

Sex differences in viewing sexual stimuli: An eye-tracking study in men and women

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Abstract

Men and women exhibit different neural, genital, and subjective arousal responses to visual sexual stimuli. The source of these sex differences is unknown. We hypothesized that men and women look differently at sexual stimuli, resulting in different responses. We used eye tracking to measure looking by 15 male and 30 female (15 normal cycling (NC) and 15 oral contracepting (OC)) heterosexual adults viewing sexually explicit photos. NC Women were tested during their menstrual, periovulatory, and luteal phases while Men and OC Women were tested at equivalent intervals, producing three test sessions per individual. Men, NC, and OC Women differed in the relative amounts of first looks towards, percent time looking at, and probability of looking at, defined regions of the pictures. Men spent more time, and had a higher probability of, looking at female faces. NC Women had more first looks towards, spent more time, and had a higher probability of, looking at genitals. OC Women spent more time, and had a higher probability of, looking at contextual regions of pictures, those featuring clothing or background. Groups did not differ in looking at the female body. Menstrual cycle phase did not affect women's looking patterns. However, differences between OC and NC groups suggest hormonal influences on attention to sexual stimuli that were unexplained by subject characteristic differences. Our finding that men and women attend to different aspects of the same visual sexual stimuli could reflect pre-existing cognitive biases that possibly contribute to sex differences in neural, subjective, and physiological arousal.

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Experimental studies generally agree that men and women respond differently to visual sexual stimuli (e.g., Laan et al., 1994; Murnen and Stockton, 1997; Schmidt, 1975; Steinman et al., 1981). However, it is unknown to what extent these differences reflect variation in the central cognitive processing of the stimuli, including memory, attention, and emotion. It is often assumed that when looking at a stimulus, such as a picture of sexual intercourse, that men and women see the same thing. However, men and women possibly attend to markedly different features of the pictures. Sex differences in attention to visual sexual stimuli would have implications for future interpretations of studies using such stimuli and assessing neural, subjective, and genital endpoints. The current study addressed the

hypothesis that previously reported sex differences in response to visual sexual stimuli may reflect sex differences in viewing patterns to sexual stimuli.

Our theoretical orientation supposes that cognitive processes, specifically attention, mediate the specific genital and subjective responses to visual sexual stimuli in men and women. Where a person looks is the first event regulating the response to stimuli since those aspects of a stimulus attended to are preferentially processed and encoded (Yantis, 2005). It is possible that men and women differ in how they attend to the same stimuli because multiple cognitive factors determine individual attention (Duchowski, 2002; Josephson and Holmes, 2002). The order and duration of fixations on specific features of a stimulus vary with the interest of the subject (Rizzo et al., 1987; Isaacowitz, 2006). Individual differences in scan patterns reflect subject-specific motivation and the individual's assessment of what aspects of an image are interesting, important, and warrant attention (Balci et al., 2006; Henderson, 2003;

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Isaacowitz, 2006). Motivational state biases information processing focusing attention to specific aspects of stimuli (Balci et al., 2006; Mogg et al., 2003; Isaacowitz, 2006). Men and women may pay attention to different aspects of sexual stimuli due to sex differences in what they find most attractive and arousing in a sexual context and differences in levels of sexual motivation (Balci et al., 2006). Levels of general sexual arousal are higher with focused attention (Koukounas and McCabe, 1997; Geer and Fuhr, 1976). Thus, different viewing strategies may produce different patterns of maximal arousal in men and women to the same stimulus.

It is unknown what characteristics are important for men and women in their evaluation of visual sexual stimuli, and therefore, it is unknown what factors men and women attend to in order to maximize arousal. A recent eye-tracking study suggests that the bodies of opposite sex nudes capture the majority of the viewer's attention (Lykins et al., 2006). This study found that men and women increased looking at the bodies and decreased looking at the faces and context in erotic compared to nonerotic stimuli. However, men and women in this previous eye-tracking study did not view the same stimuli making comparisons between the sexes impossible. Furthermore, the Lykins et al. (2006) study used opposite-sex nudes as the stimuli, rather than couples engaged in sexual activity, which are typically used in the assessment of sex differences in response to visual sexual stimuli (e.g., Hamann et al., 2004; Janssen et al., 2003; Laan et al., 1994). Studies using visual sexual stimuli depicting heterosexual intercourse found that men and women differ in their content preferences. Specifically, men and women rated visual sexual stimuli chosen by a member of their own sex as more sexually arousing than stimuli chosen by a member of the opposite sex (Laan et al., 1994; Janssen et al., 2003). Unfortunately, the characteristics that differentiated male from female selected stimuli were undefined. Possibly, there could be sex differences in men and women's interest in the contextual vs. specifically sexual elements of visual sexual stimuli; with women looking more at contextual and nonsexual details than do men. Support for this notion comes from the work finding that with repeated exposure to visual sexual stimuli, women changed their viewing strategy in later sessions and looked at contextual features of the stimuli to maintain arousal, whereas men did not (Laan and Everaerd, 1995). Thus, previous evidence for sex differences in attention to or interest in particular characteristics of visual sexual stimuli is inconclusive.

In addition to differences between sexes in attention to visual sexual stimuli, it is also possible that there are differences among women based on their use of hormonal contraceptives. Effects of hormonal contraceptives on sexual motivation may influence women's gaze patterns to sexual stimuli by altering visual perception (Balci et al., 2006; Isaacowitz, 2006). In women not using oral contraceptives, sexual desire, masturbation, and instances of sexual initiation fluctuate over the cycle, with highest levels during the periovulatory period, when sex steroid levels are also highest (reviewed in Wallen, 2001). Because women using oral contraceptives do not experience the same magnitude of hormonal fluctuations

(Carlstrom et al., 1978), one would expect them to have lower and less variable sexual motivation than cycling women. Lower sexual motivation in oral contracepting women generally appears to be the case, although there are conflicting findings (reviewed in Davis and Castano, 2004).

We investigated the hypothesized sex and within female group differences in viewing patterns of visual sexual stimuli by monitoring eye movement while subjects viewed sexual stimuli. A previous study using eye-tracking methodology to investigate gaze patterns of men and women on pictures of male and female typical toys (Alexander, 2006) found not only sex differences in gaze patterns, but also a possible relationship between prenatal androgen exposure and visual preferences, supporting the use of this technology in the investigation of sex and contraceptive use differences in attention to visual sexual stimuli. It should be noted that because previous research is so limited addressing what components of sexual stimuli are salient for men and women, it was not possible to make strong directional predictions based on the limited literature available. However, we expected sex differences in attention to the stimuli. Specifically, we predicted that viewing patterns would differ between men and women such that men would look more at explicitly sexual components, such as the genitals and female body, whereas women would be more likely than men to be interested in faces and the context of the photos, such as the background and clothing. Due to differences in hormonal profiles, we hypothesized that women's looking patterns would differ with the type of contraceptive use. Predictions based on hormonal state were especially exploratory because, again, we do not know what elements of a visual sexual stimulus are associated with higher or lower sexual motivation. However, we expected cycling women (NC Women) to show more interest in the explicitly sexual aspects of the stimuli, which we thought would be the genitals and male body, than women using oral contraceptives (OC Women). Conversely, we expected that OC Women would look more at the contextual elements of the stimuli, specifically the clothing and background regions, than NC Women. Considering the previously reported fluctuations in sexual motivation across the menstrual cycle (Wallen, 2001), we also predicted that the menstrual phase at the time of testing may influence gaze patterns such that women would look at more sexually salient aspects of the stimuli when estradiol was highest, around ovulation for NC Women and around menstruation for OC Women (Van Heusden and Fauser, 1999). We report here that men and women presented with the same sexual stimuli did not view them in the same manner and also women's viewing patterns differed according to oral contraceptive use.

Methods

Subjects

Subjects were recruited from Atlanta area graduate and professional schools by email and flyers. Participants first completed an application that included a consent form and a questionnaire that asked them their data of birth, whether they used oral contraceptives, whether they had been sexually active in the last month, some questions from the Brief Index of Sexual Function (BISF, Taylor et

al., 1994), and the Sexual Permissiveness subscale of the Sexual Attitudes Scale by Hendrick and Hendrick (1987). Questions from the BISF asked about participants' sexual motivation in the last month (the frequency of sexual thoughts and desire to engage in sexual activity), and experience viewing sexually explicit stimuli (within the last month and lifetime). Personnel other than the experimenter then screened the subjects for heterosexual preference and some experience with pornography, which were the inclusion criteria. Fifteen Men, 15 cycling women (NC Women), and 15 women using oral contraceptives (OC Women), entered the study.

Study design

Subjects attended three testing sessions. NC Women attended one session during the menstrual, periovulatory, and luteal phase of their menstrual cycle, determined using a counting method from the first day of menses. OC Women, although not actually experiencing a menstrual cycle, were scheduled to attend sessions at the same time of the month as NC Women based on the same day count from their menstruation. The phase, or OC Woman equivalent, of the Women's first test session was balanced equally across Women and they continued in succession. Therefore, all test sessions included an equal number of women in each phase of their menstrual cycle. Men also attended three sessions at comparable intervals to those of the Women.

The menstrual phase was defined as days 1 to 5, the periovulatory phase was days 9 to 13, and the luteal phase days 20 to 25 following menstruation. The actual day of menstrual onset was based on the self-report of the participant. These days were chosen approximate the menstrual phases based on a 28-day cycle. Because self-report measures of menstrual cycle can be inaccurate (Small et al., 2006), all NC Women's periovulatory and luteal phases were confirmed by progesterone (P) blood spot assay taken before each test session. The blood spot measurement technique was minimally invasive and not uncomfortable for the subjects while allowing a convenient and accurate sampling of gonadal steroid hormone levels (Worthman and Stallings, 1997). Hormones were assayed by the Yerkes National Primate Center Endocrine Core Laboratory using commercially prepared kits by Diagnostic Systems Laboratories (Webster, TX; female P average intra-assay coefficient of variation, 5.44%).

Stimuli

Stimuli were sexually explicit photos of heterosexual couples engaged in oral sex or intercourse. Participants viewed 72 pictures during each of the three sessions. To obtain the test stimuli, a total of 364 pictures were downloaded from free sites on the Internet. Before the eye-tracking sessions began, seven men and seven women not involved in the study independently rated these photos for levels of sexual attractiveness (1—least attractive to 4—most attractive). Overall, male raters found the pictures more sexually attractive than did women. The final stimulus set for the eye tracking used the pictures of highest relative interest to both male and female raters, although it was biased in favor of male subjective ratings (Men, mean \pm SD = 2.09 \pm 0.66; Women, 1.33 \pm 0.78; $t(2,15) = -18.76$, $p = 0.001$). In contrast to pilot raters, subjects did not differ by sex in their ratings of the test stimuli collected during the actual experiment (see Results). Each test session's stimulus set contained stimuli with statistically equal pilot ratings (combined across men and women) of sexual attractiveness ($F_{2,215} = 0.32$, $p = 0.73$). Participants viewed the same stimulus set as one another within each of the three sessions, but the stimulus sets differed across sessions. Within each session stimulus presentation was randomized for each participant by the eye tracker software so that no two subjects saw the same order of stimuli.

Procedure

At the start of each session, participants filled out a trait anxiety questionnaire (State Trait Anxiety Inventory, Mind Garden Inc.). Eye movements of subjects were measured using an Applied Science Laboratories Model 501 eye tracker (ASL, Bedford MA). The ASL eye-tracking system is a headband mounted, video-based, IR reflection eye tracker. The head mounted device has a magnetic sensor allowing the system to correct for head movement. This technology allowed for measurement of fixation number, fixation duration,

and fixation sequence across designated look zones. Participants viewed stimuli presented on a laptop computer using Gazetracker software (Eye Response Technologies, Charlottesville, VA).

To prepare for testing, subjects were positioned in front of a laptop computer (Dell Inspiron with 1024 \times 768 pixel screen resolution) and fitted with the eye tracker head set device. Before testing, each participant was calibrated to the presentation laptop screen based on nine calibration points. Participants viewed the stimuli at their own pace. They ended the presentation of each picture by pressing the space bar on the laptop. Between each sexual stimulus a 1-s fixation slide was presented. During testing eye orientations were recorded in relation to head position. The combined eye-head data indicated what the subject was viewing in the environment via coordinates of the gaze point on the laptop screen surface. Data samples were recorded 60 times per second. The experimenter could not see the participant or what they were looking at throughout testing. The experimenter only had a video monitor of the participant's eye that they watched during the session to ensure that the eye tracker was working and recording properly.

After the participant completed viewing the sexual stimuli, they were again shown the nine-point calibration slide to ensure that there was no drift over the session in the calibration. If the second calibration slide data suggested that drift had occurred, the pixel distance that the tracking had drifted horizontally and vertically (based on deviation from the centered cross-hair on the fixation slide) was entered into the data acquisition program that then automatically corrected the data. Immediately following the eye-tracking paradigm, subjects privately viewed all stimuli a second time in a new randomized order and rated them on a nine-point scale of sexual attractiveness using the computer keypad. Participants were then compensated for their time (\$15 for the first session, \$20 for the second, and \$25 for the third) and were scheduled for their next session.

Data analysis

Initial processing of eye-tracking data was done using Gazetracker software. The raw data from data collection were x , y , z coordinates of gaze points on the presentation screen inferred from changes in the distance between the pupil and cornea. Temporally and spatially similar coordinates were aggregated into fixation points. A fixation was defined as one or more gaze points within a 40-pixel diameter area lasting a minimum of 100 ms. The Gazetracker software calculated the duration and number of fixations for the entire image and for seven areas of interest (look zones), specifically the (1) female and (2) male faces (not including hair), (3) genitals (including penis, scrotum, female labia major, minor, and vaginal area), (4) female body (including breasts, torso, legs, arms), (5) male body (including torso, legs, arms), (6) clothing (only clothing still worn by actors, including jewelry and shoes), and (7) background (anything outside of the actors). The look zones were determined by the experimenter for each picture using the mouse to outline the desired look zone area. Finer discrimination was not performed for the look zones, specifically the separation of male and female genitalia or the eyes from the face, because the areas were too small to ensure accuracy. All look zones were mutually exclusive. The look zone quantifications were then applied to the data of all the participants. The summarized fixation information from Gazetracker for each slide was exported into Microsoft Excel. The excel data were summarized using custom UNIX KSH and AWK programs to calculate means for each subject within and across slides and within look zones. The summarized data were then transferred to SPSS for Windows (Version 13.0, SPSS Inc., Chicago, IL) for statistical analyses. Statistical analyses were designed to investigate sex differences on where participants looked when viewing sexually explicit photos.

Dependent variables

The statistical analyses looked at whether there were sex differences on where participants looked. There were three dependent measures of attention to each look zone; first fixation, percent time, and looking probability, which were defined as follows. *First fixation*: the percentage of stimuli in which the look zone contained the first fixation generated by the subject moving from the fixation slide location. Because the fixation slide required subjects to fixate on the cross hairs in the middle of the screen a participant's first fixation on the sexual slide was typically in the screen's center. Therefore, to better reflect the

subject's volitional eye movement, we used the second fixation as a measure of the first fixation the subjects generated. For simplicity, we have called this second temporal fixation 'first fixation' as it represents the first fixation unambiguously chosen by the subject. *Percent time*: the percentage of total slide viewing time allocated to each specific look zone. *Looking probability*: the ratio of the percentage of time spent in a specific look zone to the percentage of total picture area covered by that look zone. Looking probability corrected for the different areas occupied by different look zones relative to total slide area. For instance, the background look zone was much larger than the genital look zone and thus was much more likely to be viewed by chance. The chance probability of looking in a specific area was described by the percentage that the area occupied in a picture. Looking probability indicated how much looking differed from chance with ratios greater than one indicating a greater than chance looking at a specific look zone.

First, in order to investigate the specific influences of sex and repeated exposure on where participants looked, we ran a 3 (sex: M, NCW, OCW) × 3 (session: 1, 2, 3) mixed model multivariate ANOVA. We expected to see both main effects of and interactions with sex. Additionally, in order to investigate the effect of menstrual cycle within Women, we ran a 2 (oral contraceptive use: NCW, OCW) × 3 (menstrual test phase: menstrual, periovulatory, luteal) multivariate ANOVA. Additionally, because we thought it likely that any group differences could be due to group differences in participants' previous experience, sexual attitudes, and comfort with visual sexual stimuli we ran a one-way ANOVA with sex (M, NCW, OCW) as the independent variable and our subject variables collected during screening as the dependent variables. The subject information collected for screening included; participants' sexual motivation in the last month (the frequency of sexual thoughts and desire to engage in sexual activity), experience viewing sexually explicit stimuli (within the last month and lifetime), whether they had been sexually active in the last month, and scores on the Sexual Attitudes Scale (Hendrick and Hendrick, 1987). We also included their mean state anxiety scores in the ANOVA.

In order to investigate the influence of psychosocial variables on the subjective ratings of sexual attractiveness, we ran a multiple regression on the mean of the subjective ratings across sessions, entering in a stepwise manner the following variables; anxiety, sexual attitudes, sexual motivation, and viewing experience. Similar regression analyses were also performed on the across session mean values of the percent time spent in each of the seven look zones. The regression analyses were intended to investigate the potential influence of social and experiential factors in viewing patterns that may contribute to any sex differences observed overall. The effect of recent sexual activity was not included in the regression since it was a nominal variable. The influence of this variable was examined using a one-way ANOVA with the same dependent variables used in the regression analyses described above.

Results

Subjects

Of the 45 participants enrolled, including Men, NC Women, and OC Women, 42 participants completed three testing sessions. One Man completed all but one session, one NC Woman completed only one session, and one OC Woman completed none of the sessions. Data from those completing at least one session are averaged into that session's data. All participants were aged 23–28, had some years of college, and were from multiple ethnic categories. We used the P assays to verify that we had classified Women correctly into the periovulatory and luteal phases, which are characterized by low and high P, respectively. Based on previous literature, only participants with progesterone levels less than 3 ng/ml during their periovulatory session were included in the cycle phase analysis (Israel et al., 1972). This led to the exclusion of one NC Woman from the menstrual phase analyses whose P levels were approximately 10 ng/ml. Progesterone levels greater than

3 ng/ml were required during the luteal phase for inclusion in the cycle phase analysis. This led to the exclusion of six NC Women whose P levels were all below 2 ng/ml from the menstrual phase analysis. Data from all Women were included in the analyses investigating overall group differences in gaze patterns and P analyses were only used to exclude women from the cycle phase analysis.

Subjects differed by sex and contraceptive use on our subject variables of reported anxiety, sexual motivation, and previous experience viewing sexually explicit materials, but did not differ in sexual attitudes (Table 1). Men differed from NC Women on all measures, except sexual attitudes, but differed from OC Women only on previous viewing experience. NC Women reported lower sexual motivation than both groups ($F_{2,41}=8.72$, $p=0.001$). Significantly fewer NC Women were sexually active (8 of 14) in the last month compared to 14 of 14 OC Women and 13 of 15 men ($\chi^2(2)=8.91$, $p=0.01$). The lack of a sex difference in sexual attitudes suggests that the women in our sample may be more sexually liberal than women in the general population, in which men are usually found to have more liberal sexual attitudes than do women (Hendrick and Hendrick, 1987).

Stimulus ratings

Regression analyses showed that many of our subject variables were related to the participants' subjective ratings of the stimuli. Higher subjective ratings of sexual attractiveness were positively predicted by sexual attitudes (R^2 change = 0.18, $r=0.44$, $p<0.001$) and previous viewing experience (R^2 change = 0.10, $r=0.40$, $p<0.001$). Participants reporting recent sexual activity rated the pictures as significantly more sexually attractive (mean rating ± SD = 6.36 ± 1.03) than those who had not been sexually active (mean rating ± SD = 5.9 ± 0.90; $F_{1,121}=4.56$, $p=0.04$), although the difference was small, with a moderate effect size (d) of 0.48 (Cohen, 1988).

Subjects did not differ by group in their mean rating of sexual attractiveness of the stimuli, with or without the previously described subject variables as covariates. Men, NC Women, and OC Women rated the stimuli as equally sexually attractive (repeated measures ANOVA, $F_{2,35}=0.68$, $p=0.51$; mean ± SD = 6.01 ± 0.93). This suggests that any differences in

Table 1
Mean and standard deviations for subject variables by group

	Men	NC Women	OC Women	Statistic
	Mean ± SD	Mean ± SD	Mean ± SD	
Anxiety	25.20 ± 5.2 ^b	31.28 ± 7.37 ^a	27.9 ± 6.81 ^{a,b}	$F_{(2,39)}=4.63$, $p=0.02$
Sexual attitudes	52.6 ± 16.51	50.53 ± 13.46	47.79 ± 10.81	NS
Sexual motivation	5.2 ± 0.71 ^b	3.8 ± 1.18 ^a	4.64 ± 0.73 ^b	$F_{(2,41)}=8.72$, $p=0.001$
Previous viewing	3.23 ± 1.15 ^b	1.83 ± 0.86 ^a	1.93 ± 0.87 ^a	$F_{(2,41)}=9.16$, $p=0.001$

All measures except for sexual attitudes differed significantly by group.

^{a,b}Groups with different superscripts differ significantly ($p<0.05$).

looking patterns are unlikely due to differences in subjects' attraction to the stimuli. Additionally, we did not observe a significant difference in subjective ratings across sessions for any group (Table 2).

Group differences in look zone viewing

Across all subjects, we observed the following order of average percentages of first fixations occurring in each look zone: genitals, female body, female face, male face, clothing, male body, and background. We observed a similar pattern in the percentages of their overall time spent in each look zone: female body, genitals, female face, male body, background, clothing, and male face. Finally, the probability of looking at the specific look zones showed the following order: female face, genitals, male face, clothing, female body, male body, and background (Table 3).

Sex and contraceptive type (M, NCW, OCW) influenced the percentage of first fixations (Fig. 1), percent time (Fig. 2), and looking probability (Fig. 3) for many look zones. We found that for the female face look zone, there was a significant effect among the groups for all three dependent measures of look zone viewing, percentage of first fixations ($F_{2,111}=5.25$, $p=0.007$, Fig. 1), percent time ($F_{2,111}=8.24$, $p<0.001$, Fig. 2), and looking probability ($F_{2,111}=8.45$, $p<0.001$, Fig. 3). Men spent more time viewing (vs. NCF, $p<0.001$; vs. OCF, $p=0.001$, Fig. 3), and had a greater probability of looking at, the female face than did both groups of women (vs. NCF, $p<0.001$; vs. OCF, $p=0.001$, Fig. 3). Additionally, NC Women less frequently looked first at the female face look zone than did Men ($p=0.004$) or OC Women ($p=0.01$, Fig. 1). The percentage of first fixations did not differ by group for the male face look zone, but there was a main effect of sex for percent time looking at male faces ($F_{2,111}=12.91$, $p<0.001$, Fig. 1) and probability of looking at male faces ($F_{2,111}=11.06$, $p<0.001$, Fig. 3). Men had the lowest occurrence for both measures compared to NC and OC Women ($ps<0.001$), suggesting a female bias towards, or a male bias against, looking at male faces. Looking at the genital look zone also varied by group for all three measures of attention: percentage of first fixations ($F_{2,111}=8.26$, $p<0.001$, Fig. 1), percent time ($F_{2,111}=6.68$, $p<0.001$, Fig. 2), and looking probability ($F_{2,111}=6.42$, $p<0.002$, Fig. 3). For all measures, NC Women had higher values for looking at the genitals than did either Men or OC Women (p -values varied between 0.001 and 0.02). Men and OC Women did not differ in these measures. Thus women not taking hormonal contra-

Table 2
Mean and standard deviation for subjective ratings by session and group

	Session 1	Session 2	Session 3	Statistic
	Mean±SD	Mean±SD	Mean±SD	
<i>Subjective ratings (1–9)</i>				
Men	6.14±1.55	6.20±0.97	5.99±0.84	$F_{(2,9)}=2.76$, $p=0.12$
NCW	5.93±0.84	6.07±0.88	6.10±0.72	$F_{(2,12)}=0.63$, $p=0.55$
OCW	5.87±0.71	5.63±1.00	5.72±1.04	$F_{(2,11)}=0.71$, $p=0.52$
Total	5.97±1.04	5.96±0.96	5.94±0.87	$F_{(2,36)}=0.02$, $p=0.98$

Multivariate ANOVA found no differences.

Table 3
Interest in look zones across all subjects and sessions (mean±standard deviation)

Look zone	% First fixations	% Time	Looking probability
	Mean±SD	Mean±SD	Mean±SD
Genitals	29.58±12.96	25.57±6.75	6.14±1.94
Female body	27.53±11.32	29.94±4.61	0.96±0.22
Female face	24.84±14.73	18.63±6.90	6.42±3.10
Male face	6.46±3.34	6.63±1.90	4.76±1.87
Clothing	4.73±2.77	5.70±1.55	1.05±0.43
Male body	3.56±3.55	7.14±2.89	0.43±0.24
Background	2.95±4.56	6.43±4.23	0.17±0.13

ceptives displayed more consistent interest in the genitals than did the other groups, although all participants looked extensively at this region.

Surprisingly, Men did not look at the female body look zone any longer than did either NC or OC Women. By contrast, there was a main effect of group for the percent time ($F_{2,111}=6.03$, $p=0.003$, Fig. 2) and looking probability ($F_{2,111}=6.20$, $p=0.003$, Fig. 3) within the male body look zone with Men having lower values than either group of Women (vs. NC, $p=0.001$; vs. OC, $p=0.017$). There was also a main effect of group within the clothing look zone for percent time ($F_{2,111}=24.05$, $p<0.001$, Fig. 2) and looking probability ($F_{2,111}=19.64$, $p<0.001$, Fig. 3), although not first fixations, in which OC Women looked more at this look zone than did Men or NC Women (0.001 for all). Finally, for the background look zone, there was a main effect of group for the percent of first fixations ($F_{2,111}=5.57$, $p=0.005$, Fig. 1), in which Men were more likely than Women to fixate first in this zone (vs. NCF, $p=0.004$; vs. OCF, $p=0.006$). However, the main effect of group for percent time ($F_{2,111}=6.01$, $p=0.003$, Fig. 2) and looking probability ($F_{2,111}=6.00$, $p=0.003$, Fig. 3) showed that OC Women spent more time in and had a higher probability of looking at the background look zone than other groups ($p=0.001$), although generally this look zone attracted less attention from participants than did other areas of the stimuli. Together, these data show a male bias towards the female face and away from male face and male body look zones. We also observed that NC Women had a bias towards the genital look zone. For OC Women, we saw a bias towards the less sexual and more contextual background and clothing look zones.

Repeated exposure

Session influenced looking, measured by percent first fixations (Fig. 4), percent time (Fig. 5), and looking probability (Fig. 6) to some zones across sessions. There was a main effect of session within the male face look zone on percent first fixations ($F_{2,111}=6.23$, $p=0.003$, Fig. 4) and looking probability ($F_{2,111}=9.91$, $p<0.001$, Fig. 6) in which participants allocated more attention to this zone with repeated exposure. We also saw main effects of session on percent time within the genital ($F_{2,111}=4.32$, $p=0.016$) and female body ($F_{2,111}=3.65$, $p=0.029$) look zones (Fig. 5). Overall, by the third session, participants spent less time in the genital look zone and more

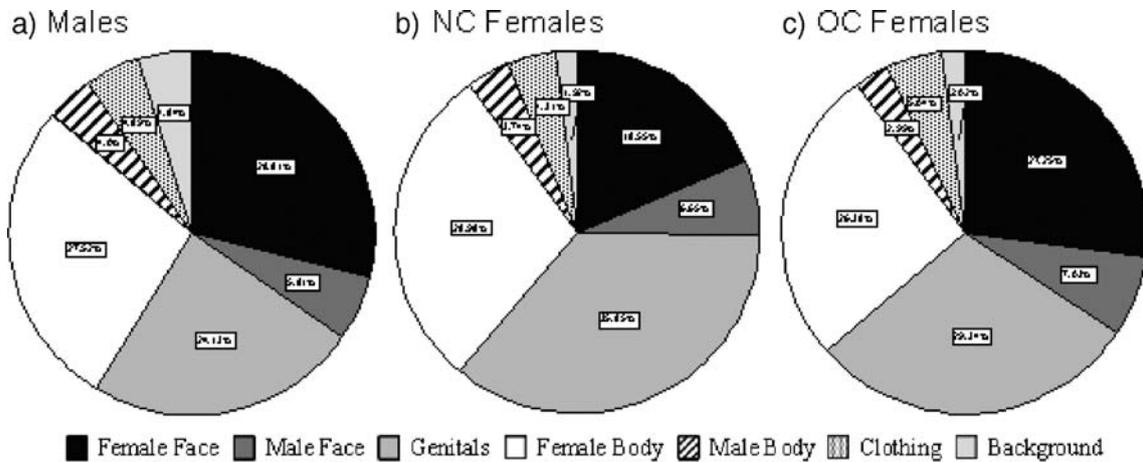


Fig. 1. The distribution of mean first fixations across look zones for (a) Men, (b) NC Women, and (c) OC Women. Multivariate ANOVA showed a main effect of group for the female face ($F_{2,111}=5.25, p=0.007$), genitals ($F_{2,111}=8.26, p<0.001$), and background ($F_{2,111}=5.57, p=0.005$) look zones.

time in the female body look zone. Looking at the male body increased across sessions, indicated by significant main effects of session for the percent of first fixations ($F_{2,111}=5.66, p=0.005$, Fig. 4), percent time ($F_{2,111}=9.14, p<0.001$, Fig. 5), and looking probability ($F_{2,111}=7.27, p=0.001$, Fig. 6). Finally, attention to the clothing look zone varied by session indicated by a main effect on percent time ($F_{2,111}=8.80, p<0.001$, Fig. 5) and looking probability ($F_{2,111}=22.80, p<0.001$, Fig. 6). By the third session participants were spending less time in the clothing look zone, although they had an increased looking probability. There was no main effect of session on any of our dependent measures for the female face or background look zones. There was, however, an interaction between session and group for the percent of first fixations in the background look zone ($F_{4,111}=4.20, p=0.003$, Fig. 4). Follow-up analyses showed a significant increase in the percentage of first fixations in the background look zone in the second session in Men. It is unclear what produced this marked increase, which was driven by a few individuals, and likely this second session increase in Men was the main contributing factor of the observed main effect of sex on this variable.

Subject variables

Subject variables partially predicted participants' looking patterns, although the proportion of variance explained was generally quite small. Sexual attitudes (R^2 change=0.03, $r=0.18, p=0.05$) positively predicted time spent looking in the female face look zone and negatively predicted looking at the male face look zone (R^2 change=0.04, $r=-0.20, p=0.03$). Sexual motivation also positively predicted time in the female face look zone (R^2 change=0.17, $r=0.31, p<0.001$) but negatively predicted time observed in the female and male body look zones (female body, R^2 change=0.06, $r=-0.10, p=0.008$; male body, R^2 change=0.07, $r=-0.16, p=0.003$). Previous viewing experience of pornography negatively predicted looking time in the male face (R^2 change=0.04, $r=-0.19, p=0.03$) and background (R^2 change=0.03, $r=-0.09, p=0.05$) look zones. Interestingly, time spent in the genital and clothing look zones was not predicted by any of the variables included in the regression analysis. Participants reporting sexual activity in the last month spent less time looking at the genital look zone than did those not reporting sexual activity ($F_{1,117}=4.19, p=0.04$;

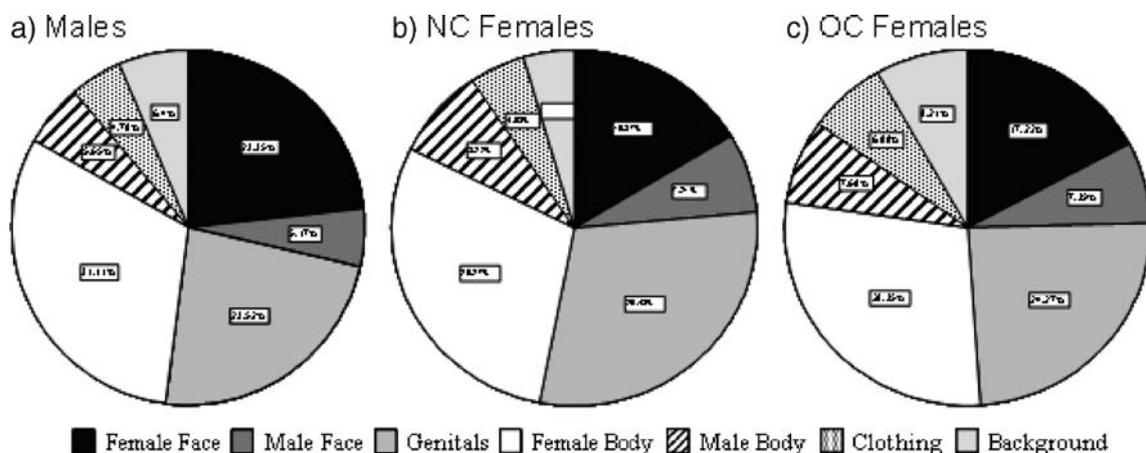


Fig. 2. Mean percent viewing time spent in each look zone for (a) Men, (b) NC Women, and (c) OC Women. Main effect of group observed for all look zones except the female body.

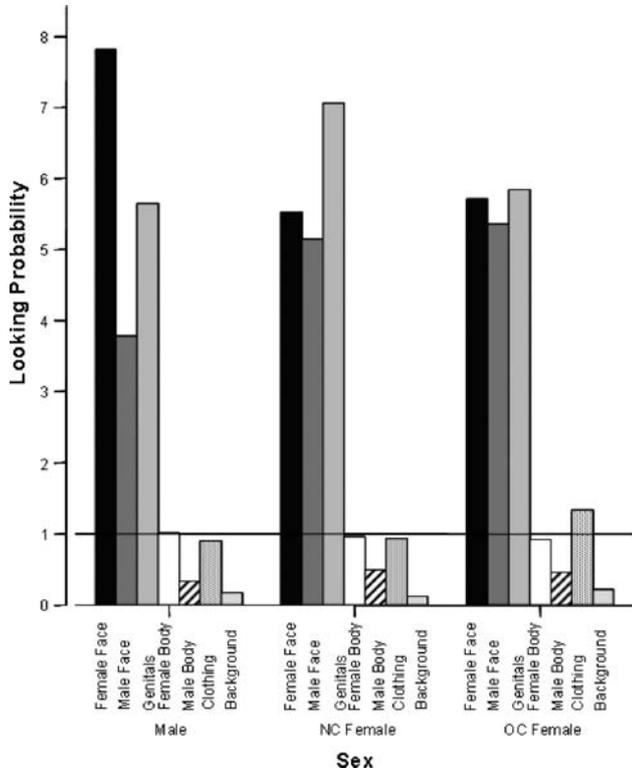


Fig. 3. Mean looking probability (percent time divided by slide area) within each look zone by group. Multivariate ANOVA showed a main effect of group for the female face ($F_{2,111}=8.45, p<0.001$), male face ($F_{2,111}=11.06, p<0.001$), genitals ($F_{2,111}=6.42, p=0.002$), male body ($F_{2,111}=6.20, p=0.003$), clothing ($F_{2,111}=19.64, p<0.001$), and background ($F_{2,111}=6.00, p=0.003$) look zones. Chance level equals 1.

sex: mean±SD=24.69±8.48 s; no sex: =28.68±8.06 s), with a moderate effect size of 0.48. Recently active participants also showed more time directed towards the clothing look zone ($F_{1,117}=6.96, p=0.01$; sex=5.75±1.95 s; no sex=4.61±1.45 s), with a large effect size of 0.66. However because the majority of participants reporting no recent sexual activity were NC Women, it is not clear whether this effect is also present in Men and OC Women.

Cycle phase

We did not find a main effect of test phase or an interaction of test phase with oral contraceptive use for any of our dependent measures of looking within any look zones.

Discussion

This study shows differences in viewing patterns of sexual stimuli related to sex and oral contraceptive use. Although overall looking patterns were similar, comparisons across groups demonstrated an increased tendency of men to look at the female face look zone, of NC Women to look at the genital look zone, and of OC Women to look at the background and clothing look zones. These observed differences in attention could contribute to previously reported sex differences in neural, genital, and subjective responses to visual sexual

stimuli. These results highlight the importance of higher order cognitive factors in attention to visual sexual stimuli and are consistent with previous research demonstrating bias to emotional content of stimuli (Balçetis and Dunning, 2006; Isaacowitz, 2006; Mogg et al., 2003). Variance in attention could be the product of multiple psychosocial and biological factors.

For all participants, the female face and genital look zones were highly salient, reflected in extensive looking, especially relative to the average area these look zones occupied in the photos (Henderson, 2003). Because attention is higher to emotional stimuli, these look zones can be interpreted to be emotional, rather than neutral, for the participants (Nummenmaa et al., 2006). The bias in both men and women towards faces is consistent with a previous study using the visual process method, a procedure in which participants uncover one body part at a time to determine the attractiveness of that person (Hassebrauck, 1998). In this study, men and women most often chose facial features as the first area to look at when presented a single member of the opposite sex in a bathing suit. Our finding that men looked more at the female face than did women is of particular interest. It is possible that men focus attention on the female face because they are seeking emotional information, such as her level of sexual excitement. Another possibility, however, is that women look at the face less than men do because they are more efficient in extrapolating information from faces than men and do not need to spend as much time looking at faces to attain the same information (Hampson et al.,

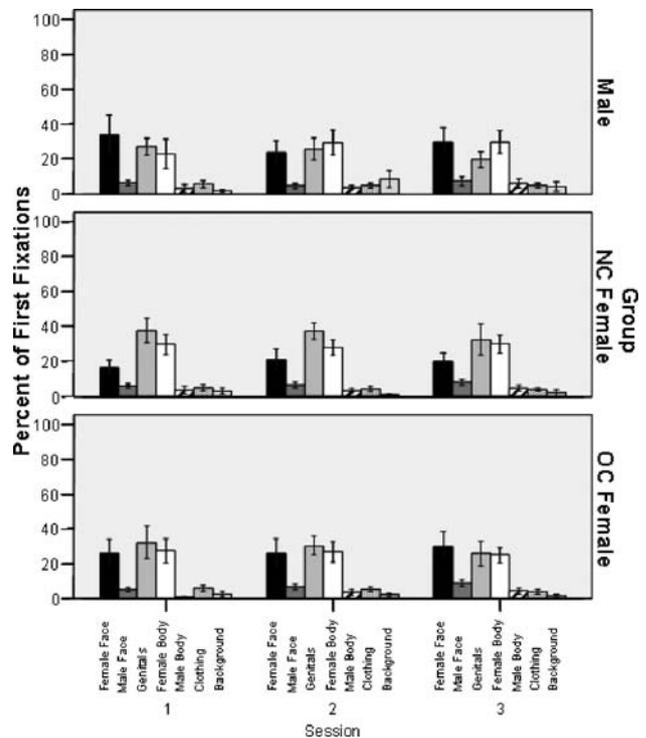


Fig. 4. Percent of slides containing the first fixation (mean±standard error) within each look zone across sessions by group. There was a main effect of session for the male face ($F_{2,111}=6.23, p=0.003$) and male body ($F_{2,111}=5.66, p=0.005$), and a group by session interaction for the background ($F_{4,111}=4.20, p=0.003$) look zones.

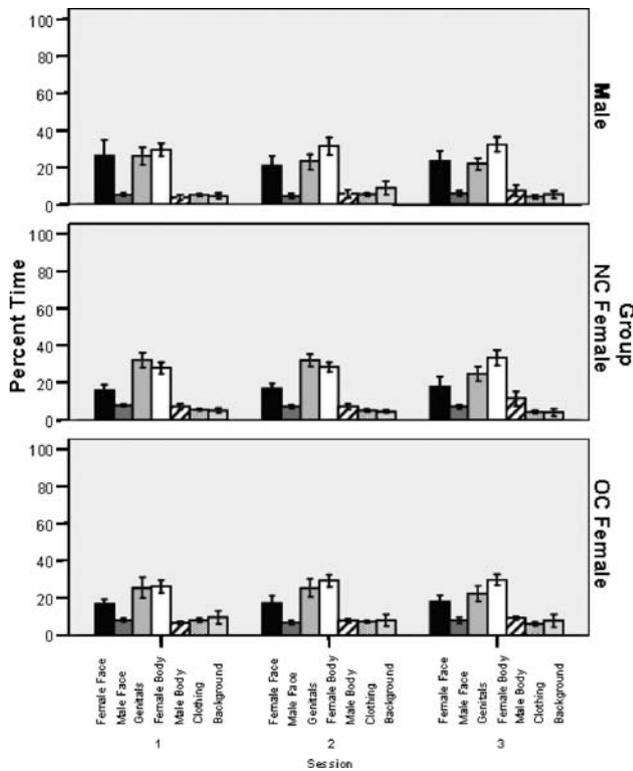


Fig. 5. Percent time (mean±standard error) spent within each look zone across sessions by group. Multivariate ANOVA showed a main effect of session within the genital ($F_{2,111}=4.32, p=0.0016$), female body ($F_{2,111}=3.65, p=0.029$), male body ($F_{2,111}=9.14, p<0.001$), and clothing ($F_{2,111}=8.80, p<0.001$) look zones.

2006; McClure, 2000). Our findings differ from the Lykins et al. (2006) study in which men showed a larger decrease than women in the attention to the face look zone in erotic compared to neutral stimuli. However, the Lykins et al. study used pictures of opposite-sex nudes presented alone, making it difficult to compare to the current study that used pictures of heterosexual intercourse.

We observed the strongest bias towards looking at the genitals in NC Women. We predicted that they would look there more than did OC Women based on their likely having higher levels of intrinsic sexual motivation (Sanders et al., 2001), but we did not anticipate NC Women looking more at genitals than did men. The difference between NC and OC Women in this looking pattern supports a hormonal influence on attentional processes. Consistent with our hypothesis, OC Women exhibited a bias in looking at the contextual elements of the pictures, including the clothing and background look zones. The meaning of this bias is difficult to interpret. OC Women may have simply been more interested in the contextual elements of the pictures or, alternatively, found the sexual aspects of the images aversive. However, because participants cannot voluntarily direct their attention away from emotional stimuli (Nummenmaa et al., 2006), it is more likely that the contextual elements of the pictures carried an emotional value for OC Women.

Interestingly, both men and women looked often at the female body look zone and it was surprising that there was no

sex difference. This is consistent with the previous eye-tracking findings in which men looked primarily at the bodies of female nudes (Lykins et al., 2006). However, since the genitals were included in the body region in the Lykins et al. study, the results are not directly comparable. The current study’s finding that women attended as much to the female body look zone as did men, although men allocated less attention to the comparably large male body look zone than did women, supports previous literature suggesting a bisexual reaction of women when viewing sexually explicit stimuli (e.g., Costa et al., 2003; Chivers et al., 2004). This does not mean that female participants are ‘bisexual’ in practice but rather they are comparably interested in pictures depicting either sex. Additionally, it is possible that female participants are not looking at the female body with the same sexual interpretation as male participants.

Of particular interest is that all groups spent less time looking at the male body look zone than would be expected based on the average proportion of picture area it occupied. Even though both groups of women looked more at the male body look zone than did men, all groups spent very little time looking at this area. This may mean that female participants were not interested in the male bodies, which would be especially noteworthy given their apparent interest in the female body look zone. Alternatively, because the male body look zone did not contain the genitalia, this result may suggest more female interest in looking at male genitalia than the rest of the male body. When the genitals were included in the male body look zone in the

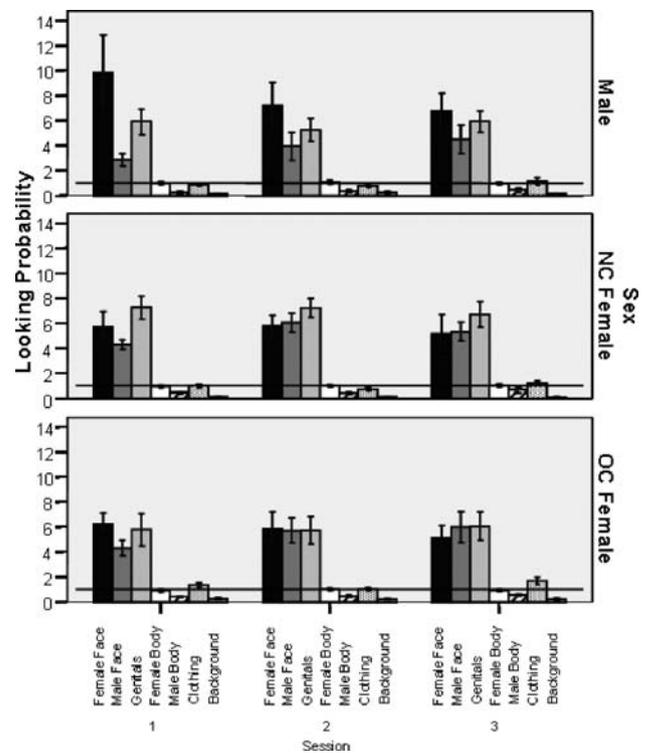


Fig. 6. Looking probability (mean±standard error) within each look zone across sessions by group. Multivariate ANOVA showed a main effect of session within the male face ($F_{2,111}=9.91, p<0.001$), male body ($F_{2,111}=7.27, p=0.001$), and clothing ($F_{2,111}=22.80, p<0.001$) look zones. Chance level equals 1.

Lykins et al. (2006) study, women preferentially viewed nude male bodies. Thus our findings may reflect a previously unreported female preference for looking at male genitalia.

This study uniquely demonstrates that men and women look differently at visual sexual stimuli. However, we can provide little insight into the sources of these sex differences. The group differences could result from sex differences in biology, socialization, or most likely, an interaction between both influences. Social variables recorded in our study correlated with both the subjective ratings of the stimuli and the participant's looking patterns. Generally, participants reporting more sexual experience and more liberal sexual attitudes rated the stimuli as more sexually attractive. Such participants also looked more at the female face look zone and less at the male face and body look zones. Social or experiential differences between OC and NC Women may also have influenced their attention to visual sexual stimuli. Consistent with previous reports (Bancroft et al., 1991) the women using oral contraceptives in our study were more likely to have a recent sexual partner. Unlike the women in the Bancroft et al. (1991) study, however, our two female groups did not differ in their sexual attitudes or experience with erotica. Thus, while this study supports previous work that social influences are relevant to understanding differences between OC and NC Women, the similarity of our female groups in sexual attitudes, and the large variance left unaccounted for by the reported social variables, leaves open the possibility that there are other nonpsychosocial influences on women's attention to visual sexual stimuli. The most likely candidate is the relatively marked differences in hormonal state between OC Women and NC Women, suggesting that hormones influence attention to sexual stimuli.

Contrary to our predictions, we did not see an effect of women's menstrual phase on their looking patterns. This result suggests that individual hormonal influences are subtle and complex. Although we expected an effect of cycle test phase on women's gaze patterns, previous studies demonstrate variable and complicated relationships between women's menstrual cycles and their interest in sexual stimuli related to context and whether one is measuring subjective or physiological arousal (Harvey, 1987; Schreiner-Engel et al., 1981; Slob et al., 1991, 1996). It is possible that only differences in hormonal state as large as that between naturally cycling and oral contraceptive using women are easily detectable. The small sample size of the current study and the fact that women's first exposure to the sexual stimuli was evenly distributed across cycle phases may not have allowed for detection of cycle phase effects (Slob et al., 1991, 1996). The influence of hormones and their relation to female sexual motivation (Wallen, 2001) on female attention to sexual stimuli need further investigation in studies with adequate sample sizes to compare across cycle phases.

The primary limitation of the study is also its strength, the novel use of the eye-tracking methodology. While eye tracking provides unique information about where subjects look, its spatial resolution is such that information about the precise location of gaze is not possible under our conditions and with our instrumentation. Thus, our look zones were necessarily

larger, i.e., considering the face as a whole instead of just the eyes or mouth, to compensate for this potential imprecision. Theoretically the eye-tracking methodology has one crucial inherent limitation in that it shows where the subject is looking, but not why the subject is looking at that specific location. Although eye tracking gets closer than other previously used measures to the actual measurement of the behavioral processes occurring when viewing sexual stimuli, inferring meaning is difficult and inherently speculative. Despite the consistent literature from other fields suggesting that participants look longer at stimuli that they like and are motivated with (Balcetis and Dunning, 2006; Isaacowitz, 2006), sexual stimuli may possess inherent confounds that make the subjects' response to them unique. Specifically, socialized stigmatization could produce discomfort when viewing sexually explicit material, even for participants experienced with and open to the viewing of visual sexual stimuli. However, previous studies show that participants cannot voluntarily divert their attention from emotional stimuli (Nummenmaa et al., 2006), thus conscious inhibition of attention to sexually graphic elements of the stimuli is unlikely. This concern could be resolved by concurrent information about arousal in response to sexual stimuli or by concurrent neural imaging and eye tracking.

Even with the limitations in interpreting eye-tracking data, these results suggest that it is not safe to assume when comparing men and women's responses to sexual stimuli that the sexes are 'seeing' the same thing when they look at sexual stimuli. Whether this is unique to sexual stimuli, or reflects generalized group differences in viewing patterns remains unknown. Future studies would benefit from the inclusion of control nonsexual stimuli. The current study's findings that men and women attend differently to the same stimuli support the hypothesis that previously reported sex differences in response to visual sexual stimuli may reflect differences in attention and stem from differences in underlying cognitive biases. The pattern of differences in looking at stimuli that both sexes rate as comparably attractive supports the notion that sometimes sex differences reflect different pathways to the same endpoint (De Vries and Boyle, 1998).

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