

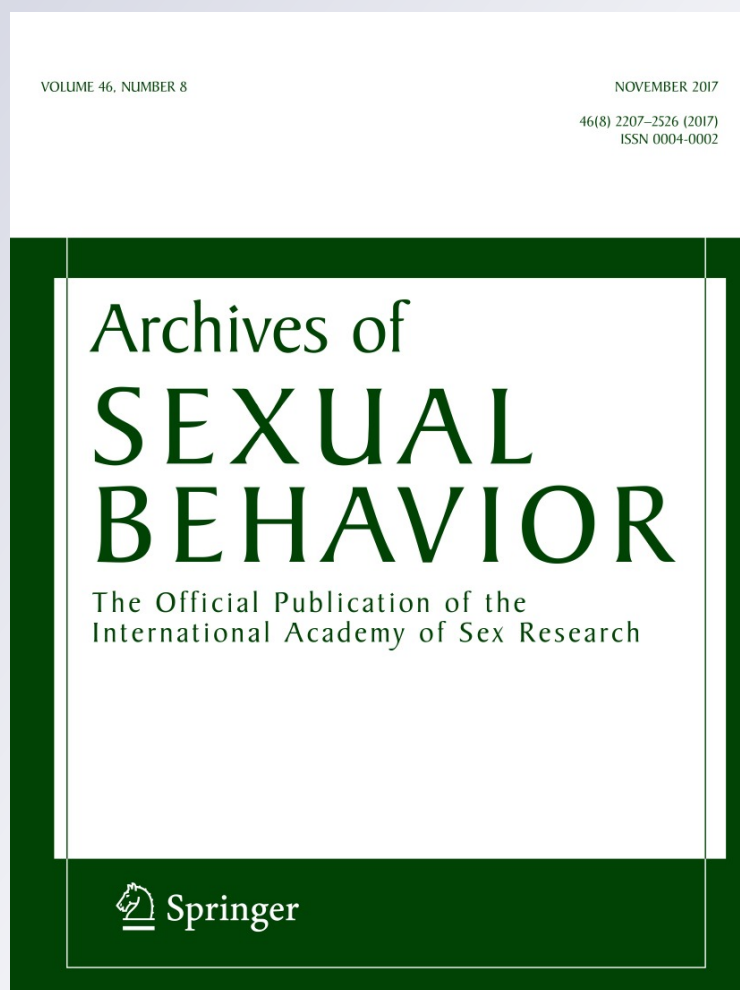
The Effects of Positive Versus Negative Mood States on Attentional Processes During Exposure to Erotica

Joana Carvalho, Raquel Pereira, Diana Barreto & Pedro J. Nobre

Archives of Sexual Behavior
The Official Publication of the
International Academy of Sex Research

ISSN 0004-0002
Volume 46
Number 8

Arch Sex Behav (2017) 46:2495-2504
DOI 10.1007/s10508-016-0875-3



Your article is protected by copyright and all rights are held exclusively by Springer Science +Business Media New York. This e-offprint is for personal use only and shall not be self-archived in electronic repositories. If you wish to self-archive your article, please use the accepted manuscript version for posting on your own website. You may further deposit the accepted manuscript version in any repository, provided it is only made publicly available 12 months after official publication or later and provided acknowledgement is given to the original source of publication and a link is inserted to the published article on Springer's website. The link must be accompanied by the following text: "The final publication is available at link.springer.com".

The Effects of Positive Versus Negative Mood States on Attentional Processes During Exposure to Erotica

Joana Carvalho^{1,2} · Raquel Pereira² · Diana Barreto² · Pedro J. Nobre²

Received: 10 July 2015 / Revised: 23 September 2016 / Accepted: 24 September 2016 / Published online: 12 October 2016
© Springer Science+Business Media New York 2016

Abstract The relationship between emotions and sexual functioning has been documented since early sex research. Among other effects, emotions are expected to impact sexual response by shaping individuals' attention to sexual cues; yet, this assumption has not been tested. This study aimed to investigate whether attentional processes to sexual cues are impacted by state emotions, and whether the processes impacted by emotions relate to subjective sexual arousal to a sex film clip. A total of 52 men and 73 women were randomly assigned to one of three experimental conditions: (1) a negative mood induction condition (sadness as dominant emotion), (2) a positive mood induction condition (amusement as dominant emotion), and a (3) neutral/control condition. After mood induction, participants were exposed to a sex film clip while their focus of visual attention was measured using an eye tracker. Three areas of interest (AOI) were considered within the sex clip: background (non-sexual cues), body interaction, and genital interaction. Self-reported attention, thoughts during the sex clip, percent dwell time, and pupil size to AOI were considered as attentional markers. Findings revealed that the attentional processes were not impacted by the mood conditions. Instead, gender effects were found. While men increased their visual attention to the background area of the film clip, women increased attention to the genital area. Also, sexual arousal thoughts during exposure to the sex clip were consistently related to subjective sexual

arousal regardless of the momentary emotional state. Findings add to the literature by showing that men and women process the sexual components of a stimulus differently and by challenging the assumption that emotions shape attention to sexual cues.

Keywords Mood induction · Attention · Emotions · Sexual arousal

Introduction

Emotions play paradoxical effects in sexual response and functioning. Studies targeting individuals complaining of sexual dysfunction consistently show an association between low positive and/or high negative affect and sexual difficulties (Carvalho, Veríssimo, & Nobre, 2013; Nobre & Pinto-Gouveia, 2006; Oliveira & Nobre, 2013; Peixoto & Nobre, 2012). Also, depression is often regarded as an etiological factor for sexual dysfunction in both genders (Araújo, Durante, Feldman, Goldstein, & McKinlay, 1998; Hartmann, 2007; Michael & O'Keane, 2000). Yet, the direction of this relationship is particularly challenging; for example, while depressed women were found to report more sexual difficulties, they also reported increased frequency of masturbation (Cyranski et al., 2004; Frohlich & Meston, 2002). Likewise, even though women presenting with depressive mood reported lower sexual desire than controls, no significant differences were found regarding subjective or genital sexual arousal (Kuffel & Heiman, 2006). In non-clinical samples, a similar process has been found. While most individuals report lower sexual desire under a negative mood state, some report increased sexual interest and arousal; among these, men report increased sexual interest/arousal more frequently than women (Lykins, Janssen, & Graham, 2006a).

Likewise, psychophysiological studies targeting the role of positive/negative emotions on sexual arousal (by means of mood

✉ Joana Carvalho
joana.pereira.carvalho@gmail.com

¹ School of Psychology and Life Sciences, Lusófona University, Lisbon, Portugal

² Center for Psychology at University of Porto, Faculty of Psychology and Educational Sciences, University of Porto, Oporto, Portugal

induction procedures) have challenged the widespread view that negative affective states *always* inhibit sexual response (e.g., Barlow, Sakheim, & Beck, 1983; Kuffel & Heiman, 2006; Laan & Everaerd, 1995). Within this regard, ter Kuile, Both, and van Uden (2010) showed that women presented no changes in genital arousal after a sad mood induction (as compared with a happy mood condition); in contrast, subjective sexual arousal was lower in the sad mood condition. Similarly, Meisler and Carey (1991) induced both elated and depressed mood in a sample of sexually functional men. Findings revealed a trend toward reduced subjective sexual arousal after depressed mood induction, but no significant effects on penile tumescence were found. On the other hand, another study showed that penile response was lower after the induction of depressed mood (Mitchell, DiBartolo, Brown, & Barlow, 1998). While a sad mood condition seems to inhibit subjective sexual arousal in both genders, findings on the relationship between sadness and genital response are still inconclusive.

Emotional states are expected to shape sexual response through several hypothetical paths. For example, in clinical/psychiatric samples, the inhibitory effect of negative emotions is attributed to the level of the emotion. A trait level (i.e., a persistent emotional pattern, usually related to the psychopathological core of the disorder) rather than a state level (i.e., a momentary emotional state, the standard approach used in experimental studies) is more likely to decrease sexual arousal or interest (Minnen & Kampman, 2000). On the other hand, the strong co-occurrence between sexual dysfunction and negative emotional states may suggest that the former is an intrinsic and structural part of high-order psychopathological phenomena; sexual problems and emotional disorders would be *neighbor* entities and would exist under the internalizing spectrum of psychopathology (Forbes & Schniering, 2013). Another hypothetical path linking emotions to sexual response involves attention. Barlow's (1986) traditional model of male sexual response emphasizes the role of autonomic arousal as a trigger of attention to sexual cues (more or less attention depending on the individuals' appraisal of the sexual situation), shaping how individuals respond sexually. However, and despite the strong co-occurrence between depressed mood and lack of sexual interest and subjective sexual arousal, the extent to which attentional processes are impacted by emotions of sadness or amusement is something that remains to be tested. Also, gender differences in the processing of sexual cues under these mood states are of particular relevance as men, more than women, are known to report increased arousal and interest under negative mood states.

For the matter of this study, we will focus on visual attention. Visual attentional processes have been under the scope of recent sex research. Particularly, eye-tracking methods allow us to track individuals' gazing and quantify gaze indicators (e.g., fixations) that are expected to work as proxies of high-level cognitive processing (cf. Lykins, Meana, & Kambe, 2006b). Furthermore, variations in pupil size are recognized as a product of attentional effort; the size of the pupil is expected to increase under conditions

of augmented cognitive load (Hoeks & Levelt, 1993; Kang, Huffer, & Wheatley, 2014) and has been further recognized as an accurate measure of sexual arousal (Rieger et al., 2015). This might be of particular importance as attentional processes are believed to play a key role in the subjective and physiological components of sexual arousal (cf. Spiering & Everaerd, 2007) and, as described in Barlow's model, attention might work as a bridge between emotional activation and sexual response.

Outside the field of sexology, emotional states are known to shape visual attention processes. For example, while positive mood states are expected to increase the range of visual attention, sad mood conditions had been shown to decrease the visual attention breadth (Hüttermann & Memmert, 2015; Rowe, Hirsh, & Anderson, 2007). Indeed, and despite the attentional broadening effects of positive emotions, the presence of severe depressive symptoms was shown to reverse such a pattern (Grol & Raedt, 2014). Also, the broadening effect of positive mood may be particularly true only for highly valenced positive stimuli, suggesting that the *emotional* characteristics of stimuli strongly influence attentional processing (Wadlinger & Isaacowitz, 2006). Findings derived from these experimental paradigms can be of interest to the field of sex research as they show that emotional states modulate attentional processes. However, such paradigms cannot be directly compared to the standard procedures that are usually used in sex research. For example, in the field of human sexuality, explicit sex stimuli, including dynamic sex stimuli, are often used. This implies that participants attend to what they choose during the course of time, hence denoting a top-down processing. This differs from the previous mentioned studies where static/non-sexual stimuli were used.

In sum, emotions appear to play a puzzling effect in human sexual response. Yet, the processes by which emotions influence sexual response are still unknown; attention could be one of those processes. Against this background, the aim of this study was to test the effect of mood induction (positive vs. negative vs. neutral) on the attentional processes during a sexual film clip. Three attentional indexes were considered: (1) self-reported attention, (2) cognitive attention (as measured by self-reported thoughts to a sex clip), and (3) visual attention (as measured by percent dwell time and pupil size to pre-defined areas of interest in a sex clip). Additionally, the relationship between attentional processes to the sex clip and subjective sexual response was tested. The following hypotheses were considered: (1) negative mood (sadness) will impair the self-reported attentional capability to the sex clip as compared with the positive mood (amusement) and the neutral/control condition; (2) negative mood will increase distractive sexual thoughts and decrease erotic thoughts to the sex clip as compared with the positive and neutral condition; (3) negative mood will decrease visual attention to the sexually relevant cues of the sex clip as compared with the positive and neutral condition; and (4) lack of attention to the sex clip will be related to decreased subjective sexual arousal.

Method

Participants

A total of 58 men and 78 women participated in the study. Inclusion criteria were: heterosexual orientation (as measured by the Kinsey scale), no sexual dysfunction (as measured by self-report considering DSM-5 indicators), and normal/corrected-to-normal vision (also based on self-report). The study was advertised among the academic community of Porto University (Porto, Portugal); participants were recruited using flyers and email advertisements.

The study was publically labeled as “Emotions and ocular movements to an erotic film clip”; the inclusion criteria were also advertised. After a visual inspection (conducted by the main researcher and two assistants) of all gaze records, cases of low quality gaze trackings (six men and five women) were excluded from analysis. The sociodemographics of the participants are shown in Table 1. Participants were not paid for participation. All gave written informed consent. The study was approved by the Ethics Committee of the Faculty of Psychology and Educational Sciences of Porto University in 2013.

Table 1 Sociodemographics and covariates: (a) by gender, (b) by experimental condition

	Men <i>N</i> = 52		Women <i>N</i> = 73			
	<i>M</i>	SD	<i>M</i>	SD		
<i>(a)</i>						
Age	27.05	9.70	24.20	6.15		
<i>F</i> (1, 123) = 4.03, <i>p</i> < .05, partial η^2 = .03						
Freq. pornography	4.21	1.61	2.49	1.20		
<i>F</i> (1, 123) = 46.55, <i>p</i> < .001, partial η^2 = .27						
Trait PANAS						
<i>F</i> (2, 122) < 1, <i>p</i> = .394, partial η^2 = .01						
Trait positive	2.54	.58	2.47	.51		
Trait negative	.76	.54	.88	.53		
Marital status						
%						
χ^2 (3) = 4.01, <i>p</i> = .260						
Single	84.6		84.9			
Living together	3.8		6.8			
Married	3.8		1.4			
Divorced	7.7		6.8			
	Positive mood induction <i>N</i> = 43		Negative mood induction <i>N</i> = 42		Neutral/control <i>N</i> = 40	
	<i>M</i>	SD	<i>M</i>	SD	<i>M</i>	SD
<i>(b)</i>						
Age	24.74	1.21	25.90	1.23	25.55	1.26
<i>F</i> (2, 122) < 1, <i>p</i> = .789, partial η^2 = .00						
Freq. pornography	3.62	.24	3.07	.24	2.90	.25
<i>F</i> (2, 122) = 2.36, <i>p</i> = .09, partial η^2 = .03						
Trait PANAS						
<i>F</i> (4, 242) < 1, <i>p</i> = .609, partial η^2 = .01						
Trait positive	2.60	.53	2.43	.50	2.46	.60
Trait negative	.80	.49	.81	.53	.88	.60
Marital status						
%						
χ^2 (6) = 3.12, <i>p</i> = .794						
Single	90.7		81.0		82.5	
Living together	2.3		9.5		5.0	
Married	4.7		4.8		7.5	
Divorced	2.3		4.8		5.0	

Procedure

After the advertisement, students willing to participate received an internet link in order to respond to the sociodemographics (including a screening form for sexual difficulties, neuropathy, and heterosexuality) and the trait affect schedule. Eligible participants were invited for a lab session. The lab session took approximately 30 min. Participants were randomly assigned to one of three experimental conditions: a negative mood induction condition (sadness as dominant emotion), a positive mood induction condition (amusement as dominant emotion), and a neutral/control condition. Mood was induced through the presentation of a non-sexual film clip (selected from a pool of film scenes aimed at inducing mood—cf. Bartolini, 2011)¹; participants were further instructed to enter the specific mood state (cf. Westermann, Spies, Stahl, & Hesse, 1996). The music track presented during sad and amusement induction film clips was further used as background music during sex clips so the emotional tone could be maintained. The sexually explicit 3-min film clip displayed a heterosexual couple engaging in oral and penile–vaginal intercourses; oral and penile–vaginal intercourses were displayed for the same amount of time. This film clip is part of the Portuguese SexLab database containing edited scenes for experimental sex research and previously rated by Portuguese samples. The film clip used in the current study was rated as a high arousal sexual film clip by both genders. Participants were evaluated individually and were left alone in a private room.

No dropouts were documented. After the experiment, no participant reported any kind of discomfort due to the eye tracker light flashes.

Measures

Covariates

Two variables were included as covariates: the frequency of pornography use and trait affect (see Table 1). Participants were questioned about their frequency of pornography consumption through the following question: “How often do you view sexually explicit materials (movies, clips, magazines, etc.)?” Potential answers were 1 (“never”) to 6 (“every day/almost every day”). This

question was included in the sociodemographic questionnaire and was answered prior to the experimental session. The potential confounding effect of trait positive/negative affect was also ruled out. Prior to the experiment, participants completed the Portuguese version of the Positive and Negative Affect Schedule—Trait form (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS trait form assesses positive (e.g., interested, excited, proud) and negative affect (e.g., distressed, ashamed, upset) as stable constructs. Participants answered the question “How much do you usually feel each of the following emotions”; answers ranged between 0 (“not at all”) and 4 (“extremely”). The Portuguese version of the PANAS (trait and state forms) presents good psychometric properties (cf. Galinha & Pais-Ribeiro, 2005).

Efficacy of Mood Induction

The efficacy of the mood induction procedure was evaluated by two means. First, participants from all conditions (positive mood, negative mood, and neutral) answered the question “How much do you feel, at this time, each of the following emotions—sadness, amusement, calm” before and after mood induction. Answers ranged between 0 (“nothing”) and 8 (“very much”). This method was based on Bartolini’s (2011) work who developed a stimulus set of film clips for mood induction procedures. Due to the common use of the PANAS in sex research, the PANAS state form was also used as an additional method. Participants responded to the question “How much do you feel, at this time, each of the following emotions” before and after mood induction; answers ranged between 0 (“not at all”) and 4 (“extremely”).

Self-Reported Attention

Participants were asked to report on their attentional capability during the sex clip. This assessment was made by asking them two questions: “How distracted were you during the erotic video?” and “How hard was it to pay attention to the erotic video?” These questions were formulated after Anderson and Hamilton’s (2014) work aimed at identifying accurate measures of distraction from erotic cues; the self-report measure—the questions just mentioned—proved to be efficient. The answers ranged between 0 (“not at all”) and 10 (“extremely”).

Cognitive Attention

Participants completed a list aimed at assessing automatic thoughts during exposure to erotic stimuli. The list covered the following topics: sexual arousal thoughts, distractive/disengaging thoughts, body image (preoccupation) thoughts, actress physical attractiveness, and sinful thoughts. Participants answered the question “To what extent did the following thoughts come to your mind during the sex clip”; answers ranged between 0 (never) and 6 (frequently). Preliminary psychometric studies support reliability (Cronbach’s alpha values ranged from 0.75 to 0.94; unpublished data).

¹ A set of film clips described in Bartolini’s (2011) work for sadness and amusement induction was previously visualized and rated by a small sample of male and female college students. Scenes from *The Shawshank Redemption* (1994) and *The Hangover* (2009) (3 min each) presented the highest rates on sadness and amusement, respectively. These scenes were selected for the main study. The neutral film clip has been regularly used for research purposes at the Portuguese SexLab and consists of a 3-min scientific documentary. While participants in the neutral and negative condition did not recognize the film scene, most of the participants in the positive condition identified the film scene as being part of *The Hangover*, even when they did not watch the movie.

Visual Attention Processes

As for the visual attention processes, two parameters were selected: percent dwell² time, computed as dwell time (ms)/(end time – start time), and average pupil size³ (average size of a pupil inside an AOI; dimension unit: pixels). *z* scores for pupil input were computed as men and women vary in pupil size. Three dynamic AOI were considered: the background (contextual/non-sexual portions of the erotic film clip), the body interaction (focusing on the corporal interaction between the male and female actors; the body/face of the actors excluding the genitals), and the genital interaction (focusing exclusively on the genital interaction—oral, penile/vaginal intercourse). The dynamic AOI were designed with the SMI BeGaze™ 2.5 software for behavioral and gaze analysis (SensoMotoric Instruments, Germany). The AOI were activated 6 s after the beginning of the clip, when all three areas were simultaneously displayed in the film clip. Because AOI necessarily overlapped, off-line analyses (subtraction of gaze parameters) were conducted in order to extract the smallest coverage area (genital area) from the body area, and the body area from the greatest coverage area (background). Gaze data were collected using an infrared remote eye tracker (iView X™ RED System, SensoMotoric Instruments, Germany). Data were sampled at 120 Hz; the RED System combines both eye channels to one averaged monocular gaze position.

Subjective Sexual Arousal

In order to evaluate subjective sexual arousal to the sex clip, participants were questioned, after the sex clip, about their level of sexual arousal, erection/lubrication, and desire to get involved in sex (with someone or masturbation) during the sex scene. Answers ranged between 0 (“not at all”) and 9 (“extremely”). The three indicators were merged into a single measure (Cronbach $\alpha = .87$).

Results

Efficacy of the Mood Induction Procedure

Before addressing the main findings, the efficacy of the mood induction procedure was tested. To do so, paired *t* tests were used to compare participants' scores on the pre-induction versus post-induction emotional assessment—sadness, amusement, calm. The same procedure was used to compare participants' scores on the PANAS pre-induction state form versus post-induction state form. Findings revealed that mood induction procedures impacted

subjects' emotional state as intended. Participants in the negative mood condition reported significantly more sadness after the mood induction procedure, as well as less amusement and calm. Similar findings were found for the PANAS state form with participants reporting less positive and more negative state affect (see Table 2). Participants in the positive mood condition reported significantly less sadness and more amusement after the mood induction procedure, and no significant differences were found regarding calm. Similar results were found for the PANAS state form with participants reporting less negative state affect (see Table 2). Although the neutral/control condition does not imply any kind of mood manipulation, participants in the control group reported a slight decrease in sadness, amusement, and negative affect after the neutral film clip. No significant differences were found for calm or positive affect (see Table 2).

In addition, a MANOVA was performed in order to confirm whether the experimental condition (negative vs. positive vs. neutral/control) had an effect on the participants' post-induction emotions. Findings showed that participants in the negative condition reported significantly more sadness than participants in the positive and neutral condition. Also, participants in the positive condition reported significantly more amusement than individuals in the negative and neutral condition and participants from the neutral condition reported feeling more calm than participants in the negative condition, Wilks' $\Lambda = .098$, $F(6, 22) = 80.93$, $p < .001$, partial $\eta^2 = .68$ (see Fig. 1). Finally, findings related to the PANAS state form showed that participants in the negative condition reported significantly more negative affect and less positive affect than individuals in the positive and neutral conditions, Wilks' $\Lambda = .451$, $F(4, 22) = 27.41$, $p < .001$, partial $\eta^2 = .32$ (see Fig. 1).

Effect of Gender and Mood on Self-Reported Attention to the Sex Clip

After controlling for the effects of the covariates, findings revealed no significant main effects regarding the role of gender and mood on self-reported attention as measured by the questions “How distracted were you during the erotic video?” and “How hard was it to pay attention to the erotic video?” (see Table 3). However, it is worth noting that pairwise comparisons for the mood condition factor showed that individuals reported that it was significantly harder to pay attention to the erotic clip under the sad mood induction condition in comparison with the neutral/control condition ($M_{\text{sadness}} = 1.54$, $SD = .25$, $M_{\text{neutral}} = .74$, $SD = .28$, $p < .05$).

Effect of Gender and Mood on Automatic Thoughts to the Sex Clip

After ruling out the confounding effects of pornography consumption, findings on the effects of gender and mood on the

² Dwell time starts at the moment the AOI is fixated and ends at the moment the last fixation on the AOI ends; sum of durations from all fixations and saccades that hit the AOI.

³ Pupil size is a measure of arousal and is often used as a marker of attentional effort. This study was designed to capture pupil size as a proxy of attention to specific cues within a sexual stimulus.

Table 2 Participants' scores on the pre-induction versus post-induction emotional assessment

	Negative mood induction (pre)		Negative mood induction (post)		<i>t</i> (<i>df</i> = 40)	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Sadness	.97	1.38	5.60	1.68	−15.66***	<.001	2.44
Amusement	4.31	1.64	.48	.89	14.16***	<.001	2.21
Calm	5.95	1.90	4.46	1.92	3.35**	.002	0.52
PANAS state positive	1.98	.62	.99	.61	10.82***	<.001	1.69
PANAS state negative	.31	.49	1.05	.76	−6.52***	<.001	1.01
	Positive mood induction (pre)		Positive mood induction (post)		<i>t</i> (<i>df</i> = 39)	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Sadness	1.07	1.85	.07	.35	3.43**	.001	0.17
Amusement	4.42	1.51	5.67	1.36	−4.27***	<.001	0.67
Calm	5.42	1.85	5.02	2.41	.95	.347	0.15
PANAS state positive	2.00	.70	2.02	.77	−.21	.833	0.03
PANAS state negative	.29	.39	.12	.23	3.41**	.001	0.54
	Neutral/control (pre)		Neutral/control (post)		<i>t</i> (<i>df</i> = 34)	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Sadness	1.05	1.69	.28	1.07	2.21*	.033	0.38
Amusement	4.31	1.77	2.57	2.44	5.06***	<.001	0.85
Calm	5.31	1.81	5.71	2.08	−1.02	.314	0.17
PANAS state positive	1.83	.68	1.73	.87	1.35	.186	0.22
PANAS state negative	.14	.15	.06	.09	2.90**	.006	0.49

automatic thoughts that occurred during the sex clip revealed a significant main effect for the gender condition (see Table 3). However, no significant differences were found in the post hoc pairwise comparisons; there was only a significant threshold regarding body image-related thoughts, with women presenting more body image preoccupation thoughts ($M_{men} = .82$, $SD = .21$, $M_{women} = 1.37$, $SD = .17$, $p = .07$).

Effect of Gender and Mood on the Visual Processes to the Sex Clip

The effect of gender and mood condition on percentage dwell time and pupil dilatation to the different AOI displayed in the sex clip was tested. Regarding percentage dwell time, and in line with the previous procedures, the effects of the selected covariates were controlled. Findings revealed a significant main effect of the gender condition (see Table 3). Pairwise comparisons showed that men paid more visual attention to the background area of the film clip ($M_{men} = 22.76$, $SD = 1.42$, $M_{women} = 18.68$, $SD = 1.15$, $p < .05$), whereas women paid more attention to the genital interaction area of clip ($M_{men} = 37.97$, $SD = 2.25$, $M_{women} = 46.14$, $SD = 1.81$, $p < .05$). Additionally, and after ruling out the potential confounding effects of pornography consumption, findings on the role of gender and mood in pupil size showed a significant main

effect for the gender condition (see Table 3). Pairwise comparisons showed that women presented a higher pupil size to the genital interaction area of the film clip in relation to men ($M_{men} = 13.21$, $SD = .33$, $M_{women} = 14.40$, $SD = .27$, $p < .05$).

Relationship Between Attentional Processes, and Subjective Sexual Arousal

Pearson product-moment correlations were computed to examine the relationship between attentional processes, pupil dilatation, and subjective sexual arousal. Findings regarding the male sample revealed that, in the positive mood condition, visual attention to the background area was negatively and significantly associated with subjective sexual arousal; also, self-reported attention (i.e., more reported distraction) was negatively related to subjective sexual arousal in the negative mood condition. In women, findings revealed that in the positive mood condition, visual attention to the body interaction part of the clip was negatively related to subjective sexual arousal; furthermore, self-reported attention (i.e., more reported distraction) was negatively related to subjective sexual arousal in the positive mood condition. In all, subjective sexual arousal was consistently related to sexual arousal thoughts (see Table 4).

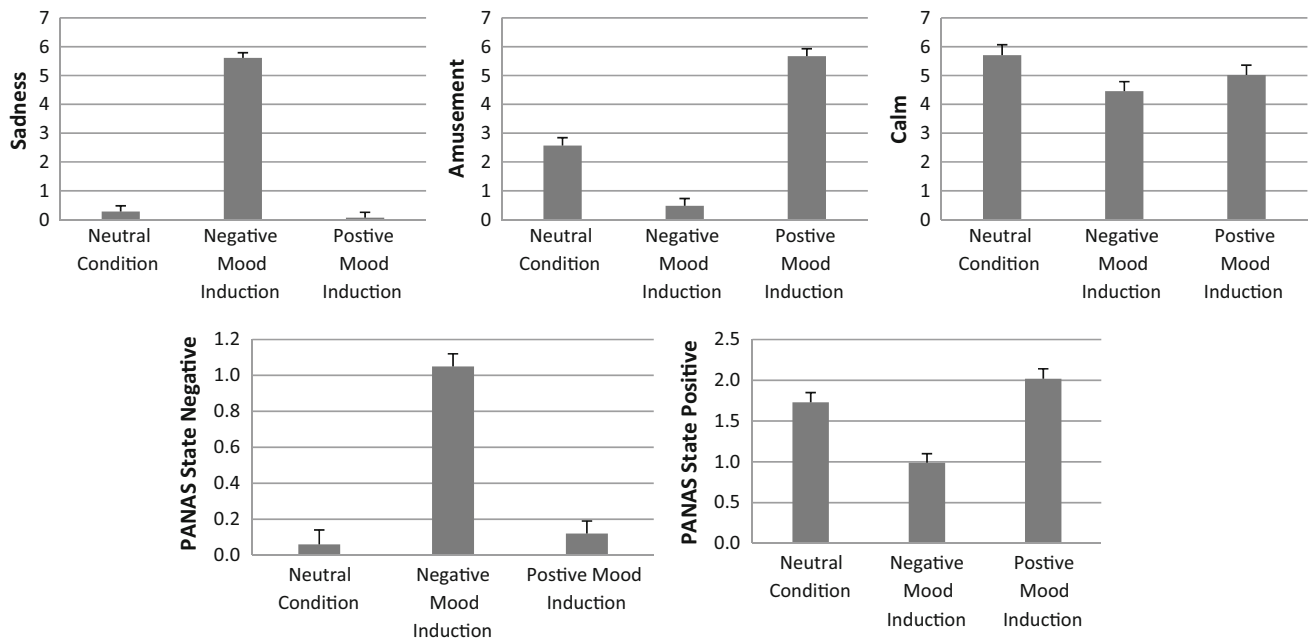


Fig. 1 Scores on participants' post-induction emotions

Table 3 Findings on MANCOVAS for automatic thoughts and ANCOVAS for self-reported attention, % dwell time, and pupil size (pornography consumption, trait negative, and trait positive affect introduced as covariates)

	Gender			Mood condition			Gender × mood condition		
	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2
Self-reported attention #1	<1	ns	.00	<1	ns	.00	<1	ns	.00
Self-reported attention #2	<1	ns	.00	2.43	ns	.04	<1	ns	.00
Automatic thoughts	6.46	<.01	.23	1.49	ns	.06	1.37	ns	.06
% Dwell time	2.76	.04	.07	<1	ns	.01	<1	ns	.01
Pupil size	4.42	<.01	.11	1.56	ns	.04	<1	ns	.01

Discussion

The association between positive/negative emotional states and sexual response is widely recognized. It is also known that a certain emotional tone (sadness, anxiety, etc.) may inhibit but also prompt sexual response; the reasons or the contexts shaping the direction of these effects are less clear, but it can be derived that emotions impact sexual response through different processes. Emotional states also modulate attention capability (Friedman & Förster, 2010). So, at least hypothetically, it could be assumed that emotions impact the attentional focus to a sexual stimulus leading to an increase or decrease in sexual arousal. According to this, the aim of the current study was to test the effect of mood (positive, negative, and neutral) on the attentional processes to a visual erotic stimulus and verify whether the attentional indexes impacted by mood relate to subjective sexual arousal.

In all, the established hypotheses were not corroborated. Regarding the expected effects of mood on the attentional pro-

cesses to the sex stimulus, none of the processes were impacted by the emotional states. One possible explanation for this pattern of results is that the experimental paradigm failed to capture the dynamics behind the impact of emotions in attentional processes. It is likely that the explicit nature of the sex clip override the effects of the emotional tones. Alternatively, we may also speculate that when confronted with sexually relevant stimuli, humans process sexual cues independently of their emotional state. From an evolutionist perspective, this behavioral pattern would eventually confirm the need for focusing on mating behavior, a key element for the survival of the human species. Another possible explanation for the lack of mood effects on the attentional processes to the sex clip is that an emotional trait level (rather than state levels), and/or severe emotional disturbance, has the potential to impact attention. Studies using clinical samples are thus expected to clarify this assumption. Even so, it is worth noting that participants from the sadness condition stated that it was significantly harder to pay attention to the sex clip. This is somehow incongruent with data on the objectively

measured parameters of attention (those registered by the eye tracker, showing that emotions had no significant impact on the visual attention processes to the sex clip). Social desirability may be behind the discrepancy between self-reported attention and the objective attentional processes. The film clip for sadness induction displayed a socially non-adjusted old man who decided on committing suicide. The semantic content of the mood induction film clip clearly departs from the erotic clip and may have interfered with participants self-reported attention; subjects may have been prompted to report more difficulty to pay attention as a means to be congruent with the emotional context provided by the sadness experimental condition. Similarly—but in a different context—the discrepancy between self-reported and objective measures of sexual arousal has long been recognized (Chivers, Seto, Lalumière, Laan, & Grimbos, 2010).

As for gender effects, data on percent dwell time showed that women were more oriented toward the genital interaction area. Also, women had a higher pupil size to the genital component of the stimulus. These findings suggest that women and men processed the genital component differently. Generally, it seemed that women paid more attention to the genital area and were more aroused by the genital interaction. During the 3 min length of the sex clip, participants are believed to make a choice in terms of what they want to focus on the scene. Visual attention would possibly be under some level of voluntary control, revealing participants' interest. On the other hand, the size of the pupil is an involuntary index of the ANS (Partala & Surakka, 2003) suggesting that women's attentional pattern is not biased by social desirability. Therefore, women could be genuinely more interested in the genital interaction area. However, it is also known that pupil size increases with emotionally arousing stimuli, regardless of the hedonic valence (Bradley, Miccoli, Escrig, & Lang, 2008). So, the attentional focus

on the genital area may reveal a process of approaching (denoting a positive appraisal of the genital area of the stimulus) but also avoidance (denoting a negative appraisal of the genital area of the stimulus). Also, attentional bias (i.e., increased attention) toward disgust stimuli has been reported; this process reflects an attempt to increase protection when one perceives environmental threats (Charash & McKay, 2002; Cisler, Olatunji, Lohr, & Williams, 2009), including sexual disgust elicitors (Haidt, McCauley, & Rozin, 1994). The nature of the female interest in this area could reflect a sexual preference, curiosity, but also disgust. On the other hand, men may have looked into the non-sexual areas more often as a means to contain erection and thus remain adjusted during the exposure to the stimulus.

The final step of this study was to see whether the attentional indexes (previously expected to be shaped by the mood condition) were related to participants' subjective sexual arousal. In general, self-reported thoughts during the sex clip—mainly sexual arousal thoughts—showed to be consistently related to individuals' subjective sexual arousal. Sexual arousal thoughts during a sex clip have been shown to be significant predictors of both male (Oliveira et al., 2014) and female (Vilarinho et al., 2014) subjective sexual arousal. The present study not only corroborates previous data, but also suggests that these thoughts—an index of cognitive attention in sexual contexts—may be independent of the individuals' emotional state. Actually, most of the attentional indexes relating to subjective sexual arousal were not impacted by emotions. So, even though it was considered that emotions impact sexual response through an attentional path, the present findings do not support this assumption. Instead, a set of attentional indexes seem to modulate subjective sexual response regardless of the emotional tone. Finally, it is worth noting that the pupil size to the background area was positively related to subjective sexual arousal, whereas

Table 4 Pearson product-moment correlations between attentional processes and subjective sexual arousal

	Men			Women		
	Positive mood	Negative mood	Neutral	Positive mood	Negative mood	Neutral
Self-reported attention #1	-.06	-.49*	-.24	-.50*	-.03	-.26
Self-reported attention #2	-.27	-.71**	.09	-.60**	-.36	-.01
Sexual arousal thoughts	.75***	.82***	.87***	.82***	.77***	.69***
Distractive/disengaging thoughts	-.43	-.06	-.48	-.50*	-.11	-.10
Body image thoughts	-.20	.30	.31	.35	.10	.20
Actress thoughts	.26	.57*	.71**	.61**	.27	.40
Sinful thoughts	-.05	-.06	-.25	-.35	-.06	-.01
% Dwell time background	-.58*	.15	-.25	-.16	.03	-.09
% Dwell time body interaction	.16	-.32	-.14	-.46*	-.25	.05
% Dwell time genital interaction	.09	.18	.30	.07	.16	.12
Pupil size background	.06	-.08	-.23	.44*	.14	.09
Pupil size body interaction	-.00	-.10	.00	.24	.21	-.14
Pupil size genital interaction	.44	-.12	.24	.03	-.44*	-.37

* $p < .05$; ** $p < .01$; *** $p < .001$

the pupil size to the genital area was negatively related to sexual arousal in women (positive and negative condition, respectively). Such findings suggest that the genital area of the sex clip was being negatively appraised by women (particularly in the sadness condition) so that it actually related to lower subjective arousal. This is congruent with findings showing that women report lower subjective sexual arousal and less positive emotions to sexually explicit film clips (which focus on the genital interaction of the actors) as compared with romantic/non-explicit clips (Heiman, 1977; Laan, Everaerd, Bellen, & Hanewald, 1994). An involuntary index, such as the variation in pupil size, seemed to be capturing this well-recognized female preference, characterized by the negative appraisal of sexually explicit stimuli when compared with romantic/non-explicit materials. This may be of relevance as the female negative appraisal of sexually explicit erotica has been supported by self-report data but not by psychophysiological data; indeed, the only psychophysiological studies conducted on this topic used genital psychophysiological assessment and showed that women presented increased genital responses to explicit rather than to romantic stimuli (e.g., Heiman, 1977; Laan et al., 1994). Because women in the present study (women in the negative mood condition only) reported decreased sexual arousal accompanied by augmented pupil size, it is possible that the arousal levels captured by pupil size were a proxy of an avoidance mechanism rather than a marker of sexual preference or interest.

This study presents some limitations that must be acknowledged. First, we used a recognized mood induction procedure that has been rated as an efficient technique to manipulate participants' mood (cf. Westermann et al., 1996). To assess the efficacy of the mood induction procedure, we used a pre- and post-emotional assessment that was based on self-report. However, it is possible that participants rate increased sadness or amusement to match the researcher's expectations. For this reason, future studies using a paradigm of mood induction should be encouraged to use psychophysiological measures as a mean to assess the efficacy of the mood induction procedures, rather than using self-report methods. Also, findings contradicted most of the established hypotheses. Although we believe that findings add to the knowledge on this research field, it should be considered that the current experimental paradigm may not have been appropriate for the scope of this study; this paradigm could eventually be improved by using low to mild arousal sex clips as a mean to match the arousal levels triggered by the mood clips. Finally, findings cannot be generalized to other emotional states (e.g., anxiety, anger, etc.), to trait emotions, or clinical samples (where participants are expected to be high on trait negative emotions).

In all, the present findings challenge the assumption that emotions impact human sexual response through a shift on attention. Instead, it was shown that most attentional indexes (particularly the automatic thoughts) relate to subjective sexual arousal regardless of the momentary emotional tone. Albeit these findings seem to be somehow implausible, they seem to be showing that what one thinks during a sexual situation has the potential to surpass

what one feels. Some clinical implications may be derived from this finding; namely, cognitive-based therapies focusing on sexual cognitions and imagery may be of relevance. Also, the current findings point new venues of research. For example, the salience of explicit sex stimuli over dysfunctional emotional states should be deepened. Tuning attention to sexual cues regardless individual's momentary negative emotions could eventually prone adaptive behaviors such as reproduction or the maintenance of dyadic bonds even when partners are not in the mood for sex.

Acknowledgments This study was funded by Fundação para a Ciência e Tecnologia, a grant awarded to Joana Carvalho (SFRH/BPD/76219/2011).

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

- Andersen, A. B., & Hamilton, L. D. (2014). Assessment of distraction from erotic stimuli by nonerotic interference. *Journal of Sex Research, 52*, 317–326.
- Araújo, A., Durante, R., Feldman, H., Goldstein, E., & McKinlay, J. (1998). The relationship between depressive symptoms and male erectile dysfunction: Cross-sectional results from the Massachusetts Male Aging Study. *Psychosomatic Medicine, 60*, 458–465.
- Barlow, D. H. (1986). Causes of sexual dysfunction: The role of anxiety and cognitive interference. *Journal of Consulting and Clinical Psychology, 54*, 140–148.
- Barlow, D. H., Sakheim, D. K., & Beck, J. G. (1983). Anxiety increases sexual arousal. *Journal of Abnormal Psychology, 92*, 49–55.
- Bartolini, E. E. (2011). *Eliciting emotion with film: Development of a stimulus set*. Unpublished bachelor's thesis, Wesleyan University, Middletown, CT.
- Bradley, M. M., Miccoli, L., Escriv, M. A., & Lang, P. J. (2008). The pupil as a measure of emotional arousal and autonomic activation. *Psychophysiology, 45*, 602–607.
- Carvalho, J., Veríssimo, A., & Nobre, P. J. (2013). Cognitive and emotional determinants characterizing women with persistent genital arousal disorder. *Journal of Sexual Medicine, 10*, 1549–1558.
- Charash, M., & McKay, D. (2002). Attention bias for disgust. *Anxiety Disorders, 16*, 529–541.
- Chivers, M. L., Seto, M. C., Lalumière, M. L., Laan, E., & Grimbos, T. (2010). Agreement of self-reported and genital measures of sexual arousal in men and women: A meta-analysis. *Archives of Sexual Behavior, 39*, 5–56.
- Cisler, J. M., Olatunji, B. O., Lohr, J. M., & Williams, N. L. (2009). Attentional bias differences between fear and disgust: Implications for the role of disgust in disgust-related anxiety disorder. *Cognition and Emotion, 23*, 675–687.

- Cyranowski, J. M., Bromberger, J., Youk, A., Mathews, K., Kravitz, H. M., & Powel, L. H. (2004). Lifetime depression history and sexual function in women at midlife. *Archives of Sexual Behavior*, *33*, 539–548.
- Forbes, M. K., & Schniering, C. A. (2013). Are sexual problems a form of internalizing psychopathology? A structural equation modeling analysis. *Archives of Sexual Behavior*, *42*, 23–34.
- Friedman, R. S., & Förster, J. (2010). Implicit affective cues and attentional tuning: An integrative review. *Psychological Bulletin*, *136*, 875–893.
- Frohlich, P. F., & Meston, C. M. (2002). Sexual functioning and self-reported depressive symptoms among college women. *Journal of Sex Research*, *39*, 321–325.
- Galinha, I. C., & Pais-Ribeiro, J. L. (2005). Contribuição para o estudo da versão Portuguesa da Positive and Negative Affect Schedule (PANAS): II—Estudo psicométrico. *Análise Psicológica*, *2*, 219–227.
- Grol, M., & Raedt, R. (2014). Effects of positive mood on attentional breadth for emotional stimuli. *Frontiers in Psychology*, *5*, 1–10.
- Haidt, J., McCauley, C., & Rozin, P. (1994). Individual differences in sensitivity to disgust: A scale sampling seven domains of disgust elicitors. *Personality and Individual Differences*, *16*, 701–713.
- Hartmann, U. (2007). Depression and sexual dysfunction. *Journal of Men's Health & Gender*, *4*, 18–25.
- Heiman, J. R. (1977). A psychophysiological exploration of sexual patterns in females and males. *Psychophysiology*, *14*, 266–274.
- Hoeks, B., & Levelt, W. J. M. (1993). Pupillary dilation as a measure of attention: A quantitative system analysis. *Behavior Research Methods*, *25*, 16–26.
- Hüttermann, S., & Memmert, D. (2015). The influence of motivational and mood states on visual attention: A quantification of systematic differences and casual changes in subjects' focus of attention. *Cognition and Emotion*, *29*, 471–483.
- Kang, O. E., Huffer, K. E., & Wheatley, T. P. (2014). Pupil dilation dynamics track attention to high-level information. *PLoS ONE*, *9*, e102463. doi:10.1371/journal.
- Kuffel, S. W., & Heiman, J. R. (2006). Effects of depressive symptoms and experimentally adopted schemas on sexual arousal and affect in sexually healthy women. *Archives of Sexual Behavior*, *35*, 163–177.
- Laan, E., & Everaerd, W. (1995). Determinants of female sexual arousal: Psychophysiological theory and data. *Annual Review of Sex Research*, *6*, 32–76.
- Laan, E., Everaerd, W., Bellen, G., & Hanewald, G. (1994). Women's sexual and emotional responses to male and female produced erotica. *Archives of Sexual Behavior*, *23*, 153–169.
- Lykins, A. D., Janssen, E., & Graham, C. A. (2006a). The relationship between negative mood and sexuality in heterosexual college women and men. *Journal of Sex Research*, *43*, 136–143.
- Lykins, A. D., Meana, M., & Kambe, G. (2006b). Detection of differential viewing patterns to erotic and non-erotic stimuli using eye-tracking methodology. *Archives of Sexual Behavior*, *35*, 569–575.
- Meisler, A. W., & Carey, M. P. (1991). Depressed affect and male sexual arousal. *Archives of Sexual Behavior*, *20*, 541–554.
- Michael, A., & O'Keane, V. (2000). Sexual dysfunction in depression. *Human Psychopharmacology*, *15*, 337–345.
- Minnen, A., & Kampman, M. (2000). The interaction between anxiety and sexual functioning: A controlled study of sexual functioning in women with anxiety disorders. *Sexual and Relationship Therapy*, *15*, 47–57.
- Mitchell, W. B., DiBartolo, P. M., Brown, T. A., & Barlow, D. H. (1998). Effects of positive and negative mood on sexual arousal in sexually functional males. *Archives of Sexual Behavior*, *27*, 197–207.
- Nobre, P. J., & Pinto-Gouveia, J. (2006). Emotions during sexual activity: Differences between sexually functional and dysfunctional men and women. *Archives of Sexual Behavior*, *35*, 8–15.
- Oliveira, C., Laja, P., Carvalho, J., Quinta-Gomes, A., Vilarinho, S., Janssen, E., & Nobre, P. J. (2014). Predictors of men's sexual response to erotic film stimuli: The role of affect and automatic thoughts. *Journal of Sexual Medicine*, *11*, 2701–2708.
- Oliveira, C., & Nobre, J. P. (2013). The role of trait-affect, depression, and anxiety in women with sexual dysfunction: A pilot study. *Journal of Sex and Marital Therapy*, *39*, 436–452.
- Partala, T., & Surakka, V. (2003). Pupil size variation as an indication of affective processing. *International Journal of Human-Computer Studies*, *59*, 185–198.
- Peixoto, M., & Nobre, P. J. (2012). Trait-affect, depressed mood, and male sexual functioning: A preliminary study. *Journal of Sexual Medicine*, *9*, 2001–2008.
- Rieger, G., Cash, B. M., Merrill, S. M., Jones-Rounds, J., Dharmavaram, S. M., & Savin-Williams, R. C. (2015). Sexual arousal: The correspondence of eyes and genitals. *Biological Psychology*, *104*, 56–64.
- Rowe, G., Hirsh, J. B., & Anderson, A. K. (2007). Positive affect increases the breadth of attentional selection. *Proceedings of the National Academy of Sciences*, *104*, 383–388.
- Spiering, M., & Everaerd, W. (2007). The sexual unconscious. In E. Janssen (Ed.), *The psychophysiology of sex* (pp. 166–183). Bloomington: Indiana University Press.
- ter Kuile, M. M., Both, S., & van Uden, J. (2010). The effects of experimentally-induced sad and happy mood on sexual arousal in sexually healthy women. *Journal of Sexual Medicine*, *7*, 1177–1184.
- Vilarinho, S., Laja, P., Carvalho, J., Quinta-Gomes, A., Oliveira, C., Janssen, E., & Nobre, P. (2014). Affective and cognitive determinants of women's sexual response to erotica. *Journal of Sexual Medicine*, *11*, 2671–2678.
- Wadlinger, H. A., & Isaacowitz, D. M. (2006). Positive mood broadens visual attention to positive stimuli. *Motivation and Emotion*, *30*, 87–99.
- Watson, D., Clark, L., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063–1070.
- Westermann, R., Spies, K., Stahl, G., & Hesse, F. (1996). Relative effectiveness and validity of mood induction procedures: A meta-analysis. *European Journal of Social Psychology*, *26*, 557–580.