Sexual and Affective Responses to Same- and Opposite-Sex Stimuli in Heterosexual and Homosexual Men: Assessment and Manipulation of Visual Attention

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Abstract Affective and cognitive factors play an important role in the activation and regulation of men's sexual arousal. Barlow (1986) argued that initial affective reactions determine the allocation of attention to sexual stimuli. We applied Barlow's model to our understanding of the role of sexual arousal in sexual orientation, where sexual arousal patterns have consistently been found to be congruent with self-reported orientation in men, but not in women. Visual attention of 28 heterosexual and 22 homosexual men to same- and opposite-sex erotic stimuli was assessed and experimentally-directed by means of a newly developed software application, while genital (penile rigidity) and affective responses (self-reported and physiological) were measured. In line with previous research, we found "category specificity" in men's sexual arousal, in that sexual responses were strongest to orientation-congruent stimuli. Also, both homosexual and heterosexual men experienced stronger sexual responses to conditions in which their attention was directed to sexual versus nonsexual content of orientation-congruent stimuli. Only homosexual men manifested higher sexual responses when their visual attention was directed towards the sexual content of orientation-incongruent stimuli. Heterosexual men experienced weaker positive and stronger negative affective responses to orientation-incongruent content, suggestive of potential avoidance or inhibitory mechanisms.

Keywords Visual attention · Sexual orientation · Sexual psychophysiology

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Introduction

From an information processing perspective, affect and attention jointly form a functionally adaptive "control system" that helps us select relevant stimuli and sets the stage for our responses to them (Taylor & Fragopanagos, 2005). Although they most likely work in interaction, a growing empirical literature supports the notion that affect, as the "prime marker of importance to the organism" (Compton, 2003, p. 115), captures and influences the focus of attention (e.g., Cacioppo & Gardner, 1999; Compton, 2003; Frijda, 1986; Öhman, Hamm, & Hugdahl, 2000; Lang, Greenwald, Bradley, & Hamm, 1993; Lang, Potter, & Bolls, 2008). This notion is also relevant to our understanding of the responses to sexual stimuli or the activation and regulation of sexual desire and arousal (e.g., Cranston-Cuebas & Barlow, 1990; Janssen, 2011; Rosen & Beck, 1988), as evolution has primed organisms to be responsive to stimuli that are related to "the overall task of promoting one's genes to prosper in subsequent generations" (Öhman et al., 2000, p. 538).

Affective and Attentional Mechanisms Underlying Sexual Arousal in Men

One of the first conceptual models to propose a role for affective and cognitive processes in the activation and regulation of sexual arousal was offered by Barlow (1986). Reviewing prior experimental and psychophysiological research, Barlow observed a pattern of cognitive and affective differences between sexually functional and sexually dysfunctional men that formed the basis of the model. Specifically, Barlow argued that initial affective reactions determine the allocation of attention to stimuli in a

sexual situation. In sexually functional men, initial positive affective reactions result in increased spontaneous attention to erotic cues. In sexually dysfunctional men, negative affective reactions would lead to increased attention for performance-related *non-erotic* cues (e.g., cues that are relevant to the expectation to become aroused, to perform, or that otherwise induce worries about sexual performance). In addition, Barlow found that, in sexually functional subjects, sexual arousal was facilitated by performance-related cognitive states and expectancies as well as impeded by nonsexual or neutral distracters. In contrast, sexual responses in sexually dysfunctional men were negatively impacted by performance-related states and not influenced (or increased) by nonsexual or neutral distracters (Barlow, 1986). Thus, attention was proposed to be the main mechanism explaining the differences between groups. Barlow's model is consistent with an information processing perspective in that it proposes that affective mechanisms impact attention, which then contributes to or detracts from sexual arousal, and potentially further amplifies initial affective reactions.

Although initially developed to explain erectile problems, Barlow's model can be applied to related topics, including the mechanisms underlying heterosexual and homosexual men's responses to same- and opposite-sex stimuli. Psychophysiological studies in this area have consistently found that men's sexual responses are orientation-congruent or consistent with their self-reported sexual orientation. Thus, heterosexual men tend to become sexually aroused to stimuli depicting heterosexual sexual activity, while they do not, or much less so, become sexually aroused when presented with (male) homosexual stimuli. The opposite is the case for homosexual men. This is in contrast to women, where such "category specificity" has not been found—that is, women are much more likely to become sexually aroused to stimuli that are not consistent with their self-reported sexual orientation (Chivers & Bailey, 2007; Chivers, Rieger, Latty, & Bailey, 2004; Chivers, Seto, & Blanchard, 2007; Chivers, Seto, Lalumière, Laan, & Grimbos, 2010; Imhoff et al., 2010; Lippa, 2012; Mavissakalian, Blanchard, Abel, & Barlow, 1975; McConaghy & Blaszczynski, 1991; Peterson, Janssen, & Laan, 2009; Rieger, Chivers, & Bailey, 2005; Sakheim, Barlow, Beck, & Abrahamson, 1985; Suschinsky, Lalumière, & Chivers, 2009; Tollison, Adams, & Tollison, 1979). In spite of extensive research in this area, few studies have focused on underlying mechanisms potentially explaining the mentioned effects.

From Barlow's model, it could be predicted that responses to orientation-congruent and orientation-incongruent sexual stimuli originate in men's initial affective reaction towards the stimuli, which impact their attention and further processing of stimuli. In other words, the category specificity in men's responses to sexual stimuli might, at least to a certain degree, be driven by their initial affective reaction: positive, directing focus towards sexual content, or negative, directing visual attention away from sexual content.

The consideration of affective mechanisms, as activated by orientation-congruent versus orientation-incongruent stimuli, brings attention to other factors. Positive affect, or its absence thereof, has been proposed to impact subjective sexual arousal (Wiegel, Scepkowski, & Barlow, 2007) and to be specifically relevant to self-reported sexual desire, defined by some as the cognitive awareness of sexual arousal (Everaerd, Laan, Both, & Spiering, 2001). Indeed, it has been found that positive affect predicts levels of self-reported sexual arousal—increasing sexual arousal when present and lowering it when absent (Peterson & Janssen, 2007). Although more research on the roles of positive and negative affect in the activation and regulation of sexual arousal is needed, following Barlow's model, they can be expected to follow patterns consistent with participants' sexual orientation.

The proposed relevance of attentional and affective mechanisms is consistent with findings of several recent studies that used viewing time to assess men's and women's responses to orientation-congruent and -incongruent stimuli. These studies support the notion of category specificity, and demonstrated stronger category specificity in heterosexual than in homosexual men. For example, Israel and Strassberg (2009) and Rullo, Strassberg, and Israel (2010) found that heterosexual and homosexual men viewed orientation-congruent stimuli significantly longer than orientation-incongruent ones. It was concluded that the results were consistent with findings from psychophysiological studies reporting category specificity in men's sexual arousal. Interestingly, a close inspection of the findings suggests that heterosexual participants experienced stronger orientation-congruent response patterns than homosexual participants: Homosexual men viewed male images for 3.7 s and female photos for 2.6 s, on average, whereas heterosexual men viewed female images for 3.5 s but viewed male images for a much shorter time, on average 1.7 s. More recently, Ebsworth and Lalumière (2012), who also used viewing time, found that the degree of category specificity was, in fact, significantly higher in heterosexual than in homosexual men.

Self-Directed Versus Manipulated Attention

Researchers have started to explore the role of visual attentional processes in sexual science using eye-tracking methodologies (Imhoff et al., 2010; Lykins, Meana, & Strauss, 2008; Rupp & Wallen, 2007, 2008, 2009). These studies have found that stimulus characteristics as well as individual difference variables (some related to sex and sexual orientation) influence attentional focus to sexual stimuli. Yet, no studies on sexual responses to sexually preferred or nonpreferred stimuli have actually *manipulated* attention. That is, although some studies have examined the effects of specific stimulus characteristics on attention, research on what the effects might be of directing individuals' attention to specific stimulus characteristics or content is lacking.

The current study, in addition to examining spontaneous or self-directed attention, investigated what the effects were of directing heterosexual and homosexual men's attention to the sexual (e.g., genitals) or nonsexual (e.g., background, hair) con-

tent of orientation-congruent and orientation-incongruent sexual stimuli. To direct visual attention, a newly developed application (Samson & Janssen, 2013) was used. The software application was designed to present circular transparent outlines (or *bubbles*) on top of a video clip, allowing only the content within a selected bubble to be made visible, while the rest of the video was dimmed. Consistent with Barlow's model, we expected that directing visual attention to sexual versus nonsexual content would lead to stronger genital responses while also potentially amplifying men's (negative) affective responses.[1] Particularly, it was expected that men's negative affect would increase when attentional focus was directed towards the sexual content of orientation-incongruent stimuli. Positive affect was expected to follow an opposite pattern: Lower levels were expected when directing visual focus towards the sexual content of orientation-incongruent stimuli.

Thus, the current study explored how cognitive and affective mechanisms influence men's responses to same- and opposite-sex erotic stimuli. In line with findings of male "category specificity" and consistent with Barlow's (1986) model, the first hypotheses focused on self-directed visual attention:

H1 Men's attentional, sexual, and affective responses will be congruent with their sexual orientation, in that more attention towards sexual content, higher genital arousal, higher subjective sexual arousal, higher positive affect, and lower negative affect will be experienced in response to erotic stimuli when they are congruent with their sexual orientation as compared to when they are not.

H2 Sexual orientation and self-directed visual attention to same- and opposite-sex stimuli will interact such that heterosexual men, more than homosexual men, will focus their attention away from the sexual content when it was orientation-incongruent than when it was congruent.

The present study further investigated the impact of directing men's visual attention towards sexual and nonsexual content of same- and opposite-sex erotic stimuli. In line with findings of male category specificity, and consistent with Barlow's (1986) model, the final two hypotheses focused on manipulated visual attention:

H3 Directing visual attention towards sexual content, regardless of whether the stimuli depicted same- or opposite- sexual behavior, will result in higher levels of genital arousal than when visual attention was directed towards nonsexual content.

H4 Directing visual attention towards orientation-incongruent sexual content will increase negative affect and lower positive affect.

Lastly, we inquired whether there would be an association between sexual and affective responses to orientation-incongruent stimuli and visual attention conditions:

RQ Will there be differences in affective and sexual responses to orientation-incongruent sexual content in manipulated versus self-directed attention conditions?

Method

Participants

A total of 50 men (28 heterosexual, 22 homosexual) participated in this study. They were recruited through flyers and online announcements. Recruitment materials invited heterosexual or homosexual men, aged 21–35 years to participate in an experiment that focused on the processing of sexual stimuli. It asked them to complete a brief screening questionnaire by following a link to a website. The screening questionnaire collected self-reported data about age, sexual orientation, and possible treatment or experience of mental health or sexual problems. Interested subjects were scheduled for an experimental session and received a link to a larger set of questionnaires, which collected demographics as well as information on sexual attitudes, sexual behavior, relationships, and experience with sexually explicit materials. Subjects were compensated $15 for their participation in the study. Study approval was obtained from the university's Human Subjects Committee.

Stimuli

Participants were presented with a series of six 3-min excerpts from commercially available sexually explicit films and seven nonsexual, neutral excerpts taken from documentaries about animals (e.g., cats, turtles). The first neutral clip lasted 8 min and was used to determine physiological baseline levels. Subsequent neutral film excerpts were used for 3-min return-to-baseline intervals.

Sexual film excerpts consisted of three videos depicting homosexual (two men engaged in same-sex with one another) and three videos depicting heterosexual (a man and a woman engaged in sex) activity.[2] All sexual clips depicted actors engaged in petting,

[1] Barlow's model was developed to describe the effects of affect on attentional processes when attention is not directed or manipulated. We propose that attention may impact both arousal and affect when attention *is* manipulated.

[2] Although a number of studies on category-specificity have focused on the comparison of heterosexual and homosexual groups, we were mainly interested in the effects of (manipulating) attention within groups. Whereas female–female stimuli have been found to be more effective in discriminating between groups, we used male-female stimuli as they were more directly aligned with heterosexual men's sexual behaviors and preferential film exposure (as male-male films are for homosexual men) and as they have been found to lead to category specificity, at least within groups of heterosexual men, in some studies (e.g., Chivers & Bailey, 2005).

fondling, and kissing (1 min), oral-genital sex (1 min), and sexual intercourse (1 min) on the visual channel. The auditory channel featured soft background music but no sexual content.

All sexual film excerpts were selected on the basis of findings from a pilot study. An initial pool of 12 clips (six homosexual and six heterosexual) included stimuli used in previous Kinsey Institute studies, videos from The Kinsey Institute's extensive film collection, and videos recommended by other researchers. These 12 film excerpts were viewed online and rated anonymously by colleagues and collaborators ($N = 24$). The three homosexual clips were chosen based on ratings provided by self-identified homosexual men and the three heterosexual clips were selected based on ratings of self-identified heterosexual men.

The Manipulation and Assessment of Visual Attention

The manipulation and measurement of visual attention was accomplished through use of a software application (Samson & Janssen, 2013)[3] that was specifically designed for this study. Circular transparent outlines moved on top of the videos, making their content fully visible while darkening the rest of the clips (see Fig. 1). During the experiment, participants were asked to use a computer mouse to keep its cursor inside either a self-selected or a prescribed bubble, depending on the instruction. To minimize awareness and sensitization to the research topic, as well as to reduce response biases, participants were not explicitly informed prior to study completion that the time they spent inside bubbles was recorded. No information about the purpose of the bubbles was provided until debriefing, at the end of the experiment.[4]

For self-directed visual attention (Condition 1), not one but two transparent outlines moved freely within the screen, and participants were told that they could select either one and move from one to the other whenever they wanted, by keeping the mouse cursor inside the chosen bubble. One of the two bubbles moved over sexual content (e.g., genitals), the other over nonsexual content (e.g., background, hair, arms). Thus, in Condition 1, the participants could choose to focus on sexual or nonsexual content. For the other two conditions, participants' visual attention was directed towards sexual (Condition 2) or towards nonsexual content (Condition 3). Self-directed attention (Condition 1) was assessed prior to the manipulation of visual focus (Conditions 2 and 3). Thus, participants were first presented with two videos presenting two bubbles (Condition 1) and were allowed to select either the sexual or the nonsexual bubble. During the second and third conditions, both involving two (one heterosexual, one homosexual) videos, only sexual or nonsexual content was available. Participants were randomly assigned to one out of three (randomly constructed) fixed orders in which the six videos and two conditions were presented.

Measures

Genital Response

Erectile responses were monitored by means of a RigiScan device (Timm Medical Technologies). This instrument measures penile circumference at 15 s intervals and penile rigidity at 30 s intervals once the circumference has increased by 20 %. For a discussion of the reliability and validity of the RigiScan, see Janssen (2002) and Janssen, Prause, and Geer (2007).

Affective Responses

Affective responses were measured through facial electromyographical (EMG) recordings of corrugator supercilii muscle activation, which has been found to be a reliable measure of negative valence and a reverse measure of positive valence (Bradley, 2000; Larsen, Norris, & Cacioppo, 2003; Potter & Bolls, 2011; Sparks, 2006; Stern, Ray, & Quigley, 2001; Tassinary & Cacioppo, 1992; Tassinary, Cacioppo, & Green, 1989). Corrugator activity was recorded using a pair of Beckman mini-Ag/AgCl electrodes, and a ground sensor (placed on the arm), filled with conductive gel. The two electrodes were, after skin preparation, placed just above the eyebrow (on the corrugator supercilii muscle). The signals were acquired using a Coulbourn V75-04 bioamplifier with a 8–150 Hz band pass filter and a Coulbourn V76-23A contour-following integrator set at 100 ms for smoothing.

In addition, affect was assessed by asking participants to indicate their affective states and subjective sexual arousal following exposure to each visual stimulus. Subjective sexual arousal and affect were evaluated using the self-report rating scale adapted from Heiman and Rowland (1983). Questions about positive and negative affect were added. Participants used 7-point semantic differential scales, from 1 (Not at All) to 7 (Intensely) to evaluate how they felt immediately after exposure to each film excerpt.

Demographics and Background Information

In addition to their sexual orientation, participants were asked to provide demographic information. They answered questions about relationship status, experience with sexually explicit materials, health and sexual problems (e.g., erectile problems) as well as frequency of various types of sexual activity (Bancroft et al., 2003, 2004).

[3] More detailed information on the included options and availability of the software application can be obtained from the authors.

[4] Prior to revealing the purpose of the study, participants were asked about their thoughts on what the experiment was about. None of the participants guessed correctly the purpose of the study.

Fig. 1 The manipulation and assessment of visual attention

Procedure

Upon arrival to the lab, participants, who were tested individually, entered a room furnished with an armchair, a desk, a mouse with mouse-pad, and a large 42-inch LCD television monitor. An experimenter explained the procedures and showed the measurement devices. After the participant read and signed the informed consent form, the experimenter left the room and the participant put, after lowering his pants, the RigiScan in place and a disposable sheet and towel on his lap, a procedure commonly used in studies of this kind (Janssen, Goodrich, Petrocelli, & Bancroft, 2009). After the device was put in place, the experimenter reentered the room and attached the EMG electrodes. Following this, the experimenter retired to the adjoining room and started a 15-min adaptation period. During the adaptation period, the participant was asked to practice the experimental task by trying to keep the mouse-cursor inside bubbles placed on top of a practice film. At completion of the practice task, participants were presented with an 8-min neutral film. This was followed by presentation of the sexual clips. Between presentations of the sexual films and at the end of the experimental procedure, 3-min neutral clips were shown to establish return-to-baseline levels. After each film stimulus, a short questionnaire asked for participants' self-reports regarding the film excerpt just viewed. At the end of the testing session, payment arrangements were made and participants were debriefed regarding the purpose and hypotheses of the study. Testing sessions took approximately 90 min.

Data Analysis

Genital responses were reported as the maximum penile rigidity as measured at the base of the penis (Janssen, Vorst, Finn, & Bancroft, 2002). Corrugator muscle activation was calculated as the mean difference between the recording during exposure to the sexual clip minus responses to last 3 min of the baseline neutral stimulus.

Analyses were conducted using a mixed 2 (Sexual Orientation) × 2 (Sexual Stimulus) × 2 (Attention Manipulation) factorial design. Sexual Orientation, a between-subjects factor, had two levels: self-reported heterosexual or homosexual orientation. Sexual Stimulus, a within-subjects factor, consisted of video clips depicting homosexual (man–man) and heterosexual (man–woman) sexual activity. The Attention Manipulation, also a within-subjects factor, was created using the following two manipulations: (1) visual attention directed towards sexual content (e.g., genitals), and (2) visual attention directed towards to nonsexual content (e.g., the environment).

SPSS 18 for Windows and SPSS 11 for Mac OS X were used for all analyses. The Greenhouse-Geisser epsilon procedure was applied to mixed-factor ANOVAs to correct for the violation of the sphericity assumption in repeated measures designs (Vasey & Thayer, 1987).

The data from one heterosexual participant were excluded from all analyses because he fell asleep during the study. In addition, the data from one homosexual and one heterosexual

participant were excluded from the analyses on sexual arousal because their RigiScan recording was unusable due to experimenter error. The data from one heterosexual and two homosexual participants were excluded from the analyses of affect responses, as their EMG data were unusable due to recurring artifacts (i.e., coughing). No other participants were excluded from analysis. The final sample consisted of 47 men for the sexual arousal analyses and 46 men for the affect analyses.

Results

Sample Characteristics

The mean age of the participants was 23.5 years ($SD = 3.1$), ranging from 21 to 32. The marital status of the majority (92 %) of participants was single, but 26 (58 %) of the men were involved in a sexual relationship at the time of the study. Most men reported moderate levels of experience with sexually explicit materials (SEM) with preferential exposure to orientation-congruent SEM (see Table 1). The majority of men also reported having viewed orientation-incongruent SEM—except 12 heterosexual men. Other demographic and sexual history variables are shown in Table 1.

Table 1 Sample characteristics

Variable	Group				
	Heterosexual men ($N = 27$)		Homosexual men ($N = 22$)		
	M	*SD*	*M*	*SD*	$F(1, 47)$
Age (in years)	23.7	3.1	23.3	3.2	
Number of female sexual partners/year	2.3	1.5	0.05	0.2	50.17*
Number of male sexual partners/year	0.0	0.0	6.5	8.4	16.98*
Attraction towards opposite sex	3.9	0.2	1.7	0.7	221.41*
Attraction towards same sex	1.3	0.6	4.0	0.0	396.07*
Experience with heterosexual erotica[a]	3.6	0.5	2.4	0.6	49.39*
Experience with homosexual erotica[a]	1.6	0.7	3.8	0.4	181.24*

[a] Absolute range, 1–4

* $p < .01$

Self-Directed Visual Attention

Hypothesis 1 stated that men will display more attention to sexual content, stronger penile erections, higher levels of subjective sexual arousal, higher positive and lower negative affect when sexual stimuli were congruent with their sexual orientation.

Self-Selected Visual Attention

Figure 2 shows the time participants spent viewing the sexual content during the self-directed visual attention condition for each type of erotic stimulus. A 2 (Sexual Orientation) × 2 (Sexual Stimulus) mixed-model ANOVA was performed on the time participants chose to spend in the sexual bubble during Condition 1. We found a significant interaction, $F(1, 47) = 37.92$, $p < .0001$, $\eta_p^2 = .49$. Follow-up tests on the interaction effect revealed that homosexual participants did not focus for different amounts of time on the sexual content of homosexual and heterosexual stimulus presentations (169.5 vs. 158.4 s). In contrast, heterosexual men showed orientation-congruency: their self-directed visual attention for sexual content was significantly longer for orientation-congruent (154.9 s) than for orientation-incongruent stimuli (56.9 s), $t(26) = -7.16$, $p < .0001$.

Genital Responses

A 2 (Sexual Orientation) × 2 (Sexual Stimulus) mixed-model ANOVA was performed on men's penile rigidity[5] during the self-directed visual attention condition. We found a significant interaction, $F(1, 45) = 24.11$, $p < .0001$, $\eta_p^2 = .40$. Both heterosexual and homosexual men displayed stronger penile erections to orientation-congruent than to orientation-incongruent stimuli (Fig. 3, upper-left panel). Homosexual men had significantly stronger erectile responses to homosexual stimuli ($M = 37.24$, $SE = 4.81$) than to heterosexual stimuli ($M = 18.52$, $SE = 6.63$), $t(20) = 3.68$, $p < .005$. Heterosexual men had significantly stronger erectile responses to heterosexual ($M = 40.77$, $SE = 5.96$) than to homosexual stimuli ($M = 7.42$, $SE = 4.32$), $t(25) = -4.49$, $p < .0001$.

Subjective Sexual Arousal

A 2 (Sexual Orientation) × 2 (Sexual Stimulus) mixed-model ANOVA revealed a significant interaction, $F(1, 45) = 59.79$, $p < .0001$, $\eta_p^2 = .59$, on subjective feelings of sexual arousal. As for genital responses, subjective sexual arousal of both heterosexual and homosexual men was higher during orientation-congruent stimuli than during orientation-incongruent ones (Fig. 3, upper-right panel). Homosexual men reported significantly higher levels of sexual arousal during homosexual stimuli ($M = 5.48$, $SE = .24$) than during heterosexual stimuli ($M = 3.48$, $SE = .43$), $t(20) = 5.63$, $p < .0001$. Similarly, heterosexual men reported significantly stronger levels of sexual arousal during heterosexual films ($M = 4.19$, $SE = .21$) than during homosexual ones ($M = 1.77$, $SE = .39$), $t(25) = -6.02$, $p < .0001$.

[5] All genital response analyses were repeated using circumference change as the dependent variable and revealed an identical pattern of findings.

Affective Responses

Three additional 2 (Sexual Orientation) × 2 (Sexual Stimulus) mixed-model ANOVAs were performed on men's affective responses, two for self-reported affect and one for the EMG measure.

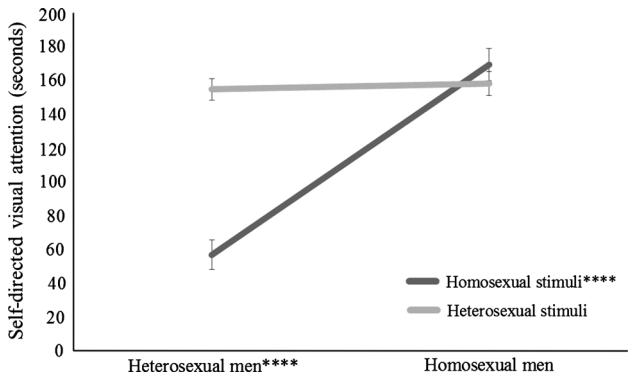

Fig. 2 Self-directed visual attention for sexual content (in seconds). ****$p < .0001$

For self-reported positive affect, we found a significant interaction, $F(1, 44) = 75.77$, $p < .0001$, $\eta_p^2 = .63$, on men's self-reported positive affect. Figure 3 (lower-left panel) shows men's self-reported positive affect during the self-directed visual attention condition for each type of erotic stimulus. Consistent with the genital response and subjective sexual arousal findings, homosexual men reported lower positive affect during heterosexual stimuli ($M = 3.90$, $SE = .31$) than during homosexual stimuli ($M = 5.43$, $SE = .29$), $t(19) = -5.59$, $p < .0001$. Similarly, heterosexual men reported higher positive affect during heterosexual stimuli ($M = 4.65$, $SE = .28$) than during homosexual stimuli ($M = 2.27$, $SE = .27$), $t(25) = 7.06$, $p < .0001$.

Self-reported negative affect partly followed expected patterns (Fig. 3, lower-right panel). There was a significant interaction, $F(1, 44) = 11.91$, $p < .001$, $\eta_p^2 = .21$. Follow-up tests on the interaction effect revealed that homosexual men reported lower negative affect during homosexual stimuli than during heterosexual stimuli presentations ($M = 1.57$, $SE = .32$ vs. $M = 1.71$, $SE = .15$). In line with their genital responses, heterosexual men's negative affect varied more strongly. Their self-reported negative affect was significantly lower during heterosexual

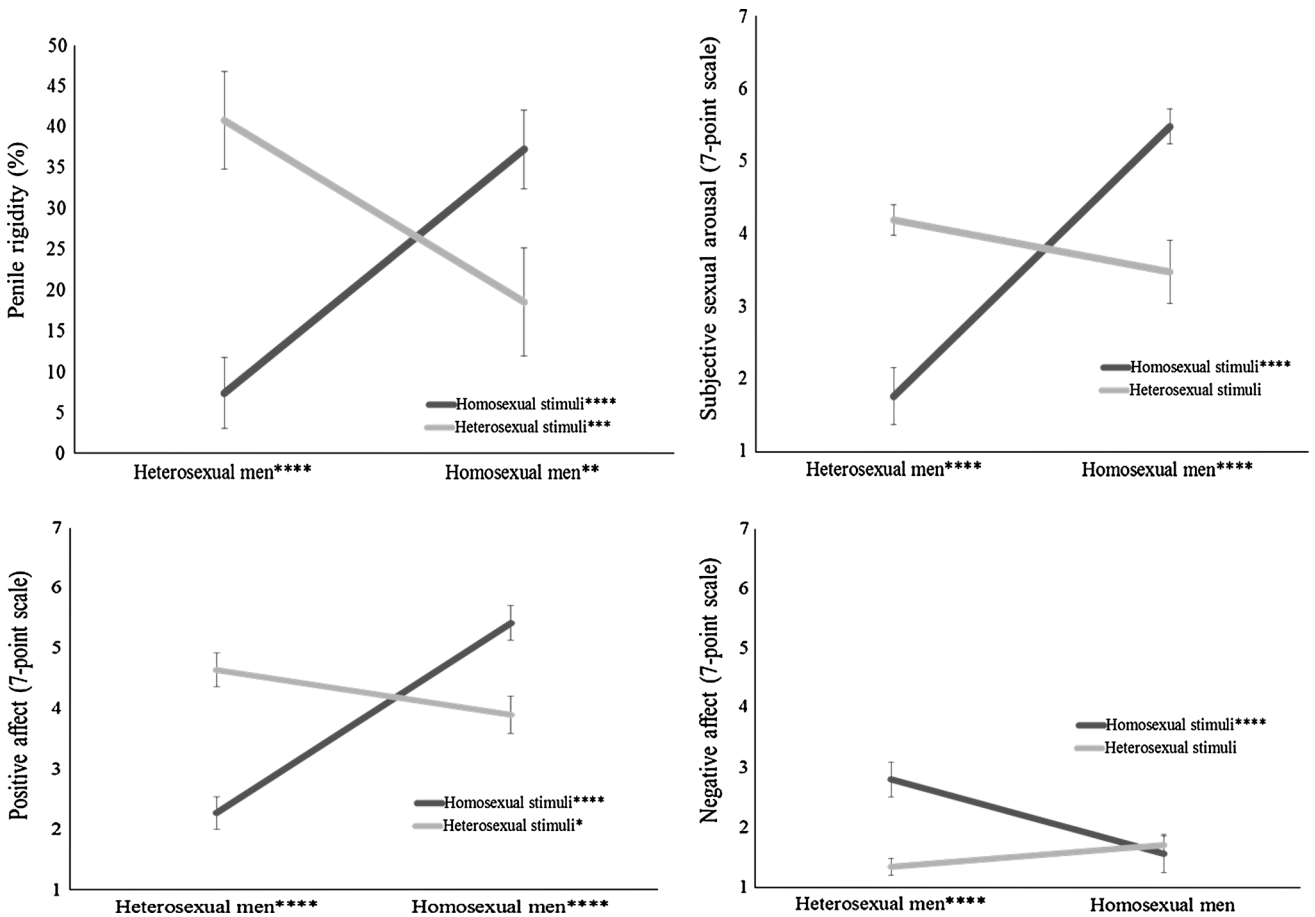

Fig. 3 Men's sexual and affective responses during the self-directed attention condition. *$p < .05$; **$p < .01$; ***$p < .001$; ****$p < .0001$

stimuli ($M = 1.35$, $SE = .14$) than during homosexual ones ($M = 2.81$, $SE = .29$), $t(25) = -3.75$, $p < .0001$.

In contrast to the self-report data, no significant main or interaction effects were found for the physiological measure (corrugator activity) of affect.

Manipulated Visual Attention

A manipulation check was performed for the conditions during which participants' attention was directed towards sexual and nonsexual content (Conditions 2 and 3). It revealed that participants conformed to the experimental task. Heterosexual men kept the mouse cursor inside the sexual bubble (during Condition 2) for an average of 172 s during homosexual stimuli and for 170 s during heterosexual stimuli. Similarly, homosexual men kept the mouse cursor inside the sexual bubble for an average of 177 s during homosexual stimuli and for 174 s during heterosexual stimuli. The participants also conformed to the experimental task when their visual attention was directed towards the nonsexual content of the videos (Condition 3). Heterosexual men kept the mouse cursor inside the nonsexual bubble for an average of 173 s during homosexual stimuli and for 172 s during heterosexual stimuli. Homosexual men kept the mouse cursor inside the nonsexual bubble for an average of 174 s during both erotic stimuli type. None of these differences were significant.

Genital Response

Hypothesis 3 stated that directing visual attention to sexual content would lead to stronger genital responses than directing visual attention to nonsexual content. To test this prediction, a 2 (Attention Manipulation) × 2 (Sexual Orientation) × 2 (Sexual Stimulus) mixed-model ANOVA was performed on men's genital responses. The analysis revealed a significant three-way interaction (see Table 2).

Follow-up analyses on the three-way interaction revealed that when visual attention was directed towards the sexual content of the heterosexual stimuli, genital responses were significantly stronger in both the heterosexual men ($M = 22.50$, $SE = 5.16$ for nonsexual content, $M = 35.85$, $SE = 6.52$ for sexual content, $t(25) = 2.85$, $p < .01$) and the homosexual men ($M = 18.05$, $SE = 5.74$ for nonsexual content, $M = 26.00$, $SE = 7.25$ for sexual content, $t(20) = 2.19$, $p < .05$). However, directing attention to sexual content of the homosexual stimuli resulted in significantly stronger genital responses in homosexual men only ($M = 19.81$, $SE = 3.74$ for nonsexual content, $M = 37.14$, $SE = 5.28$ for sexual content, $t(20) = 2.66$, $p < .01$). No significant difference was found for the heterosexual men ($M = 3.08$, $SE = 3.36$ for nonsexual content vs. $M = 5.39$, $SE = 4.75$ for sexual content, respectively).

Affective Responses

Hypothesis 4 stated that directing visual attention towards sexual content would impact men's affective responses. More specifically, it was expected that men's negative affect would increase when their visual focus was directed towards orientation-incongruent sexual stimuli. Positive affect was expected to follow an opposite pattern.

A 2 (Sexual Orientation) × 2 (Sexual Stimulus) mixed-model ANOVA revealed a significant interaction, $F(1, 44) = 54.45$, $p < .0001$, $\eta_p^2 = .64$, on men's self-reported positive affect. Figure 4 (upper-left panel) shows men's self-reported positive affect during the manipulated visual attention to sexual content condition. Both heterosexual and homosexual men reported higher positive affect when their visual focus was directed towards orientation-congruent stimuli than towards orientation-incongruent ones. Homosexual men experienced significantly stronger positive affect during homosexual stimuli ($M = 5.21$, $SE = .27$) than during heterosexual stimuli, $M = 4.32$, $SE = .36$, $t(19) = 2.26$, $p < .05$. Similarly, heterosexual men experienced significantly lower levels of positive affect during homosexual stimuli ($M = 2.08$, $SE = .24$) than during heterosexual ones, $M = 5.32$, $SE = .31$, $t(25) = -8.43$, $p < .0001$.

Regarding self-reported negative affect, we again found a significant interaction, $F(1, 44) = 17.36$, $p < .0001$, $\eta_p^2 = .32$ (see Fig. 4, upper-right panel). Homosexual men did not show significantly different levels of negative affect to homosexual ($M = 1.32$, $SE = .35$) than heterosexual stimuli ($M = 1.42$, $SE = .15$). However, in heterosexual men, self-reported negative affect was significantly higher when their visual focus was directed towards orientation-incongruent ($M = 3.12$, $SE = .29$) than when it was directed towards orientation-congruent stimuli ($M = 1.12$, $SE = .14$, $t(25) = 5.00$, $p < .0001$).

In contrast to the self-directed attention condition, our physiological measure of affect revealed a significant interaction, $F(1, 44) = 15.15$, $p < .0001$, $\eta_p^2 = .16$, on men's corrugator muscle activation (see Fig. 4, lower-right panel). Significantly higher corrugator muscle activation (reflecting stronger negative affect) was found in heterosexual men during homosexual ($M = .103$, $SE = .048$) than during heterosexual stimulus presentations ($M = .031$, $SE = .029$, $t(25) = 2.73$, $p < .005$), which were close to base levels. Homosexual men manifested significantly lower activation over corrugator supercilii muscle during homosexual stimuli ($M = -.151$, $SE = .055$) than during heterosexual ones ($M = -.045$, $SE = .033$, $t(19) = -2.69$, $p < .005$), which were close to base levels.

Associations Between Visual Attention and Responses to Orientation-Incongruent Sexual Stimuli

We conducted additional, exploratory analyses on the association between sexual and affective responses to orientation-

Table 2 Analysis of variance (ANOVA) for genital responses during the manipulated attention condition

	$F(1, 45)$	p	η_p^2
Attention Manipulation	25.97	<.0001	.37
Sexual Stimulus	4.58	<.03	.09
Sexual Orientation × Sexual Stimulus	13.22	<.001	.23
Attention Manipulation × Sexual Orientation × Sexual Stimulus	4.96	<.03	.10

Mean penile rigidity (%) during attention manipulation condition

	Sexual Orientation			
	Heterosexual men[a]		Homosexual men[b]	
Sexual Stimulus–Attention Manipulation	*M*	*SD*	*M*	*SD*
Heterosexual–sexual content	35.85	6.52	26.00	7.25
Heterosexual–nonsexual content	22.50	5.16	18.05	5.75
Homosexual–sexual content	5.39	4.75	37.14	5.28
Homosexual–nonsexual content	3.08	3.36	19.81	3.74

[a] Significant difference between the means for the heterosexual men:
heterosexual–sexual content versus heterosexual–nonsexual content, $t(25) = 2.85$, $p < .01$;
homosexual–sexual content versus homosexual–nonsexual content, $t(25) = 1.69$;
heterosexual–nonsexual content versus homosexual–nonsexual content, $t(25) = 3.89$, $p < .001$;
heterosexual–sexual content versus homosexual–sexual content, $t(25) = 4.25$, $p < .0001$

[b] Significant difference between the means of the homosexual men:
heterosexual–sexual content versus heterosexual–nonsexual content, $t(20) = 2.21$, $p < .05$;
homosexual–sexual content versus homosexual–nonsexual content, $t(20) = 2.66$, $p < .01$;
heterosexual–nonsexual content versus homosexual–nonsexual content, $t(20) < 1$;
heterosexual–sexual content versus homosexual–sexual content, $t(20) = -1.27$

incongruent stimuli and visual attention, by calculating the difference between manipulated versus self-directed attention (time-in-bubble) to sexual content. Because we did not find a difference for homosexual men in self-directed attention to homosexual versus heterosexual content, we limited these analyses to the heterosexual participants. The difference between manipulated versus self-directed visual attention to homosexual erotic content was positively correlated with heterosexual men's self-reported and physiological (corrugator activity) negative affect to the homosexual stimuli (see Table 3) during the manipulated attention condition. Furthermore, it was negatively correlated with self-reported positive affect and both genital and subjective sexual responses. Thus, heterosexual men who were least likely to focus their attention on homosexual erotic content during the self-directed attention condition experienced more negative and less positive affect, smaller genital responses, and lower subjective sexual arousal to homosexual erotic content when their attention was directed to such content. In other words, heterosexual men who tended to avoid the sexual content of homosexual film stimuli during the self-directed attention condition demonstrated the highest levels of category specificity during the other parts of the study.

Discussion

The main goal of this study was to explore the role of cognitive and affective processes in the activation and regulation of men's sexual arousal to same- and opposite-sex erotic stimuli. The results indicated that variation in men's affective and attentional processes accounted for differences in their sexual responses to different sexual orientation stimuli in complex ways.

Our first hypothesis received partial support. Regarding self-selected visual attention, only heterosexual men exhibited category-specificity. Homosexual men focused on the sexual content of both orientation-congruent and orientation-incongruent sexual stimuli. Similar patterns emerged for self-reported negative affect, with category specificity in heterosexual but not in homosexual men. These findings were consistent with those reported by Israel and Strassberg (2009), Rullo et al. (2010), and Ebsworth and Lalumière (2012), who also found stronger category specificity in heterosexual than in homosexual men.

With respect to our second hypothesis, heterosexual men's negative affect and lower self-directed visual attention for homosexual erotic content allowed us to speculate that, perhaps, some negative, avoidance processes may have led to a relative lack of

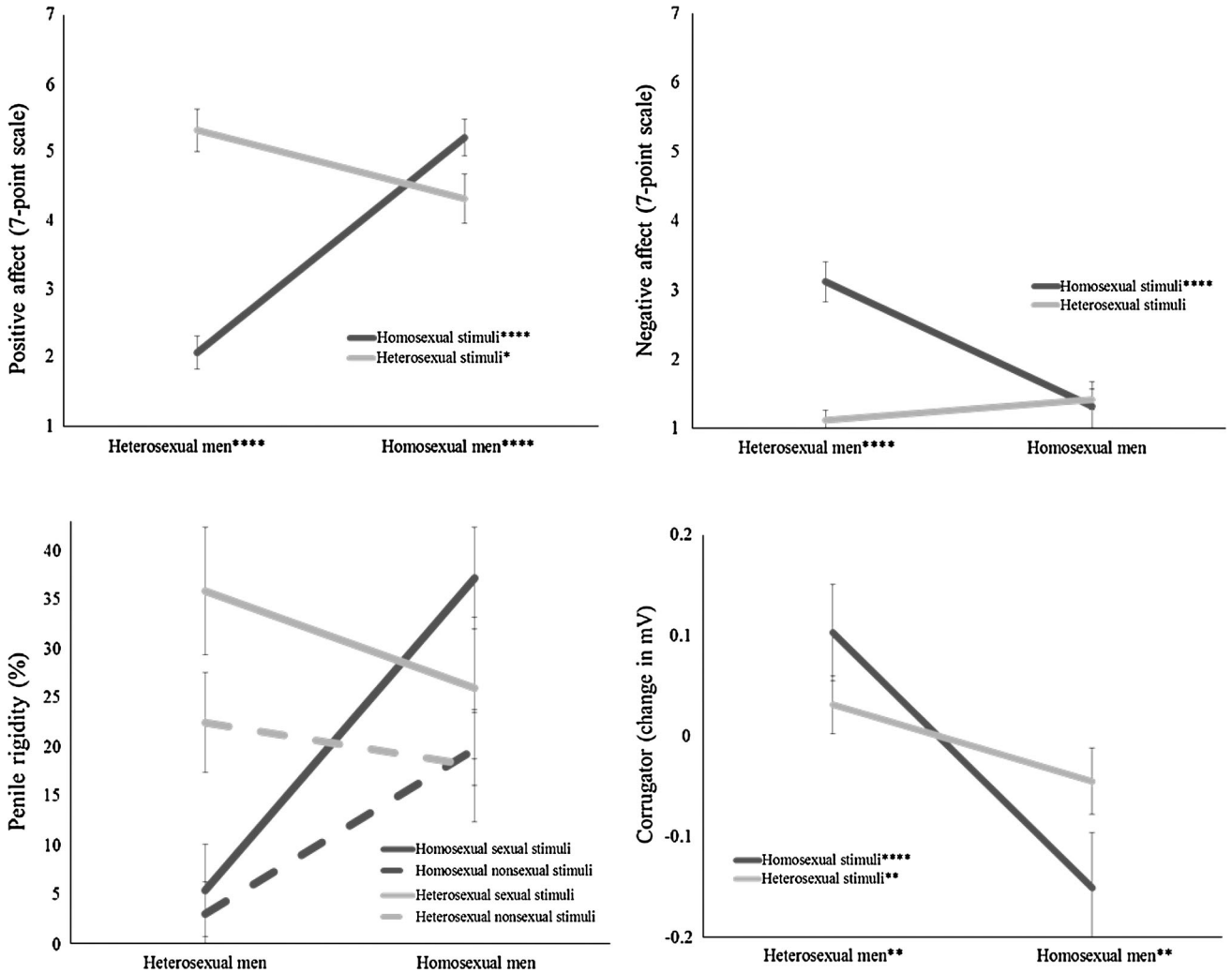

Fig. 4 Men's sexual and affective responses when their visual attention is directed towards sexual content. *$p < .05$; **$p < .01$; ***$p < .001$; ****$p < .0001$

genital responses to the homosexual stimuli in this group of men. In contrast, homosexual men did not avoid the sexual content of orientation-incongruent stimuli nor did they report negative affect when viewing them. Yet, their genital arousal was, like that of the heterosexual men, category specific.

Table 3 Correlations between affect and sexual responses and the difference between men's self-directed versus manipulated visual attention to sexual content

Variable	Pearson correlation	*p*
Penile rigidity during homosexual stimuli	−.44	.001
Subjective sexual arousal for homosexual stimuli	−.72	<.0001
Self-reported positive affect for homosexual stimuli	−.77	<.0001
Self-reported negative affect for homosexual stimuli	.58	<.0001
Physiological negative affect during homosexual stimuli	.29	.036

The present study also investigated the effects of manipulating visual attention towards sexual and nonsexual content of orientation-congruent and -incongruent stimuli. As expected, when attention was directed towards the sexual versus the nonsexual content of orientation-congruent stimuli, both heterosexual and homosexual men experienced stronger sexual responses. However, when attention was directed towards the sexual versus nonsexual content of orientation-incongruent stimuli, genital responses were significantly stronger for homosexual men only. The genital responses of heterosexual men did not differ significantly for conditions in which their attention was directed towards sexual versus nonsexual content of the homosexual stimuli. Yet, their responses did differ between orientation-congruent and orientation-incongruent stimuli. In fact, directing heterosexual men's attention towards the *nonsexual* content (e.g., furniture, swimming pools, hair) of heterosexual erotic clips resulted in

significantly stronger genital responses as compared to directing their attention towards the *sexual* content of homosexual clips. Thus, Hypothesis 3, stating that stronger genital responses would occur when attention was directed towards sexual versus nonsexual content, was only partially supported. Self-reported sexual arousal and positive affect did not follow similar patterns—they remained category specific even when visual attention was manipulated. Self-reported negative affect was also category specific, but only for heterosexual men.

In contrast to the self-directed attention condition, where no effects were found for the physiological measure of affect, directing visual attention towards orientation-incongruent sexual stimuli not only impacted self-reported affect, but also corrugator muscle activity—our physiological measure of affect. Thus, although corrugator activity did not reflect or match with self-reported affect in the condition where orientation-incongruent cues could be (and actually were) avoided, it did so when participants were not allowed to avoid orientation-incongruent sexual content. Heterosexual men's higher level of corrugator activity when their visual focus was directed towards the sexual content of orientation-incongruent stimuli suggests that (in this case, negative) affect does not only operate during the initial allocation of attention, as Barlow's (1986) model emphasizes, but throughout the activation and regulation of sexual responses to relevant stimuli. Actively directing the focus of attention towards content that was largely avoided during the self-directed condition—where no discernible activation of corrugator activity was recorded—seems to have amplified physiological negative affect in the heterosexual men.

The combination of these findings raises questions about whether responses to orientation-congruent and orientation-incongruent stimuli were exclusively the result of mechanisms relevant to the activation of sexual arousal or whether they may also involve inhibitory processes (cf. Cerny & Janssen, 2011). That is, evidence of increased negative affect and minimal responses to homosexual erotic content in heterosexual men (with genital responses lower than those to the *nonsexual* content of the heterosexual stimuli) may suggest a role for inhibitory influences (cf. Bancroft, Graham, Janssen, & Sanders, 2009).

Furthermore, when their visual focus was directed towards orientation-incongruent stimuli, heterosexual men who were initially least likely to focus on the sexual content of these stimuli exhibited the highest category-specificity, in terms of their genital and subjective sexual arousal, self-reported positive affect, and negative affect—both physiological and self-reported. That is, those heterosexual men who were least likely to visually focus on homosexual erotic content during the self-directed attention condition reported the lowest levels of positive affect and sexual arousal towards them, and both physiologically and subjectively manifested the highest levels of negative affect and lowest genital responses to orientation-incongruent stimuli. These findings further suggest that category specificity in heterosexual men is unlikely to be contingent solely upon visual attention to sexual stimuli and may involve more complex interactions with avoidance-related inhibitory processes.

This study represents the first systematic manipulation of visual attention towards sexual and nonsexual elements in visual stimuli. As predicted, directing visual attention towards sexual versus nonsexual content resulted in stronger sexual responses in men, but this effect was, especially when it pertained to responses to orientation-incongruent stimuli, stronger for homosexual men. In the absence of strong negative affect towards or avoidance of orientation-incongruent sexual stimuli, homosexual men demonstrated stronger genital responses to the conditions depicting only sexual activity. Displaying only sexual content (in the condition in which attention was directed towards sexual cues), without other possibly distracting (e.g., faces, furniture, a second bubble) content, seemed to have transformed an initial lack of excitation pattern towards orientation-incongruent stimuli—exhibited during self-directed visual attention condition—into stronger sexual responses.

Visual attention was not, by itself, powerful enough to induce high levels of sexual arousal. In fact, our findings suggest that visual attention may be a necessary but not a sufficient condition for sexual arousal—at least not in responses to sexual stimuli that were incongruent with sexual orientation. Although there is growing support for the idea that eye-gaze and visual focus are closely related to viewers' interest in and subsequent information processing of visual stimuli (Carrasco, 2011; Henderson & Hollingsworth, 1998; Parkhurst, Law, & Niebur, 2002; Theeuwes, 1993; Treisman & Gelade, 1980; Yantis, 1998), attention involves more than visual focus and can be conceptualized as a complex, multifunctional cognitive process. It includes the ability to focus on and select information as well as the capacity to coordinate and integrate that information for conscious access. Visual input, even when selected for further processing, may not necessarily be introduced into working memory. Thus, visual focus may not be sufficient in activating higher-level cognitive mechanisms and awareness, as incoming sensory information often competes with other mental processes—e.g., inner speech, imagery (Baars, 2007). Whereas visual attention is relevant to sexual response activation and regulation, the extant and extensive literature on cognition and information processing invites a more comprehensive and intricate perspective on attention, bringing further nuance to the interpretation of our findings.

We believe our study sheds some new light on the underlying processes involved in men's sexual responses and preference for same- and opposite-sex erotic stimuli. Barlow's (1986) model offered a useful framework for exploring the activation and regulation of men's sexual arousal. The study adds to the literature showing that cognitive and affective mechanisms are relevant to men's sexual responses. Yet, the patterns followed complex interactions between attentional and affective processes—in line with the perspective of Taylor and Fragopanagos (2005). Whereas we, on the basis of Barlow's model, only predicted that affect would guide the allocation of cognitive resources towards

or away from the sexual content of stimuli, our findings suggest a more complex and dynamic interaction between attentional and affective processes. Taylor and Fragopanagos—differentiating between bottom-up excitatory and top-down control processes—have proposed such an interactive model of attention and emotion. In their model, emotions guide attention—starting with but also following the initial allocation of cognitive resources to emotional cues. By the same token, attention facilitates the further processing of motivationally-relevant stimuli, guiding and maintaining its own focus as well as controlling higher-order cognitive mechanisms and, ultimately, behavior.

Some limitations of the study should be mentioned. First of all, we should acknowledge the potential impact of the nature of stimuli used, which consisted of video clips depicting male homosexual (man–man) and heterosexual (man–woman) sexual activity. The stimuli did not include a stimulus displaying female homosexual (woman–woman) sexual activity. The presence of men in both the homosexual and heterosexual stimulus used in this study might be partially responsible for the findings in homosexual men when it comes to their responses to orientation-incongruent stimuli. That is, homosexual men may have demonstrated less category specificity because the orientation-incongruent stimulus contained a male actor. Still, our findings were consistent with those of Israel and Strassberg (2009), Rullo et al. (2010), and Ebsworth and Lalumière (2012), who used images of nude female and male individuals and also found stronger category specificity in heterosexual than homosexual men (at least in terms of viewing time). Yet, as other studies (e.g., Chivers et al., 2004; Mavissakalian et al., 1975) have found that depictions of two women engaged in sex lead to better discrimination between sexual orientation groups, future studies could compare men's attentional, affective, and sexual responses to stimuli presenting different constellations of male and female actors and include some with just men or women. Also, future studies could include female participants to examine whether the manipulation of visual attention would change response patterns, or levels, in women as well.

Second, the assessment and manipulation of visual focus was enabled through the use of bubbles that moved within the screen. Although we believe our study demonstrates that this novel approach to the manipulation of attention has promise, we cannot be certain that it fully captures the intricate nature of visual attention. That is, we should acknowledge the possibility that participants may, in varying degrees, have managed to keep the mouse cursor inside the bubble by focusing only on the cursor, while ignoring or attempting to filter out the rest of the content. However, even in such a case, peripheral or parafoveal vision—which involves an automatic or involuntary process (cf. Holender, 1986)—would have been expected to lead to the processing of surrounding visual content.

Lastly, the fixed order of the stimuli used in this study represents a limitation—in the current study, the self-directed attention condition always came first. This design choice allowed to first establish a baseline of attentional preferences for sexual or nonsexual content of both the orientation-congruent and incongruent stimuli. However, future investigations could advance understanding of self-directed versus manipulated attention by varying the order of all conditions. This would allow for the test of the idea that directed attention to sexual stimuli increases sexual arousal above and beyond response levels to sexual stimuli when attention is not directed.

While acknowledging these shortcomings, we believe that the findings of the present study contribute to our understanding of the mechanisms underlying the activation and regulation of men's sexual arousal. Furthermore, we believe that the current study contributes to the literature on men's sexual responses to same- and opposite-sex erotic stimuli. To the best of our knowledge, it is the first study to both measure and manipulate attention to the sexual and nonsexual content of such stimuli. The methodology developed for the current study, which is—compared to, for example, eye-tracking—more cost-effective and easier to implement, and allows for the exploration of many more questions on the role of attention in the processing of sexual stimuli.

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