Sex differences in gaze patterns while viewing dynamic and static sexual stimuli

Vesa Putkinen[1,4*], Elina Lewandowski[1*], Severi Santavirta[1,2], and Lauri Nummenmaa[1,2,3]

[1] Turku PET Centre, University of Turku and Åbo Akademi University, Finland

[2] Turku University Hospital, Turku, Finland

[3] Department of Psychology, University of Turku, Finland

[4] Turku Institute for Advanced Studies, University of Turku, Finland

[*] Equal contribution

Address correspondence to

Lauri Nummenmaa

Turku PET Centre

Kiinamyllynkatu 4-6

20520 Turku Finland

Email: latanu@utu.fi

Tel: +358505747933

Abstract

Faces and bodies serve as important cues of physical attractiveness and reproductive fitness. Previous studies however indicate that there are sex-related differences in the visual processing of erotic stimuli. Here we measured eye movements from 43 male and 67 female subjects to investigate gaze patterns and sex differences during perception of dynamic sexual scenes (intercourse; Experiment 1) and static (nude and clothed men and women; Experiment 2) erotic stimuli. Dwell times were longest for faces in both experiments and faces were most likely to be looked at first. In the video experiment, male participants looked more at female chest, buttocks, and genital areas while female participants looked more at male faces. In the picture experiment faces received more fixations when stimuli were clothed, whereas fixations on chest and genital areas increased when the stimuli were nude. Our results show that i) sex differences during sexual perception are larger for static versus dynamic stimuli, ii) that faces are prioritized over sexual signals both while viewing dynamic sexual scenes and static images of humans, and iii) that visibility of sexual cues increases saliency of the sexually relevant body regions (genitals; chest). The overall preference for faces even when viewing sexual intercourse may reflect both the importance of facial characteristics in mate selection as well as the role of facial expressions in evaluating partner satisfaction while having sex.

Keywords: Sexual perception; Eye-tracking; Attention; Emotion

Introduction

Mate selection and sexuality are essential parts of human life. Mate preferences have been extensively studied, and it is known that faces and bodies are important cues of physical attractiveness and overall health thus providing information for mate choice (Frith, 2009; Jonason et al., 2012; Perilloux et al., 2010; Rhodes, 2006). Facial and bodily signals such as waist-to-hip ratio and facial symmetry signal physical attractiveness of a potential partner. But humans also extract nonverbal cues from faces and bodies and this is essential for successful emotional communication and in interpersonal relationships (Bull, 2001). Such cues arise from body language and especially from facial expressions, which are critical for social engagement (Ishii et al., 2018). Such nonverbal communication is also critical for mating, in that communication skills has been linked to sexual satisfaction (Purnine & Carey, 1997), and the ability to read both verbal and non-verbal cues is important for enjoyable sexual intercourse (Vowels et al., 2022).

Eye tracking indexes locus of attention through spatiotemporal fixation distributions (Borys & Plechawska-Wójcik, 2017) and arousal via pupil dilation (Bradley et al., 2008). Eye tracking methodology has been used increasingly to study sexual behaviours and particularly attention to sexual signals. These studies have investigated, for example, differences in sexual arousal and desire between sexes (Farisello, 2017), visual attention to sexual stimuli in different levels of sexual functioning (Velten et al., 2021) and in special groups such as sexual offenders (Godet & Niveau, 2021). Such studies have revealed that pupil dilation and pupil dilation patterns are significant indicators of sexual orientation and arousal (Rieger & Savin-Williams, 2012). Eye tracking has numerous advantages in sex research when compared to other widely used methods such as self-reports and physiological measurements (Lykins et al., 2006) as it overcomes problems such as inaccurate recall, self-presentation bias and validity issues. Importantly, eye-tracking provides an unobtrusive means for measuring time-varying cognitive and visual information processing, while individuals view visual stimuli (Lykins et al., 2006).

Eye tracking studies have shown that attention is in general biased towards emotionally relevant stimuli (Nummenmaa et al., 2006). Similarly, sexual stimuli attract preferential attention when they are competing with non-sexual stimuli (Fromberger et al., 2012a). Multiple studies have also found that erotic and non-erotic material are processed in different ways (Fromberger et al., 2012a; Lykins et al., 2006; Nummenmaa et al., 2012). For example, observers make longer fixations to erotic stimuli, and nude versus clothed bodies are examined more thoroughly. This is evidenced by a greater number of fixations and longer fixation total times in chest and genital regions (Nummenmaa et al., 2012). While nudity biases the fixations away from the face, multiple studies have confirmed that faces are still attended the most: first fixations land almost always on the faces, and it is the region which attracts most of the overall attention even for nude bodies (Lykins et al., 2006; Nummenmaa et al., 2012; Tsujimura et al., 2009). These findings suggest that faces might be the most important source of sexual signals and supports the importance of faces in social engagement.

Men and women have different reproduction strategies, which reflect the different evolutionary selection pressures on each sex (Buss, 1989). Females carry the metabolic cost of childbearing but are consequently a limited mating resource and thus able to evaluate and choose potential partners to reproduce with, whereas males have theoretically unlimited reproductive potential but males need to compete with each other to gain the access to mates (Workman & Reader, 2021). These differences in reproduction lead to different mating strategies, and due to larger reproductive capacity of males, they also have stronger sexual drive than females. This is also reflected in frequency and intensity of the desired amount of intercourse, desired number of partners and spontaneous thoughts about sex, and consequently brain activation patterns in the limbic and paralimbic emotion and reward circuits also differ between males and females (Putkinen et al., 2023).

Previous studies have revealed marked sex differences in visual processing of sexual information (Lykins et al., 2008a; Rupp & Wallen, 2007a). First, men and women allocate their attention differently. When viewing couples engaged in sexual activities men allocate more attention to opposite sex figures, while women distribute their attention more equally (Fromberger et al., 2012a; Nummenmaa et al., 2012; Tsujimura et al., 2009). Men also look at women’s faces more than women (Rupp & Wallen, 2007a). Finally, men tend to look more female chests and women look more male genital region (Nummenmaa et al., 2012). These differences in visual processing might reflect the attraction to the opposite sex and the evaluation of the physical properties of potential partner.

Human bodies are always in motion, and the importance of body movements as part of a multichannel system of communication is well known (Bull, 2001). Yet, according to a systematic literature review (Wenzlaff et al., 2016), most studies on sexual perception have used static images of real or computer-generated human figures to study sexual attention. In turn, data from attention allocation during naturalistic, dynamic sexual scenes is extremely sparse. Analyzing of spatial gaze data during static snapshots such while viewing pictures generates artificial "snapshot" data although real-world gaze control necessitates parallel processing of overlapping sensory features and ever-changing locations of the objects of interest in dynamic scenes (Santavirta et al., 2024). Moreover, there is prima facie doubt regarding the generalizability of the results of simplistic studies with static stimuli to real-world dynamic human behaviour (Adolphs et al., 2016). Accordingly, it has been questioned whether the results from simplified static stimulation conditions transfer to natural vision of the dynamic environment (Williams & Castelhano, 2019) particularly as the visual system is differently influenced by static versus dynamic stimuli (Dorr et al., 2010). Video-based studies could thus help in elucidating the mechanisms of visual sexual attention, as videos evoke the highest levels of physiological and subjective arousal, and they are also more representative of real-life interaction and may produce visual attention patterns that are representative of real-world active vision (Julien & Over, 1988).

The current study

The aim of this study is to investigate the visual processing of sexual stimuli using videos showing heterosexual intercourse (Experiment 1) as well as images of clothed and nude human bodies (Experiment 2). We found that in both experiments, participants showed preferential attention towards faces even in the presence of strong sexual signals and that eye movements during sexual perception were consistent across the whole participant sample and across men and women. Altogether these results highlight the importance of faces in sexual perception and underline the bottom-up nature of selective sexual attention.

Materials and methods

Participants

A total of 110 subjects volunteered for the study. The mean age was 27 years and 43 of the participants were males (38.7%). Descriptive data of the participants is presented in Table 1. Subject recruitment was done via emails (University of Turku email lists), flyers on notice boards and via social media platforms (e.g. Facebook, Reddit). Before the experiment, all participants were informed about their rights and how the information will be used in the future and a written informed consent was collected. Participants were compensated with a lunch and movie tickets. Adults (> 18 year) were able to participate in the study. Exclusion criteria were 1) diagnosis of reading impairment or neurological/ psychiatric disorder, 2) substance abuse and 3) current medication influencing nervous system.

Table 1 Means (M) and standard deviations (SD) of the participants' background information (age, height, weight, handedness, and education).

	Age (years)	**Height (cm)**	**Weight (kg)**	**Handedness n (%)**	**Education* n (%)**
Female	M = 29.2	M = 166	M = 65.1	Right: 58 (0.87)	1: 1 (0.01)
	SD = 9.36	SD = 5.38	SD = 10.5	Left: 6 (0.09)	2: 28 (0.42)
				Both: 3 (0.04)	3: 38 (0.57)
Male	M = 25.7	M = 179	M = 74.9	Right: 42 (0.98)	1: 2 (0.05)
	SD = 9.10	SD = 5.66	SD = 10.2	Left: 1 (0.02)	2: 11 (0.26)
					3: 30 (0.70)

**Education levels: 1 = primary school, 2 = secondary school, 3 = higher education*

Participants sexual attraction to men and women was measured with a scale ranging from 0 (not at all attracted) to 100 (highly attracted). The experienced and desired frequency of different sexual acts was measured with a Likert scale ranging from 1 ("never") to 9 ("four or more times a day") as a part of Derogatis Sexual Functioning Inventory, DSFI (Derogatis & Melisaratos, 1975). The measured sexual acts were kissing and caressing, sexual fantasies, masturbation, oral sex, vaginal intercourse, and anal intercourse. These data are shown in **Table 2**.

Table 2 Means (M) and standard deviations (SD) of the participants' sexual attraction scores as well and experienced and desired sexual acts.

	Attraction to women (scale 0-100)*	**Attraction to men (scale 0-100)**	**Actual frequency of sexual acts (scale 1-9)***	**Desired frequency of sexual acts (scale 1-9)***
Female	M = 33.7 SD = 27.9	M = 83.4 SD = 21.5	M = 3.12 SD = 1.09	M = 4.20 SD = 1.02
Male	M = 89.8 SD = 20.2	M = 16.3 SD = 25.6	M = 3.37 SD = 1.01	M = 4.65 SD = 1.28

** (1 = never; 9 = 4 or more times /day)*

Eye tracking

We performed two separate eye movement experiments which all participants completed. Participants viewed the stimuli while their eye movements were recorded using Eyelink 1000 eye-tracker (SR Research, Mississauga, Ontario, Canada; sampling rate 1000 Hz, spatial accuracy better than 0.5°, with a 0.01° resolution in the pupil-tracking mode). A five-point calibration and validation were completed at least at the beginning of each task and in the video task after every 17^{th} video clip. Validation was successful if gaze position error was below 1°. Saccade detection was performed using a velocity threshold of 30°/s and an acceleration threshold of $4000°/s^2$.

Experiment 1: Erotic videos

The stimuli for Experiment 1 consisted of seven erotic videos showing heterosexual intercourse. Duration of each erotic trial varied between 12 – 27 seconds, and the entire task took 14 min 26 s. Sixty-one other videos were used as fillers in the experiment, and they contained different types of social (n=43) and non-social (n=8) content. These videos were excluded from the analysis in this study. Dynamic regions of interest (ROIs) were drawn frame-by frame on the face, breast, genital, and buttocks (back) areas of the male and female characters in the erotic scenes. Examples of the videos and ROIs are shown in **Figure 1**. Before the task, participants were explained that they were going to see videos with variable content. They were instructed to watch videos as they were watching Netflix or other video content on a computer. ´

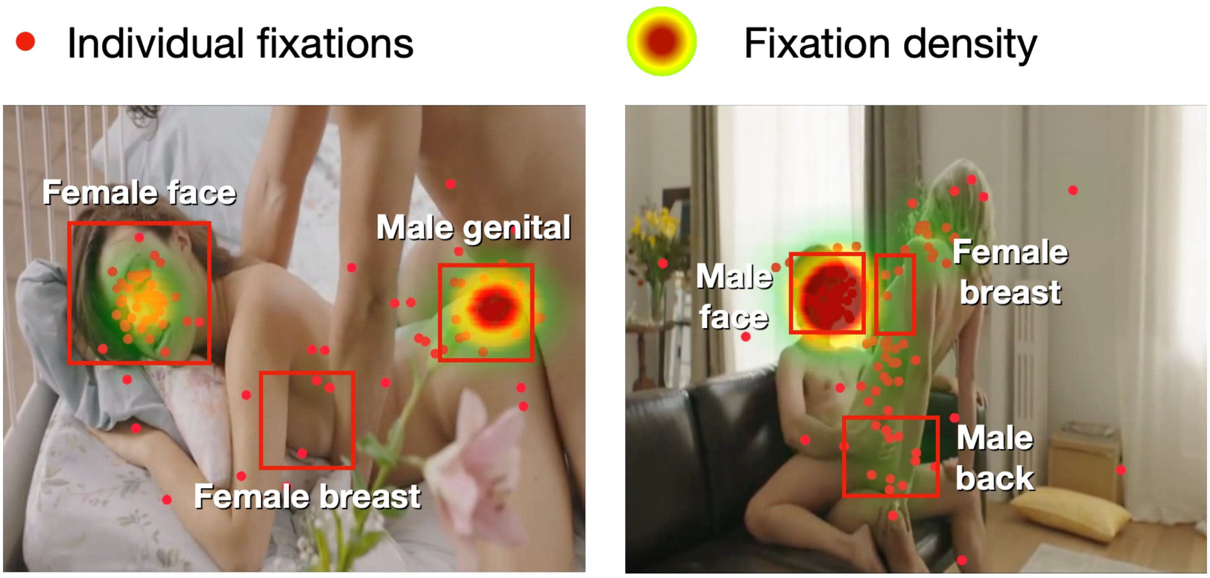

Figure 1 Sample stimulus frames illustrating representative ROIs in Experiment 1. The overlaid heatmaps show mean fixation distribution during the frame.

Experiment 2: Static images

In Experiment 2 four different static image types were used: photographs of nude or clothed adult men and women (**Figure 2B**). Altogether 52 stimuli (13 per category) were used. The stimuli have been validated and described in detail previously (Nummenmaa et al., 2012). Each trial (**Figure 2A**) begun with a drift correction, after which a single picture was shown for four seconds. The location of the stimuli on the screen varied from trial to trial so that they could appear on the left or right bottom or top corner of the screen; this ensured that the participants had to direct their attention to correct target to view the image.

To ensure attention to the stimuli, participants were instructed to evaluate the valence and arousal of each stimulus on a scale ranging from 1 to 9 after the stimulus display. Before the actual trials the participants were presented with four practice trials to confirm they had understood the task. The practice session began after the eye-tracker was calibrated successfully. The whole experiment lasted approximately 15 minutes.

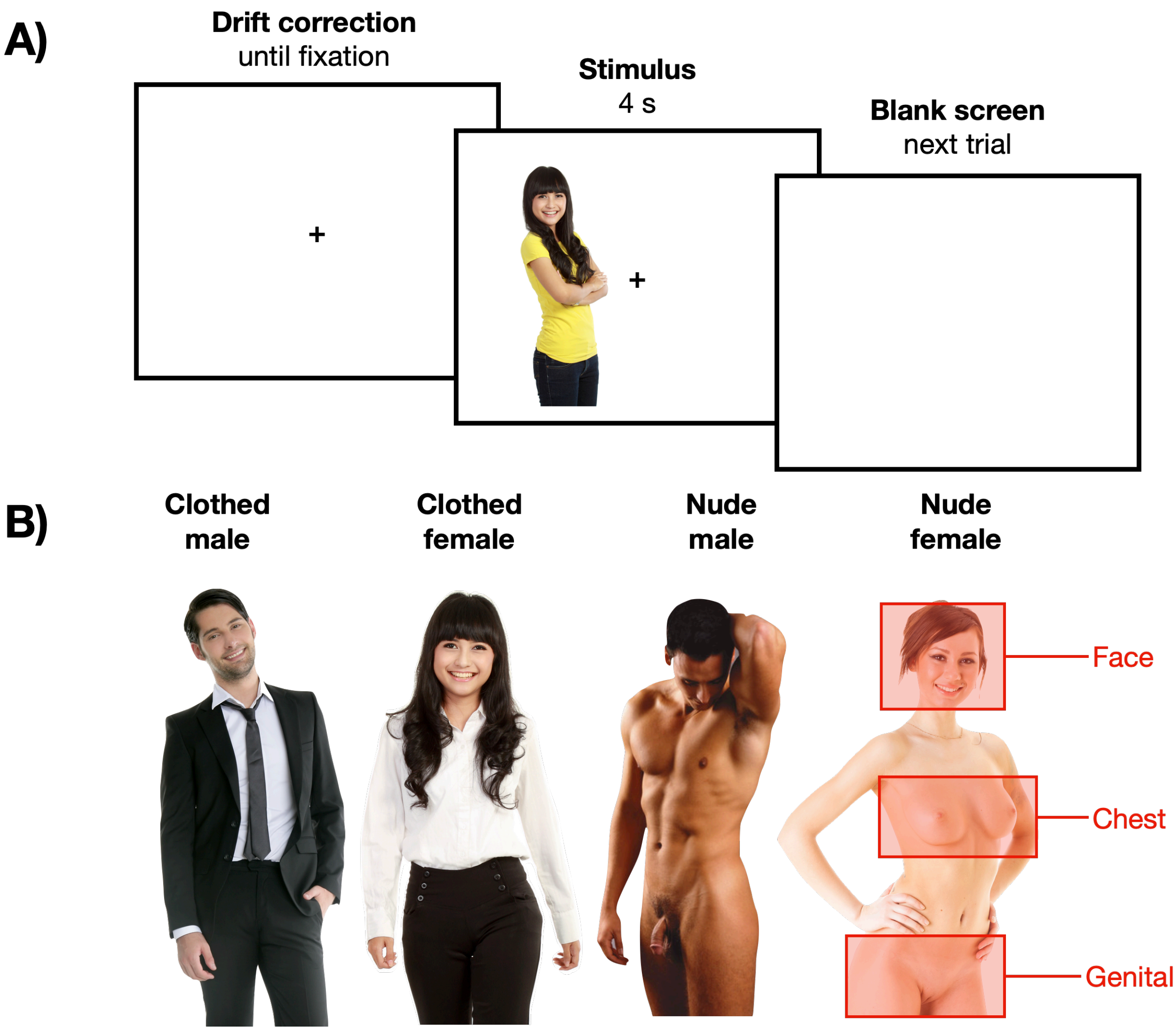

Figure 2 Illustration of the trial structure (A) and stimulus categories and regions of interest (B) in Experiment 2.

Data analysis

In Experiment 1, we computed three eye movement metrics. First, **intersubject correlation** of the gaze position (ISC) was dynamically calculated for measuring the moment-to-moment gaze position synchronization across participants using eISC-toolbox for Matlab (Nummenmaa et al., 2014). Briefly, the eISC is based on computing participant-wise fixation heatmaps with pre-defined time window (1000 ms in the Experiment 1), and momentary ISC is defined as the mean spatial correlation across participants. To assess whether males and females viewed the movies similarly, the ISC was computed and averaged separately for i) all possible male subject pairs, ii) all possible female subject pairs and iii) all possible male-female subject pairs.

Proportional dwell time (indexing sustained attention) for each ROI was defined as trial-wise proportional looking time for each ROI whereas **pupil size** (indexing arousal) was indexed as the average pupil size while looking at each ROI. The eye movement data were analysed with a 2 (Subject sex: Male vs. Female) x 2 (Stimulus sex: Male vs. Female) x 4 (ROI: Face, Chest, Back, Genital)) linear mixed model in R. Two-tailed alpha level of $p < .05$ was used in all analyses. Multiple comparisons were analysed with pairwise post-hoc analyses and corrected by using the Bonferroni procedure. In Experiment 2 we computed the mean **dwell time** and pupil size similarly as described above. Additionally, we quantified attentional orienting with **first fixation latency** i.e. latency of the very first fixation on the trial landing on a ROI and attentional engagement with **first fixation duration** i.e. the duration of the first fixation landing on a ROI). For each of these measures, the data were initially analysed with a 2 (Subject sex: Male vs. Female) x 2 (Stimulus sex: Male vs. Female) x (Clothing: Clothed vs. Nude) x 3 (ROI: Face, Chest, Genital) LMM. For all measures, these analyses showed a main effect of ROI or interactions between ROI and the other predictors indicating that the effects of subject sex, stimulus sex or clothing differed across the ROIs (see supplementary table S1). Therefore, we further explored these effects in separate ROI-wise 2 (Subject sex: Male vs. Female) x 2 (Stimulus sex: Male vs. Female) x (Clothing: Clothed vs. Nude) LMMs. As in Experiment 1, the multiple comparisons were analysed with pairwise post-hoc analyses and corrected by using the Bonferroni procedure. Two-tailed alpha level of $p < .05$ was used in all analyses.

Results

Experiment 1

ISC time series for the movie clips are shown in **Figure 3.** Mean ISC was 0.321 for male-male subject pairs, 0.337 for female-female subject pairs and 0.327 for male-female subject pairs, with no differences between the ISCs computed for different subject pairings indicating that males and females viewed the movies similarly.

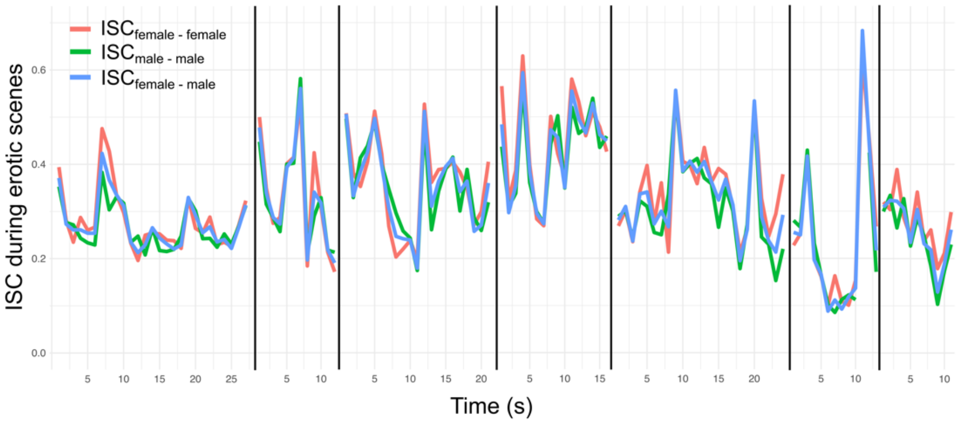

Figure 3. Clip-wise mean ISC time series for all male subject pairs, all female subject pairs and all female-male subject pairs.

The ANOVA results for dwell time (%) and the average pupil sizes are summarised in **Table 3**.

Table 3 LMM results of the ROI data in sexual scenes for the dwell time and pupil size.

	DF	F value	*p* value
Proportional dwell time			
Participant Sex	1, 108	1.022	0.314
ROI	3, 756	708.519	**0.000**
Stimulus Sex	1, 756	465.715	**0.000**
Participant Sex × ROI	3, 756	2.400	0.067
Participant Sex × Stimulus Sex	1, 756	12.238	**0.000**
ROI × Stimulus Sex	3, 756	68.565	**0.000**
Participant Sex × ROI × Stimulus Sex	3, 756	0.518	0.670
Average Pupil Size			
Participant Sex	1, 108	1.121	0.292
ROI	3, 720	23.607	**0.000**
Stimulus Sex	1, 720	41.954	**0.000**
Participant Sex × ROI	3, 720	1.588	0.191
Participant Sex × Stimulus Sex	1, 720	2.678	0.102
ROI × Stimulus Sex	3, 720	36.186	**0.000**

	DF	F value	*p* value
Proportional dwell time			
Participant Sex × ROI × Stimulus Sex	3, 720	1.342	0.259

Dwell time

The LMM revealed a main effect of the ROI, showing that dwell time differed between the ROIs. No main effect of Participant sex was found. The significant main effect of Stimulus sex indicated that female characters were viewed more than to male characters in all ROI's. As illustrated in **Figure 4**, female faces were looked at the longest and male's chest the shortest by all subjects regardless of their sex.

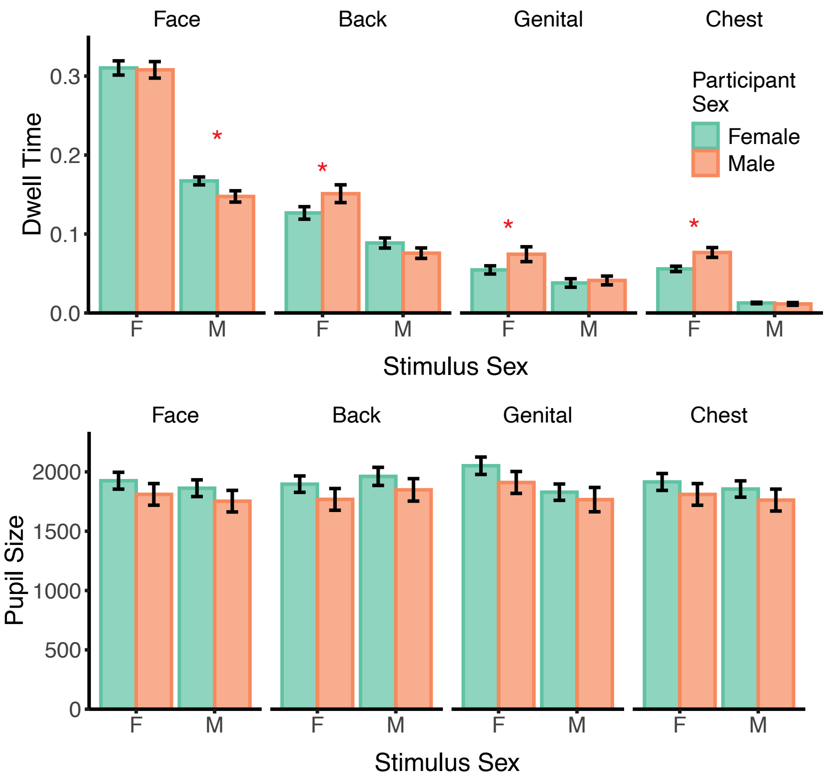

Figure 4 Proportional dwell time as a function of ROI and sex (top) and average pupil sizes for each ROI (bottom) * = p < 0.05 in contrast test between participant sexes).

There was also an interaction effect between participant sex and ROI. Pairwise post-hoc tests, reported in **Table 3**, revealed statistically significant sex-related differences in four ROIs. Female participants viewed more male faces than male participants ($p < 0.05$, *Cohen's d* = -0.408) while male participants looked female back ($p < 0.05$, *Cohen's d* = 0.505), genitals ($p <$

0.05, *Cohen's d* = 0.412) and breasts ($p < 0.05$, *Cohen's d* = 0.432) longer than female participants.

Table 3 Pairwise post-hoc tests comparing dwell times across male and female subjects in all ROIs in Experiment 1. P values smaller than .05 are highlighted in bold.

Stimulus Sex	**ROI**	**Sex Difference (F- M)**	***p* value***	**Cohen's_d**
Female	Back	-0.024	**0.012**	-0.505
Male	Back	0.013	0.183	0.267
Female	Chest	-0.021	**0.032**	-0.431
Male	Chest	0.001	0.903	0.024
Female	Face	0.002	0.803	0.050
Male	Face	0.020	**0.042**	0.408
Female	Genital	-0.020	**0.040**	-0.412
Male	Genital	-0.003	0.744	-0.065

**p-values are corrected with Bonferroni procedure*

Pupil size

As seen in **Table 3**, the LMM didn't reveal significant differences in pupil sizes between male and female participants. Overall pupil size was however larger when looking at female characters (**Figure 4**). There was an interaction between ROI and Stimulus sex. As shown in **Figure 4**, pupil size was larger when viewing female characters in all ROIs except in the Back, where pupils size was larger when viewing male characters (all $p < .001$).

Experiment 2

The ROI data were analysed with a linear mixed model (LMM) and the statistically significant results are summarised in **Table 4**. The analysis was performed for dwell time (%), first fixations, first fixation durations and the average pupil sizes. Pairwise post-hoc analyses were performed to qualify the interactions.

Table 4. Statistically significant results of the Experiment 2 in dwell time (%), first fixation, first fixation time and average pupil size.

Source	*df*	*F*	*p*
Dwell time (%)			
FACE region:			
Clothing	1,4982	49.431	< 0.001
Subject sex × Stimulus sex	1,4982	4.064	< 0.05
CHEST region:			
Clothing	1,4984	51.768	< 0.001
Stimulus sex	1,4984	19.230	< 0.001
Subject sex × Clothing	1,4984	6.973	< 0.01
Clothing × Stimulus sex	1,4984	5.422	< 0.05
GENITAL region:			
Clothing	1,4984	39.580	< 0.001
Subject sex × Clothing	1,4984	34.626	< 0.001
Subject sex × Clothing × Stimulus sex	1,4984	8.152	< 0.01
First fixation			
FACE region:			
Subject sex	1,101	4.520	< 0.05
Subject sex × Clothing	1,4218	19.394	< 0.001
CHEST: ns			
GENITAL region:			
Subject sex × Clothing	1,3217	16.633	< 0.001
First fixation time			
FACE region:			
Subject sex × Clothing	1,4213	4.723	< 0.05
CHEST region:			
Clothing	1,3729	5.091	< 0.05
GENITAL region:			
Subject sex × Clothing	1,3207	24.166	< 0.001
Average pupil size			
FACE region:			
Clothing	1,4214	4.607	< 0.05

Stimulus gender	1,4214	8.308	< 0.01
Subject sex × Clothing	1,4214	3.950	< 0.05
Subject sex × Stimulus sex	1,4214	20.378	< 0.001
CHEST region:			
Stimulus gender	1,3703	8.026	< 0.01
Subject sex × Stimulus sex	1,3703	30.013	< 0.001
GENITAL region:			
Stimulus gender	1,3153	14.268	< 0.001
Subject sex × Stimulus sex	1,3153	26.851	< 0.001

Dwell time

Overall dwell times differed across ROIs and faces received the most attention (see **Figure 5**). The main effect of the clothing was significant in every ROI so that clothed stimuli's faces were viewed longer than nudes' ($F(1,4982) = 49.431$, $p < 0.001$). In contrast, both the chest region ($F(1,4984) = 51.768$, $p < .001$), and the genital region ($F(1,4984) = 39.580$, $p < 0.001$) were viewed longer when the stimuli were nude. Stimulus sex's main effect was revealed in chest region ($F(1,4984) =19.230$, $p < .001$), and both male and female subjects viewed female chest area longer than male chest area.

There was also an interaction effect of Subject sex X Stimulus sex ($F(1,4982) = 4.064$, $p < 0.05$) in face region. Pairwise post-hoc analysis revealed no statistically significant effects, but numerically male subjects viewed female faces more than male faces ($p = .657$, *Cohen's d* = .051) and female subjects viewed male faces more than female faces ($p = .288$, *Cohen's d* = .064).

In the chest region, there was an interaction between Clothing X Subject sex ($F(1,4984) = 6.973$, $p <.05$). Male subjects looked at the chest region of naked stimuli longer than female subjects did ($p < .05$, *Cohen's d* = .223). There was also a significant interaction between Clothing and Stimulus sex in the chest area ($F(1,4984) =5.422$, $p < .05$). Nude female chest area was viewed longer than clothed female chest ($p < .0001$, *Cohen's d* = .638). Similar results were seen in the dwell time of male chest area ($p < .0001$, *Cohen's d* = .280), but the effect was smaller. Female chest region was viewed longer than male chest also for the clothed stimuli ($p < .0001$, *Cohen's d* = .225).

In the genital region, there was an interaction between Subject sex and Clothing ($F(1,4984) = 34.626$, $p < 0.001$). As for the chest area, nude genital area was viewed more than clothed genital area by both male ($p < .0001$, *Cohen's d* = .935) and female participants ($p < .0001$, *Cohen's d* = 1.271). Female participants viewed naked genital regions more that male participants ($p < .05$, Cohen's *d* = .264). Finally, there was an interaction between Subject sex, Clothing and Stimulus sex ($F(1,4984) = 8.152$, $p < 0.01$). This three-way interaction revealed the different effect of the clothing on dwell times for female and male stimuli. Nudity increased viewing time particularly for the male genital region in female participants: Female subjects viewed nude genital regions of male stimuli longer than nude genital regions of female stimuli ($p < .001$, Cohen's *d* = .289), and longer than male participants viewed nude female (p < .01, Cohen's *d* = .440) or male genital regions ($p < .05$, Cohen's *d* = 378).

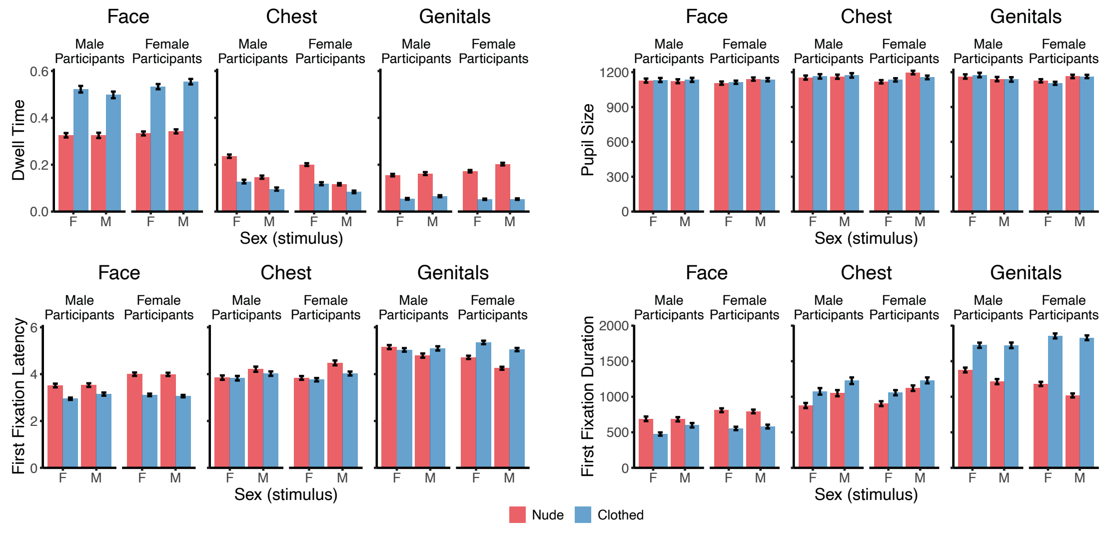

Figure 5 Means and SD of the dwell times, pupil sizes, first fixation latencies, and first fixation durations for face (**a**), chest (**b**) and genital (**c**) region.

First fixation latency

Results for the first fixation latency analysis are shown in **Figure 5**. Overall faces received the earliest fixations of the ROIs. In the face region, only the Subject sex had main effect on the first fixations ($F(1,104) = 4.520$, $p < 0.05$). Male subjects viewed stimulus face earlier than female subjects. There was also a statistically significant interaction between Subject sex and Clothing ($F(1,4218) = 19.395$, $p < 0.001$). Faces of the clothed stimuli were viewed earlier by both male ($p < .0001$, *Cohen's d* = 0.307) and female subjects ($p < .0001$, *Cohen's d* = 0.580) than nude stimulus. However, the effect was stronger in the female participants since male participants viewed the face of nude stimuli earlier than female subjects ($p < .001$, Cohen's *d* = 294).

There were no significant differences in first fixation latencies in the analysis of chest area. The only statistically significant interaction in the genital area was Subject sex X Clothing ($F(1,3217) = 16.633$, $p < 0.001$). Female participants viewed the genital region of the nude stimuli faster than when stimulus was clothed ($p < .0001$, *Cohen's d* = .401), while the same effect was not seen in male subjects ($p = .430$, *Cohen's d* = .09).

First fixation duration

First fixation durations (**Figure 5**) revealed an opposite pattern in comparison with latencies: when faces were attended first, they were attended fort the shortest time, whereas first fixations were longest on the genital area. Analysis on the face region revealed a statistically significant interaction between Subject sex and Clothing ($F(1,4213) = 4.727$, $p < 0.05$). Male subjects' first fixation durations were longer for nude stimuli ($p < .0001$, *Cohen's d* = 0. 231) when compared to clothed stimuli. Similar results were found for female subjects *(p* < .0001, *Cohen's d* = 0. 366) and the effect was numerically even stronger. The first fixation duration of female participants for nude stimuli was longer than that of male participants for clothed stimuli ($p < .001$, Cohen's *d* = 0.411).

In the chest region analysis, main effect was found for clothing of the stimulus ($F(1,3729)$ = 5.091, $p < 0.05$). As illustrated in **Figure 5**, first fixation durations were longer for clothed stimulus in comparison to nude stimulus for chest and genital regions.

A significant interaction of Subject sex X Clothing was found for the genital region ($F(1,3207) = 24.166$, $p < 0.001$). While both sexes had longer first fixation duration for on clothed genital regions, female subjects had a greater difference between nude and clothed stimuli ($p < .0001$, *Cohen's d* = -0.964) than male subjects ($p < .0001$, *Cohen's d* = -0.588). This resulted from a longer first fixation duration for nude stimuli's genital regions in male participants compared to female participants ($p < .05$, Cohen's $d = .241$).

Pupil size

In the pupil size analysis (**Figure 5**), interaction of Subject sex X Stimulus sex was found for all three ROIs: face ($F(1,4214) = 20.378$, $p < 0.001$), chest ($F(1,3703) = 30.013$, $p < 0.001$) and genital region ($F(1,3153) = 26.851$, $p<0.001$). This was seen systematically in the size of female pupils, which were larger when they viewed male stimulus' face ($p < .0001$, *Cohen's d* = -.262), chest ($p < .0001$, *Cohen's d* = -.417) and genital region ($p < .0001$, *Cohen's d* = -.304) when compared to female stimuli.

The analysis of face region revealed a main effect of the Clothing ($F(1,4214) = 4.607$, $p <.05$). Pupils were larger while viewing the face of nude stimulus than that of a clothed stimulus. Interaction between Subject sex X Clothing was found in the pupil size analysis of face region ($F(1,4214) = 3.950$, $p < 0.05$).

Discussion

Our main finding was that faces were the most salient and thus looked at signals both when viewing actual sexual acts on videos or pictures of humans with sexual signals visible or covered. This effect was observed consistently across male and female subjects. When analyzing the spatiotemporal gaze patterns for the static stimuli, significant sex differences were also found. For video stimuli, male participants viewed female breasts, genitals, and buttocks statistically significantly longer than females, while female participants allocated more attention to male faces than male participants whereas sex-dependent effects were less salient when viewing the static stimuli. This experiment however revealed that visibility of sexual cues influenced the gaze patterns significantly. Although faces were in general looked at earliest and for longest, the participants allocated significantly more attention to genital and chest regions versus faces when the stimuli were nude. These results underscore the sex-dependent differences in sexual attention particularly for dynamic sexual scenes and highlight the role of facial information in sexual perception.

Importance of faces and bodies in sexual perception

Consistent with the previous studies, faces received most of the attention for the clothed and nude stimuli and during the naturalistic perception of highly arousing videos showing sexual intercourse. Even in the presence of extremely salient and arousing sexual signals (Julien & Over, 1988), the attention-grabbing power of the faces persisted. Faces also attracted selective attention as indicated by the shortest latency of first fixations in Experiment 2. After the face area, attention was drawn to the chest area and finally on the genitals. suggesting a head-to-toes processing of static human figures. Overall, faces are the most attended feature in dynamic social stimuli and looking at faces is the best predictor of gaze synchronization with others (Santavirta et al., 2024) and the current results accord with prior studies (Lykins et al., 2006; Nummenmaa et al., 2012; Tsujimura et al., 2009) confirming the importance of facial information in sexual context. This face preference may relate to the fact that faces are an important source of fitness and overall health in sexual selection (Rhodes, 2006) but they may also reflect the communicative value of faces in intimate interactions. We read nonverbal cues from faces, and it is known to be an important area for social engagement (Ishii et al., 2018) and this is likely also critical for affective communication during sexual intercourse. Indeed, multiple studies have discovered that communication and sexual satisfaction are closely linked to each other (Kelly et al., 2006; Montesi et al., 2011; Purnine & Carey, 1997). Thus, close attention to partner's facial responses during intercourse could be an important mechanism for sampling partner's sexual satisfaction.

Clothing of the stimuli had the largest effects on the gaze patterns. Faces were inspected earlier for clothed stimuli in comparison to nude stimuli. Additionally, attention was drawn mainly to face region when the stimuli were clothed. When the stimulus was nude, dwell times for face region decreased, which was reflected in later first fixations and diminished dwell times on faces. Overall inspection of the stimulus was faster on nude bodies, which was seen in diminished gaze durations in the chest and genital regions. Additionally, the durations of the first fixations were longer for clothed genital and chest regions of the stimulus compared to corresponding nude regions. Also, the duration differences were longer between face and other regions when stimulus was clothed, which might reflect the more precise inspection of the body when the visual cues of the physical attractiveness are not available due to clothing. These results from the static images replicate prior findings using exactly the same paradigm (Nummenmaa et al., 2012), where clothing had also a strong effect on gaze patterns. All in all, these results show that limiting the availability of sexually relevant information by clothing results in information loss in the bodies, thus focusing the attention on the faces where socially and sexually meaningful information is still available (Fromberger et al., 2012a; Lykins et al., 2006; Nummenmaa et al., 2012).

Sex differences

Gaze patters while viewing the videos were moderately consistent across participants, with ISCs exceeding r = 0.32 for both sexes. Gaze patterns were also consistent across males and females, as evidenced by similar mean ISC for male-male, female-female, and male-female viewer pairs. This likely reflects the strong bottom-up nature in processing cinema and the role of visual features rather than top-down goals in dynamic perception (Fromberger et al., 2012a; Lykins et al., 2006; Nummenmaa et al., 2012). It is however notable that attention was preferentially allocated towards the socially (faces) and sexually (back; genitals) relevant bodily regions suggesting that the bottom-up guidance is governed also by social / sexual priors rather than mere low-level visual features. Both sexes viewed female bodies more than male bodies in the video and in the picture experiments. This is in line with prior studies establishing that visual attention in males is clearly biased towards opposite sex, whereas in females the opposite-sex bias is either absent or smaller in magnitude (Fromberger et al., 2012a; Lykins et al., 2008a; Nummenmaa et al., 2012; Tsujimura et al., 2009). Overall, these attentional patterns accords with well-known greater discrimination of physiological responses to sexually arousing opposite-sex vs. same-sex stimuli in men versus women (Alexander & Charles, 2009; Costa et al., 2003; Lykins et al., 2008a), broadly reflecting greater sexual plasticity in women (see review in Peplau, 2003). Although overall pattern of sexual attention was similar across sexes, notable sex differences were also observed particularly while viewing the videos depicting intercourse. While viewing the videos, male participants looked more at female chest, buttocks and genital areas in comparison to female participants. Conversely, female participants allocated more attention to the facial area. These sex differences accord with prior work using pictorial stimuli (Fromberger et al., 2012a; Lykins et al., 2008a; Nummenmaa et al., 2012; Tsujimura et al., 2009) but contrast prior small-scale studies using videos (Tsujimura et al., 2009). It is likely that our experiment had simply better statistical power (n = 110) for establishing the sex differences in gaze patterns. Female subjects' pupils were also larger when they viewed male stimulus, and the difference was seen in every region of interest. This might indicate the attraction to opposite sex on female subjects, as the previous studies have discovered that the pupil dilation is a significant indicator of sexual orientation and arousal (Rieger & Savin-Williams, 2012). Yet, the same effect was not seen in the male subjects, but male subjects' pupils were larger when they viewed face region of the clothed stimuli. All in all, our results suggest that visual attention to sexual stimuli is broadly similar for males and females. Nevertheless, it must be noted that the subsequent processing of sexually relevant information in the brain diverges across men and women, as multivariate activation patterns for sexual signals differ robustly between the sexes (Putkinen et al., 2023).

Limitations

First, most of the participants were university students and highly educated so the results may not directly translate across education levels. Second, the sexual orientation of the participants was measured with the attraction scale for different sexes (see **Table 2**). Female participants' mean attraction to men (M = 83.4) was higher than the attraction to women (M = 33.7). whereas the opposite was true for men (M[women] = 89.8, M[men] = 16.3). Because the sample is not purely heterosexual, the results should thus be interpreted to reflect sex differences rather than sexual orientation differences in visual sexual attention. This might have an impact to the results because we cannot conclude whether the sex-dependent eye movement differences between individuals relate to sex versus sexual orientation. Third, menstrual cycle or oral contraceptive use was not controlled for the female participants, although some prior studies have suggested that female's hormonal profile's may impact gaze patterns (Rupp & Wallen, 2007a). Finally, the sexual stimuli differed in their content across the experiment (intercourse vs. static nude bodies) precluding direct comparisons between the results of the experiments. Despite this, the overall pattern of the selective attention allocation was broadly consistent across the experiments.

Conclusions

Faces and bodies are important cues of physical attraction and sources nonverbal communicative signals. Our study revealed the importance of the facial area and the sex-related differences in the visual processing of erotic stimulus. Variation in the clothing of the stimulus had an impact on the gaze patterns, and nude bodies were inspected more thoroughly. Visual sexual attention was also found to be broadly similarly allocated across the sexes. The overall preference for faces even when viewing sexual intercourse may reflect both the importance of facial characteristics in mate selection as well as the role of facial expressions in evaluating partner satisfaction while having sex.

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Table S1. Results of ROI × Participant Sex × Stimulus Sex × Clothing linear mixed effects model analyses for dwell time, first fixation latency, first fixation duration, and pupil size in experiment 2.

Dwell Time

	Df	F value	p value
Participant Sex	1,100	0.128	0.721
ROI	2,15158	279.366	0.000
Clothing	1,15158	0.006	0.938
Stimulus Sex	1,15158	9.851	0.002
Participant Sex × ROI	2,15158	17.616	0.000
Participant Sex × Clothing	1,15159	0.202	0.653
ROI × Clothing	2,15158	60.558	0.000
Participant Sex × Stimulus Sex	1,15159	3.519	0.061
ROI × Stimulus Sex	2,15158	3.143	0.043
Clothing × Stimulus Sex	1,15158	0.525	0.469
Participant Sex × ROI × Clothing	2,15158	9.041	0.000
Participant Sex × ROI × Stimulus Sex	2,15158	1.547	0.213
Participant Sex × Clothing × Stimulus Sex	1,15159	0.041	0.840
ROI × Clothing × Stimulus Sex	2,15158	3.226	0.040
Participant Sex × ROI × Clothing × Stimulus Sex	2,15158	2.602	0.074

First Fixation Latency

	Df	F value	p value
Participant Sex	1,104	0.225	0.636
ROI	2,11360	92.336	0.000
Clothing	1,11339	1.859	0.173
Stimulus Sex	1,11302	1.411	0.235
Participant Sex × ROI	2,11358	11.169	0.000
Participant Sex × Clothing	1,11336	0.003	0.956
ROI × Clothing	2,11312	1.810	0.164
Participant Sex × Stimulus Sex	1,11300	0.851	0.356
ROI × Stimulus Sex	2,11294	0.186	0.831
Clothing × Stimulus Sex	1,11294	2.413	0.120
Participant Sex × ROI × Clothing	2,11313	15.722	0.000
Participant Sex × ROI × Stimulus Sex	2,11294	2.688	0.068
Participant Sex × Clothing × Stimulus Sex	1,11294	2.555	0.110
ROI × Clothing × Stimulus Sex	2,11291	0.644	0.525

	Df	F value	p value
Participant Sex × ROI × Clothing × Stimulus Sex	2,11291	0.041	0.960

First Fixation Duration

	Df	F value	p value
Participant Sex	1,105	0.330	0.567
ROI	2,11354	109.177	0.000
Clothing	1,11332	3.072	0.080
Stimulus Sex	1,11299	0.951	0.330
Participant Sex × ROI	2,11352	3.778	0.023
Participant Sex × Clothing	1,11330	3.039	0.081
ROI × Clothing	2,11308	2.676	0.069
Participant Sex × Stimulus Sex	1,11298	0.071	0.790
ROI × Stimulus Sex	2,11292	1.018	0.361
Clothing × Stimulus Sex	1,11292	1.782	0.182
Participant Sex × ROI × Clothing	2,11309	14.453	0.000
Participant Sex × ROI × Stimulus Sex	2,11292	0.828	0.437
Participant Sex × Clothing × Stimulus Sex	1,11293	0.600	0.439
ROI × Clothing × Stimulus Sex	2,11289	0.489	0.613
Participant Sex × ROI × Clothing × Stimulus Sex	2,11290	0.086	0.918

Pupil Size

	Df	F value	p value
Participant Sex	1,105	0.000	0.997
ROI	2,11280	4.143	0.016
Clothing	1,11280	2.448	0.118
Stimulus Sex	1,11280	31.526	0.000
Participant Sex × ROI	2,11280	0.416	0.660
Participant Sex × Clothing	1,11280	0.766	0.381
ROI × Clothing	2,11280	0.631	0.532
Participant Sex × Stimulus Sex	1,11280	78.636	0.000
ROI × Stimulus Sex	2,11280	0.899	0.407
Clothing × Stimulus Sex	1,11280	1.731	0.188
Participant Sex × ROI × Clothing	2,11280	1.128	0.324
Participant Sex × ROI × Stimulus Sex	2,11280	1.685	0.185
Participant Sex × Clothing × Stimulus Sex	1,11280	4.216	0.040
ROI × Clothing × Stimulus Sex	2,11280	0.144	0.866
Participant Sex × ROI × Clothing × Stimulus Sex	2,11280	0.006	0.994