies theory: An evolutionary perspective on human mating. *Psychological Review, 100*(2), 204–232. https://doi.org/10.1037/0033-295X.100.2.204

Cain, V. S., Johannes, C. B., Avis, N. E., Mohr, B., Schocken, M., Skurnick, J., & Ory, M. (2003). Sexual functioning and practices in a multi-ethnic study of midlife women: Baseline results from SWAN. *Journal of Sex Research, 40*(3), 266–276. https://doi.org/10.1080/00224490309552191

Carvalho, J., Gomes, A. Q., Laja, P., Oliveira, C., Vilarinho, S., Janssen, E., & Nobre, P. (2013). Gender differences in sexual arousal and affective responses to erotica: The effects of type of

film and fantasy instructions. *Archives of Sexual Behavior, 42*(6), 1011–1019. https://doi.org/10.1007/s10508-013-0076-2

Chivers, M. L., & Bailey, J. M. (2005). A sex difference in features that elicit genital response. *Biological Psychology, 70*(2), 115–120. https://doi.org/10.1016/j.biopsycho.2004.12.002

Chivers, M. L., & Timmers, A. D. (2012). Effects of gender and relationship context in audio narratives on genital and subjective sexual response in heterosexual women and men. *Archives of Sexual Behavior, 41*(1), 185–197. https://doi.org/10.1007/s10508-012-9937-3

Chivers, M. L., Rieger, G., Latty, E., & Bailey, J. M. (2004). A sex difference in the specificity of sexual arousal. *Psychological Science, 15*(11), 736–744.

Chivers, M. L., Seto, M. C., Lalumiere, M. L., Laan, E., & Grimbos, T. (2010). Agreement of self-reported and genital measures of sexual arousal in men and women: A meta-analysis. *Archives of sexual behavior, 39*(1), 5-56.

Dawson, S. J., & Chivers, M. L. (2016). Gender-specificity of initial and controlled visual attention to sexual stimuli in androphilic women and gynephilic men. *PLoS ONE, 11*(4), 1–22. https://doi.org/10.1371/journal.pone.0152785

Dewitte, M. (2015). Gender differences in liking and wanting sex: Examining the role of motivational context and implicit versus explicit processing. *Archives of Sexual Behavior, 44*(6), 1663–1674. https://doi.org/10.1007/s10508-014-0419-7

Feng, C., Wang, L., Wang, N., Gu, R., & Luo, Y. J. (2012). The time course of implicit processing of erotic pictures: An event-related potential study. *Brain Research, 1489,* 48–55. https://doi.org/10.1016/j.brainres.2012.10.019

Ferrey, A. E., Frischen, A., & Fenske, M. J. (2012). Hot or not: response inhibition reduces the hedonic value and motivational incentive of sexual stimuli. *Frontiers in Psychology, 3,* 575. https://doi.org/10.3389/fpsyg.2012.00575

Fisher, H. E., Aron, A., & Brown, L. L. (2006). Romantic love: A mammalian brain system for mate choice. *Philosophical Transactions of the Royal Society B: Biological Sciences, 361*(1476), 2173–2186. https://doi.org/10.1098/rstb.2006.1938

Hahn, A. C., Xiao, D., Sprengelmeyer, R., & Perrett, D. I. (2013). Gender differences in the incentive salience of adult and infant faces. *Quarterly Journal of Experimental Psychology, 66*(1), 200–208. https://doi.org/10.1080/17470218.2012.705860

Hald, G. M. (2006). Gender differences in pornography consumption among young heterosexual Danish adults. *Archives of Sexual Behavior, 35*(5), 577–585. https://doi.org/10.1007/s10508-006-9064-0

Hamann, S., Herman, R. A., Nolan, C. L., & Wallen, K. (2004). Men and women differ in amygdala response to visual sexual stimuli. *Nature Neuroscience, 7*(4), 411–416. https://doi.org/10.1038/nn1208

Herrmann, M. J., Schreppel, T., Jäger, D., Koehler, S., Ehlis, A. C., & Fallgatter, A. J. (2007). The other-race effect for face perception: An event-related potential study. *Journal of Neural Transmission, 114*(7), 951–957. https://doi.org/10.1007/s00702-007-0624-9

Hsu, K. J., Rosenthal, A. M., Miller, D. I., & Bailey, J. M. (2017). Sexual arousal patterns of autogynephilic male cross-dressers. *Archives of Sexual Behavior, 46*(1), 247–253.

Hugenberg, K., Young, S. G., Bernstein, M. J., & Sacco, D. F. (2010). The categorization-individuation model: An integrative account of the other-race recognition deficit. *Psychological Review, 117*(4), 1168–1187. https://doi.org/10.1037/a0020463

Judd, C. M. (2000). Everyday data analysis in social psychology: Comparisons of linear models. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 370–392). New York: Cambridge University Press.

Kenrick, D. T., Groth, G. E., Trost, M. R., & Sadalla, E. K. (1993). Integrating evolutionary and social exchange perspectives on relationships: Effects of gender, self-appraisal, and involvement level on mate selection criteria. *Journal of Personality and Social Psychology, 64*(6), 951–969. https://doi.org/10.1037/0022-3514.64.6.951

Kimmel, M., & Plante, R. F. (2002). The gender of desire: The sexual fantasies of women and men. *Advances in Gender Research, 6,* 55–77. https://doi.org/10.1016/S1529-2126(02)80004-2

Kowalski, R. M. (1993). Inferring sexual interest from behavioral cues: Effects of gender and sexually relevant attitudes. *Sex Roles, 29*(1–2), 13–36. https://doi.org/10.1007/BF00289994

Kurdi, B., Lozano, S., & Banaji, M. R. (2017). Introducing the Open Affective Standardized Image Set (OASIS). *Behavior Research Methods, 49*(2), 457–470. https://doi.org/10.3758/s13428-016-0715-3

Laan, E., Everaerd, W., van Bellen, G., & Hanewald, G. (1994). Women's sexual and emotional responses to male- and female-produced erotica. *Archives of Sexual Behavior, 23*(2), 153–169. https://doi.org/10.1007/BF01542096

Lemer, J. L., Salafia, E. H. B., Benson, K. E., Lemer, J. L., Salafia, E. H. B., & Benson, K. E. (2013). The relationship between college women's sexual attitudes and sexual activity: The mediating role of body image. *International Journal of Sexual Health, 25*(2), 104–114. https://doi.org/10.1080/19317611.2012.722593

Lykins, A. D., Meana, M., & Kambe, G. (2006). Detection of differential viewing patterns to erotic and non-erotic stimuli using eye-tracking methodology. *Archives of Sexual Behavior, 35*(5), 569–575. https://doi.org/10.1007/s10508-006-9065-z

Lykins, A. D., Meana, M., & Strauss, G. P. (2008). Sex differences in visual attention to erotic and non-erotic stimuli. *Archives of Sexual Behavior, 37*(2), 219–228. https://doi.org/10.1007/s10508-007-9208-x

Morrison, D., Wang, H., Hahn, A. C., Jones, B. C., & DeBruine, L. M. (2017). Predicting the reward value of faces and bodies from social perception. *PLoS ONE, 12*(9), 1–11. https://doi.org/10.1371/journal.pone.0185093

Murnen, S. K., & Stockton, M. (1997). Gender and self-reported sexual arousal in response to sexual stimuli: A meta-analytic review. *Sex Roles, 37*(3–4), 135–153.

Peplau, L. A. (2003). Human sexuality: How do men and women differ? Relationships aggression. *Current Directions in Psychological Science, 12*(2), 37–41. https://doi.org/10.1111/1467-8721.01221

Pitts, M. K., Smith, A. M. A., Grierson, J., O'Brien, M., & Misson, S. (2004). Who pays for sex and why? An analysis of social and motivational factors associated with male clients of sex workers. *Archives of Sexual Behavior, 33*(4), 353–358. https://doi.org/10.1023/B:ASEB.0000028888.48796.4f

Ponseti, J., & Bosinski, H. A. G. (2010). Subliminal sexual stimuli facilitate genital response in women. *Archives of Sexual Behavior, 39*(5), 1073–1079. https://doi.org/10.1007/s10508-009-9587-2

Regnerus, M., Gordon, D., & Price, J. (2016). Documenting pornography use in America: A comparative analysis of methodological approaches. *Journal of Sex Research, 53*(7), 873–881. https://doi.org/10.1080/00224499.2015.1096886

Rupp, H. A., & Wallen, K. (2007). Sex differences in viewing sexual stimuli: An eye-tracking study in men and women. *Hormones and behavior, 51,* 524–533. https://doi.org/10.1016/j.yhbeh.2007.01.008

Schmitt, D. P. (2014). Evaluating evidence of mate preference adaptations: How do we really know what Homo sapiens sapiens really want? In V. A. Weekes-Shackelford & S. K. Todd (Eds.), *Evolutionary Perspectives on Human Sexual Psychology and Behavior* (pp. 3–42). Springer. https://doi.org/10.1007/978-1-4939-0314-6

Schmitt, D. P. (2015). Fundamentals of Human Mating Strategies. In D. M. Buss (Ed.), *The Handbook of Evolutionary Psychology*. New Jersey: John Wiley & Sons, Inc. https://doi.org/10.1002/9780470939376

Schmitt, D. P., Alcalay, L., Allik, J., Ault, L., Austers, I., Bennett, K. L., et al. (2003). Universal sex differences in the desire for sexual variety: Tests from 52 Nations, 6 Continents, and 13 Islands. *Journal of Personality and Social Psychology, 85*(1), 85–104. https://doi.org/10.1037/0022-3514.85.1.85

Spiering, M., Everaerd, W., Karsdorp, P., Both, S., Spiering, M., Everaerd, W., et al. (2010). Nonconscious processing of sexual information: A generalization to women. *Journal of Sex Research, 43*(3), 268–281. https://doi.org/10.1080/00224490609552325

Sprengelmeyer, R., Lewis, J., Hahn, A., & Perrett, D. I. (2013). Aesthetic and incentive salience of cute infant faces: Studies of observer sex, oral contraception and menstrual cycle. *PLoS ONE*, *8*(5). https://doi.org/10.1371/journal.pone.0065844

Symons, D. (1979). Sexual Choice. *The Evolution of Human Sexuality* (pp. 166–205). New York: Oxford University Press.

Thomas, T. L., Yarandi, H. N., Dalmida, S. G., Frados, A., & Klienert, K. (2015). Cross-cultural differences and sexual risk behavior of emerging adults. *Journal of Transcultural Nursing, 26*(1), 64–72. https://doi.org/10.1177/1043659614524791

Trivers, R. L. (1972). Parental investment and sexual selection. In B. Campbell (Ed.), *Sexual selection and the descent of man, 1871–1971* (pp. 136–179). Cicago: Aldine Atherton.

Wiederman, M. W., & Dubois, S. L. (1998). Evolution and sex differences in preferences for short-term mates: Results from a policy capturing study. *Evolution and Human Behavior, 19*(3), 153–170. https://doi.org/10.1016/S1090-5138(98)00006-3

Wierzba, M., Riegel, M., Pucz, A., Leśniewska, Z., Dragan, W. Ł, Gola, M., et al. (2015). Erotic subset for the Nencki Affective Picture System (NAPS ERO): A cross-sexual comparison study. *Frontiers in Psychology, 6*(9), 1–13. https://doi.org/10.3389/fpsyg.2015.01336

Woo, J. S. T., Brotto, L. A., & Gorzalka, B. B. (2011). The role of sex guilt in the relationship between culture and women's sexual desire. *Archives of Sexual Behavior, 40*(2), 385–394. https://doi.org/10.1007/s10508-010-9609-0

Zurbriggen, E. L., & Yost, M. R. (2004). Power, desire, and pleasure in sexual fantasies. *Journal of Sex Research, 41*(3), 288–300. https://doi.org/10.1080/00224490409552236

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