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BRIEF REPORT

Sexual desire, not hypersexuality, predicts self-regulation of sexual arousal

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A person's ability to control their own sexual arousal is important both to reduce the risks associated with some sexual behaviours and to respond sexually with intimate partners. A lack of control over sexual urges is a proposed feature of "hypersexual disorder", though some evidence suggests that sexual desire predicts the self-regulation of sexual arousal better than hypersexuality. In the current study, a sample ($N = 116$) of men and women recruited from community ads viewed a series of 20-second neutral and sexual films. Before each sexual film, participants were instructed to increase their sexual arousal, decrease their sexual arousal or respond as usual. Higher levels of desire for sex with a partner consistently predicted failures to downregulate sexual arousal. Hypersexuality was unrelated. These findings replicate Winters et al.'s study and extend their findings by including upregulation, women, a new measure of hypersexuality and a higher-trial design.

Keywords: Sexual arousal; Sexual desire; Hypersexuality; Self-regulation.

High sexual arousal may be a key feature of compulsive sexual behaviour, sometimes termed "hypersexuality" or "sexual addiction". Those who reported more problems with viewing sexual images online also reported more sexual arousal to sexual images in the laboratory (Brand et al., 2011). Also, hypersexuality measures are positively correlated with sexual desire for a partner

($r = .3$ to $r = .44$ in Winters, Christoff, & Gorzalka, 2010). Sexual arousal is known to cause many shifts in perception, such as lower disgust sensitivity (Stevenson, Case, & Oaten, 2011), so sexual arousal may promote compulsive sexual behaviours. High sexual arousal that is difficult to control may promote negative consequences, such as relationship dissolution due to infidelity

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and physical health consequences, such as HIV transmission.

Sexual arousal, the momentary level of sexual excitement (Whalen, 1966), is often distinguished from sexual desire, an individual's learned expectation to experience pleasure in response to sex cues (Hardy, 1964). People with higher sexual desire may initially attend more to sexual cues (Prause, Janssen, & Hetrick, 2008), become more absorbed by sexual cues (Vardi et al., 2009) and experience broader and stronger neural activations during the processing of sexual cues (Arnouk et al., 2009). Of course, high sexual drive does not necessarily lead to sexual behaviours. Social skills, opportunity (e.g. privacy), effort and other factors may stop desire from manifesting as sexual behaviour. However sexual behaviours are unlikely to occur in the absence of sexual desire. When sexual desire and sexual arousal emerge, these are related to intentions to engage in risky sexual behaviours (Ariely & Loewenstein, 2006; George et al., 2009; Prause, Staley, & Finn, 2011). Sexual arousal could increase risk behaviours due to either (1) strong initial cue reactivity causing very high sexual arousal levels or (2) normal sexual arousal levels that some people are simply unable to down-regulate effectively.

Some have suggested that high sexual desire alone is not sufficient to explain problems in regulating sexual arousal. Specifically, some believe that those who struggle to control their sexual arousal are not merely struggling with high sexual desire, but actually have a pathology. Indeed, measures of hypersexual problems have been related to a number of risky sexual behaviours, including unprotected anal sex (Coleman et al., 2010; Yeagley, Hickok, & Bauermeister, 2013), more previously unknown ("casual sex") partners (Schnarrs et al., 2010) and a greater likelihood of having paid for sex (Storholm, Fisher, Napper, Reynolds, & Halkitis, 2011). The current study examines whether success in regulating sexual arousal is better characterised by higher sexual desire levels, "hypersexuality", or both.

Difficulty controlling sexual urges has been proposed as a primary feature of hypersexual problems (Goodman, 2008). Affect regulation

research provides a useful literature to conceptualise sexual regulation. In affect regulation paradigms, participants are asked to increase and/or decrease their response to emotional stimuli. This work has shed light on the neural systems that support successful emotion regulation (Ochsner, Bunge, Gross, & Gabrieli, 2002). Participants who attempt to inhibit sexual arousal in response to erotic stimuli show patterns of activation similar to those in other emotion regulation studies, including activation in the hypothalamus, amygdala and right prefrontal cortex (Beauregard, Levesque, & Bourgouin, 2001). However, these authors only examined the downregulation of sexual arousal in a relatively small ($N = 10$) male sample. Less is known about the regulation of positive affect in general (Giuliani, McRae, & Gross, 2008), and even less is known about upregulation in the context of sexual stimuli.

Up- and downregulation refer to increasing or decreasing the intensity of experienced emotion (Ochsner et al., 2004). Specifically, downregulation refers to the act of inhibiting the emotional response, or the intensity of the emotional response, regardless of its valence; conversely, upregulation refers to the act of facilitating the response. Up- and downregulation rely on separable neural processes (Kim & Hamann, 2007) such that one cannot assume downregulation ability is indicative of upregulation ability. Rather, it might be useful to consider both up- and downregulation in terms of regulation *flexibility*. Those who are most flexible and able to increase and decrease their emotions as needed tend to have better executive function (Gyurak, Goodkind, Kramer, Miller, & Levenson, 2012) and also tend to experience less distress (Kashdan & Rottenberg, 2010). Thus, in the current study, up- and downregulation were included to examine participant's affective *flexibility*—their facility to alter response to sexual stimuli in either direction.

Winters, Christoff, and Gorzalka (2009) examined two individual differences related to the ability of men to downregulate their sexual arousal: sexual desire and hypersexuality. They examined the self-reported sexual arousal and genital sexual responses of men instructed to watch or

downregulate their responses to erotic or amusing films. Participants were instructed not to regulate by looking away from the films. Men who reported higher levels of desire for sex with a partner were less able to regulate their self-reported sexual arousal, while sexual compulsivity was unrelated to sexual arousal regulation.

The current study attempted to replicate and extend the Winters et al. (2009) study. We used a new questionnaire measure that assesses consequences of “hypersexual” feelings and behaviours (McBride, Reece, & Sanders, 2008) rather than compulsive feelings alone. An upregulation instruction condition was included. Upregulating positive affect to a positive stimulus may require different cognitive efforts than downregulating positive affect to a positive stimulus (Pavlov et al., 2014). Those with hypersexual behaviour problems may have challenges regulating their sexual arousal because they are engaging a regulation strategy that is less effective. If participants were experimentally assigned a regulation strategy in the laboratory, it might mask deficits that would be present in a more ecologically valid context. Thus, strategy was not controlled. Also, it is unclear when regulation failures should first be evidence during the stages of processing sexual information. Finally, the previous study only included men. Excluding women may underrepresent lower sexual desire levels. The current study used film stimuli to examine efforts to regulate early arousal responses in both men and women.

The goal of this paper was to investigate whether regulation success was better characterised by sexual desire levels, “hypersexuality” levels or both. Specifically, it was expected that those with higher sexual desire would have more difficulty reducing their sexual arousal when instructed. Similarly, those with higher scores on hypersexual problem measures were expected to report higher sexual arousal to the sexual films they were just told to watch (cp., Brand et al., 2011), but it was unclear whether hypersexuality would also predict upregulation problems (cp., Winters et al., 2010).

METHODS

Participants

Participants were recruited from undergraduate psychology classes using a confidential online service. Of the 142 participants who completed the study, 26 were excluded from analyses due to missing items on the Cognitive and Behavioural Outcomes of Sexual Behaviour (CBOSB) scale. The remaining 116 participants tended to be heterosexual and single (see Table 1). All were required to report attraction to the opposite sex so that the film stimuli were appropriate to evoke sexual arousal. The majority had sexual intercourse at least once per month in the last year. A high proportion identified as Hispanic, consistent with the population in Albuquerque, NM. This study was approved by the University of New Mexico’s Institutional Review Board.

Regulation task

Films were selected to be neutral, to induce hunger or to induce sexual arousal. The neutral film (Rottenberg, Ray, & Gross, 2007) portrayed neon lines appearing on a black background. The hunger-inducing films portrayed a person or persons enjoying high calorie density foods while expressing positive affect. These films were used as part of a separate study of self-regulation specificity, so those data are not presented here.

Stimuli used to induce sexual arousal included a total of 30 film clips. Each film clip was 20 seconds and depicted one man and one woman having consensual penile–vaginal intercourse, portrayed both male and female pleasure and excluded low base rate behaviours such as bondage and anal intercourse (Woodard et al., 2008). Films were selected on the basis of the following criteria as recommended by Janssen, Carpenter, and Graham (2003): (1) consensual heterosexual petting, oral sex and intercourse, (2) no sadomasochistic, fetishistic activities and (3) no sex toys. Films included two films used in previous studies

Table 1. *Characteristics of participants*

(<i>N</i> = 116) ^a	<i>n</i>	%
<i>Gender</i>		
Female	54	46.6
Male	61	52.6
<i>Ethnicity</i>		
Native American or Alaskan Native or Asian	12	10.3
Hispanic	46	39.7
White (not Hispanic)	44	37.9
Other	11	9.5
<i>Relationship status</i>		
Monogamous sexual relationship	41	35.3
Non-monogamous sexual relationship	15	12.9
Not in a relationship	57	49.1
<i>Sexual orientation</i>		
Heterosexual or "straight"	100	86.2
Bisexual	12	10.3
Something else	1	0.9
	Mean	<i>SD</i>
Age (years)	21.59	5.95
Sexual intercourse partners	3 ^b	14.34
One-time partners	3.81	10.94
Masturbation frequency	2.98	1.43
View sexual stimuli (hours/week)	1.47	1.94
<i>CBOSE^c</i>		
Cognitive ^d	7.9	6.8
Behavioural ^e	1.7	1.9
<i>Sexual Desire Inventory</i>		
Dyadic ^f	49.22	11.64
Solitary ^g	10.24	6.14

^aSome figures do not sum to total due to non-responders; ^bNumber reflects median because mean (8) was strongly influenced by outliers; ^cCognitive and Behavioural Outcomes of Sexual Behaviour scale; ^drange 0–60; ^erange 0–16; ^frange 8–70; ^grange 3–26.

(Janssen et al., 2003) that were rated as very highly arousing, and 28 additional films that were selected from nominees and winners of the Best Film of the Adult Video Network awards in 2008, 2009 and 2010. As compared to neutral films [M (SD) = 1.9 (.84)], sexual films [view-only condition; M (SD) = 4.2 (.13)] resulted in significantly greater reported sexual arousal [$t(143) = -22.2$, $CI = -2.5$ to -2.1 , $p < .001$, $d = 1.8$].

The regulation task was modelled after Goldin, McRae, Ramel, and Gross (2008). Participants were instructed to "watch", "increase" or "decrease" their responses before each sex film. No regulation

instruction (only "watch") appeared before the neutral films (see Figure 1). The same regulation instruction never appeared more than three times in a row. Participants heard the following instructions presented auditorily:

You should try to respond naturally to each film. After each film, the computer will ask you to rate how you felt during the film. That is mainly what you will be doing for about the next 30 minutes. However, each sex film will start with an instruction. As soon as you see the instruction, try to do what it says for that film. If it says WATCH, please continue to watch the film and respond normally. If it says INCREASE, you should try to increase the intensity of your response to the film as it is playing. If it says DECREASE, try to decrease and dampen the intensity of your responses to the film as it is playing. The only rule is that you must keep watching the film, you cannot look away. You will be asked questions about the films at the end of the study to make sure that you watched the films.

After listening to these instructions, the experimenter asked whether the participant had any questions. After answering any questions, the experimenter left the room and shut the door to provide privacy for the participant. Participants wore headphones to increase their sense of privacy while viewing sexual films.

The task was presented on a 1280 × 1024 LCD monitor using Presentation (Neurobehavioral Systems, 2004) with 75 Hz refresh and 32-bit colour depth. Films were randomised by condition and order, such that each film was assigned different instructions (increase, decrease, watch-as-usual) and appeared at different times of the task between participants. This ensured that, if some of the new sexual films added were particularly effective, or ineffective, at inducing sexual arousal, the manipulation would be balanced across them. Since visual sexual cues can induce quite sustained motivated responses relative to other emotions (e.g. Weinberg & Hajcak, 2010), neutral film trials were presented between each sexual film to allow time to return to baseline levels of sexual arousal. This may be important to ensure sexual arousal does not simply build and potentially reach a ceiling during testing.

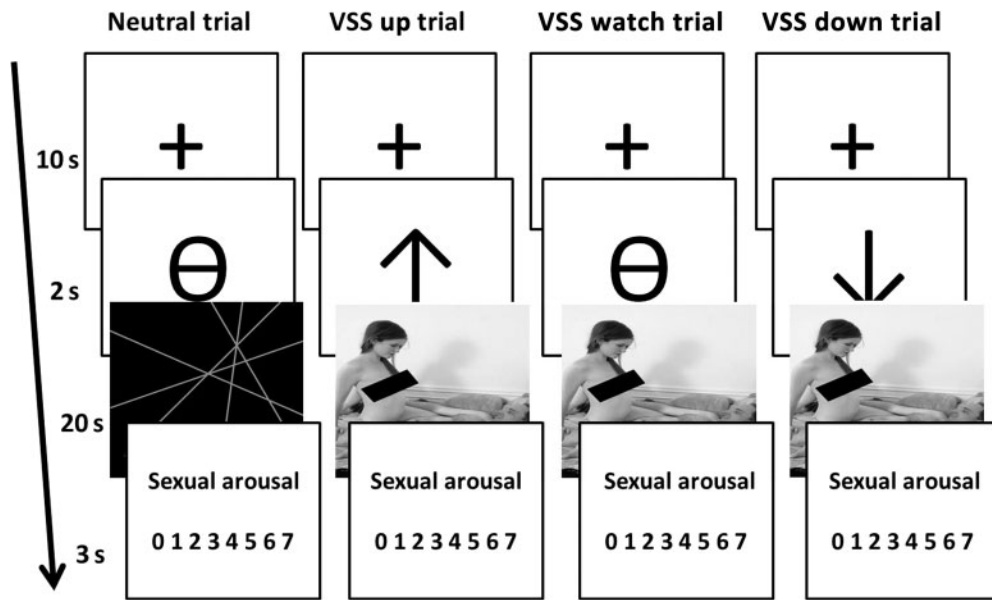


Figure 1. Protocol and four trial types in the sexual regulation task. VSS, visual sexual stimulation.

Questionnaires

Sexual history

Sexual history data were collected, in part, using questions from the National AIDS Behaviour Survey (Binson & Catania, 1998). Participants also answered “With how many different partners have you had *sexual intercourse* (vaginal or anal penetration) in your lifetime?” and “With how many different partners have you had *sexual intercourse* (vaginal or anal penetration) on *one and only one* occasion in your lifetime?”

Cognitive and Behavioural Outcomes of Sexual Behaviour scale (CBOSB; McBride et al., 2008)

The CBOSB assesses the extent to which individuals are concerned about possible consequences of their sexual behaviours, and whether they experience problems as a result of their sexual behaviours in six domains. These domains were explicitly selected to reflect the outcome domains that the Society for the Advancement of Sexual Health identified as likely if a person is sexually compulsive (2014). Domains include financial, legal, physical, psychological, spiritual and social consequences.

Each of these domains was subsumed into hierarchical (1) cognitive and (2) behavioural domains. These two domains separate the extent of worry (cognitive) from the experience of actual consequences (behavioural) in each of the six, smaller areas. The cognitive outcomes subscale ($\alpha = .89$; McBride et al., 2008) consists of 20 items rated on a 4-point scale ranging from “never” to “always” concerning the extent to which they worried about their sexual activities in the past year (e.g. “Were making me feel guilty”). The behavioural outcomes subscale ($\alpha = .75$; McBride et al., 2008) consists of 16 items answered “yes” or “no” assessing the extent to which respondents have experienced negative outcomes as a result of their sexual activities in the past year (e.g. “Might have presented the potential for me to lose my job”). Both the cognitive ($B = 2.17$) and behavioural ($B = 1.57$) subscales are significantly related to the Sexual Compulsivity Scale (McBride et al., 2008).

Sexual Desire Inventory (SDI; Spector, Carey, & Steinberg, 1996)

The SDI is a 14-item scale used to measure two types of sexual desire. The Solitary Sexual Desire

Table 2. Reported sexual arousal when instructed to increase/decrease regressed to compulsive sexuality and sexual desire measures

	<i>B</i>	<i>SE (B)</i>	β	<i>p</i>
Increase instruction				
Step 1				
Sexual arousal baseline ^a	.93	.03	.93	<.001
Step 2				
CBO SB ^b				
Cognitive	.002	.01	.01	.87
Behavioural	-.04	.04	-.04	.37
Sexual Desire Inventory				
Solitary	.001	.01	.004	.91
Dyadic	-.001	.01	-.01	.85
Decrease instruction				
Step 1				
Sexual arousal baseline ^a	.87	.04	.91	<.001
Step 2				
CBO SB ^b				
Cognitive	-.004	.01	-.02	.76
Behavioural	-.06	.04	-.07	.17
Sexual Desire Inventory				
Solitary	.002	.01	.01	.86
Dyadic	.02	.01	.13	.002

^aReported sexual arousal when instructed to merely watch sexual films; ^bCognitive and Behavioural Outcomes of Sexual Behaviour scale.

scale measures an individual's desire for autoerotic sexual activity. The Dyadic Desire scale measures an individual's desire for sexual activity with a partner. The SDI has been validated in studies assessing sexual desire (King & Allgeier, 2000; Spector et al., 1996). Test-retest reliability was calculated at $r = .76$ over a one-month period (Spector et al., 1996).

Solitary sexual behaviours are consistently underreported (e.g. Halpern, Udry, Suchindran, & Campbell, 2000), so this subscale may be subject to more reporting bias. The Dyadic Desire scale measures an individual's desire for sexual activity with a partner. It is comprised of eight items (e.g. "When you have sexual thoughts, how strong is your desire to engage in sexual behaviour with a partner?"). The dyadic subscale is commonly used as an index of trait sexual desire level

(Giargiari, Mahaffey, Craighead, & Hutchison, 2005; Goldey & van Anders, 2012; Prause et al., 2008). While both subscales are related to impulsive sexual behaviours, intentions to engage in risky sexual behaviours and risky anal intercourse, only the dyadic scale has been related to actual risky sex acts, including with uncommitted partners (Turchik & Garske, 2009). In this study, the subscales assessing hypersexuality and measures of sexual desire were not significantly correlated with one another ($r = .002$ to $r = .10$), suggesting they tap different constructs. The full SDI scale was administered, scored and both subscales entered into the analysis as covariates.

Sexual arousal rating

After every film, the participant rated the level of "sexual arousal" (0, "Not at all"; 7, "Extremely") that they felt during the film (see Figure 1). (They also rated how "pleasant" they felt and how "hungry" they were for food. Those data will be presented elsewhere.) Rated sexual arousal was the primary dependent variable.

This rating approach was first used in 1983 (Heiman & Rowland) and is a common approach used to study felt sexual response in men and women. Rated sexual arousal tends to converge strongly with genital response in men (Chivers, Seto, Lalumière, Laan, & Grimbos, 2010). Sexual arousal ratings are uniquely elevated to sexual stimuli (e.g. as compared to exciting films in Staley & Prause, 2013). Also, felt sexual arousal is prioritised over physiological measures in making clinical judgements of sexual problems, especially for women (Bancroft, Loftus, & Long, 2003). Finally, physiological sexual arousal that does not reach conscious awareness through attention is not expected to influence sexual function or behaviours. Given that the goal of the study was to characterise responsiveness to, and regulation of, sexual responses that are expected to affect problematic urges to behave sexually, self-reported sexual arousal ratings were the primary dependent variable.

Procedure

After providing informed consent, participants were led to a private testing room. They first completed questionnaires (see above). They were told that their responses could not be viewed by study staff while they were answering. They also were encouraged to ask questions to clarify confusing items.

Once they notified the experimenter that they had completed the questionnaires, they received instructions for the sexual regulation task. After completing the regulation task, they alerted the experimenter. They were awarded course credit for their participation.

Data analysis

First, a manipulation check was conducted for the self-regulation task. A repeated-factors analysis of variance was conducted to test whether participants successfully increased or decreased their self-reported sexual arousal as instructed, relative to the “watch” condition. Sexual arousal ratings for increase and decrease conditions were strongly correlated ($r = .89$); this multicollinearity limited the data analytic approaches. Thus, two different analytic strategies were used.

For the primary analysis, reported sexual arousal following increase instructions and reported sexual arousal following decrease instructions were predicted separately using regression analyses. In both regressions the four scales (CBOSB cognitive, CBOSB behavioural, SDI solitary and SDI dyadic) were the predictors. In addition, sexual arousal in the watch condition was entered as a covariate to control for individual differences in baseline sexual responsiveness. In other words, this covariate controlled for the possibility that an individual may report higher or lower levels of sexual arousal across all three conditions. Since the first analysis included both up- and downregulation in a difference score, we felt that this

individual difference was captured by the range in that analysis.

In all analyses, Greenhouse–Geisser corrected, exact p values are reported to adjust for violations of sphericity, except where $p < .001$. To detect effects in these regressions as small as $f^2 = .1$, a sample of 125 was needed. Given the data loss (see above), our achieved power for that small effect size was .77. All data exclusions, manipulations and measures used in this study are described.

RESULTS

Manipulation check

Sexual arousal reported was significantly predicted by the manipulation instruction, $F(2, 284) = 30.91$, $p < .001$. Sexual arousal was highest following instructions to increase sexual arousal as compared to watch only, $t(142) = 3.09$, $p = .002$, and decrease, $t(142) = 7.01$, $p < .001$, instructions. Decrease instructions also resulted in significantly less sexual arousal reported as compared to watch only, $t(142) = 4.99$, $p < .001$, instructions. Given the successful manipulation, the primary hypothesis test was conducted.

Hypersexual problems, sexual desire and sexual regulation

In the primary analyses, sexual arousal following upregulation and downregulation were predicted in two separate regressions. The sexual arousal reported following instructions to *increase* sexual arousal was not associated with any of the four scales (CBOSB cognitive, CBOSB behavioural, SDI solitary and SDI dyadic; see Table 2). However, sexual arousal following instructions to *decrease* sexual arousal was positively associated (representing a failure to downregulate as effectively) with desire for sex with a partner, $\beta = .13$, $CI_{95} = .01$ to $.03$, $p = .002$.¹ None of the other predictors were significant (see Table 2). In

¹When split by gender, this effect appeared stronger in men than women, although the pattern of the results remained the same. Analyses were underpowered to detect effects due to gender.

summary, the instruction to downregulate sexual arousal produced smaller changes in sexual arousal in individuals with higher desire for partnered sex than individuals with lower desire for partnered sex.

DISCUSSION

Men and women who varied in their level of sexual problems and sexual desire attended one laboratory session. They viewed a series of short sexual films and reported their level of sexual arousal after each film. Just before each film, a cue indicated whether they were to watch only, increase or decrease their responses to the film. On average, the sample performed the task as instructed. However, individual differences in sexual desire predicted successful performance. Those with higher sexual desire for a partner exhibited less change in their sexual arousal to regulation instructions; specifically, higher desire for sex with a partner predicted more difficulty decreasing sexual arousal as instructed. Unexpectedly, the measure of hypersexual problems was unrelated to regulation abilities. While the current study differed in some respects from a very similar protocol of Winters et al. (2009), the current findings largely replicate that original study.

Given that a lack of control over strong sexual urges is cited as a primary feature of hypersexuality, it was surprising that neither of two scales measuring hypersexual problems were related to the self-regulation of sexual arousal. Other studies have been unable to find relationships between hypersexuality and executive dysfunction (Reid, Garos, Carpenter, & Coleman, 2011), affect dysregulation (Prause, Staley, & Fong, 2013) or responsivity to sexual cues (Steele, Staley, Fong, & Prause, 2013). If high sexual desire is primarily responsible for a failure to control sexual urges, as these data suggest, it may be useful to consider addressing this underlying construct directly. Those with lower sexual desire exhibit lesser activation of brain areas associated with reward (Woodard, Nowack, Balon, Tancer, & Diamond, 2013), while those with higher sexual desire

(Demos, Heatherton, & Kelley, 2012) and more sexual partners (Prause, Steele, Staley, & Sabatelli, 2014) exhibit greater reactivity to visual sexual stimuli. These functional differences are supported by structural differences (Bloemers et al., 2013). These data add to a growing literature that high sexual desire may, itself, be an important target to curb high frequency sexual behaviours that interfere with daily functions. Interventions specifically addressing craving in substance use and other behavioural problems could provide useful guidance.

These findings partially fail to replicate a study by Brand and colleagues (2011) where a self-report measure of excessive online sexual behaviour and perceived negative consequences was positively correlated with sexual arousal reported to pictures ($r = .27$). There were several differences between the two studies. For example, their study used only men, measured only excessive online sexual behaviour, included images of masturbation by women and did not include films. Both studies used a convenience sample without pathology, the same images across all participants and measured self-ratings of sexual arousal. The current findings suggest that sexual desire levels might have explained the variance attributed to the sex addiction measure in that study.

Several design decisions suggest limitations and possible future directions. Only self-reported sexual arousal was measured. Objective indicators of sexual arousal could be included in future work, such as genital response measures (Janssen, Prause, & Geer, 2007) or measures of non-specific activation, such as skin conductance. However, given that hypersexual problems are largely described by practitioners as subjective feelings of out-of-control sexual urges (Kafka, 2010), it seemed reasonable that self-reported sexual arousal might be more strongly related than genital responses to regulation instructions. Demand characteristics could have influenced responses. Visual erotica are more commonly consumed in the privacy of home. Additionally, sexual arousal ratings may have been influenced by the instructions to up- or downregulate. These findings are clearly limited to volitional regulation efforts,

where less explicit instructions or direct manipulation of relevant neural areas (e.g. neural feedback as in Ruiz, Buyukturkoglu, Rana, Birbaumer, & Sitaram, 2014) could reduce demand characteristics. Finally, the correspondence of real-world sexual behaviours with laboratory ratings of sexual arousal has not been well characterised. Another limitation is that participants in this study were not selected on the basis of meeting any clinical criteria. As no accepted clinical criteria exist, examining the proposed underlying construct, hypersexuality, in a continuous fashion appeared reasonable. Given that the current sample included individuals with high scores on the CBO SB scales, it is difficult to argue that extreme selection criteria would have resulted in a different pattern of results. As ever with null results, it is possible that the effect size was so small and had such limited clinical utility that the study was underpowered to detect it.

The exact timing of the impact on sexual regulation by sexual desire remains unclear. The engagement of regulation strategies occurs very quickly, on the order of milliseconds (Weinberg & Hajcak, 2010), and continues to develop dynamically (Hajcak, MacNamara, Foti, Ferri, & Keil, 2013). However, relatively less is known about the regulation of positive affect, especially the upregulation of positive affect. When processing highly pleasurable or rewarding stimuli, upregulation may be highly practised or automatic. Participants in this study, and those anticipating money rewards (Langeslag & van Strien, 2013), appear able to volitionally upregulate their pleasant rewards as a whole. However, a ceiling effect may occur in individuals with higher sexual desire. Consider, for example, participants in a functional magnetic resonance imaging study examining responses to chocolate cues (Schaefer, Knuth, & Rumpel, 2011). Participants exhibited greater activity in areas of the brain associated with reward when presented with their preferred chocolate brand. How successful would the participants have been in upregulating their response to their preferred chocolate brand if instructed? This may have been a difficult task if they already were at their maximal chocolate “liking”. Something similar

could be occurring with sexual stimuli, wherein those who already like sexual images very much would have difficulty further increasing their naturally strong positive response to sexual cues. If not a ceiling effect, some participants may even have had a reactionary *decrease* when instructed to increase. A similar pattern was observed when participants were provided a positive context for a sexual image, their brain response actually *decreased* relative to when a neutral context was provided for the sexual image (Peng, Qu, Gu, & Luo, 2012).

Identifying when sexual arousal, usually a strong pleasant feeling, can be effectively regulated may identify effective times to intervene. For example, early sexual arousal downregulation may be important for HIV prevention, whereas sexual arousal upregulation for low sexual desire problems might be better impacted by later “booster” upregulation to sustain positive affect.

Disclosure statement

No potential conflict of interest was reported by the authors.

REFERENCES

- Ariely, D., & Loewenstein, G. (2006). The heat of the moment: The effect of sexual arousal on sexual decision making. *Journal of Behavioral Decision Making, 19*(2), 87–98. doi:10.1002/bdm.501
- Arnow, B. A., Millheiser, L., Garrett, A., Lake Polan, M., Glover, G. H., Hill, K. R., & Desmond, J. E. (2009). Women with hypoactive sexual desire disorder compared to normal females: A functional magnetic resonance imaging study. *Neuroscience, 158*, 484–502.
- Bancroft, J., Loftus, J., & Long, J. S. (2003). Distress about sex: A national survey of women in heterosexual relationships. *Archives of Sexual Behavior, 32*, 193–208. doi:10.1023/A:1023420431760
- Beauregard, M., Levesque, J., & Bourgouin, P. (2001). Neural correlates of conscious self-regulation of emotion. *Journal of Neuroscience, 21*, RC165.
- Binson, D., & Catania, J. A. (1998). Respondents' understanding of the words used in sexual behavior questions. *Public Opinion Quarterly, 62*(2), 190–208.

- Bloemers, J., Scholte, H. S., van Rooij, K., Goldstein, I., Gerritsen, J., Olivier, B., & Tuiten, A. (2013). Reduced gray matter volume and increased white matter fractional anisotropy in women with hypoactive sexual desire disorder. *Journal of Sexual Medicine*, *11*, 753–767. doi:10.1111/jsm.12410
- Brand, M., Laier, C., Pawlikowski, M., Schachtle, U., Scholer, T., & Altstotter-Gleich, C. (2011). Watching pornographic pictures on the internet: Role of sexual arousal ratings and psychological-psychiatric symptoms for using internet sex sites excessively. *Cyberpsychology Behavior and Social Networking*, *14*, 371–377. doi:10.1089/cyber.2010.0222
- 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*(1), 5–56. doi:10.1007/s10508-009-9556-9
- Coleman, E., Horvath, K., Miner, M., Ross, M., Oakes, M., & Rosser, B. R. S. (2010). Compulsive sexual behavior and risk for unsafe sex among internet using men who have sex with men. *Archives of Sexual Behavior*, *39*(5), 1045–1053. doi:10.1007/s10508-009-9507-5
- Demos, K. E., Heatherton, T. F., & Kelley, W. M. (2012). Individual differences in nucleus accumbens activity to food and sexual images predict weight gain and sexual behavior. *The Journal of Neuroscience*, *32*, 5549–5552. doi:10.1523/jneurosci.5958-11.2012
- George, W. H., Davis, K. C., Norris, J., Heiman, J. R., Stoner, S. A., Schacht, R. L., ... Kajumulo, K. F. (2009). Indirect effects of acute alcohol intoxication on sexual risk-taking: The roles of subjective and physiological sexual arousal. *Archives of Sexual Behavior*, *38*, 498–513. doi:10.1007/s10508-008-9346-9
- Giargiari, T. D., Mahaffey, A. L., Craighead, W. E., & Hutchison, K. E. (2005). Appetitive responses to sexual stimuli are attenuated in individuals with low levels of sexual desire. *Archives of Sexual Behavior*, *34*, 547–556. doi:10.1007/s10508-005-6280-y
- Giuliani, N. R., McRae, K., & Gross, J. J. (2008). The up- and down-regulation of amusement: Experiential, behavioral, and autonomic consequences. *Emotion*, *8*, 714–719. doi:10.1037/a0013236
- Goldey, K. L., & van Anders, S. M. (2012). Sexual arousal and desire: Interrelations and responses to three modalities of sexual stimuli. *Journal of Sexual Medicine*, *9*(9), 2315–2329. doi:10.1111/j.1743-6109.2012.02845.x
- Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: Reappraisal and suppression of negative emotion. *Biological Psychiatry*, *63*, 577–586. doi:10.1016/j.biopsych.2007.05.031
- Goodman, A. (2008). Neurobiology of addiction. An integrative review. *Biochemical Pharmacology*, *75*, 266–322. doi:S0006-2952(07)00507-2[pii]
- Gyurak, A., Goodkind, M. S., Kramer, J. H., Miller, B. L., & Levenson, R. W. (2012). Executive functions and the down-regulation and up-regulation of emotion. *Cognition and Emotion*, *26*(1), 103–118. doi:10.1080/02699931.2011.557291
- Hajcak, G., MacNamara, A., Foti, D., Ferri, J., & Keil, A. (2013). The dynamic allocation of attention to emotion: Simultaneous and independent evidence from the late positive potential and steady state visual evoked potentials. *Biological Psychology*, *92*, 447–455. doi:10.1016/j.biopsycho.2011.11.012
- Halpern, C. J. T., Udry, J. R., Suchindran, C., & Campbell, B. (2000). Adolescent males' willingness to report masturbation. *Journal of Sex Research*, *37*(4), 327–332. doi:10.1080/00224490009552055
- Hardy, K. (1964). An appetitional theory of sexual motivation. *Psychological Review*, *71*(1), 1–18.
- Heiman, J. R., & Rowland, D. L. (1983). Affective and physiological sexual response patterns: The effects of instructions on sexually functional and dysfunctional men. *Journal of Psychosomatic Research*, *27*(2), 105–116.
- Janssen, E., Carpenter, D., & Graham, C. (2003). Selecting Films for Sex Research: Gender Differences in Erotic Film Preference. *Archives of Sexual Behavior*, *32*(3), 243–251.
- Janssen, E., Prause, N., & Geer, J. (2007). The sexual response system. In L. G. Tassinary, G. Berntson, & J. T. Cacioppo (Eds.), *Handbook of Psychophysiology* (3rd ed., pp. 315–341). New York, NY: Cambridge University Press.
- Kafka, M. P. (2010). Hypersexual disorder: A proposed diagnosis for DSM-V. *Archives of Sexual Behavior*, *39*(2), 377–400. doi:10.1007/s10508-009-9574-7
- Kashdan, T. B., & Rottenberg, J. (2010). Psychological flexibility as a fundamental aspect of health. *Clinical Psychology Review*, *30*, 865–878. doi:10.1016/j.cpr.2010.03.001
- Kim, S. H., & Hamann, S. (2007). Neural correlates of positive and negative emotion regulation. *Journal of Cognitive Neuroscience*, *19*, 776–798. doi:10.1162/jocn.2007.19.5.776

- King, B. E., & Allgeier, E. R. (2000). The sexual desire inventory as a measure of sexual motivation in college students. *Psychological Reports, 86*, 347–350.
- Langeslag, S. J., & van Strien, J. W. (2013). Up-regulation of emotional responses to reward-predicting stimuli: An ERP study. *Biological Psychology, 94*, 228–233. doi:10.1016/j.biopsycho.2013.05.021
- McBride, K. R., Reece, M., & Sanders, S. A. (2008). Using the sexual compulsivity scale to predict outcomes of sexual behavior in young adults. *Sexual Addiction & Compulsivity, 15*(2), 97–115.
- Ochsner, K. N., Bunge, S. A., Gross, J. J., & Gabrieli, J. D. E. (2002). Rethinking feelings: An fMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience, 14*, 1215–1229. doi:10.1162/089892902760807212
- Ochsner, K. N., Ray, R. D., Cooper, J. C., Robertson, E. R., Chopra, S., Gabrieli, J. D. E., & Gross, J. J. (2004). For better or for worse: Neural systems supporting the cognitive down- and up-regulation of negative emotion. *NeuroImage, 23*, 483–499.
- Pavlov, S. V., Reva, N. V., Loktev, K. V., Tummy, A. V., Korenyok, V. V., & Aftanas, L. I. (2014). The temporal dynamics of cognitive reappraisal: Cardiovascular consequences of downregulation of negative emotion and upregulation of positive emotion. *Psychophysiology, 51*, 178–186. doi:10.1111/psyp.12159
- Peng, J., Qu, C., Gu, R., & Luo, Y. J. (2012). Description-based reappraisal regulate the emotion induced by erotic and neutral images in a Chinese population. *Frontiers in Human Neuroscience, 6*, 355. doi:10.3389/fnhum.2012.00355
- Prause, N., Janssen, E., & Hetrick, W. P. (2008). Attention and emotional responses to sexual stimuli and their relationship to sexual desire. *Archives of Sexual Behavior, 37*, 934–949.
- Prause, N., Staley, C., & Finn, P. (2011). The effects of acute ethanol consumption on sexual response and sexual risk-taking intent. *Archives of Sexual Behavior, 40*, 373–384.
- Prause, N., Staley, C., & Fong, T. W. (2013). No evidence of emotion dysregulation in “hypersexuals” reporting their emotions to a sexual film. *Sexual Addiction & Compulsivity, 20*(1–2), 106–126.
- Prause, N., Steele, V. R., Staley, C., & Sabatinelli, D. (2014). Late positive potential to explicit sexual images associated with the number of sexual intercourse partners. *Social Cognitive and Affective Neuroscience*.
- Reid, R. C., Garos, S., Carpenter, B. N., & Coleman, E. (2011). A surprising finding related to executive control in a patient sample of hypersexual men. *Journal of Sexual Medicine, 8*, 2227–2236. doi:10.1111/j.1743-6109.2011.02314.x
- Rottenberg, J., Ray, R. D., & Gross, J. J. (2007). Emotion elicitation using films. In J. A. Coan & J. J. B. Allen (Eds.), *Handbook of emotion elicitation and assessment* (pp. 9–28). New York: Oxford University Press.
- Ruiz, S., Buyukturkuglu, K., Rana, M., Birbaumer, N., & Sitaram, R. (2014). Real-time fMRI brain computer interfaces: Self-regulation of single brain regions to networks. *Biological Psychology, 95*, 4–20. doi:10.1016/j.biopsycho.2013.04.010
- Schaefer, M., Knuth, M., & Rumpel, F. (2011). Striatal response to favorite brands as a function of neuroticism and extraversion. *Brain Research, 1425*, 83–89. doi:10.1016/j.brainres.2011.09.055
- Schnarrs, P. W., Rosenberger, J. G., Satinsky, S., Brinegar, E., Stowers, J., Dodge, B., & Reece, M. (2010). Sexual compulsivity, the internet, and sexual behaviors among men in a rural area of the United States. *AIDS Patient Care STDS, 24*(9), 563–569. doi:10.1089/apc.2010.0117
- Spector, I. P., Carey, M. P., & Steinberg, L. (1996). The sexual desire inventory: Development, factor structure, and evidence of reliability. *Journal of Sex and Marital Therapy, 22*, 175–190. doi:10.1080/00926239608414655
- Staley, C., & Prause, N. (2013). Erotica viewing effects on intimate relationships and self/partner evaluations. *Archives of Sexual Behavior, 42*(4), 1–10. doi:10.1007/s10508-012-0034-4
- Steele, V. R., Staley, C., Fong, T., & Prause, N. (2013). Sexual desire, not hypersexuality, is related to neurophysiological responses elicited by sexual images. *Socioaffective Neuroscience & Psychology, 3*, 20770. doi:10.3402/snp.v3i0.20770
- Stevenson, R., Case, T., & Oaten, M. (2011). Effect of self-reported sexual arousal on responses to sex-related and non-sex-related disgust cues. *Archives of Sexual Behavior, 40*(1), 79–85. doi:10.1007/s10508-009-9529-z
- Storholm, E., Fisher, D., Napper, L., Reynolds, G., & Halkitis, P. (2011). Proposing a tentative cut point for the compulsive sexual behavior inventory. *Archives of Sexual Behavior, 40*(6), 1301–1308. doi:10.1007/s10508-010-9712-2
- Turchik, J. A., & Garske, J. P. (2009). Measurement of sexual risk taking among college students. *Archives of Sexual Behavior, 38*(6), 936–948. doi:10.1007/s10508-008-9388-z

- Vardi, Y., Sprecher, E., Gruenwald, I., Yarnitsky, D., Gartman, I., & Granovsky, Y. (2009). The p300 event-related potential technique for libido assessment in women with hypoactive sexual desire disorder. *Journal of Sexual Medicine*, *6*, 1688–1695. doi:10.1111/j.1743-6109.2009.01280.x
- Weinberg, A., & Hajcak, G. (2010). Beyond good and evil: The time-course of neural activity elicited by specific picture content. *Emotion*, *10*, 767–782. doi:10.1037/a0020242
- Whalen, R. (1966). Sexual motivation. *Psychological Review*, *73*, 151–163.
- Winters, J., Christoff, K., & Gorzalka, B. B. (2009). Conscious regulation of sexual arousal in men. *Journal of Sex Research*, *46*, 330–343. doi:10.1080/00224490902754103
- Winters, J., Christoff, K., & Gorzalka, B. B. (2010). Dysregulated sexuality and high sexual desire: Distinct constructs? *Archives of Sexual Behavior*, *39*, 1029–1043. doi:10.1007/s10508-009-9591-6
- Woodard, T. L., Collins, K., Perez, M., Balon, R., Tancer, M. E., Kruger, M., ... Diamond, M. P. (2008). What kind of erotic film clips should we use in female sex research? An exploratory study. *Journal of Sexual Medicine*, *5*(1), 146–154. doi:10.1111/j.1743-6109.2007.00641.x
- Woodard, T. L., Nowak, N. T., Balon, R., Tancer, M., & Diamond, M. P. (2013). Brain activation patterns in women with acquired hypoactive sexual desire disorder and women with normal sexual function: A cross-sectional pilot study. *Fertility and Sterility*, *100*, 1068–1076. doi: 10.1016/j.fertnstert.2013.05.041
- Yeagley, E., Hickok, A., & Bauermeister, J. A. (2013). Hypersexual behavior and HIV sex risk among young gay and bisexual men. *Journal of Sex Research*, doi:10.1080/00224499.2013.818615