VALIDATION OF MOUSEVIEW.JS AS AN ONLINE ALTERNATIVE TO EYE-TRACKING IN SEX RESEARCH

by

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Validation of MouseView.js as an Online Alternative to Eye-Tracking in Sex Research

Submitted by Sonia Jafari Milani in partial fulfillment of the requirements for

the degree of Master of Arts

in Psychology

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Abstract

Attention is a key mechanism underlying many aspects of sexuality and researchers have relied on eye-tracking technology to demonstrate that attention is both sustained by sexual stimuli and corresponds with sexual interest. Despite its utility in the field, eye-tracking experiments are limited to being conducted in a laboratory setting. Given restrictions to in-laboratory research due to the COVID-19 pandemic, exploring an online eye-tracking platform is timely. The overarching objective of this research was to validate a novel online method, MouseView.js, for assessing attentional processing of sexual stimuli. MouseView.js is an open-source, web-based application in which mouse cursor movements mimic eye movements. Study 1 was conducted to first examine whether MouseView.js was capable of detecting attentional biases to sexual versus nonsexual stimuli, whereas study 2 was conducted to replicate and extend these findings to test the robustness of the effects. Results from both studies revealed evidence for response specificity (i.e., response patterns that are specific to processing sexual stimuli relative to nonsexual stimuli) and convergent validity (i.e., dwell times that correlate with self-report sexuality measures). These findings will have a broad impact. Not only do the results mirror those observed for time-intensive eye-tracking research, this freely available instrument for gaze tracking offers important advantages to traditional eye-tracking methods. These include the ability to recruit larger and more diverse samples, thereby strengthening the generalizability of research findings.

Lay Summary

The goal of this research was to validate a novel online method, MouseView.js, for assessing attentional processing of sexual stimuli. MouseView.js is a web-based application in which mouse cursor movements mimic eye movements. In two studies (n = 239 and n = 483), pairs of sexual and nonsexual images were presented and participants used their mouse cursor to move a clear circle (to mimic the fovea) to view regions of interest that were obscured behind a blurred overlay. Consistent with previous eye-tracking research, results from both studies revealed response patterns that are specific to processing sexual stimuli relative to nonsexual stimuli. Further, dwell times positively correlated with self-report sexuality measures. These findings support the validity of MouseView.js as an online alternative to eye-tracking in sex research.

Preface

All of the work in the present document was conducted in the Sexuality and Well-Being laboratory at the University of British Columbia where Dr. Samantha Dawson is the Principal Investigator. I was responsible for the study design, data collection, data analysis, interpretation, and preparation of the final thesis. Dr. Samantha Dawson was the supervisory author of the current project for all components of the study including study design, data analysis, interpretation, and thesis preparation. The MouseView.js task is the work of collaborators Drs. Thomas Armstrong, Edwin Dalmaijer, and Alexander Anwyl-Irvine, and they provided input and guidance in the adaptation of the existing MouseView.js configuration and the data extraction process.

This project and methods were approved by the University of British Columbia's Behavioural Research Ethics Board (certificate # H21-00444). None of the text of this thesis has been taken directly from previously published articles.

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Chapter One: Introduction

Sexual response is an emotional state comprising phases of physiological response (i.e., genital arousal) and subjective response (i.e., subjective sexual arousal or excitement, sexual desire; Bancroft, 2003; de Jong, 2009). Theoretical models emphasize that attentional processes play a central role in sexual response, such that attention to sexual stimuli is essential to activate and regulate sexual response (Barlow, 1986; Dewitte, 2016; Janssen et al., 2000; Toates, 2009). Eye-tracking was initially validated for sex research over a decade ago (Lykins et al., 2006). Studies using eye-tracking have revealed that attention is captured by sexual stimuli and corresponds with sexual interest, arousal, and function (Dawson & Chivers, 2016, 2018, 2019; Lykins et al., 2006, 2011; Milani et al., 2019; Morandini et al., 2020; Nummenmaa et al., 2012; O'Kane et al., 2022; Velten et al., 2021a, 2021b). Despite its utility for understanding aspects of sexuality, eye-tracking technology is limited to being conducted in a laboratory setting. An online alternative could offer important advantages including the ability to recruit larger and more diverse samples (e.g., age, gender, ethnicity, sexual orientation) and collect data when laboratory research is curtailed. The overarching goal of this research was to validate MouseView.js as an online alternative to eye-tracking in the field of sex research. MouseView.js is an open-source, web-based application in which mouse cursor movements mimic eye movements (Anwyl-Irvine et al., 2021). In the first study, we explored if MouseView.js showed evidence of response specificity (i.e., response patterns that are specific to processing sexual stimuli relative to nonsexual stimuli) and convergent validity (i.e., dwell times that correlate with self-reported sexual attraction). In the second study, we sought to replicate evidence of response specificity and extend evidence of convergent validity to include other sexuality-based measures known to influence attentional processing of sexual cues.

Cognitive-Motivational Model

Figure 1 presents an overview of the cognitive-motivational model of sexual response which posits that both automatic and controlled attentional processes are responsible for the initiation and maintenance of sexual response (Dewitte, 2016; Janssen et al., 2000; Toates, 2009). Automatic or initial attention is involved in the onset of sexual response, such that genital sexual response is triggered by sexual stimuli (e.g., an attractive partner or an erotic picture) that are pre-attentively processed and automatically capture attention. The appraisal of sexual stimuli as rewarding increases attentional engagement and directs the conscious allocation of attention (i.e., controlled attention) on sexual stimuli to regulate sexual response. It follows that positively appraised sexual stimuli attract attention and facilitate sexual response, while stimuli with negative or unrewarding associations divert attentional resources and impede sexual response (Dewitte, 2016; Janssen et al., 2000; Toates, 2009). Thus, according to this model, we would predict that sexual stimuli should be preferentially attended to relative to nonsexual stimuli due to differences in reward salience (i.e., response specificity). Specifically, the reward salience of a sexual stimulus will capture and sustain attention and facilitate sexual response, whereas a nonsexual stimulus will not. The cognitive-motivational model also proposes that controlled attention is strongly related to subjective sexual arousal, which includes self-reported attraction. If attention is maintained on salient stimuli that are sexually arousing, we would expect a positive relationship between time spent viewing sexual stimuli and self-reported sexual attraction to such stimuli (i.e., convergent validity).

Assessing Controlled Attention to Sexual Stimuli

Eye-tracking enables the direct recording of eye movements and provides a continuous measure of attention allocation in real time (Andersen et al., 2012; Hall et al., 2011; Henderson

et al., 1999). Eye-tracking provides reliable indices to assess both initial and controlled visual attention patterns. Initial attention is assessed through the latency to first fixation and provides an index of initial attentional capture (i.e., how quickly a stimulus captures attention). Controlled attention is most commonly assessed through total fixation duration or dwell time and provides an index of overt orienting of visual attention (i.e., the total amount of time spent looking at a stimulus). Researchers have used eye-tracking to test pathways proposed in the cognitive-motivational model, including investigating differences in attention to sexual and nonsexual stimuli, as well as examining visual attention as an index of sexual interest and attraction (Dawson & Chivers, 2016, 2018, 2019; Lykins et al., 2006; Milani et al., 2019; Nummenmaa et al., 2012; O'Kane et al., 2022).

The first study to validate eye-tracking for sex research presented heterosexual women and men with sexual (e.g., nude) and nonsexual (e.g., fully clothed) stimuli of single male and female[1] targets (Lykins et al., 2006). Evidence of response specificity was supported by a pattern of responding to sexual stimuli that differed from that observed to nonsexual stimuli. Specifically, both women and men attended more (i.e., greater number of fixations and longer dwell time) to the targets within the sexual stimuli than targets within the nonsexual stimuli. More recent studies have corroborated Lykins et al.'s (2006) finding that sexual stimuli elicit longer dwell times relative to nonsexual stimuli (Milani et al., 2019; Nummenmaa et al., 2012).

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[1] Although previous research has described visual sexual stimuli using "Stimulus Gender" (i.e., woman, man), we elected to describe sexual stimuli using the phrase "Stimulus Sex" (i.e., female, male) since the character's gender cannot be deduced on the basis of their physical characteristics.

Taken together, the differences observed in visual attention as a function of stimulus salience (i.e., sexual versus nonsexual) demonstrate response specificity and suggest that, for both women and men, nudity—particularly stimuli depicting prepotent cues—is an important cue that sustains attention consistent with the cognitive-motivational model (for reviews, see Milani et al., 2020, 2021).

Additional evidence of response specificity comes from studies manipulating stimulus reward salience (i.e., stimuli that individuals are interested in and attracted to). Using a forced-attention paradigm—the simultaneous presentation of two distinct images that compete for attention—Dawson and Chivers (2016, 2018, 2019) found that controlled attention was maintained on stimuli of interest such that both women and men attended more to their preferred sexual targets. Consistent with the cognitive-motivational model and providing initial evidence of convergent validity, Dawson and Chivers (2016) also found that visual attention was strongly correlated with self-reported attraction ratings to sexual images among women and men (r = .47 to .82). Given the dynamic and multi-faceted processes involved in sexual response, other studies have demonstrated that individual difference correlates of sexuality, such as self-reported sexual desire, motivation, attitude, sociosexual orientation, and compulsivity, influence patterns of visual attention with respect to how long people attend to sexual stimuli and which regions sustain the most attention (Hall et al., 2014; Maner et al., 2003; Rupp & Wallen, 2007; Velten et al., 2021b).

Although eye-tracking is a valid measure for assessing sexual interest and has shed important light on our understanding of attentional processing of sexual stimuli, eye-tracking methodology is not without limitations. First, eye-tracking requires equipment beyond a personal computer, making it incompatible for online use and thus, restricting eye-tracking experiments to

be conducted in a laboratory setting. This has become a particularly critical limitation given that the COVID-19 pandemic resulted in the curtailment of in-laboratory research worldwide. Second, in-laboratory studies may restrict the generalizability of findings given that they are typically limited by small sample sizes and/or homogenous samples of young (undergraduate) participants. Most eye-tracking studies, especially those conducted early on, involved samples ranging from 20 to 50 participants in each group (e.g., Dawson et al., 2016, 2018, 2019; Lykins et al., 2006; Nummenmaa et al., 2012). The relatively small samples may produce less reliable estimates, as well as reduce variability in gaze and other outcomes. Lastly, given that sexual stimuli are often viewed and experienced in the privacy of one's own home, viewing sexual stimuli in a laboratory setting does not necessarily simulate experiences in the real world and this may influence the patterns observed. Indeed, implied social presence (i.e., being aware that one's eye movements are being recorded in a laboratory setting) has been shown to influence gaze behaviour to sexual stimuli in women (Milani et al., 2019). Thus, the tightly controlled conditions of in-laboratory eye-tracking studies come at the cost of ecological validity, which may not reflect how sexual stimuli are processed in real-life situations.

Alternatives to Eye-Tracking

To overcome some of the limitations associated with eye-tracking, researchers have written algorithms to track eye movements without the use of eye-tracking equipment. Numerous webcam-based eye-tracking approaches to detect gaze patterns have been proposed (for a summary, see Gómez-Poveda & Gaudioso, 2016); however, such approaches produce only rough gaze estimates, and thus do not provide the accuracy needed for spatial attention research (Semmelmann & Weigelt, 2018). Furthermore, studies using webcam eye-tracking have reported high attrition rates (up to 62%) due to limitations on the eye signal in webcam streams—even in

cases where participants had compatible equipment (Semmelmann & Weigelt, 2018; Yang & Krajbich, 2021). Finally, and perhaps most importantly, webcam eye-tracking streams raise privacy concerns given that the data may be identifiable (Semmelmann & Weigelt, 2018), and this may be particularly problematic in the study of sensitive topics such as sexuality.

Another alternative to simulate gaze tracking without the limitations of webcam eye-tracking involves a limited-viewing approach. Specifically, "viewing" is limited by presenting an obscured display (e.g., blurred out image) with an aperture—a circle that mimics the fovea (McConkie & Rayner, 1975)—which individuals move and control with their mouse cursor to explore and "see" different parts of the display (Anwyl-Irvine et al., 2021). Different iterations have been used, including moving aperture approaches (Gomez et al., 2017; Jiang et al., 2015) and participant-operated "bubbles", which use mouse clicks instead of continuous mouse scrolling (Deng et al., 2013; Kim et al., 2017). Although these limited-viewing approaches have successfully demonstrated that mouse explorations reveal the same areas of visual salience as eye-tracking, they are not integrated into any online experimental platforms (e.g., Gorilla, JsPych, PsychoPy, etc.) and thus, are not readily available for psychological experiments.

Building upon these approaches, Anwyl-Irvine and colleagues (2021) developed MouseView.js as an alternative to eye-tracking that can be employed in web-based attention research. MouseView.js is an open-source application that is implemented in JavaScript and usable within web-based experiment builders such as Gorilla and PsychoPy. Similar to the limited-viewing method described above, MouseView.js blurs the display to mimic peripheral vision and contains an aperture that can be directed, using a mouse cursor, to fixate on regions of interest within the display (Anwyl-Irvine et al., 2021). Using continuous mouse movements (rather than mouse clicks), MouseView.js has the potential to provide the same continuous

measurement of attention provided by eye-tracking, but in a manner scalable to online samples (Niehorster et al., 2018). Anwyl-Irvine et al. (2021) recently established preliminary evidence demonstrating the validity of MouseView.js using a forced attention paradigm with emotionally salient images. They compared patterns observed via MouseView.js (n = 165) with laboratory-based eye-tracking data (n = 83). To examine reliability, dwell time differences between the affective (e.g., disgust) and neutral image in each trial across the MouseView.js and eye-tracking experiments were compared. Specifically, a within-subjects examination revealed that average eye-tracking gaze and mouse dwell correlated strongly for both disgust ($r = .72$, $p < .001$) and pleasant ($r = .54$, $p < .001$) stimuli. Thus, evidence of reliability included similar gaze patterns detected across both methodologies consistent with an attentional bias to emotional stimuli. Evidence of convergent validity was supported by strong positive correlations between dwell times and self-reported stimulus disgust and pleasantness ratings (Anwyl-Irvine et al., 2021). Given that MouseView.js is a freely available instrument for attention-tracking that is both reliable and valid, MouseView.js appears to be one of the best available online alternatives to eye-tracking.

One potential limitation of the currently validated MouseView.js design is the limited overlay configurations that have been explored (e.g., standard blurred overlay, solid black overlay, and pink overlay). In the current iteration of MouseView.js, stimuli appear obscured under overlays, necessitating a period of blind exploration to inform decisions regarding where to consciously allocate attention. Traditional eye-tracking studies, on the other hand, present stimuli that are clearly visible and thereby allow individuals to make decisions regarding where to focus their attention. Thus, it remains unclear whether the current overlay configurations are the most optimal for approximating eye-tracking paradigms or whether a preview then overlay

would be more suitable. To further validate MouseView.js, we sought to examine a new configuration that provides a preview of the stimuli (100ms) before the blurred overlay and compared it with the existing configuration. This comparison will enable us to establish which configuration is more similar to (and may better approximate) traditional eye-tracking paradigms.

The Current Research

An online alternative to eye-tracking has not yet been validated in the field of sex research. The objective of the current research was to establish the validity of MouseView.js for assessing the attentional processing of sexual stimuli in two separate samples. Study 1 was conducted to first examine whether MouseView.js was capable of detecting attentional biases to sexual versus nonsexual stimuli, whereas study 2 was conducted to replicate and extend these findings to ensure the robustness of the effects. In both studies, response specificity was determined by comparing attentional processing of sexual versus nonsexual stimuli within and between trials. We hypothesized that women and men would attend more (i.e., greater mouse dwell) to sexual stimuli compared to nonsexual stimuli both within and between trials (Hypotheses 1). Convergent validity was established by examining the strength of the correlations between MouseView.js data and self-reported sexual attraction ratings (study 1 and study 2), and self-report measures of sexuality (study 2). We predicted that in both studies, mouse dwell would be positively correlated with self-reported sexual attraction ratings (Hypothesis 2a), and in study 2, mouse dwell would be positively correlated with self-report measures of sociosexuality and sexual desire (Hypothesis 2b). In both studies, we also conducted exploratory analyses to determine whether different types of MouseView.js overlays, namely

standard blurred (Anwyl-Irvine et al., 2021) versus preview and then blurred, would influence mouse dwell patterns.

Chapter Two: General Methodology for Studies 1 and 2

Participants

In study 1, a community sample was recruited through Prolific, an online crowdsourcing platform. In study 2, an undergraduate student sample was recruited through the University of British Columbia Human Subject Pool (HSP) in the Department of Psychology. Individuals were eligible to participate in studies 1 and 2 if they met the following criteria: 18 years of age or older, had access to the internet, were fluent in English, and used a Mac or PC that runs Chrome, Firefox, or Edge. Individuals who only had access to Linux, tablets, or smartphones, or who used other browsers (i.e., Safari or Explorer) were ineligible for the study due to limited device compatibility with the online experimental tool.

Despite the large effect sizes typically observed for patterns of visual attention using eye-tracking, we adopted a conservative approach for study 1 because it had not yet been established if MouseView.js was comparable to eye-tracking in sex research. An *a priori* sample size based on a small effect size revealed a total sample size of 178 (power = .90, alpha = .05) was necessary to detect an interaction between participant gender, stimulus sex (i.e., female versus male targets), and stimulus type (i.e., sexual versus nonsexual). To account for potential data loss due to technical problems, we oversampled and recruited 239 participants (118 women and 121 men) from Prolific. To replicate and extend our findings in study 2, we recruited 483 participants (252 women and 231 men) from HSP. A larger sample was recruited to increase statistical power to further examine convergent validity through associations between MouseView.js and various sexuality measures which were expected to be of a smaller effect size. The sample demographic information for participants in studies 1 and 2 who are included in at least one analysis can be found in Table 1.

Materials

Experimental Stimuli

The stimuli used in studies 1 and 2 included sexual and nonsexual images. Sexual images depicted male and female models in sexually provocative poses with visibly aroused genitals (e.g., erect penis or engorged vulva). Nonsexual images depicted male and female models in casual clothing. A total of 64 novel images were presented across two experimental conditions. The images were taken from freely accessible internet sites. The sexual images have been used in previously published studies (Dawson et al., 2016, 2018; Milani et al., 2019). To prevent contextual features within stimuli from attracting attention, the background from all images was removed so that each target within an image was isolated against a white background. All images were matched for size (400 x 275 pixels) and brightness (see Figure 2).

Experimental Paradigm

Using a forced-attention paradigm, two images were presented simultaneously in each trial. To compare attentional processing of sexual versus nonsexual stimuli, images were paired in two ways: (1) within trials (i.e., a sexual image paired with a nonsexual image), and (2) between trials (i.e., a sexual image paired with a sexual image; a nonsexual image paired with a nonsexual image; see Figure 2 for stimulus pairings). Image pairs for within trial comparisons were matched for gender cues to isolate the effect of sexual salience within a trial (e.g., a sexual male target paired with a nonsexual male target; a sexual female target paired with a nonsexual female target). Image pairs for between trial comparisons were matched for sexual or nonsexual cues, creating sexual trials (i.e., a sexual male target paired with a sexual female target) versus nonsexual trials (i.e., a nonsexual male target paired with a nonsexual female target).

There were two experimental conditions, each containing a total of 32 trials. In each trial, one image appeared on the left side of the screen and the other appeared on the right side. Although novel image pairs were presented in each condition, image pairs within each condition were shown twice and image location (e.g., male left/female right and female left/male right) were counterbalanced to prevent the possible impact of the relative location of the images (e.g., preference for the left versus right side of the screen) on dwell.

Experimental Apparatus

MouseView.js is a highly configurable JavaScript library that is integrated into Gorilla, a popular experiment-building platform (www.gorilla.sc; Anwyl-Irvine et al., 2021). The JavaScript library contains the available configuration options to produce an overlay that obscures the image pairs that appear on display. The contents of the display can then be viewed through an aperture (i.e., a small circle to mimic the fovea), which the participant can move using their mouse cursor. To ensure consistency across participants, the size of the aperture was set to be 10% of each participant's screen width. Gorilla records the coordinates of the mouse cursor to produce the dependent variable—dwell time. In the current study we used two overlays across two conditions to identify the most valid and reliable form of stimulus presentation: (1) *standard* MouseView.js where image pairs appeared blurred; and (2) *preview* MouseView.js where image pairs were fully visible for 100ms before being blurred (see Figure 3 for image and overlay displays).

Post-Task Stimulus Ratings

At the end of the experimental task, after all stimulus pairs were presented, participants completed a separate stimulus rating task. Participants viewed a clear representation of each image (i.e., without the MouseView.js overlay) and rated how sexually attracted they were to

each of the female and male models, using a 7-point scale ranging from 0 (*not at all sexually attracted*) to 6 (*very sexually attracted*; see Figure 3).

Questionnaire

Participants completed a questionnaire asking demographic information including age, gender, sex, sexual orientation, sexual attraction, race/ethnicity, relationship status, education, income, sexual history, and frequency and type of previous erotica exposure and use.

Procedures

For both study 1 and study 2, interested participants selected the study from a list of advertised studies on the Prolific and HSP platforms, respectively. A link provided on the study advertisement page directed interested participants to the consent form and experiment on the Gorilla platform. After indicating that they read and understood the study procedures, met eligibility criteria, and provided consent electronically, participants began the online experimental task. In both studies, participants completed both conditions of the experimental task, each presenting a different iteration of the overlay (i.e., standard and preview) and the order of conditions was randomized. Participants were provided with the following instructions at the beginning of each condition: "*A circle will appear around your mouse cursor, and you will move it to view different parts of the two images. You can look at the images however you please".* Thus, participants controlled and explored what part of the image was visible by moving their mouse cursor.

Each condition started with a practice trial containing two neutral images of household objects with the appropriate overlay to familiarize participants with the task and the overlay. The experimental trials followed the practice trial in each condition and displayed 32 image pairs (16 novel image pairs were randomized and presented followed by the same 16 pairs randomized

again and presented for a second time). Image pairs were preceded by a central fixation cross that participants were required to click in order to advance the trial. This procedure ensured that all participants were looking at the centre of the screen at the beginning of each trial. Image pairs were presented for 8000-milliseconds. Participants were provided with a brief break after each condition before proceeding to the next condition. Upon completion of the two conditions, participants were presented with each image without any overlay to facilitate self-reported attraction ratings using a 7-point slider that appeared on the screen. After the self-report ratings, participants completed a short demographic questionnaire on the Gorilla platform (see Figure 3). Upon completion of the experiment, participants were provided with an electronic debriefing form and received compensation for their participation: Prolific participants in study 1 were paid £3.75 following Prolific guidelines, and HSP participants in study 2 were granted 1-course credit. The University of British Columbia Behavioural Research Ethics Board approved all procedures.

Data Reduction for Study 1 and Study 2

Within Trials

MouseView.js collects time-stamped data about the cursor coordinates enabling a calculation of total time spent "viewing" an image region (i.e., total mouse dwell). Given that each stimulus pair was presented twice and the pattern of results did not change when we used mouse dwell from the first or the second presentation, total mouse dwell across both presentations was averaged for each image to produce the dependent variable—mean total mouse dwell. To analyze total mouse dwell within trials, we first divided each pair of stimuli into two general areas of interest (AOIs): one contained the sexual image and the other contained the nonsexual image. Each trial for the within trial examination was matched for gender cues (e.g.,

each trial contained either two female targets or two male targets), as such, we had the following four AOIs to capture both the stimulus type as well as the stimulus sex: sexual female, nonsexual female, sexual male, and nonsexual male. Then, to examine within trial response specificity to sexual versus nonsexual stimuli, total mouse dwell on each AOI (i.e., raw data from MouseView.js) was averaged across trials and this yielded our four dependent variables—one for each AOI. We identified invalid trials in cases where the mean total mouse dwell across trials was less than 1000ms, and only participants who had valid trials (i.e., mean total mouse dwell > 1000ms) for both the trials within a category (i.e., female targets, male targets) were included in the analyses.

Between Trials

In order to analyze total mouse dwell between trials, we created two AOIs: one corresponded with the sexual trial and the other corresponded with the nonsexual trial. The sexual trial AOI was computed by summing the total mouse dwell on the sexual male and sexual female target within each sexual trial. The nonsexual trial AOI was computed by summing the total mouse dwell on the nonsexual male and nonsexual female target within each nonsexual trial. To examine between trial response specificity to sexual versus nonsexual stimuli, total mouse dwell on each AOI was averaged across trial type and this yielded our two dependent variables—one for each AOI. We identified invalid trials in cases where the mean total mouse dwell across trial type was less than 1000ms, and only participants who had valid trials (i.e., mean total mouse dwell > 1000ms) for both the trials presenting sexual stimuli and the trials presenting nonsexual stimuli were included in the analyses.

Convergent Validity

To analyze the association between mouse dwell and sexual attraction ratings within-subjects, we used total mouse dwell on each image and the corresponding self-reported attraction rating for that image (64 pairs of observations per participant across both conditions). For the between-subjects correlations, total mouse dwell on each type of image (i.e., sexual images and nonsexual images, regardless of stimulus sex) was averaged across trials to yield one variable for sexual mouse dwell and one for nonsexual mouse dwell in each condition. Similarly, the total sexual attraction ratings for each type of image (i.e., sexual images and nonsexual images, regardless of stimulus sex) were averaged across trials to yield one variable for sexual stimuli ratings and one for nonsexual stimuli ratings. For these analyses, only data from participants who reported attraction to either men, women, or both were included. Specifically, participants who identified as asexual were not included given that an asexual sexual orientation involves a lack of sexual attraction to others and thus, the self-reported sexual attraction rating task may not have been relevant to their experience or identity.

Effect of Overlay Condition

For the exploratory analyses assessing the effect of overlay across each experimental condition (i.e., standard versus preview), mean total mouse dwell for the within and between trials were computed into an index score. Specifically, to compute a standardized index score, we first computed the percentage of dwell on each image/variable during an 8000ms trial. Then, for the trials containing female targets, we subtracted the percentage of mouse dwell towards the female nonsexual targets from the percentage of mouse dwell towards the female sexual targets. To compute an index score for the trials containing male targets, we subtracted the percentage of mouse dwell towards the male nonsexual targets from the percentage of mouse dwell towards the male sexual targets. For the between trials examination, we similarly computed a standardized

index score for trial type and then subtracted the percentage of mouse dwell in the nonsexual trials from the percentage of mouse dwell in the sexual trials. In all cases, positive index scores indicated greater attentional engagement with sexual stimuli, whereas negative index scores indicated greater attentional engagement with nonsexual stimuli.

Data Analysis for Study 1 and Study 2

Within and Between Trials

To test whether there was a bias towards sexual over nonsexual stimuli within and between trials (Hypotheses 1), two separate mixed-model analyses of variance (ANOVAs) were conducted for each experimental condition. The model comparing differences between sexual and nonsexual stimuli *within trials* using mean total mouse dwell for our dependent variables (sexual female, nonsexual female, sexual male, and nonsexual male) was as follows: 2 (Participant Gender: Woman, Man) x 2 (Stimulus Type: Sexual, Nonsexual) x 2 (Stimulus Sex: Female, Male). The other model comparing differences *between trials* using mean total mouse dwell for our dependent variables (sexual trial and nonsexual trial) was as follows: 2 (Participant Gender: Woman, Man) x 2 (Trial Type: Sexual, Nonsexual). Significant interactions were examined using post-hoc pairwise comparisons. Bonferroni corrections were applied to all models to account for family-wise error rates. For all relevant variables, we assessed for normality and violations were noted for the between trials dependent variables in study 2. Of note, the pattern of results did not change when we log-transformed the data or when we used nonparametric tests. Given these consistent patterns, we report the mixed-model ANOVA results throughout. Notably, mixed-model ANOVAs are robust to violations of normality in large sample sizes (Blanca et al., 2017).

Convergent Validity

To test for convergent validity (Hypothesis 2a), repeated measures correlations were calculated. Such correlations evaluate the overall intra-individual association between two measures, which in this case were mouse dwell and sexual attraction ratings (Bakdash & Marusich, 2017). The repeated measures correlations technique is preferred over Pearson bivariate correlations because it takes into account non-independence among repeated observations. Repeated measures correlations also have greater statistical power relative to Pearson correlations given that aggregating and averaging data points are not necessary (Bakdash & Marusich, 2017). Using parallel regression lines with the same slope but varying intercepts, the repeated measures correlations R package (https://cran.rproject.org/web/packages/rmcorr/) provides the best linear fit for each participant (Bakdash & Marusich, 2017). In both studies, the repeated measures correlations yielded the concordance of mouse dwell and attraction ratings for the 16 sexual images and the 16 nonsexual images in each condition separately. To further examine convergent validity, between-subjects Pearson correlations were also used to assess the relationship between average mouse dwell and average attraction ratings across all participants.

Exploratory Analysis

To examine the effect of overlay in each experimental condition, two separate mixed-model ANOVAs were conducted. One model included the within trial stimulus pairs using the computed index scores for female targets and male targets: 2 (Participant Gender: Woman, Man) x 2 (Stimulus Sex: Female, Male) x 2 (Condition: Standard, Preview). Another model included the between trial stimulus pairs using the computed index score for trial type: 2 (Participant Gender: Woman, Man) x 2 (Condition: Standard, Preview).

Chapter Three: Study 1 Results

Table 2 contains the means and standard deviations for the dependent variables. Number of participants with valid trials (i.e., *n*s) included in the analyses is indicated in the table. Descriptive statistics for mean total mouse dwell for the within- and between-trial variables across women and men are broken down by the MouseView.js condition (standard and preview).

Within Trial Response Specificity

In the Standard MouseView.js condition, the mixed model ANOVA revealed a significant three-way interaction between Gender, Stimulus Type, and Stimulus Sex for mean total mouse dwell, $F(1, 225) = 19.28$, $p < .001$, partial $\eta^2 = .08$ (see Table 2 for descriptives). Post-hoc comparisons indicated that when female targets were presented, both women ($p = .044$, $d = 0.30$) and men ($p < .001$, $d = 1.37$) had significantly greater mouse dwell on the sexual female relative to the nonsexual female targets (see Figure 4a). When male targets were presented, women had significantly greater mouse dwell on the sexual male relative to the nonsexual male targets ($p = .018$, $d = 0.40$), however, no significant differences were observed for men's mouse dwell on the sexual versus nonsexual male targets ($p = .256$, $d = 0.16$; see Figure 4b).

In the Preview MouseView.js condition, the mixed model ANOVA revealed a significant three-way interaction between Gender, Stimulus Type, and Stimulus Sex for mean total mouse dwell, $F(1, 220) = 33.87$, $p < .001$, partial $\eta^2 = .13$. Post-hoc comparisons indicated that when female targets were presented, no significant differences were observed for women's mouse dwell on the sexual versus nonsexual female targets ($p = .811$, $d = 0.04$). Men, on the other hand, had significantly greater mouse dwell on the sexual female relative to the nonsexual female targets ($p < .001$, $d = 1.53$; see Figure 5a). When male targets were presented, women had

significantly greater mouse dwell on the sexual male relative to the nonsexual male targets (p = .047, d = 0.34), however, no significant differences were observed for men's mouse dwell on the sexual versus nonsexual male targets (p = .369, d = 0.13; see Figure 5b).

Between Trial Response Specificity

In the Standard MouseView.js condition, the two-way interaction between Gender and Trial Type was not significant, $F(1, 222) = 1.68$, $p = .196$, partial $\eta^2 = .01$ (see Table 2 for descriptives). There was a significant main effect of Trial Type for mean total mouse dwell, $F(1, 222) = 128.24$, $p < .001$, partial $\eta^2 = .37$. For both women and men, mean total mouse dwell was significantly greater in the sexual trials relative to the nonsexual trials (see Figure 6a).

In the Preview MouseView.js condition, the mixed model ANOVA revealed a significant interaction between Gender and Trial Type for mean total mouse dwell, $F(1, 219) = 7.17$, p = .008, partial $\eta^2 = .03$. Post-hoc comparisons indicated that mean total mouse dwell was significantly greater in the sexual trials relative to the nonsexual trials for women (p = .002, d = 0.22) and men ($p < .001$, d = 0.51). As well, a gender difference was observed such that compared to women, men had significantly greater mouse dwell in the sexual trials ($p < .001$, d = 0.59) and the nonsexual trials (p = .043, d = 0.27; see Figure 6b).

Convergent Validity

In the Standard MouseView.js condition, the repeated measures correlation assessing the relationship between mouse dwell and attraction ratings within-subjects revealed a significant positive relationship for sexual stimuli, $r_{rm}(3467) = 0.59$, 95% CI [0.57, 0.61], $p < .001$. Mouse dwell on nonsexual stimuli was also positively associated with attraction ratings for nonsexual stimuli, $r_{rm}(3473) = 0.25$, 95% CI [0.22, 0.28], $p < .001$. These associations were also significant

in the Preview MouseView.js condition for sexual stimuli, $r_{rm}(3469) = 0.60$, 95% CI [0.58, 0.62], $p < .001$, and for nonsexual stimuli $r_{rm}(3473) = 0.25$, 95% CI [0.22, 0.28], $p < .001$.

In the Standard MouseView.js condition, the between-subjects correlations assessing the relationship between average mouse dwell and average attraction ratings revealed a significant positive correlation across women and men for sexual stimuli ($r(224) = .29$, $p < .001$). The association was not significant for nonsexual stimuli ($r(228) = .13$, $p = .053$). Similar patterns were observed in the Preview MouseView.js condition, such that these associations were significant and positive for sexual stimuli ($r(225) = .33$, $p < .001$), but not significant for nonsexual stimuli ($r(227) = .10$, $p = .120$).

Effect of Overlay Condition

For the within trial stimulus pairs, the mixed model ANOVA revealed a significant three-way interaction between Gender, Stimulus Sex, and Condition for the standardized index scores of mean total mouse dwell, $F(1, 228) = 7.11$, $p = .008$, partial $\eta^2 = .03$ (see Table 3). Post-hoc comparisons indicated that when female targets were presented, women's attentional bias towards sexual female targets relative to nonsexual female targets was significantly stronger in the standard condition than in the preview condition ($p = .012$, $d = 0.21$). In men, the reverse pattern was observed such that men's attentional bias towards sexual female targets relative to nonsexual female targets was significantly stronger in the preview condition than in the standard condition ($p = .009$, $d = 0.20$). When male targets were presented, the strength of the attentional bias towards sexual male targets relative to nonsexual male targets did not differ as a function of condition in women ($p = .590$, $d = 0.04$) nor men ($p = .859$, $d = 0.01$).

For the between trial stimulus pairs, the two-way interaction between Condition and Gender was not significant, $F(1, 228) = 2.18$, $p = .141$, partial $\eta^2 = .01$. There was a main effect

of Condition for the standardized index scores, $F(1, 228) = 10.13$, $p = .002$, partial $\eta^2 = .04$. For both women and men, the strength of the attentional bias towards sexual stimuli relative to nonsexual stimuli between trials was stronger in the standard condition than in the preview condition (see Table 3).

Study 1 Summary

Overall, the pattern of results from study 1 revealed strong evidence of response specificity, such that sexual stimuli garnered more mouse dwell than nonsexual stimuli both within- and between trials. That is, MouseView.js was capable of detecting attentional biases to sexual versus nonsexual stimuli—particularly when viewing stimuli with greater reward salience (i.e., stimuli that individuals were interested in and attracted to). Evidence of convergent validity was also established, such that both within- and between-subjects correlations assessing the relationship between mouse dwell and sexual attraction ratings were significant and positive. Examining the effect of the overlay condition revealed differences in the strength of attentional bias as a function of the overlay, but the same overall pattern of attentional bias towards sexual stimuli was observed across both conditions.

Chapter Four: Study 2

Given the promising findings observed in study 1 with respect to response specificity and convergent validity, the goal of study 2 was to replicate the findings from study 1 in a larger sample. We also wanted to extend the convergent validity effects by examining associations between mouse dwell and two individual difference correlates of sexuality: sociosexuality and sexual desire. These constructs are thought to influence attention to sexual stimuli as per the cognitive-motivational model. Specifically, sociosexuality and sexual desire may influence both the degree to which sexual cues are salient and subsequent motivation to engage with such cues. Thus, we would expect positive correlations between these constructs and mouse dwell towards sexual stimuli.

Measures

Sociosexuality

The *Sociosexual Orientation Inventory* (SOI-R; Penke & Asendorpf, 2008) assesses the tendency to engage in sexual relationships without a deep emotional commitment (i.e., interest in casual and uncommitted sexual relationships). The SOI-R is a valid measure that examines three components of sociosexuality: behaviour (e.g., "*With how many different partners have you had sex within the past 12 months*?"), attitude (e.g., "*Sex without love is OK*."), and desire (e.g., "I*n everyday life, how often do you have spontaneous fantasies about having sex with someone you have just met?*"). Items related to each subscale are summed, with higher scores indicating an unrestricted sociosexual orientation (e.g., an overall more promiscuous behavioural tendency), and lower scores indicating a more restricted sociosexual orientation. A total score of global sociosexual orientation is also generated, with a possible range of 9-81. The SOI-R has demonstrated good internal consistency as reflected by Cronbach's alpha values higher than .81

for the total global score as well as the three components (Penke & Asendorpf, 2008). The SOI-R showed high internal consistency in the present sample, with Cronbach's alpha values of .85, .88, .82, and .88, for global sociosexual orientation, behaviour, attitude, and desire, respectively.

Sexual Desire

The 14-item *Sexual Desire Inventory* (SDI-2; Spector et al., 1996) assesses the frequency and strength of three subscales of sexual desire: dyadic (e.g., "*How strong is your desire to engage in sexual activity with a partner?*"), solitary ("*How strong is your desire to engage in sexual behaviour by yourself?*"), and other-focused (e.g., "*When you see an attractive person, how strong is your sexual desire?*") desire. In this validated measure of sexual desire, items related to each subscale are summed, with higher scores indicating greater sexual desire. The SDI-2 has been found to have good internal consistency as reflected by Cronbach's alpha values higher than .80 across all three subscales (Moyano et al., 2017). The test-retest reliability of the SDI-2 is $r = .76$ over a one-month period (Carey, 1995, in Spector et al., 1998). Cronbach's alpha values in the present sample were .88, .90, and .82, for the dyadic, solitary, and other-focused subscales, respectively.

Data Reduction in Study 2

Data reduction procedures for study 2 were identical to study 1, with the addition of the two self-report sexuality measures. To analyze the association between dwell time and individual difference correlates of sexuality, total mouse dwell on sexual images (regardless of stimulus sex) was averaged across trials to yield the variable for sexual mouse dwell in each condition. The sum scores for each of the subscales from the sociosexuality and sexual desire measures were used. Similar to study 1, for these analyses, only data from participants who reported attraction to either men, women, or both were included. Specifically, participants who identified

as asexual were not included given that an asexual sexual orientation involves a lack of sexual attraction to others and thus, the self-report sociosexual orientation and sexual desire measures may not have been relevant to their experience or identity.

Data Analysis for Study 2

The analyses for study 2 were identical to study 1. However, additional analyses were necessary to further establish convergent validity of Mouseview.js with other sexuality variables. Specifically, Pearson correlations were conducted to assess the association between average mouse dwell on all sexual images and self-reported sociosexual orientation (behaviour, attitude, and desire) as well as sexual desire (dyadic, solitary, and other-focused; Hypothesis 2b).

Chapter Five: Study 2 Results

Within Trial Response Specificity

Descriptives for women and men by condition can be found in Table 2. In the Standard MouseView.js condition, the mixed model ANOVA revealed a significant three-way interaction between Gender, Stimulus Type, and Stimulus Sex for mean total mouse dwell, $F(1, 445) = 99.23$, $p < .001$, partial $\eta^2 = .18$. Post-hoc comparisons indicated that when female targets were presented, both women ($p < .001$, $d = 0.63$) and men ($p < .001$, $d = 1.67$) had significantly greater mouse dwell on the sexual female relative to the nonsexual female targets (see Figure 4c). When male targets were presented, women had significantly greater mouse dwell on the sexual male relative to the nonsexual male targets ($p < .001$, $d = 0.68$). Men, on the other hand, had significantly greater mouse dwell on the nonsexual male relative to the sexual male targets ($p = .024$, $d = 0.23$; see Figure 4d).

In the Preview MouseView.js condition, the mixed model ANOVA revealed a significant three-way interaction between Gender, Stimulus Type, and Stimulus Sex for mean total mouse dwell, $F(1, 444) = 133.02$, $p < .001$, partial $\eta^2 = .23$. Post-hoc comparisons indicated that when female targets were presented, both women ($p = .007$, $d = 0.31$) and men ($p < .001$, $d = 1.45$) had significantly greater mouse dwell on the sexual female relative to the nonsexual female targets (see Figure 5c). When male targets were presented, women had significantly greater mouse dwell on the sexual male relative to the nonsexual male targets ($p < .001$, $d = 0.77$). Men, however, had significantly greater mouse dwell on the nonsexual male relative to the sexual male targets ($p < .001$, $d = 0.40$; see Figure 5d).

Between Trial Response Specificity

In the Standard MouseView.js condition, the mixed model ANOVA revealed a significant interaction between Gender and Trial Type for mean total mouse dwell, $F(1, 439) = 14.91$, $p < .001$, partial $\eta^2 = .03$ (see Table 2 for descriptives). Post-hoc comparisons indicated that mean total mouse dwell was significantly greater in the sexual trials relative to the nonsexual trials for women ($p < .001$, $d = 0.42$) and men ($p < .001$, $d = 0.80$). Compared to women, men had significantly greater mouse dwell in the sexual trials ($p < .001$, $d = 0.34$). However, no significant gender differences in mouse dwell were observed for the nonsexual trials ($p = .902$, $d = 0.01$; see Figure 6c).

In the Preview MouseView.js condition, the mixed model ANOVA revealed a significant interaction between Gender and Trial Type for mean total mouse dwell, $F(1, 432) = 17.29$, $p < .001$, partial $\eta^2 = .04$. Post-hoc comparisons indicated that mean total mouse dwell was significantly greater in the sexual trials relative to the nonsexual trials for women ($p < .001$, $d = 0.42$) and men ($p < .001$, $d = 0.82$). Compared to women, men had significantly greater mouse dwell in the sexual trials ($p < .001$, $d = 0.36$). However, no significant gender differences in mouse dwell were observed for the nonsexual trials ($p = .890$, $d = 0.01$; see Figure 6d).

Convergent Validity

In the Standard MouseView.js condition, the within-subjects correlations assessing the relationship between mouse dwell and attraction ratings revealed a significant positive association for sexual stimuli, $r_{rm}(6895) = 0.59$, 95% CI [0.58, 0.61], $p < .001$. Mouse dwell on nonsexual stimuli was also positively associated with attraction ratings for nonsexual stimuli, $r_{rm}(6887) = 0.20$, 95% CI [0.18, 0.22], $p < .001$. In the Preview MouseView.js condition, the

associations were significantly positive for sexual stimuli, $r_{rm}(6882) = 0.60$, 95% CI [0.59, 0.62], $p < .001$, and for nonsexual stimuli, $r_{rm}(6860) = 0.17$, 95% CI [0.14, 0.19], $p < .001$.

In the Standard MouseView.js condition, the between-subjects correlations assessing the relationship between average mouse dwell and average attraction ratings across all participants revealed a significant positive correlation for sexual stimuli, $r(442) = .33$, $p < .001$. This association was also significant and positive for nonsexual stimuli, $r(440) = .16$, $p < .001$. The same pattern was observed in the Preview MouseView.js condition, such that these associations were significant and positive for sexual and nonsexual stimuli, $r(446) = .34$, $p < .001$ and $r(441) = .18$, $p < .001$, respectively.

In the Standard MouseView.js condition, assessing the relationship between average mouse dwell on sexual stimuli and sociosexual orientation revealed that across all participants, average mouse dwell was positively correlated with global sociosexual orientation ($r(442)= .15$, $p = .001$), as well as the sociosexual attitude ($r(442) = .15$, $p = .002$), and sociosexual desire ($r(442)= .16$, $p < .001$) subscales. Mouse dwell on sexual stimuli was not significantly correlated with the sociosexual behaviour subscale ($r(442) = .01$, $p = .856$). Similar patterns were observed in the Preview MouseView.js condition, such that mouse dwell was positively correlated with global sociosexual orientation ($r(446) = .18$, $p < .001$), sociosexual attitude ($r(446)= .17$, $p < .001$), and sociosexual desire ($r(446)= .20$, $p < .001$). Whereas the association between mouse dwell and sociosexual behaviour was not significant ($r(446)= .02$, $p = .750$).

In the Standard MouseView.js condition, assessing the relationship between average mouse dwell on sexual stimuli and sexual desire revealed that across all participants, average mouse dwell was positively correlated with dyadic sexual desire ($r(442) = .26$, $p < .001$), and solitary sexual desire ($r(442) = .22$, $p < .001$). However, the association between mouse dwell

and other-attractive person focused sexual desire was not significant ($r(442) = .09$, $p = .064$). In the Preview MouseView.js condition, mouse dwell was positively correlated with dyadic, solitary, and other focused sexual desire subscales ($r(446)= .28$, $p < .001$, $r(446)= .22$, $p < .001$, and $r(446)= .17$, $p < .001$, respectively).

Effect of Overlay Condition

For the within trial stimulus pairs, the mixed model ANOVA revealed a significant three-way interaction between Gender, Stimulus Sex, and Condition for the standardized index scores of mean total mouse dwell, $F(1, 453) = 23.76$, $p < .001$, partial $\eta^2 = .05$. As shown in Table 3, when female targets were presented, women's attentional bias towards sexual female targets relative to nonsexual female targets was significantly stronger in the standard condition compared to the preview condition ($p = .031$, $d = 0.10$). In men, the strength of the attentional bias towards sexual female targets relative to nonsexual female targets did not significantly differ as a function of condition ($p = .087$, $d = 0.08$). When male targets were presented, women's attentional bias towards sexual male targets relative to nonsexual male targets was stronger in the preview condition than in the standard condition ($p = .042$, $d = 0.11$), whereas, in men, the strength of the attentional bias towards nonsexual male targets relative to sexual male targets was stronger in the preview condition than in the standard condition ($p = .008$, $d = 0.13$).

For the between trial stimulus comparisons, there was no significant interaction between Gender and Condition, $F(1, 454) = 0.85$, $p = .358$, partial $\eta^2 = .00$. We also did not observe a significant main effect of Condition, $F(1, 454) = 0.74$, $p = .391$, partial $\eta^2 = .00$. Thus, the strength of the attentional bias toward sexual stimuli relative to nonsexual stimuli between trials did not differ as a function of overlay condition (see Table 3).

Study 2 Summary

The pattern of results from study 2 largely replicated results from study 1. We observed further evidence for response specificity, that MouseView.js was capable of detecting attentional biases to sexual versus nonsexual stimuli. In addition to replicating the convergent validity results from study 1, we extended evidence of convergent validity in study 2. Specifically, we found that across all participants, average mouse dwell on sexual stimuli was positively associated with sociosexual orientation and sexual desire. The effect of the overlay condition revealed a consistent attentional bias towards sexual stimuli across both conditions. Although the strength of this bias differed as a function of the overlay, the effect sizes were small.

Chapter Six: Discussion

In two studies we established the validity of a novel method, MouseView.js, as an online alternative to eye-tracking in the field of sex research. In line with our predictions, we observed evidence of within- and between-trial response specificity, demonstrating MouseView.js' sensitivity to detect attentional biases to sexual versus nonsexual stimuli. As predicted, mouse dwell was positively correlated with self-report measures of sexuality (sexual attraction ratings, sociosexuality, and sexual desire), demonstrating evidence of convergent validity. Exploratory analyses to examine the differential effects of the two experimental conditions (i.e., standard MouseView.js versus preview MouseView.js) revealed similar overall patterns of attentional biases towards sexual stimuli; however, the strength of these biases differed as a function of condition. The preview condition facilitated a more deliberate exploration of the stimuli and as such, the patterns observed may better approximate controlled attention assessed via eye-tracking.

Response Specificity

Consistent with previous eye-tracking research (e.g., Dawson & Chivers, 2016, 2018, 2019; Lykins et al., 2006; Milani et al., 2019; Nummenmaa et al., 2012; O'Kane et al., 2022), we observed robust controlled attentional biases towards sexual stimuli using MouseView.js—particularly for stimuli with greater reward salience (i.e., stimuli that individuals are interested in and attracted to). One exception was in the preview condition of study 1 where women attended similarly to sexual and nonsexual female targets (i.e., did not show an attentional bias). Of note, this effect was relatively small and was not replicated in study 2 with a larger sample size where we did see an attentional bias towards sexual female targets relative to nonsexual targets. Across both studies and experimental conditions, women tended to have greater mouse dwell on the

sexual targets in the within trial comparisons. These findings suggest that for women, sexual stimuli are salient and attract attention regardless of whether male or female targets are presented.

Across both studies and experimental conditions, men consistently exhibited a strong attentional bias towards sexual stimuli when female targets were presented. When male targets were presented, however, patterns of attentional bias varied such that men showed either no attentional bias (study 1) or avoidance of sexual male targets, such that they showed an attentional bias towards nonsexual male targets (study 2). Specifically, we observed that men exhibited robust patterns of response specificity when highly salient stimuli (e.g., female targets) were presented. These findings are consistent with patterns observed using eye-tracking where men's visual attention biases are driven by their sexual preferences (Dawson & Chivers, 2016, 2018, 2019; Hall et al., 2014; Lykins et al., 2006; Milani et al., 2019; O'Kane et al., 2022).

Additional evidence of response specificity was gleaned from the between trial comparisons. Across studies and conditions, attentional processing of sexual versus nonsexual stimuli yielded a consistent pattern whereby more attention was sustained during sexual trials. Our finding that sexual trials garnered more mouse dwell than nonsexual trials is consistent with eye-tracking research that has examined between trial differences in visual attention patterns towards sexual and nonsexual stimuli (e.g., Lykins et al., 2006; Milani et al., 2019; Nummenmaa et al., 2012). Together, these data provide strong evidence that sexual stimuli command attentional resources, consistent with the cognitive-motivational model of sexual response (Dewitte, 2016; Janssen et al., 2000; Toates, 2009).

In sum, for both women and men, we saw strong evidence of within- and between-trial response specificity consistent with theoretical models and previous research using eye-tracking

to assess attentional processing of sexual cues. In particular, stimuli with a high degree of salience and sexual relevance (i.e., preferred sexual stimuli) produce the strongest attentional biases using MouseView.js. Thus, we demonstrated that MouseView.js is capable of detecting attentional biases in women and men similar to the patterns observed using eye-tracking.

Convergent Validity

The cognitive-motivational model posits that controlled attention is positively associated with subjective sexual arousal, including self-reported sexual attraction (Dewitte, 2016; Janssen et al., 2000; Toates, 2009). In line with the model, we observed strong positive correlations between mouse dwell on sexual stimuli and self-reported sexual attraction ratings in women and men in both studies. As expected, mouse dwell and sexual attraction ratings for nonsexual stimuli were positive, though the magnitude of these correlations was much weaker than those observed for sexual stimuli. The nonsexual stimuli in our studies included runway models who are generally considered attractive; thus, it is not surprising to see small positive correlations for the nonsexual, but attractive, stimuli. These results are consistent a large body of literature on attraction. Specifically, attractive faces capture and sustain visual attention given that attractiveness cues (e.g., facial symmetry) reflect important biological signals from an evolutionary perspective (e.g., Aharon et al., 2001; Leder et al., 2010; Shimojo et al., 2003; Sui & Liu, 2009; Valuch et al., 2015).

Consistent with the cognitive-motivational model, if rewarding salient stimuli sustain attention and activate the sexual response system, then other motivational correlates like sexual attitudes and sexual desire may also influence attentional engagement with sexual stimuli. In study 2, additional evidence of convergent validity was observed via positive associations between mouse dwell on sexual stimuli and self-reported sociosexual orientation and sexual

desire. These constructs capture an individual's interest in casual and uncommitted sexual relationships (e.g., liberal sexual attitudes) and desire to engage in sexual activity, and may influence the degree to which people attend to sexual cues. Our findings using MouseView.js align with previous eye-tracking research showing that sexual attitudes (Rupp & Wallen, 2007), sexual compulsivity (Hall et al., 2014), sociosexual orientation (Maner et al., 2003), and subjective sexual desire (Velten et al., 2021b) are associated with visual attention to salient cues. Interestingly, unlike the positive associations observed between mouse dwell and the sociosexual attitude and desire subscales, we found no significant relationship between mouse dwell and sociosexual behaviour. These findings provide strong evidence linking the motivational aspects of sociosexuality (i.e., attitude and desire) with the allocation of attention, but not with actual sexual behaviour. That is, individual difference correlates of sexuality may motivate an interest to allocate attention toward sexual stimuli, but they do not necessarily translate into behaviours. These results are consistent with existing research that has demonstrated that the allocation of visual attention is closely tied to cognition, motivation, and interest (Dawson & Chivers, 2016, 2018, 2019; Hall et al., 2014).

Our findings for convergent validity add to existing research using MouseView.js to examine attentional biases elicited by emotional stimuli. Indeed, Anwyl-Irvine et al. (2021) observed strong positive correlations between emotionally salient stimuli (i.e., disgusting and pleasant images) and self-reported disgust and pleasantness ratings. In sum, these findings suggest that an individual's attention is captured and maintained on emotionally salient and evolutionarily relevant stimuli (e.g., pleasant, attractive, threatening). Such attentional biases are highly adaptive and would be strongly selected for given their relevance for approaching

appetitive and avoiding aversive or dangerous stimuli in the environment (Calvo & Lang, 2004; Mogg et al., 2000).

Overall, we found strong evidence of convergent validity for MouseView.js for sex research. Indeed, dwell time on sexual images was positively correlated with degree of sexual attraction, as well as individual differences in sociosexual orientation and desire. All three of these correlates of sexuality are hypothesized to influence both the degree to which sexual cues are salient and the subsequent motivation to engage with such cues, consistent with the cognitive-motivational model. Importantly, these findings also mirror those observed in traditional eye-tracking research (e.g., Dawson & Chivers, 2016, 2018, 2019).

Effects of the Standard and Preview Conditions on Attentional Biases to Sexual Cues

In the current studies, we extended previous research using MouseView.js to examine which overlay condition would better approximate traditional in-lab eye-tracking paradigms. Specifically, we compared a new configuration of the overlay (i.e., the preview condition) with the previously established configuration (i.e., the blurred condition). While both configurations produced the same overall pattern of results (i.e., patterns of response specificity and convergent validity) that replicate previous work using eye-tracking, there were notable differences in the strength of the attentional biases between conditions. In general, women's and men's attentional bias towards male and female targets, respectively, were stronger in the preview condition where the targets were initially visible and attention could be directed accordingly. Women's attentional biases were stronger to female sexual targets presented in the standard condition, perhaps because the standard condition may facilitate exploration of the stimuli, whereas the preview condition may result in a more deliberate exploration. Specifically, both women and men exhibit a more robust preference to view stimuli with higher reward salience (e.g., male and

female targets, respectively) when they are shown a preview and have knowledge of where such stimuli are located on the screen. The finding that men's preference towards nonsexual male targets was stronger in the preview condition is consistent with findings demonstrating patterns of visual avoidance. For example, in samples of men who are attracted to women, greater aversion-related inhibitory processes (e.g., disgust, homonegativity) predicted less sustained visual attention towards nonpreferred (i.e., male) sexual stimuli (Tassone et al., 2019).

The strength of the attentional bias towards sexual trials was stronger in the standard relative to the preview condition (study 1). That is, although the sexual trials garnered greater mouse dwell than nonsexual trials overall, mouse dwell during the sexual trials in the standard condition was greater than mouse dwell during the sexual trials in the preview condition. These observed differences may reflect the voluntary exploration that is necessary in the standard condition. Our results are consistent with research indicating that peripheral masking (e.g., a blurred background) influences the number and duration of fixations, such that more and longer dwell may be required because each stimulus and/or area of interest has to be fixated on multiple times to maximize information processing (Foulsham et al., 2011; Loschky & McConkie, 2002; van Diepen & d'Ydewalle, 2003). Our results indicated that the standard blurred overlay induces periods of exploratory dwell whereas the preview before the overlay facilitates a more deliberate exploration and thus, may yield patterns that more closely approximate controlled attention patterns in eye-tracking. However, these exploratory findings should be interpreted with caution given that the effect sizes were small and not all effects of condition replicated across both studies. A more direct test of which condition better approximates eye-tracking would be to compare mouse dwell patterns directly with gaze patterns from eye-tracking using a within-subjects design.

Limitations and Future Directions

Despite the notable strengths to the current research including a discovery and replication design, large sample sizes, and a novel paradigm, our research is not without limitations. Eye tracking enables estimation of both controlled and automatic attentional processing of sexual cues, but only the former was examined in the present research. In the initial validation study, Anwyl-Irvine and colleagues (2021) found that MouseView.js failed to detect the automatic capture of attention by affective stimuli often observed using eye-tracking. Thus, for the initial validation of MouseView.js for sex research, we opted to focus on response specificity and convergent validity for controlled dwell times. An important difference between the current studies and Anwyl-Irvine et al. (2021) was that the latter only used standard MouseView.js configurations. Given that the standard condition requires voluntary exploration prior to directed attention, this likely precludes reflexive attention patterns from being detected. The new preview condition utilized in our study provided participants with a clear presentation of the content beneath the blurred overlay similar to traditional eye-tracking studies where the stimuli are fully visible. Even though mouse movements are slower than eye movements (Anwyl-Irvine et al., 2021), the preview condition of MouseView.js that we created enables participants to make an informed decision regarding where to look first. Thus, it is possible that this condition may be suitable for examining variables reflecting initial attentional capture. Investigating whether the new preview configuration can be used to capture initial attention (i.e., latency to the first fixation) is a fruitful line of examination for future research.

We consistently replicated findings from previous research and found strong positive associations between mouse dwell and individual difference correlates of sexuality as evidence of convergent validity. A more robust test of convergent validity, however, would be an in-

laboratory direct comparison of MouseView.js with eye-tracking within-subjects. The curtailment of in-laboratory research hindered our ability to examine convergent validity in this manner. Nevertheless, Anwyl-Irvine et al. (2021) found that mouse dwell from MouseView.js and gaze time from eye-tracking correlated highly, and showed similar patterns of association to self-report measures. Given these promising results, future research should directly compare mouse and gaze dwell time to statistically test differences between the two methods and establish more robust evidence of convergent validity in sex research.

Given that our goal was to validate a novel methodology as an alternative to traditional eye-tracking, we opted to use sexual stimuli used in previous eye-tracking studies. Unfortunately, these sexual stimuli depicted predominantly White heteronormative targets, which may not have had adequate relevance or been representative of all participants' preferences, particularly participants from minoritized groups. Thus, although our effects were large and robust, we would expect that by including more diverse stimuli that better matched the participants' preferences with respect to ethnicity, gender/sex cues, our effects would become even stronger. In a similar vein, although we recruited two large samples in our research and did not have any exclusion criteria based on gender identity, the generalizability of our findings is limited to predominantly cisgender women and men. Future studies should not only recruit more inclusive and diverse samples—which the online nature of this methodology enables—but researchers should also consider including stimuli that better reflect the diversity in their samples (e.g., stimuli depicting transgender individuals, and different ethnicities).

Conclusion

Together, the two studies establish for the first time the validity of MouseView.js as an online alternative for eye-tracking in sex research. We established robust evidence for response

specificity and convergent validity, replicating previously established patterns of visual attention observed using eye-tracking. Consistent with theoretical models, mouse dwell patterns were specific to processing sexual relative to nonsexual stimuli, and were positively correlated with individual difference correlates known to influence attentional processing of sexual cues (i.e., self-reported attraction, sociosexual orientation, and sexual desire). Our experimental manipulation revealed that the preview condition may better approximate traditional eye-tracking given that individuals are aware of what lies beneath the blurred overlay and can make more deliberate explorations. Findings from this research have important implications for sex research and attention research more broadly. MouseView.js offers a freely accessible and convenient alternative to in-laboratory methodologies commonly used to understand sexual function, sexual interest and orientation. Additional benefits include increasing sample diversity and subsequent generalizability of research findings.

Tables and Figures

Table 1

Demographic Information for Women and Men in Studies 1 and 2

	Study 1		Study 2	
	Women (n = 114) ***M* (SD)** ***n* (%)**	**Men** (n = 117) ***M* (SD)** ***n* (%)**	**Women** (n = 236) ***M* (SD)** ***n* (%)**	**Men** (n = 215) ***M* (SD)** ***n* (%)**
Age	26.1 (8.08)	27.0 (7.65)	20.2 (2.79)	20.7 (3.37)
Gender Identity				
Cisgender	108 (94.7%)	112 (95.7%)	232 (98.3%)	207 (96.3%)
Transgender	1 (0.9%)	2 (1.7%)	1 (0.4%)	2 (0.9%)
Prefer not to respond	5 (4.4%)	3 (2.6%)	3 (1.3%)	6 (2.8%)
Sexual Orientation				
Asexual	4 (3.5%)	2 (1.7%)	9 (3.8%)	7 (3.3%)
Bisexual	28 (24.6%)	13 (11.1%)	23 (9.7%)	10 (4.7%)
Gay/Lesbian	6 (5.3%)	10 (8.5%)	4 (1.7%)	6 (2.8%)
Heterosexual	58 (50.9%)	87 (74.4%)	153 (64.8%)	173 (80.8%)
Pansexual	3 (2.6%)	0 (0%)	2 (0.8%)	2 (0.9%)
Questioning	8 (7.0%)	4 (3.4%)	27 (11.4%)	6 (2.8%)
Not listed	7 (6.1%)	1 (0.9%)	18 (7.6%)	10 (4.7%)
Ethnicity				
African American/Black	6 (5.3%)	2 (1.7%)	3 (1.3%)	2 (0.9%)
Asian	6 (5.3%)	3 (2.6%)	164 (69.5%)	115 (53.5%)
Hispanic	14 (12.3%)	19 (16.2%)	1 (0.4%)	7 (3.3%)
White	85 (74.6%)	84 (71.8%)	49 (20.8%)	63 (29.3%)
Other	3 (2.6%)	9 (7.7%)	19 (8.1%)	28 (13.0%)
Highest education completed				
High school	24 (21.1%)	35 (29.9%)	2 (0.8%)	1 (0.5%)
University (attending or completed bachelor's degree)	61 (53.5%)	61 (52.1%)	234 (99.2%)	212 (99.0%)
Graduate/professional school (attending or completed degree)	29 (25.4%)	21 (17.9%)	0 (0%)	1 (0.5)
Erotica use and experience				
Never seen erotica	3 (2.6%)	0 (0%)	12 (5.2%)	1 (0.5%)
Seen sexual erotica once/twice	31 (27.2%)	5 (4.3%)	41 (17.6%)	6 (2.8%)
Less than once per month	25 (21.9%)	7 (6.0%)	47 (20.2%)	9 (4.2%)
Once per month	16 (14.0%)	6 (5.2%)	46 (19.7%)	15 (7.1%)
Once per week	16 (14.0%)	21 (18.1%)	47 (20.2%)	45 (21.2%)
Several times a week	22 (19.3%)	59 (50.9%)	36 (15.5%)	83 (39.2%)
Once a day	1 (0.9%)	12 (10.3%)	3 (1.3%)	32 (15.1%)
Several times a day	0 (0%)	6 (5.2%)	1 (0.4%)	21 (9.9%)

Table 2

Mean Total Mouse Dwell (ms) by Condition for Studies 1 and 2

		Study 1				Study 2			
		Standard Condition *M (SD)*		**Preview Condition** *M (SD)*		**Standard Condition** *M (SD)*		**Preview Condition** *M (SD)*	
		Women (*n* = 111)	**Men** (*n* = 116)	**Women** (*n* = 114)	**Men** (*n* = 108)	**Women** (*n* = 232)	**Men** (*n* = 215)	**Women** (*n* = 236)	**Men** (*n* = 210)
Stimulus Type (Within Trial)	Female Nonsexual	2100.83 (783.55)	1936.50 (828.09)	2250.07 (987.94)	1798.27 (914.37)	2558.32 (1028.57)	2205.32 (874.06)	2749.61 (1273.49)	2242.59 (1125.15)
	Female Sexual	2367.54 (966.99)	3187.59 (988.87)	2213.06 (1085.88)	3320.67 (1070.31)	3271.25 (1239.92)	3932.55 (1174.62)	3181.69 (1482.82)	4130.76 (1457.35)
	Male Nonsexual	2027.65 (1024.55)	2143.31 (1112.37)	1983.65 (967.33)	2043.36 (1160.43)	2444.65 (1041.84)	2662.26 (1274.07)	2385.59 (1131.08)	3064.46 (1689.49)
	Male Sexual	2446.86 (1093.83)	2340.18 (1381.43)	2351.32 (1199.18)	2213.71 (1382.42)	3233.85 (1257.52)	2353.20 (1362.53)	3396.44 (1468.99)	2391.19 (1667.91)
		Women (*n* = 107)	**Men** (*n* = 117)	**Women** (*n* = 105)	**Men** (*n* = 116)	**Women** (*n* = 226)	**Men** (*n* = 215)	**Women** (*n* = 223)	**Men** (*n* = 211)
Trial Type (Between Trial)	Nonsexual Trial	2262.51 (584.77)	2514.06 (564.37)	2284.87 (563.17)	2437.84 (554.42)	2721.10 (559.68)	2714.45 (575.26)	2759.73 (589.40)	2751.81 (605.27)
	Sexual Trial	2505.91 (552.97)	2820.35 (488.12)	2406.53 (529.59)	2700.02 (459.76)	2950.96 (543.03)	3111.02 (396.94)	3007.62 (594.25)	3199.94 (474.39)

Table 3

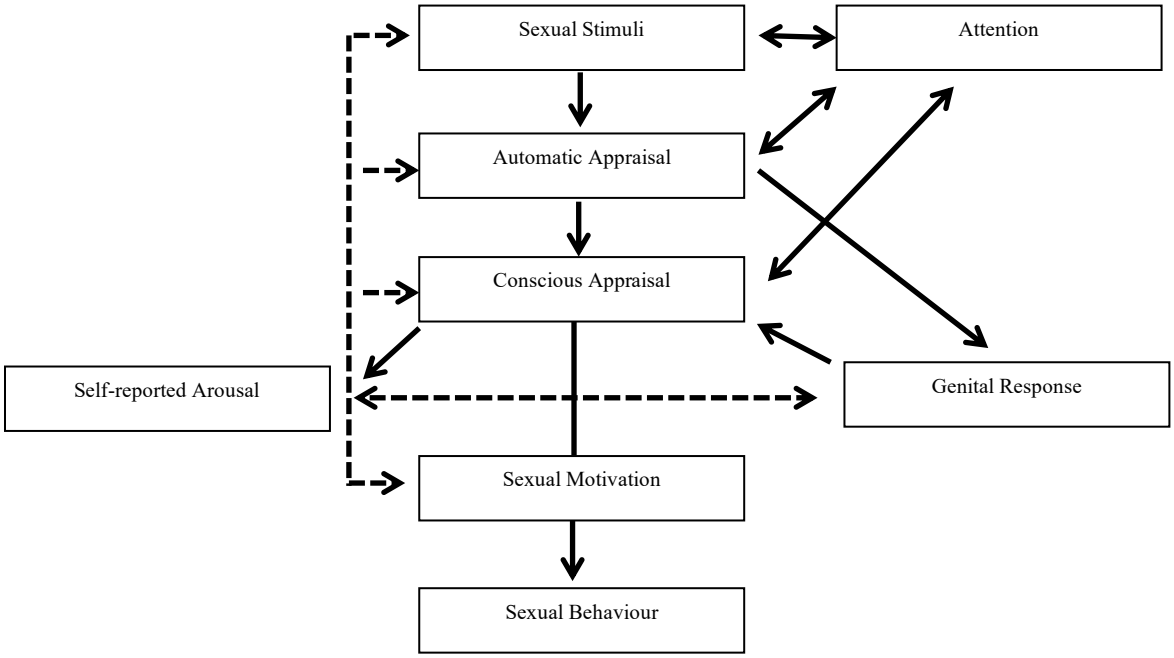
Percentage of Mouse Dwell as Standardized Index Scores to Examine the Effect of Overlay Condition for Studies 1 and 2

	Study 1				**Study 2**			
	Standard Condition ***M*** ***(SD)***		**Preview Condition** ***M*** ***(SD)***		**Standard Condition** ***M*** ***(SD)***		**Preview Condition** ***M*** ***(SD)***	
	Women (n = 113)	**Men** (n = 117)	**Women** (n = 113)	**Men** (n = 117)	**Women** (n = 237)	**Men** (n = 218)	**Women** (n = 237)	**Men** (n = 218)
Female Sexual – Female Nonsexual	3.36 (16.81)	15.87 (17.93)	-0.58 (20.24)	19.90 (21.18)	8.33 (24.41)	21.12 (22.95)	5.63 (30.50)	23.34 (30.67)
Male Sexual – Male Nonsexual	5.22 (20.97)	2.05 (24.64)	4.35 (22.51)	1.77 (25.49)	9.39 (23.98)	-3.75 (25.31)	12.35 (28.03)	-7.74 (35.40)
	Women (n = 115)	**Men** (n = 115)	**Women** (n = 115)	**Men** (n = 115)	**Women** (n = 238)	**Men** (n = 218)	**Women** (n = 238)	**Men** (n = 218)
Sexual Trials – Nonsexual Trials	2.72 (4.51)	3.86 (4.56)	1.08 (5.44)	3.26 (5.26)	2.88 (5.97)	5.14 (6.06)	2.86 (7.36)	5.67 (7.57)

Note. The means and standard deviations for the standardized index scores are calculated for the within trial stimulus pairings (i.e., female targets, male targets) and for the between trial stimulus pairings (i.e., trial type) for each Condition in Studies 1 and 2. The *n*s indicate the number of participants with valid trials included in the mixed-model ANOVA.

Figure 1

Cognitive-Motivational Model of Sexual Response



Note. Cognitive-Motivational model of sexual response (adapted from Dewitte, 2016, Janssen et al., 2011, Toates, 2009).

Figure 2

Experimental Image Pairings

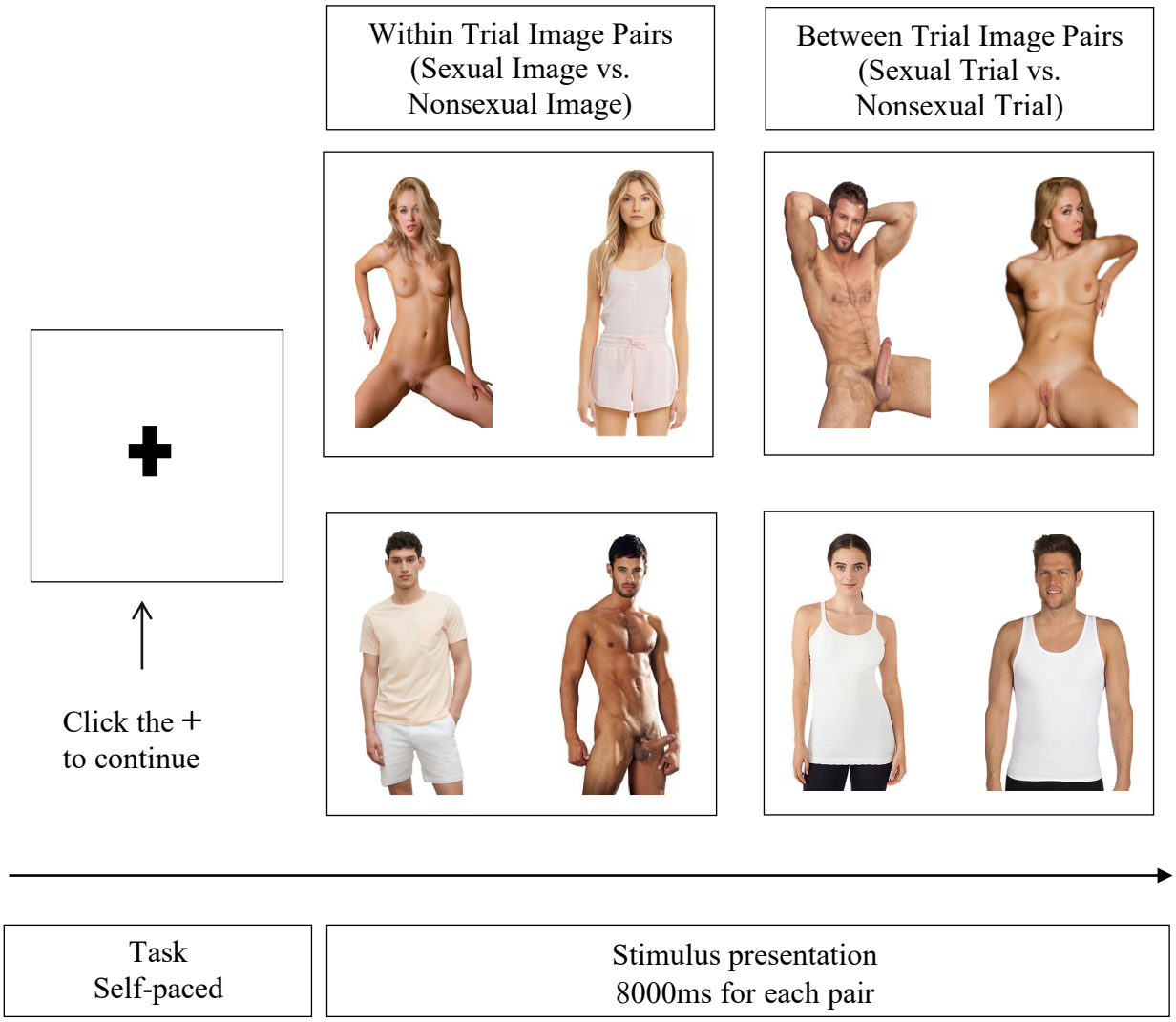


Figure 3

Illustration of Experimental Procedure

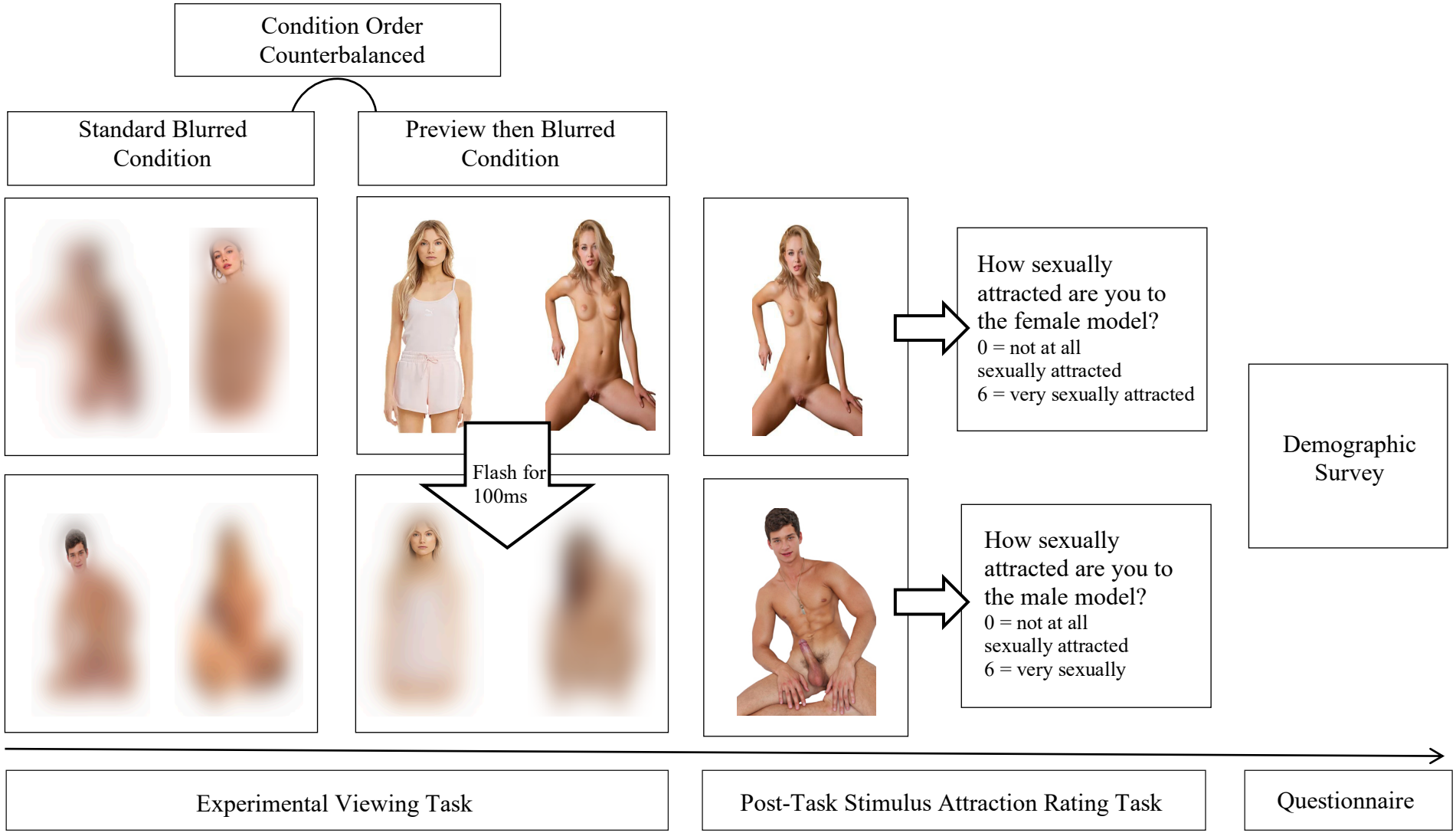
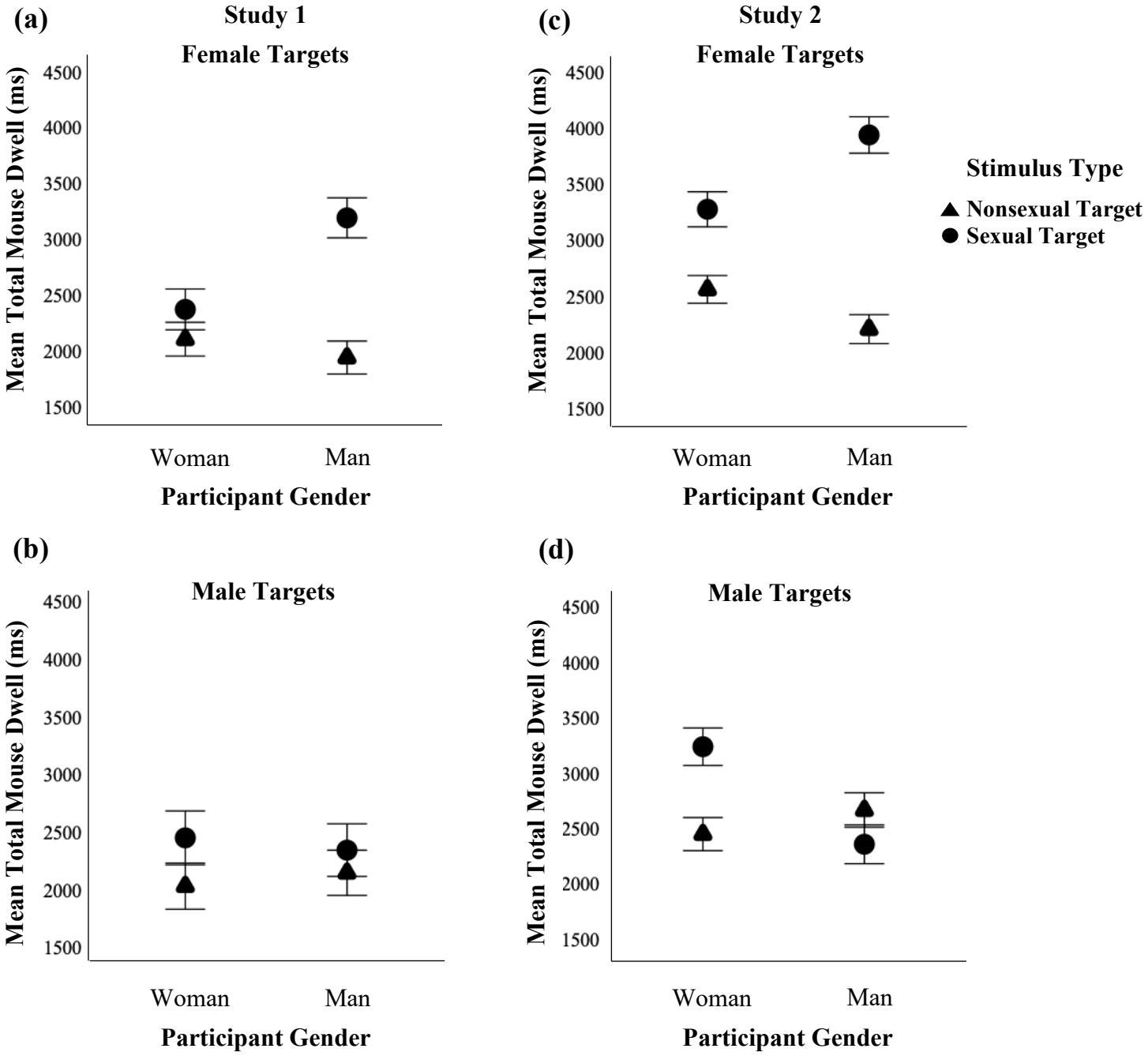


Figure 4

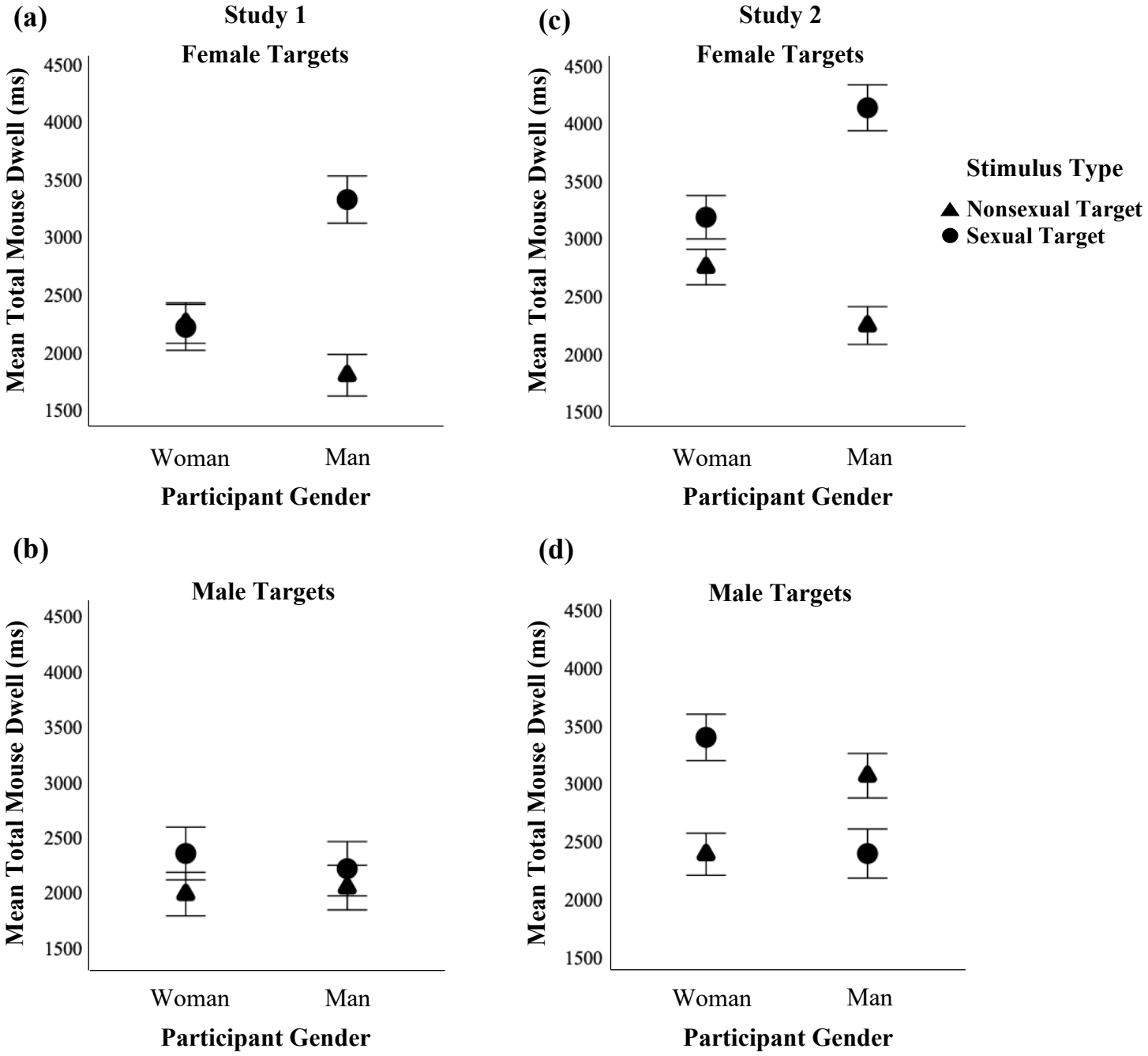
Within Trial Comparisons for the Standard Condition for Studies 1 and 2



Note. Within trial comparisons for the Standard condition showing the interactions between Gender, Stimulus Type, and Stimulus Sex for Female Targets in (a) Study 1 and (c) Study 2, as well as for Male Targets in (b) Study 1 and (d) Study 2. Error bars represent 95% CI.

Figure 5

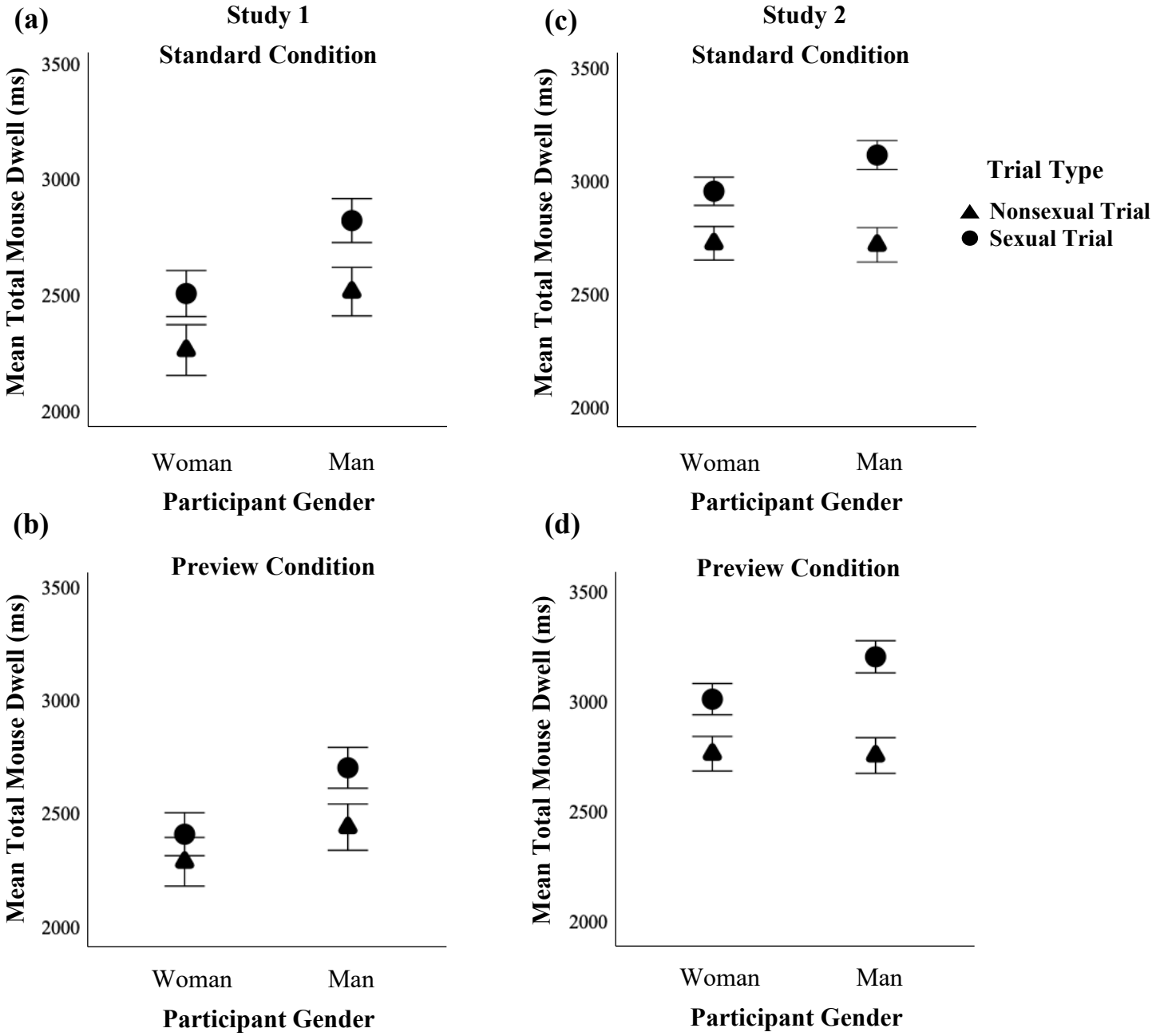
Within Trial Comparisons for the Preview Condition for Studies 1 and 2



Note. Within trial comparisons for the Preview Condition showing the interactions between Gender, Stimulus Type, and Stimulus Sex for Female Targets in (a) Study 1 and (c) Study 2, as well as for Male Targets in (b) Study 1 and (d) Study 2. Error bars represent 95% CI.

Figure 6

Between Trial Comparisons across Standard and Preview Conditions for Studies 1 and 2



Note. Between trial comparisons showing (a) main effect of Trial Type in the Standard condition of Study 1, as well as an interaction between Gender and Trial Type in the (b) Preview condition of Study 1, (c) Standard condition of Study 2, and (d) Preview condition of Study 2. Error bars represent 95% CI.

References

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

Andersen, N. E., Dahmani, L., Konishi, K., & Bohbot, V. D. (2012). Eye tracking, strategies, and sex differences in virtual navigation. *Neurobiology of Learning and Memory, 97*(1), 81–89. https://doi.org/10.1016/j.nlm.2011.09.007

Anwyl-Irvine, A. L., Armstrong, T., & Dalmaijer, E. S. (2021). MouseView.js: Reliable and valid attention tracking in web-based experiments using a cursor-directed aperture. *Behavior Research Methods.* https://doi.org/10.3758/s13428-021-01703-5

Bakdash, J. Z., & Marusich, L. R. (2017). Repeated measures correlation. *Frontiers in Psychology, 8*, 456-456. https://doi.org/10.3389/fpsyg.2017.00456

Bancroft, J. (2003). *Sexual arousal.* In L. Nadel (Ed.), Encyclopedia of Cognitive Science. New York: Nature Publications.

Barlow, D. H. (1986). Causes of sexual dysfunction: The role of anxiety and cognitive interference. *Journal of Consulting and Clinical Psychology, 54*(2), 140–148. https://doi.org/10.1037/0022-006X.54.2.140

Blanca, M. J., Alarcón, R., Arnau, J., Bono, R., & Bendayan, R. (2017). Non-normal data: Is ANOVA still a valid option? *Psicothema, 29*(4), 552–557. https://doi.org/10.7334/psicothema2016.383

Calvo, M. G., & Lang, P. J. (2004). Gaze patterns when looking at emotional pictures: Motivationally biased attention. *Motivation and Emotion*, *28*(3), 221–243. https://doi.org/10.1023/B:MOEM.0000040153.26156.ed

Dawson, S. J., & Chivers, M. L. (2016). Gender-specificity of initial and controlled visual attention to sexual stimuli in androphilic women and gynephilic Men. *PLOS ONE, 11*(4), e0152785. https://doi.org/10.1371/journal.pone.0152785

Dawson, S. J., & Chivers, M. L. (2018). The effect of static versus dynamic stimuli on visual processing of sexual cues in androphilic women and gynephilic men. *Royal Society Open Science, 5*(6). https://doi.org/10.1098/rsos.172286

Dawson, S. J., & Chivers, M. L. (2019). The effect of task demands on gender-specificity of attentional biases in androphilic women and gynephilic men. *Personality and Individual Differences, 146*, 120-126. https://doi.org/10.1016/j.paid.2019.04.006

de Jong, D. C. (2009). The role of attention in sexual arousal: Implications for treatment of sexual dysfunction. *The Journal of Sex Research*, *46*(2–3), 237–248. https://doi.org/10.1080/00224490902747230

Deng, J., Krause, J., & Fei-Fei, L. (2013). Fine-grained crowdsourcing for fine-grained recognition. *2013 IEEE Conference on Computer Vision and Pattern Recognition*, 580–587. https://doi.org/10.1109/CVPR.2013.81

Dewitte, M. (2016). Gender differences in implicit processing of sexual stimuli. *European Journal of Personality, 30*(2), 107-124. https://doi.org/10.1002/per.2031

Foulsham, T., Teszka, R., & Kingstone, A. (2011). Saccade control in natural images is shaped by the information visible at fixation: Evidence from asymmetric gaze-contingent windows. *Attention, Perception & Psychophysics, 73*(1), 266-283. https://doi.org/10.3758/s13414-010-0014-5

Gomez, S. R., Jianu, R., Cabeen, R., Guo, H., & Laidlaw, D. H. (2017). Fauxvea: Crowdsourcing gaze location estimates for visualization analysis tasks. *IEEE Transactions on*

Visualization and Computer Graphics, 23(2), 1042–1055. https://doi.org/10.1109/TVCG.2016.2532331

Gómez-Poveda, J., & Gaudioso, E. (2016). Evaluation of temporal stability of eye tracking algorithms using webcams. *Expert Systems with Applications, 64*, 69–83. https://doi.org/10.1016/j.eswa.2016.07.029

Hall, C., Hogue, T., & Guo, K. (2011). Differential gaze behavior towards sexually preferred and non-preferred human figures. *The Journal of Sex Research*, *48*(5), 461–469. https://doi.org/10.1080/00224499.2010.521899

Hall, C., Hogue, T., & Guo, K. (2014). Sexual cognition guides viewing strategies to human figures. *The Journal of Sex Research, 51*(2), 184-196. https://doi.org/10.1080/00224499.2012.716872

Henderson, J. M., Weeks, P. A., & Hollingworth, A. (1999). The effects of semantic consistency on eye movements during complex scene viewing. *Journal of Experimental Psychology: Human Perception and Performance, 25*(1), 210–228. https://doi.org/10.1037/0096-1523.25.1.210

Janssen, E., Everaerd, W., Spiering, M., & Janssen, J. (2000). Automatic processes and the appraisal of sexual stimuli: Toward an information processing model of sexual arousal. *The Journal of Sex Research, 37*(1), 8-23. https://doi.org/10.1080/00224490009552016

Jiang, M., Huang, S., Duan, J., & Zhao, Q. (2015). SALICON: Saliency in context. *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 1072–1080.

Kim, N., Bylinskii, Z., Borkin, M., Gajos, K., Oliva, A., Durand, F., & Pfister, H. (2017). BubbleView: An interface for crowdsourcing image importance maps and tracking visual

attention. *ACM Transactions on Computer-Human Interaction (TOCHI), 24*(5), 1-40. https://doi.org/10.1145/3131275

Leder, H., Tinio, P. P. L., Fuchs, I. M., & Bohrn, I. (2010). When attractiveness demands longer looks: The effects of situation and gender. *Quarterly Journal of Experimental Psychology (2006), 63*(9), 1858-1871. https://doi.org/10.1080/17470211003605142

Loschky, L. C., & McConkie, G. W. (2002). Investigating spatial vision and dynamic attentional selection using a gaze-contingent multiresolutional display. *Journal of Experimental Psychology. Applied, 8*(2), 99–117. https://doi.org/10.1037/1076-898X.8.2.99

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

Lykins, A. D., Meana, M., & Minimi, J. (2011). Visual attention to erotic images in women reporting pain with intercourse. *The Journal of Sex Research, 48*(1), 43-52. https://doi.org/10.1080/00224490903556374

Maner, J. K., Kenrick, D. T., Becker, D. V., Delton, A. W., Hofer, B., Wilbur, C. J., & Neuberg, S. L. (2003). Sexually selective cognition: Beauty captures the mind of the beholder. *Journal of Personality and Social Psychology, 85*(6), 1107-1120. https://doi.org/10.1037/0022-3514.85.6.1107

McConkie, G. W., & Rayner, K. (1975). The span of the effective stimulus during a fixation in reading. *Perception & Psychophysics, 17*(6), 578–586. https://doi.org/10.3758/BF03203972

Milani, S., Brotto, L. A., & Kingstone, A. (2019). “I can see you”: The impact of implied social presence on visual attention to erotic and neutral stimuli in men and women. *The Canadian Journal of Human Sexuality, 28*(2), 105–119. https://doi.org/10.3138/cjhs.2019-0007

Milani, S., Dawson, S. J., & Velten, J. (2021). Visual attention and sexual function in women. *Current Sexual Health Reports, 13*(3), 89-96. https://doi.org/10.1007/s11930-021-00312-9

Milani, S., Moscovitz, A., & Dawson, S. J. (2020). *Gender and sexual attraction effects in visual attention to sexual cues* [Manuscript submitted for publication]. Department of Psychology, University of British Columbia.

Mogg, K., Millar, N., & Bradley, B. P. (2000). Biases in eye movements to threatening facial expressions in generalized anxiety disorder and depressive disorder. *Journal of Abnormal Psychology (1965), 109*(4), 695-704. https://doi.org/10.1037/0021-843X.109.4.695

Morandini, J. S., Spence, B., Dar-Nimrod, I., & Lykins, A. D. (2020). Do bisexuals have a bisexual viewing pattern? *Archives of Sexual Behavior, 49*(2), 489–502. https://doi.org/10.1007/s10508-019-01514-y

Moyano, N., Vallejo-Medina, P., & Sierra, J. C. (2017). Sexual desire inventory: Two or three dimensions? *The Journal of Sex Research, 54*(1), 105-116. https://doi.org/10.1080/00224499.2015.1109581

Niehorster, D. C., Cornelissen, T. H. W., Holmqvist, K., Hooge, I. T. C., & Hessels, R. S. (2018). What to expect from your remote eye-tracker when participants are unrestrained. *Behavior Research Methods, 50*(1), 213-227. https://doi.org/10.3758/s13428-017-0863-0

Nummenmaa, L., Hietanen, J. K., Santtila, P., & Hyönä, J. (2012). Gender and visibility of sexual cues influence eye movements while viewing faces and bodies. *Archives of Sexual Behavior, 41*(6), 1439–1451. https://doi.org/10.1007/s10508-012-9911-0

O'Kane, K. M. K., Milani, S., Chivers, M. L., & Dawson, S. J. (2022). Gynephilic men's and androphilic women's visual attention patterns: The effects of gender and sexual activity cues. *The Journal of Sex Research*, 1-10. https://doi.org/10.1080/00224499.2022.2033675

Penke, L., & Asendorpf, J. B. (2008). Beyond global sociosexual orientations: A more differentiated look at sociosexuality and its effects on courtship and romantic relationships. *Journal of Personality and Social Psychology, 95*(5), 1113-1135. https://doi.org/10.1037/0022-3514.95.5.1113

Rupp, H. A., & Wallen, K. (2007). Sex differences in viewing sexual stimuli: An eye-tracking study in men and women. *Hormones and Behavior, 51*(4), 524–533. https://doi.org/10.1016/j.yhbeh.2007.01.008

Semmelmann, K., & Weigelt, S. (2018). Online webcam-based eye tracking in cognitive science: A first look. *Behavior Research Methods, 50*(2), 451-465. https://doi.org/10.3758/s13428-017-0913-7

Shimojo, S., Simion, C., Shimojo, E., & Scheier, C. (2003). Gaze bias both reflects and influences preference. *Nature Neuroscience, 6*(12), 1317-1322. https://doi.org/10.1038/nn1150

Spector, I. P., Carey, M. P., & Steinberg, L. (1996). The sexual desire inventory: Development, factor structure, and evidence of reliability. *Journal of Sex & Marital Therapy, 22*(3), 175-190. https://doi.org/10.1080/00926239608414655

Spector, I. P., Carey, M. P., & Steinberg, L. (1998). Sexual desire inventory. *Handbook of sexuality-related measures*, 174-176.

Sui, J., & Liu, C. H. (2009). Can beauty be ignored? Effects of facial attractiveness on covert attention. *Psychonomic Bulletin & Review, 16*(2), 276-281. https://doi.org/10.3758/PBR.16.2.276

Tassone, D., Dawson, S. J., & Chivers, M. L. (2019). The impact of homonegativity on gynephilic men's visual attention toward non-preferred sexual targets. *Personality and Individual Differences, 149*, 261-272. https://doi.org/10.1016/j.paid.2019.05.062

Toates, F. (2009). An integrative theoretical framework for understanding sexual motivation, arousal, and behavior. *The Journal of Sex Research, 46*(2-3), 168-193. https://doi.org/10.1080/00224490902747768

Valuch, C., Pflüger, L. S., Wallner, B., Laeng, B., & Ansorge, U. (2015). Using eye tracking to test for individual differences in attention to attractive faces. *Frontiers in Psychology, 6*, 42-42. https://doi.org/10.3389/fpsyg.2015.00042

van Diepen, P., & d'Ydewalle, G. (2003). Early peripheral and foveal processing in fixations during scene perception. *Visual Cognition, 10*(1), 79-100. https://doi.org/10.1080/713756668

Velten, J., Milani, S., Margraf, J., & Brotto, L. A. (2021a). Visual attention to sexual stimuli in women with clinical, subclinical, and normal sexual functioning: An eye-tracking study. *Journal of Sexual Medicine, 18*(1), 144-155. https://doi.org/10.1016/j.jsxm.2020.10.005

Velten, J., Milani, S., Margraf, J., & Brotto, L. A. (2021b). Visual attention and sexual arousal in women with and without sexual dysfunction. *Behaviour Research and Therapy,* 144, 103915-103915. https://doi.org/10.1016/j.brat.2021.103915

Yang, X., & Krajbich, I. (2021). Webcam-based online eye-tracking for behavioral research. *Judgment and Decision Making, 16*(6), 1485-1505. https://doi.org/10.31234/osf.io/qhme6