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FEMALE SEXUAL FUNCTION

Visual Attention to Sexual Stimuli in Women With Clinical, Subclinical, and Normal Sexual Functioning: An Eye-Tracking Study

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ABSTRACT

Background: Visual attention to sexual stimuli is an important means to facilitate sexual arousal and is thereby relevant for healthy sexual functioning. Experimental studies suggest that sexual dysfunction is associated with less attention toward sexual stimuli.

Aim: The goal of this study was to use an eye-tracking-based free-viewing paradigm to investigate whether women in the clinical range of sexual function attend to a genital area in visual sexual stimuli differently than women with subclinical sexual function or those with normal sexual functioning.

Methods: Toward this goal, 69 women (M_{age} = 27.77, SD = 8.00, range = 19−54) with clinical (n = 30), subclinical (n = 23), and normal (n = 16) levels of sexual functioning watched a series of 10 pictures depicting heterosexual couples during vaginal intercourse while their eye movements were recorded. Each picture was presented twice—once with a distracting object (eg, a to-do list or household appliance) present in the picture and once without—for 8 seconds, each.

Outcomes: 5 eye-tracking measures indicative of different aspects of initial and sustained attention were analyzed.

Results: As hypothesized, 3 out of 5 eye-tracking measures (ie, first fixation duration, number of first fixations, and total fixation duration) indicated that women in the clinical group attended less to the genital area in the pictures than women with normal sexual functioning. For 2 indices (ie, first fixation duration and total fixation duration), women with subclinical (vs normal) sexual functioning also attended less to the genital area. In contrast to our hypothesis, the presence of a distracting object did not influence attention to the genital area in either of the sexual function groups.

Clinical Implications: This study provides further evidence of the role of attentional biases in sexual dysfunction in women.

Strengths and Limitations: Eye-tracking methodology allows for a continuous measurement of visual attention; this is one of the first studies using this methodology to assess differences in visual attention in women with and without sexual dysfunction. However, the cross-sectional nature of this study prevents causal interpretation of findings.

Conclusion: Future studies should use experimental paradigms to determine the causal role of visual attention for the development or maintenance of sexual dysfunction. **Velten J, Milani S, Margraf J, et al. Visual Attention to Sexual Stimuli in Women With Clinical, Subclinical, and Normal Sexual Functioning: An Eye-Tracking Study. J Sex Med 2021;18:144−155.**

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Key Words: Sexual Dysfunction; Subclinical Sexual Dysfunction; Eye-Tracking; Attention

INTRODUCTION

Theoretical models of the etiology and maintenance of sexual dysfunction (ie, a distressing and clinically significant inability to respond sexually or to experience sexual pleasure)[1] emphasize the relevance of attentional processes, which operate at different stages of awareness and control.[2,3] In his cognitive interference model of sexual arousal,[4] Barlow postulates that sexual difficulties depend on a negative feedback loop involving the interaction

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between automatic bodily arousal and cognitive interferences. When confronted with implicit or explicit demands for sexual performance, individuals with sexual dysfunction selectively attend to negative cues (eg, consequences of performance failure). In contrast, individuals with normal sexual functioning are able to continuously attend to sexual stimuli and thereby experience higher levels of sexual arousal.[4] Different pathways have been brought forward to explain why individuals with sexual dysfunction fail to attend to sexual stimuli. From an incentive motivation perceptive, individuals with low sexual desire may find sexual stimuli less salient and may therefore be more easily distracted by competing stimuli.[3] Alternatively, the association of sexual stimuli with negative experiences (eg, pain or interpersonal conflict) may result in active avoidance of sexual cues.[5] In line with Barlow's work, the information-processing model proposes that the degree to which individuals direct their attention toward sexual stimuli influences their sexual arousal response.[3] According to the model, a cue that is first to be recognized as sexual,[6] is processed involving both preattentive/unconscious and deliberate/controlled attentional processes requiring conscious awareness. A focus of attention on sexual cues (eg, an attractive partner or erotic picture) can facilitate sexual arousal, and distraction that diverts attention from such cues can lead to reductions in arousal.

Experimental Manipulation of Attention

Since the 1980s, several laboratory-based experimental studies have been conducted to examine the role of attention in sexual dysfunction. An early study using different experimental instructions (eg, performance demand or use of distractions) found support for the notion that attention toward sexual stimuli is relevant for sexual functioning. Beck and Baldwin[7] showed that women who were shown erotic film segments and used cognitive strategies such as nonsexual and negative thoughts (eg, about pain) were able to inhibit arousal, while those using positive thoughts and fantasy were able to increase arousal. In another study, women with increased attention to erotic cues were able to experience higher levels of arousal.[6] Using a reflecting television screen with the goal of inducing a state of self-focused attention led to reduced genital sexual arousal by an erotic film only in women without sexual dysfunction, but not in those with sexual dysfunction.[8] Authors interpreted this finding as indicative that women with sexual dysfunction may have been distracted (eg, by the laboratory setting or negative thoughts) during both the self-attention and control condition which may have limited the effect of experimental manipulation.

Reaction Time Tasks

Studies using reaction time (RT) measures provide further support for the notion that individuals with sexual dysfunction attend to sexual stimuli differently. Generally speaking, RT measures are computerized paradigms requiring participants to react as fast as possible to target stimuli by pressing specified keys on a keyboard. RT measures provide information on visual attention defined as "the selective use of information from one region of the visual field at the expense of other regions of the visual field" [p. 260].[5] In this respect, findings from RT studies may be more informative for this study than those focusing on, for example, auditory or cognitive distraction.[9]

A commonly used RT measure is a dot detection task. In a typical dot probe trial, 2 cues (eg, neutral vs sexual) compete for attention at opposite screen locations before a dot appears at either one of these locations. Participants are instructed to indicate the location of this dot as quickly as possible by pressing a key on a keyboard. A study using a dot probe as well as a line orientation task revealed an attentional bias for sex pictures, that is, participants were faster when they had to respond to sexual vs neutral stimuli in sex/neutral picture combinations.[10] The authors provided further information on the attentional bias suggesting that participants showed slower disengagement from but not enhanced orienting to sexual stimuli. In other words, participants were distracted by a sex picture when they had to respond to a neutral picture, but not drawn to the sexual content per se. In their sample of healthy adults, attentional biases for sexual stimuli were not correlated with levels of sexual desire.[10] In line with this, another study using a similar paradigm showed that women with and without acquired hypoactive sexual desire disorder showed equal levels of attentional (dis)engagement with the sexual stimuli.[11] In contrast, another dot-probe study found that *lower* levels of sexual desire were associated with *faster* RTs when a dot replaced a sexual vs a neutral image, as compared to higher desire participants. An explanation offered was that reduced attentional engagement or absorption with the sexual material resulted in faster reactions by lower desire participants.[12]

Using a spatial cueing task in a series of studies, Imhoff et al[13] found that participants deliberately dedicated more attention to sexual vs neutral stimuli but found no evidence for an automatic visual orientation toward them. The bias in deliberate attention for sexual stimuli was, however, less pronounced for individuals low on sexual excitation and high on sexual inhibition, 2 traits associated with increased risk for sexual dysfunction.[14,15] In other words, individuals willfully and deliberately dedicated their attention to sexual images, and this happened to a greater extent if the person shows traits that are associated with high sexual functioning. Despite being convenient and cost-effective, RT measures' usefulness has been questioned as "the 'snapshot' nature of RT measures (ie, their restriction to a single time point within a trial)" [p. 705][4] limits their ability to capture the time course and components of attentional processes.[16] In addition, mixed results as well as the use of different (versions of) paradigms limits interpretability of findings.[17]

Eye-Tracking and Visual Attention Toward Sexual Stimuli

Eye-tracking technology, which provides a continuous measure of attentional selection performed via eye movements, can

be an important supplement to RT measures.[18] A first study using eye-tracking and sexual stimuli showed that such stimuli capture visual attention differently than nonsexual stimuli. In sexual pictures, participants fixated more often and for a longer period of time on bodies than bodies in nonsexual pictures.[19] Another study showed that nude bodies attract more attention than clothed ones and that areas relevant for identification of sexual partners (eg, pelvic area) receive particular attention.[20] These findings were interpreted as supporting the usefulness of applying eye-tracking methodology as a measure of attentional capture in sexuality research. In contrast to bodies in erotic vs nonerotic poses, no differences in viewing patterns were found for faces and background in sexual vs nonsexual pictures. The duration of first fixation, a more subtle measure of initial attention,[19] also showed no differences between picture types.

Studies using eye-tracking and sexual stimuli were conducted to assess gender differences,[21,22] the role of sexual orientation,[10,11] or, as described previously, to compare viewing patterns between sexual and nonsexual stimuli.[19] Heterosexual women tend to direct their attention toward preferred targets (ie, men) in static pictures, while directing their attention toward nonpreferred sexual targets (ie, women) in dynamic videos.[23] Using a forced attention paradigm in a sample of 46 heterosexual women, a gender-nonspecific initial attention was shown in that preferred and nonpreferred targets (ie, nude men or women) attracted attention similarly quickly.[23] To our knowledge, only one study has used eye-tracking methodology to investigate the relationship between sexual functioning and attention to sexual stimuli. Using a set of 9 pictures depicting couples engaging in foreplay as well as nonfitting, distracting objects (eg, a squirrel in the bedroom), women with sexual problems (ie, low sexual desire or pain during intercourse) were more easily distracted from or avoided looking at sexual stimuli than healthy controls.[5]

Clinical Relevance

Women seeking treatment for sexual dysfunctions often describe feeling distracted and not being able to focus on relevant stimuli (eg, a partner's body or sensual touch) during sex. Women with low desire and/or arousal difficulties experience this inability to focus their attention on sexual stimulation.[24] Moreover, in the case of chronic genital pain, there may be aversive reactions to sexual stimuli as well as avoidance of those stimuli, leading to impaired arousal and intensified pain.[25,26] Thus, to identify how women with sexual dysfunction attend to sexual stimuli may contribute new information on understanding the etiology of sexual dysfunction and can inform targeted treatments that address attention.

Current Study

This study used eye-tracking methodology to investigate whether women with and without sexual dysfunction attend to a sexually explicit area in a picture (ie, genital area depicting male and/or female genitals and penetration) differently. As women may exhibit varying degrees of sexual functioning which may not always align with the presence or absence of a sexual dysfunction diagnosis, we deliberately compared 3 groups: Group 1 included women who met Diagnostic and Statistical Manual of Mental Disorders fifth edition (DSM-5) criteria for either female sexual interest/arousal disorder or genitopelvic pain/penetration disorder and scored in the clinical ranges on validated measures of sexual functioning and sexual distress. The normal sexual functioning group included women who did *not* meet criteria for any DSM-5 sexual dysfunction and scored above the clinical cutoffs on validated measures of sexual functioning and sexual distress. The third group we referred to as subclinical included women with some but not all the criteria endorsed by women in group 1 (eg, either met diagnostic criteria or scored below clinical cutoffs on measures of sexual functioning or sexual distress). This group may represent a substantial proportion of the female population who may experience some sexual difficulties but do not necessarily seek treatment for or feel bothered by it.[27] By comparing these 3 groups, this study aims to overcome a limitation of previous studies that only included dimensional questionnaires to assess sexual functioning[15] that may fail to differentiate between women with clinically low vs medium levels of sexual functioning from clinical participants.

In this study, a series of 10 motives showing vaginal intercourse between a man and a woman were presented, and eye-movements were measured. Viewing patterns were analyzed with respect to 5 variables assessing different aspects of initial (ie, time to first fixation, number of first fixations, and duration of first fixation) and sustained attentional processing (ie, number of fixations, total fixation duration). While the unique contribution of each of these variables has not been determined and previous studies often included only a subset of these variables,[19,28] the inclusion of 5 measures is thought to have the potential to reveal attentional biases in different facets of initial vs sustained attention. Hypothesis 1 was that women with sexual dysfunction would attend less to the genital area than women with normal sexual functioning. Women with subclinical sexual dysfunction were expected to score between these 2 groups. Hypothesis 2 was that presentation of distracting objects (eg, household appearances, clock, to-do lists) in the pictures would reduce the attention that participants directed to the genital area using the same measures of attention described previously. Hypothesis 3 was that the effect of the distracting object would be more pronounced for women with sexual dysfunction than the subclinical and normal sexual functioning groups, with the subclinical group scoring between the other 2 groups. In addition, we explored whether other areas of interest, namely the faces of the female and male actors, and the remaining parts of the picture would be attended to differently by the 3 sexual function groups.

METHODS

Participants

Adult cis-gender women aged 19 years or older who were fluent in English, with mostly or exclusively heterosexual

orientation, had normal or corrected-to-normal vision, with premenopausal hormonal status, were not taking any medication that might interfere with sexual response (eg, hormonal contraception, antidepressants), and without current major mental disorders that might interfere with sexual response or the experimental procedure (eg, current major depression, psychosis, substance abuse) were eligible for this study. Participants were recruited from advertisements placed online (eg, university paid-studies list, hospital electronic mailing lists, Facebook, Instagram, online discussion boards), in local newspapers, and on flyers posted throughout the community (eg, coffee shops, community centers, university boards). In addition, the study coordinator also contacted participants of previous studies who had provided consent to be contacted for future studies. During a short telephone screening conducted by a trained research assistant, the inclusion and exclusion criteria were assessed, and a brief, standardized interview was conducted to screen for major mental disorders and to assess for the diagnosis of a female sexual dysfunction. Of the 115 women who expressed interest in the study, 107 participated in the telephone screening. Of these, 10 women did not meet the inclusion criteria, and 19 did not proceed to schedule the in-lab assessment. In total, 78 women provided written consent and completed both the questionnaires and the in-laboratory assessment. Owing to technical problems, eye-tracking data were not measured in 9 participants. Data from 69 women were included in this study.

Instruments and Measures

Eye Tracker

Eye movements were measured using a SensoMotoric Instruments (SMI) Red 500 eye tracker, Teltow, Germany in combination with SMI's Experiment Suite software program. The SMI Red 500 is a contact-free, remote sensor eye-tracker that measures bright and dark pupil tracking using an infrared camera. It is used in combination with a standalone 22″ monitor (resolution of 1,920 × 1,080). The eye tracker automatically compensates for small head movements, so it is not necessary to immobilize the head using a chin rest. The system is compatible for use with most eyeglasses and contact lenses. It also has a built-in detector to identify saccades (ie, rapid changes in gaze location), blinks, and fixations (ie, very-low-velocity eye movements that correspond to a person staring at a particular point).[29] The algorithm measures the distance between neighboring gaze points and calculates the eye movement velocity for all the eye movements sampled for each individual. Raw data points are assigned to the same fixation if the velocity remains below a set threshold or are assigned to a new fixation when the velocity rises above this threshold (dispersal threshold of 30 pixels corresponding to 0.9° and a minimum temporal duration of 100 ms).

Measures of Attention

Initial attentional processing can be assessed by investigating the time to first fixation, defined as the length of time (in seconds) for an overt or conscious shift in visual attention to a specific area (eg, the genital area) of a visual stimulus.[22] Initial attention can also be assessed by examining the number of first fixations landing in a specific area of a visual stimulus, which captures overt orienting biases such that higher frequencies suggest greater attentional capture.[22] Duration of first fixation, defined as the total time visual attention remains in a specific area the very first that area is fixated on, is thought to be another measure of attentional capture.[23] Controlled attentional processing can be assessed by investigating the total number of fixations in a specific area of a visual stimulus, as well as the total fixation duration, defined as the total time spent viewing a specific area. For these indices of controlled attention, more fixations and longer durations, respectively, indicate greater attentional capture and engagement.[22,30–32]

Self-Report Measures

We used the Female Sexual Function Index (FSFI)[33] to measure overall sexual function and assist with classifying women to one of the 3 groups. This validated 19-item scale asks about the frequency and intensity of a variety of domains of sexual response and generates a total score. The FSFI has been found to have good discriminant validity, correctly identifying 71% of women with sexual dysfunction using a cutoff score of 26.55.[34] Any woman who did not engage in sexual activity during the preceding 4 weeks was coded as *not applicable*, and her FSFI total score was missing. In this sample, Cronbach's alpha was 0.96. We also administered the 13-item Female Sexual Distress Scale-Revised (FSDS-R)[35] which measures a woman's distress associated with her sexual functioning. Total scores range from 0 to 52, with higher scores indicating greater distress. The FSDS-R has been found to have excellent discriminant validity, correctly identifying 93% of women with sexual dysfunction using a cutoff score of 11.[35] In this sample, Cronbach's alpha was 0.95.

Sexual Function Groups

In order to compare visual attention patterns by sexual function status, 3 sexual function groups were created: (i) A clinical group of women with low sexual functioning included participants who met 3 criteria: diagnosis of at least one sexual dysfunction as determined via telephone interview, low sexual functioning according to obtaining a FSFI total score $<$ below 26.55, and high sexual distress as indicated by a FSDS-R score $>$ 11. (ii) A normal sexual functioning group consisted of women who did not meet any of these criteria. (iii) A subclinical group included women who met one or 2, but not all 3 criteria met by the clinical groups (eg, no clinical diagnosis, but low function and high distress). These women represent a substantial proportion of the female population who experience subclinical sexual concerns (eg, difficulties with sexual arousal, some distress about their sexual lives) that do not meet the threshold of a sexual dysfunction.[27]

Sexual Stimuli

The stimuli used in this study were downloaded from a commercial website and consisted of 10 motives of heterosexual couples engaged in vaginal intercourse. As no comparisons between different stimuli were planned, corrections for contrast or luminescence were not done. Comparable stimuli from the same website were validated in the context of a previous study using a sample of 22 heterosexual women who found the stimuli moderately sexually arousing and pleasant. Importantly, the pilot sample did also indicate that the stimuli did not evoke substantial negative emotions, such as anxiety, disgust, shame, or guilt.[36] After each presentation, participants were asked to rate the picture for sexual arousal ("*how sexually arousing did you find this picture?*") and liking ("*how much did you like the picture*?") on a scale from 0 (not arousing at all, and not at all, respectively) to 9 (extremely arousing, and very much, respectively). To assess an overall explicit evaluation of the pictures, a mean score of arousal and liking was calculated.[37]

Procedure

Interested participants received the consent form via email and were asked to carefully review the study details and eligibility criteria before scheduling a telephone screening. After reviewing the consent form, if prospective participants continued to express interest in participating in the study, a short telephone interview was conducted to thoroughly evaluate the eligibility criteria. During the telephone screening, women were asked about their sexual functioning. Criteria for 2 sexual dysfunctions from the DSM-5,[1] namely female sexual interest/arousal disorder and genito-pelvic pain/penetration disorder, were assessed. To receive a diagnosis of female sexual interest/arousal disorder, 3 out of 6 aspects of sexual desire and/or arousal must be absent or markedly reduced (ie, (i) interest in sexual activities, (ii) sexual fantasies or thoughts, (iii) sexual initiative or receptiveness to partners initiative, (iv) sexual arousal during most sexual activities, (v) responsive desire to internal or external sexual stimuli, (vi) genital or nongenital sensations during most sexual activities).[1] To receive a diagnosis of genito-pelvic pain/penetration disorder, at least one of the following symptoms needed to be endorsed: problems with intercourse, genito-pelvic pain, fear of this pain or penetration, and increased pelvic-tension during attempted penetration.[1] For both the aforementioned diagnoses, the symptoms must have been accompanied by significant personal distress and experienced for at least 6 months.

Eligible participants then scheduled an appointment for the in-laboratory assessment at a time when they were not menstruating. Participants also received a link to an online questionnaire that included sociodemographic variables and measures of sexual functioning to be answered before the lab appointment. Informed consent was obtained twice: first, electronically as part of the online questionnaire, and second, on paper after receiving extensive information about the in-laboratory testing procedure right before the assessment.

The assessment took place in a sexual psychophysiology laboratory located in an academic medical center. After obtaining informed consent, participants were tested by a female researcher. First, participants were seated in a comfortable chair facing a computer monitor equipped with the SMI eye tracker at a viewing distance of approximately 60 cm. The researcher then provided a thorough overview of the procedures and described the eye-tracking calibration procedures. The female researcher left the room while participants inserted a vaginal plethysmograph used to measure vaginal pulse amplitude, a measure of genital sexual arousal (data not presented). They then informed the researcher via intercom of their readiness. The researcher then initiated the study sequence. First, the SMI 5-point calibration was executed to ensure the eye tracker was properly calibrated. This procedure required participants to follow the calibration fixation dot with their eyes as closely as possible. Upon completing the calibration procedure, a total of 60 pictures with 30 different scenes were presented for 8 seconds each in randomized order. Each scene was presented twice with and without an added illustration (eg, household appliances, a to-do-list, or an alarm clock) to capture the attention of the viewers. After each presentation, participants were asked to rate the picture for arousal and valence. A fixation cross was shown in the middle of the screen for 1 second before each picture to ensure that all participants were looking at the center of the screen before stimulus onset. 10 scenes showed naked female adult actresses, and twenty scenes depicted male-female couples engaging in sexual activities—half of these were hardcore pictures with visible, aroused genitals, and the other half were softcore pictures without. This study focuses on findings from the hardcore couples scenes, while results from the female-only pictures will be presented elsewhere.

After the picture paradigm, participants watched a series of erotic film clips while their sexual responses were measured. Data on this video paradigm will be presented elsewhere. After the session, women were asked to remove the vaginal probe, place it in a plastic bag, and inform the researcher via intercom when they were finished. After a debriefing period, participants received a small reimbursement ($25 CAD). This study was approved by the Behavioral Research Ethics Board at the University of British Columbia as well as the Vancouver Coastal Health Research Institute research ethics board. All procedures were carried out in accordance with the provisions of the World Medical Association Declaration of Helsinki (2013).

Table 1. Sample characteristics (N = 69)

	Total sample (n = 69), M (SD)	Clinical group (n = 30), M (SD)	Subclinical group (n = 23), M (SD)	Normal sexual function group (n = 16), M (SD)	Comparison
Age (range: 18–54)	28.09 (8.09)	29.77 (8.43)	27.26 (8.97)	26.13 (5.54)	$F(6,66) = 1.25$, $P = .295$
	n (valid %)	n (valid %)	n (valid %)	n (valid %)	
Children					
No	62 (91.2)	28 (93.3)	20 (87.0)	14 (93.3)	χ^2 (2, $N = 68) = 0.77$, $P = .681$
Yes	6 (8.8)	2 (6.7)	3 (13.0)	1 (6.7)	
Relationship status					
Monogamous relationship or marriage	35 (51.5)	15 (50.5)	11 (47.8)	9 (60.0)	χ^2 (4, $N = 68) = 3.16$, $P = .531$
Currently no sexual partner	17 (25.0)	10 (33.3)	5 (21.7)	2 (13.3)	
Other (eg, consensual nonmonogamy)	16 (23.5)	5 (16.7)	7 (30.4)	4 (26.6)	
Sexual orientation					
Exclusively heterosexual	44 (63.8)	19 (63.3)	14 (60.9)	11 (68.8)	χ^2 (4, $N = 69) = 1.59$, $P = .810$
Predominantly heterosexual	24 (34.7)	10 (33.3)	9 (39.1)	5 (31.2)	
Other	1 (1.4)	1 (3.3)	0	0	
Self-reported ethnicity					
Caucasian	40 (58.8)	20 (66.7)	11 (47.8)	9 (60.0)	χ^2 (6, $N = 68) = 6.18$, $P = .403$
East Asian	14 (20.6)	3 (10.0)	6 (26.1)	5 (33.3)	
South Asian	5 (7.4)	3 (10.0)	2 (8.7)	0	
Other (incl. Hispanic, Arabic, Caribbean)	9 (13.2)	4 (13.3)	4 (17.4)	1 (6.7)	
Education					
High school	3 (4.4)	2 (6.7)	1 (4.3)	0	χ^2 (10, $N = 68) = 5.24$, $P = .875$
Some college	19 (27.9)	6 (20.0)	7 (30.4)	6 (40.0)	
Graduated 2-year college	5 (7.4)	2 (6.7)	2 (8.7)	1 (6.7)	
Graduated 4-year college	23 (33.8)	10 (33.3)	8 (34.7)	5 (33.3)	
Postgraduate degree	16 (23.5)	9 (30.0)	5 (21.7)	2 (13.3)	
Other	2 (2.9)	1 (3.3)	0	1 (6.7)	
Occupation					
Full-time occupation	19 (27.9)	7 (23.3)	7 (30.4)	5 (33.3)	χ^2 (6, $N = 68) = 2.99$, $P = .810$
Part-time occupation	14 (20.6)	6 (20.0)	4 (17.4)	4 (26.7)	
Student	26 (38.2)	11 (36.7)	10 (43.5)	5 (33.3)	
Other	9 (13.2)	6 (20.0)	2 (8.7)	1 (6.7)	

Data Reduction and Analysis

In order to address our hypotheses, we used SMI's BeGaze software to create 3 different areas of interest (ie, genital area, female face, male face) in each picture. For eye-tracking measures, means and standard deviations are reported as descriptive values. A series of hierarchical linear models (HLMs) were calculated using IBM SPSS 26. To test the 3 hypotheses, 5 HLMs were calculated: one for every eye-tracking measurement.

As an additional exploratory analysis, we compared the impact of the different areas of the body as a focus of attention. The following formula describes the HLM for each outcome:

$$\text{Outcome}_{ij} = \beta_0 + \beta_1(\text{Sexual function group})_i + \beta_2(\text{Distractor})_{ij} + \beta_4(\text{Sexual function group} * \text{Distractor})_{ij} + \varepsilon_{ij}$$

where Outcome_{ij} is the $_i$th individual's eye-tracking measure at the $_j$th picture. In all HLMs, β_0 is the individual-specific intercept, and ε_{ij} indicates the residuals. Data were estimated using maximum-likelihood estimation. For each model, fixed effects are reported as well as estimates of fixed effects for the clinical and subclinical groups (vs normal functioning reference group) including 95% confidence intervals. We also computed semi-partial R^2 (R^2) effect sizes representing the variance in the eye-tracking measures that is uniquely explained by the model parameter of each fixed effect.[38] The magnitude of R^2 may be classified as small ($0.02 \leq R^2 < 0.13$), medium ($0.13 \leq R^2 < 0.26$), or large ($0.26 \leq R^2$).[38,39]

RESULTS

Participant Characteristics

Participants were, on average, 28 years old (M = 27.77, SD = 8.00, range = 19−54). They described their ethnicity as Caucasian (n = 39, 58%), East Asian (n = 14, 21%), South Asian (n = 5, 7.5%), or other (n = 9, 3.0%). About half of the participants were in a committed relationship or married (n = 34, 51%), and the remaining women indicated not having a sexual partner (n = 17, 25%), having casual sexual partners but no committed relationship (n = 10, 15%), or being in an open or nonmonogamous relationship (n = 10, 4.5%). Most participants indicated an exclusively (n = 43, 63%) or predominantly (n = 23, 34%) heterosexual orientation. The sample was highly educated with 24% having a postgraduate degree, 33% (n = 22) graduating a 4-year college, 7.5% (n = 5) graduating a 2-year college, and 28% (n = 19) having attended some college. Most participants were students (n = 26, 39%) or either working full time (n = 19, 28%) or part time (n = 14, 21%). Women with sexual dysfunction (n = 34) exhibited similar sociodemographic characteristics as healthy controls (n = 35; Table 1). Clinical participants were, however, on average 4 years older (ie, 30 vs 26 years old).

Comparisons of Sexual Function Groups on Measures of Sexual Functioning

Out of the 69 women in this study, 30 met all indicators of sexual dysfunction (ie, clinical diagnosis, low function, high distress), 16 met none, and 23 endorsed some but not all of these criteria. Among the 55 women who indicated any kind of sexual activity over the last 4 weeks and for whom an FSFI score was calculated, 61.8% scored within the clinical range (M = 22.98, SD = 5.50, range = 10.70−31.30). High levels of sexuality-related personal distress as measured with the FSDS-R (M = 16.78, SD = 12.25) were indicated by 61.8% of women. As expected, sexual function groups significantly differed on their level of sexual functioning as measured with the FSFI, $F(2,52) = 56.27$, $P < .001$, partial $\eta^2 = 0.68$ (clinical:

Table 2. Descriptive values of eye-tracking measures in pictures without distracting object

	Sustained attention				Initial attention					
	Number of fixations		Total fixation duration (s)		Time to first fixation (s)		Duration of first fixation (s)		Number of first fixations	
Genital area										
Clinical	3.14	1.62	1.28	0.75	1.71	0.96	0.35	0.14	1.11	0.61
Subclinical	3.41	1.11	1.53	0.68	1.58	0.71	0.35	0.09	1.26	0.51
Normal	3.58	1.36	1.86	0.82	1.57	0.67	0.46	0.28	1.49	0.71
Female face										
Clinical	3.43	0.84	1.28	0.24	1.46	0.52	0.28	0.08	1.51	0.61
Subclinical	3.83	0.87	1.45	0.37	1.37	0.54	0.30	0.08	1.73	0.61
Normal	3.72	1.18	1.45	0.49	1.59	0.87	0.33	0.11	1.47	0.57
Male face										
Clinical	2.33	1.09	.90	0.37	1.67	0.73	0.29	0.11	1.07	0.56
Subclinical	2.83	1.11	1.06	0.43	1.53	0.54	0.31	0.11	1.29	0.59
Normal	2.63	0.98	1.02	0.43	1.55	0.56	0.29	0.10	1.25	0.40
Background										
Clinical	9.34	3.45	2.77	0.68						
Subclinical	9.24	2.27	2.62	0.66						
Normal	10.32	1.91	2.90	0.58						

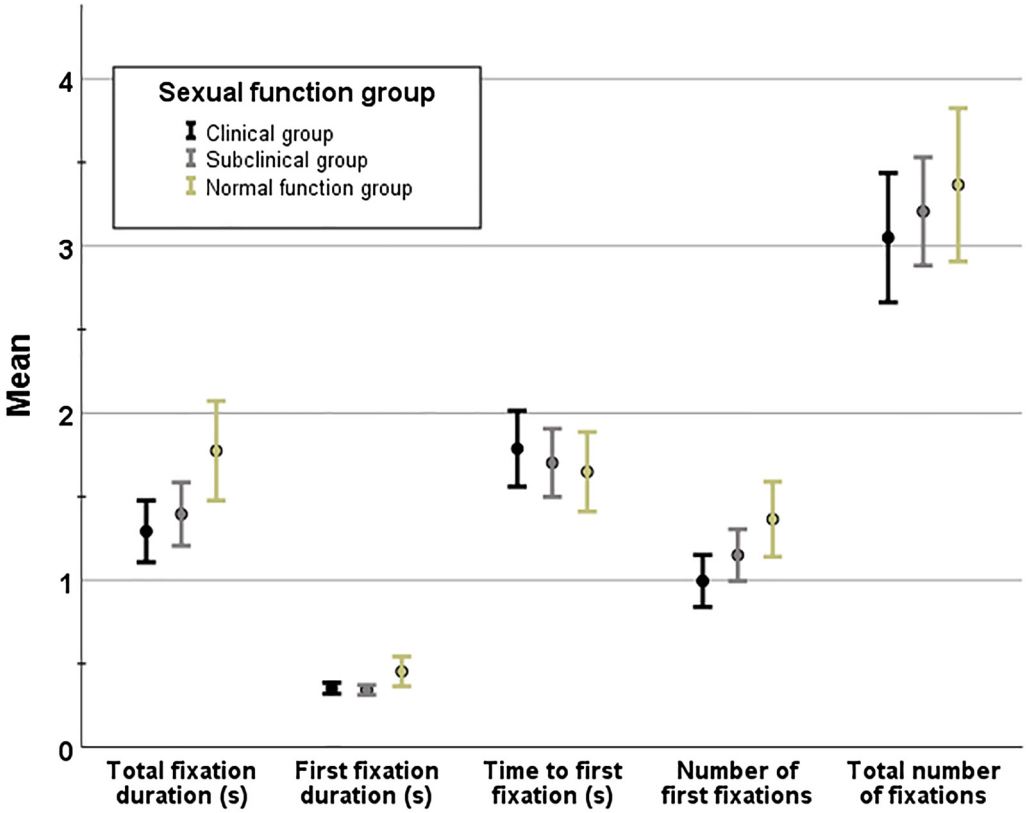

Figure 1. Mean values including 95% confidence intervals of eye-tracking measures for the clinical, subclinical, and normal sexual function groups. Figure 1 is available in color online at www.jsm.jsexmed.org.

M = 17.95, SD = 3.32; subclinical: M = 24.29, SD = 3.78; normal function: M = 29.11, SD = 1.42). There were also significant group differences in sexual distress, $F(2,65) = 53.83$, $P < .001$, partial $\eta^2 = 0.62$ (clinical: M = 27.10, SD = 8.95; subclinical: M = 11.65, SD = 7.84; normal function: M = 4.00, SD = 3.07). These large differences in validated measures of sexual function and distress support our classification of women into sexual function groups.

Picture Rating

Across groups, participants evaluated the pictures neither positively not negatively (M = 4.32, SD = 1.98). Evaluation of pictures significantly differed between groups, $F(2,64) = 7.33$, $P < .001$, $R^2 = 0.19$. A post-hoc Scheffé test showed that only the clinical but not the subclinical group evaluated the stimuli more negatively than the normal functioning group ($P = .001$).

Attention to Sexually Explicit Areas

First Fixation Duration

There was a significant effect of sexual function group, $F(2,132) = 5.83$, $P = .004$, $R^2 = 0.08$, suggesting that the first fixation on the genital area was shorter for women with sexual dysfunction than that for the normal function group (Table 2 and Figure 1). Compared with the normal sexual function group, both the clinical group, $t(135) = -3.20$, $P = .002$, 95% CI = −0.18 to −0.04, and the subclinical group $t(135) = -3.00$, $P = .003$, 95% CI = −0.18 to −0.38, fixated on the genital area significantly shorter when they first looked at it. Across all participants, presence of a distracting object was not associated with first fixation duration, $F(1,132) = 0.20$, $P = .639$, $R^2 < 0.01$. The distractor had no differential impact on the first fixation duration in women with and without sexual dysfunction, $F(2,132) = 0.01$, $P = .988$, $R^2 < 0.01$.

Time to First Fixation

There was no significant effect of sexual function group, $F(2,130) = 0.37$, $P = .691$, $R^2 < 0.01$, the presence of a distracting object, $F(1,130) = 1.95$, $P = .165$, $R^2 = 0.02$, and no interaction between these 2 variables, $F(2,130) = 0.055$, $P = .947$, $R^2 < 0.01$, suggesting that the time it took for participants to attend to the sexual area was not associated with any of these variables.

Total Fixation Duration

While there was a significant effect of sexual function group, $F(2,132) = 5.50$, $P = .005$, $R^2 = 0.08$, the presence of a distracting object was not associated with the total fixation duration, $F(1,132) = 1.72$, $P = .191$, $R^2 = 0.01$, and the distractor had no differential impact on this eye-tracking measure, $F(2,132) = 0.26$, $P = .773$, $R^2 < 0.01$. Compared with the normal sexual function group, both the clinical group,

$t(135) = -3.32$, $P = .001$, 95% CI = −0.84 to −0.21, and the subclinical group, $t(135) = -2.27$, $P = .024$, 95% CI = −0.71 to −0.05, fixated on the genital area for a shorter duration.

Total Number of Fixations

There was no significant effect of sexual function group, $F(2,132) = 1.11$, $P = .333$, $R^2 = 0.02$, of the distracting object, $F(1,132) = 2.95$, $P = .088$, $R^2 = 0.02$, and no interaction between these 2 variables, $F(2,132) = 0.05$, $P = .995$, $R^2 < 0.01$.

Number of First Fixations

There was a significant effect of sexual function group, $F(2,132) = 4.33$, $P = .015$, $R^2 = 0.06$. Compared with the normal sexual function group, only the clinical group, $t(133) = -2.91$, $P = .004$, 95% CI = −0.62 to −0.12, but not the subclinical group, $t(133) = -1.62$, $P = .108$, 95% CI = −0.48 to 0.05, revisited the genital area of the picture less often. Across all participants, women revisited the genital area less often when a distractor was present, $F(1,132) = 5.22$, $P = .024$, $R^2 = 0.04$; this effect was not moderated by sexual function group, $F(2.132) = 0.01$, $P = .990$, $R^2 < 0.01$.

Impact of Body Location

We explored whether women in the 3 sexual function groups attended differently to the faces of the actors and the remaining parts of the picture (ie, the background).* We did not find a significant effect for sexual function group for attention toward faces and background for 4 out of 5 outcome variables (all $P > .099$). There was a significant group effect for number of first fixations on the female face, $F(2,135) = 4.48$, $P = .013$, $R^2 = 0.06$, with the subclinical group revisiting this area more often than the clinical group, $t(133) = 2.98$, $P = .003$, 95% CI = 0.11−0.53.

DISCUSSION

The goals of this eye-tracking study were to assess whether visual attention toward a genital area in pictures showing vaginal intercourse varies depending on women's levels of sexual functioning and whether this attention is (differentially) impacted by distracting objects presented in the pictures. The main finding is that compared with women with normal sexual functioning, women with subclinical and clinical sexual dysfunction paid less attention to the genital area and that the presence of a distractor did not influence this. Findings with respect our hypotheses will be discussed first, followed by limitations, recommendations for future studies, and clinical implications.

Hypothesis 1 was that the genital area depicting male and/or female genitals and penetration would capture the attention of women across the sexual function groups differently. This hypothesis was partially supported; 3 out of 5 eye-tracking measures showed the expected differences in attention between sexual function groups. When women with normal sexual functioning were used as a reference category, the initial fixation on the genital area was significantly shorter for women in the subclinical and clinical groups. This area was revisited less often by women with sexual dysfunction, suggesting that it did not capture the attention of these women as much.[31] In addition, one out of 2 indices of sustained attention (ie, total fixation duration) indicated that women in the subclinical and clinical groups deliberately dedicated less attention to this area than women with normal sexual function. Taken together, this study is in line with studies using RT measures to assess cognitive biases for sexual stimuli[14] and provides support for the notion that sexual dysfunction is associated with reduced attention toward sexual stimuli. It is also in line with Barlow's cognitive interference model of sexual arousal in that women with normal sexual functioning are deliberately maintaining a focus on sexual stimuli.[4] As expected, subclinical women scored between the normal and low-functioning groups. For 2 out of 3 variables for which group differences were found, this subclinical group attended to the genital region less than women with normal sexual functioning suggesting that differences in attention toward sexual stimuli are not limited to clinical groups but may also affect women who are not significantly distressed by subclinical sexual concerns.

As movement artifacts prevented us from measuring genital sexual arousal during the picture paradigm, it remains unclear whether the sexual function groups experienced different levels of genital arousal. In other words, we cannot determine whether the sustained attention toward the genital area shown by women with normal sexual functioning facilitated their sexual arousal or if high arousal was a precursor for increased initial or sustained attention toward this area. Support for the latter notion comes from at least 2 lines of research: Basson's circular model of sexual response[40] posits that a state of sexual arousal increases motivation to seek further sexual stimulation (ie, to focus on sexual information). In addition, research on sexual disgust, a facet of disgust that is more pronounced in women with sexual dysfunction, finds that sexual arousal is critical to counteract disgust-induced sexual avoidance.[41,42] Future studies should measure sexual arousal to clarify its role in the directionality between arousal and attention between sexual function groups.

Our exploratory analyses investigating attention toward male and female faces as well as the background (calculated only for total fixation duration and number of fixations) did not reveal any substantial differences in attention patterns between sexual function groups. This finding is in line with a previous eye-tracking study that also showed no differences in attention toward faces and background in sexual vs nonsexual pictures.[19] Thus, most between-group differences in attention seem to be specific to the genital areas supporting our view that those with a

* Owing to the definition of the areas of interest, attention toward the background was only calculated for total number of fixations and total fixation duration.

sexual dysfunction may attend to sexual stimuli less than those without. The only difference that emerged suggested that women with subclinical sexual functioning dedicated more attention toward the female face. Studies have found that heterosexual women tend to exhibit a nonspecific viewing pattern in that they too attend to both preferred and nonpreferred targets equally.[23,43] There is, however, also evidence that women watching dynamic sexual stimuli (ie, videos) direct their attention toward their nonpreferred target (ie, women).[23] A possible explanation is that focusing on the (sexually aroused) face of the female actor may help women to project themselves into the sexual situation which may ultimately facilitate their arousal. Owing to the exploratory nature of these supplementary analyses, however, this finding should be interpreted with caution.

Hypothesis 2 (ie, presentation of distracting objects reduces the attention toward the genital area) was mostly not supported, with the exception that women revisited the genital area less often when a distractor was present. There was also no support for hypothesis 3 suggesting that the presence of a distractor had no impact on visual attention toward the genital area across sexual function groups. A potential reason for these findings is that the distracting objects were relatively large and easily recognizable in the visual periphery, even when participants fixated on another part of the picture.[44] As they were simple drawings or illustrations, they might not have been interesting enough to draw attention from the sexually explicit content of the pictures. In addition, visual distractors used in this study may not be representative of the nonvisual distractions that women experience during sexual activity. While some women may be distracted by visual stimuli (eg, things they see in the bedroom), others may be more strongly affected by nonsexual or distracting thoughts (eg, *Can I satisfy my partner?* or *I forgot to buy milk.*).[45,46] To address these problems, future studies could include distractors with greater personal relevance (eg, personal pictures), use nonvisual distractors, or use a paradigm that requires participants to decide whether to attend to one stimulus or another (ie, a distractor vs a sexual stimulus).[22]

Limitations

A total of 5 HLMs were calculated to test hypotheses 1−3 which raises the risk of alpha error inflation. As the 5 eye-tracking measures reflected different facets of visual attention, we decided not to compensate for multiple comparisons. This was the first study using this set of eye-tracking measures to investigate the role of visual attention for sexual dysfunction, and more studies are needed to verify if this pattern of results reflects specific differences in initial or sustained attention.

Our cross-sectional study does not allow for causal interpretation. Thus, it remains unclear whether reduced attention to sexual cues is a risk factor for or a consequence of sexual dysfunction. Furthermore, factors that were not assessed in this study (eg, sexual excitation and inhibition,[36,47] religiosity,[48] or cyberpornography)[49] may also play a role, and future studies should investigate whether these may mediate the relationship between visual attention to sexual stimuli and sexual functioning. While we were able to recruit a sample of women of different ethnicities, most participants were young and highly educated. In order to increase homogeneity, nonheterosexual women as well as women using medication with known side effects on sexual functioning (eg, hormonal contraception, antidepressants) were not included for participation. These factors limit generalizability of findings to other groups of women. Clinical women in our study met criteria for sexual dysfunctions in the DSM-5 pertaining to low desire/arousal or genito-pelvic pain. As many participants endorsed symptoms of both disorders, no subgroup comparisons were conducted. Theoretical models may, however, suggest that women with low desire vs genito-pelvic pain may show reduced attention to sexual stimuli for different reasons. While low desire may be associated with a lack of incentive value of sexual stimuli, deeming these cues as less interesting or salient,[3] women with genito-pelvic pain may actively avoid looking at aroused genitals or vaginal intercourse because these are associated with painful memories.[26] To further complicate this, there is also evidence that women with sexual pain conditions show a hypervigilance for coital pain which may result in earlier or longer fixation of areas that show vaginal penetration.[50]

Future Directions

To further investigate the role of attention for sexual dysfunction, research from the field of experimental psychopathology can be used. It offers tools to test the potential causal role of attention for mental disorders by means of attention bias modification training.[51,52] This approach teaches individuals to pay more (or less) attention to certain disorder-specific stimuli (eg, to reduce attention to threat-related stimuli in anxiety disorders) to change attentional biases and thereby improving symptoms (for more critical reviews, see the studies by Hall et al and Cornelissen and Võ).[43,44] Correspondingly, training women with low sexual functioning to specifically attend to sexual stimuli may be promising. Another line of experimental studies measuring sexual arousal in the laboratory suggest that mindful attention toward bodily symptoms of arousal might be a way to boost women's feelings of sexual arousal.[53,54] To determine whether directing attention toward external (eg, visual erotic cues) or internal (eg, body sensations) stimuli is more beneficial for women's sexual arousal and their sexual functioning, we recommend that future studies should combine eye-tracking and sexual arousal measurements as well as an experimental manipulation of attentional focus.

Clinical Implications

Our findings suggest that women with clinical and subclinical sexual functioning exhibit reduced attention to sexual stimuli. Although the direction of effects is yet to be determined, these findings may offer support for evidence-based strategies to improve attention, for example, in the form of

mindfulness-meditation skills. A considerable body of data support the effectiveness of mindfulness for improving sexual desire and decreasing sexual distress[55] and reducing genital pain in women,[56] but these studies have not used experimental paradigms to measure the extent to which improvements in attention mediate these clinical symptom improvements. Future studies should evaluate the extent to which changes in attention account for improvements in sexual functioning after mindfulness interventions vs other evidence-based treatments (eg, cognitive behavioral therapy).

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Julia Velten: Conceptualization, Methodology, Investigation, Resources, Writing - Original Draft, Writing - Review & Editing, Formal Analysis, Funding Acquisition. Sonia Milani: Conceptualization, Methodology, Investigation, Writing - Original Draft, Writing - Review & Editing, Funding Acquisition, Project Administration. Jürgen Margraf: Conceptualization, Writing - Original Draft, Writing - Review & Editing. Lori A. Brotto: Conceptualization, Methodology, Investigation, Resources, Writing - Original Draft, Writing - Review & Editing, Formal Analysis, Funding Acquisition.

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