The role of incentive learning and cognitive regulation in sexual arousal

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SECTION 2

Chapter 8

The Influence of Emotion Down-Regulation on the Expectation of Sexual Reward

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Abstract

Emotion regulation research has shown successful altering of unwanted aversive emotional reactions. Cognitive strategies can also regulate expectations of reward arising from conditioned stimuli. However, less is known about the efficacy of such strategies with expectations elicited by conditioned appetitive sexual stimuli, and possible sex differences therein. In the present study it was examined whether a cognitive strategy (attentional deployment) could successfully down-regulate sexual arousal elicited by sexual reward-conditioned cues in men and women. A differential conditioning paradigm was applied, with genital vibrostimulation as unconditioned stimulus (US) and sexually relevant pictures as conditional stimuli (CSs). Evidence was found for emotion down-regulation to effect extinction of conditioned sexual responding in men. In women, the emotion down-regulatory strategy resulted in attenuated conditioned approach tendencies towards the CSs. The findings support that top-down modulation may indeed influence conditioned sexual responses. This knowledge may have implications for treating disturbances in sexual appetitive responses.

8.1. Introduction

Research in animals and humans support the notion that reward learning in the form of classical conditioning can contribute to the etiology of both normal and maladaptive sexual behaviors, like paraphilias, or deviant sexual preferences (Brom et al., 2014a; Pfaus, Kippin & Centeno, 2001). In classical conditioning, through the repeated association with the unconditional stimulus (US), a neutral stimulus (NS) can eventually elicit the same reaction as the US (Bindra, 1974; Pavlov, 1927). The NS is now called the conditioned stimulus (CS) and the reaction to the CS is called the conditioned response (CR). Several notable studies have demonstrated conditioned sexual arousal responses in humans (for a review see Brom et al., 2014a). Both from a learning theory and neuroscience perspective, disorders in sexual motivation, like hypersexuality, can potentially be characterized as disorders involving disturbed emotional learning and memory processes resulting in enhanced sexual response acquisition and maintenance.

The expectation of a potential sexual reward can elicit positive feelings and sexual arousal and therefore can aid in the learning about environmental cues that predict future sexual rewards. However, this reward expectation signal can also be maladaptive, potentially eliciting sexual urges that may be difficult to control, like in case of hypersexuality. Therefore, it is important to understand how to regulate or control the positive feelings associated with reward expectation. One promising method for examining this is the utilization of cognitive strategies. The term emotion regulation signifies any process that serves to initiate, inhibit or modulate (e.g. cognitively re-evaluate) emotional feelings or behavior (Aldao, 2013; Gross, 2002; Gross & Thomspon, 2007). Successful emotion-regulation may be dependent on top-down control from the prefrontal cortex over subcortical regions involved in reward and emotion. Failures in this deployment of top-down cognitive control mechanisms or

overactive bottom-up processes may contribute to several forms of psychopathology (Heatherton and Wagner, 2011; Ray and Zald, 2012), including sexual disorders with a learned component (Bancroft & Janssen, 2000; Both, Laan & Everaerd, 2011; Klucken et al., 2013; van Lankveld, van den Hout & Schouten, 2004; Salemink, van Lankveld, 2006). Cognitive strategies can successfully alter unwanted aversive emotional reactions. Emotional down-regulation strategies can influence emotions at the input phases (i.e. antecedent focused like cognitive reappraisal or attentional deployment) and at the output phase (i.e. response focused like suppression) (Gross, 1998; Webb, Miles & Sheeran, 2012). Gross and Thompson (2007) suggest that antecedent-focused strategies (e.g. attentional deployment) are more effective than response-focused strategies. As relatively few studies on negative emotions, and even less studies on positive emotions, have investigated the effects of the promising active distraction strategies (where the emphasis is on participants to bring to mind something unrelated to the emotion or emotional stimulus to serve as a distraction), especially on behavioral and physiological measures of emotion, this is an important avenue for future research (Webb, Miles & Sheeran, 2012). At present, there is growing evidence that cognitive strategies like attentional deployment can also regulate expectations of reward arising from conditioned stimuli (Delgado, Gillis & Phelps, 2008). However, less is known about the efficacy of such strategies with expectations elicited by conditioned appetitive sexual stimuli. To our knowledge, the present study is the first to investigate whether a cognitive down-regulatory strategy can efficiently regulate sexual arousal elicited by sexual reward-conditioned cues.

At present, it is unclear if men and women are equally prone to conditioning of sexual response and if sex differences do exist in the emotion regulation of positive emotions, like sexual arousal. Given the fact that paraphilia and hypersexuality are predominantly observed in men (Kafka 1994;

Kuzma & Black, 2008; Rosen, 2000) it is speculated that men are more receptive to increased CR acquisition (Domjan, 2005; Gutiérrez & Domjan, 1997; Klucken et al., 2009; Pfaus, Kippin & Centeno, 2001). Nevertheless, few studies have addressed sexual conditioning in both men and women (Brom et al., 2014a), and some results are contradictory to this general assertion (Brom et al, 2014b; Hoffmann, Janssen & Turner, 2004). Second, with respect to emotion regulation, the general assertion is that women use more emotion-focused strategies, while men are thought to use more efficient cognitive (rational) cognitive strategies (Whittle et al., 2011). However, most –if not all- of these results relate to the regulation of particularly negative emotions (Mak et al., 2009; McRae et al., 2008; Gross, 2007). Hence, the contradictory results of previous sexual conditioning studies and the lack of studies on sex differences in positive emotion regulation, point to the importance for further investigation of possible gender differences in sexual learning and cognitive regulation thereof.

In the present study, a differential conditioning paradigm was applied, with instructions adapted from Delgado, Gillis and Phelps (2008). It was predicted that participants in two conditions (the control condition *Attend* and the experimental *Down-Regulate* condition) would show conditioned genital and subjective sexual responding to the CS that was paired with the US (the CS+), which was expected to gradually decrease during extinction trials. When the *Attend* instruction preceded the CSs, the participant was instructed just to pay attention to the stimulus. In contrast, when the instruction *Regulate* appeared on screen, participants were instructed to conjure a soothing image from nature prompted by the colour of the stimulus. Instructions were presented in acquisition and extinction phases. It was predicted that an emotion down-regulation strategy would successfully decrease arousal elicited by the sexual reward-conditioned cue, in men and women, in both the acquisition and extinction phases. Since subjective ratings are susceptible to demand

characteristics, in addition a task was included to assess implicit approach and avoidance tendencies towards the CS (Cousijn, et al., 2011). We assumed participants should be faster when instructed to approach the CS+ and avoid from the CS- than when instructed to avoid the CS+ and approach the CS-, and an emotion down regulation strategy should decrease these responses elicited by reward-conditioned cues.

8.2. Method

8.2.1. Participants

Research participants were 40 men and 53 women. Participants were paid €30,- for their participation and were recruited using posted advertisements. The advertisement stated that the focus of the study would be on the relationship between erotic (genital) stimulation and sexual arousal. Inclusion criteria were: age between 18 and 45 years and a heterosexual orientation. Exclusion criteria were: sexual problems, a Diagnostic and Statistical Manual of Mental Disorders 4th Edition (DSM-IV) diagnosis of an affective or psychotic disorder or abusive drug use, pregnancy or breastfeeding, and a medical illness or use of medication that could interfere with sexual response. Written informed consent was obtained from all participants. The study was approved by the Ethical Committee of the Medical Center.

8.2.2. Design and Conditioning Procedure

One stimulus (the CS+) was followed by the genital vibrostimulation (US) during the acquisition phase, whereas the other stimulus (CS-) was never followed by genital vibrostimulation. Participants were randomly assigned to one of the two conditions: Down-Regulate or Attend, with restriction that conditions matched on sex as close as possible. For a schematic overview of the procedure see Figure 1. In the preconditioning phase, participants saw four

nonreinforced presentations of the CS+ and four presentations of the CS-, for 9 seconds each. Subsequently, in the acquisition phase the CS+ and CS- were presented 10 times each and the CS+ was always followed by the US. In the extinction phase the CS+ was no longer followed by the US. Prior to CS presentation, in the acquisition- and extinction phases participants were presented with a written cue (*attend* or *regulate*) on screen for 2 s that reminded participants to either Attend or Down-Regulate. All phases were presented without interruption. Genital response was measured continuously during resting baseline, preconditioning, acquisition, and extinction phases. There were two random CS orders for each phase (that was counterbalanced across participants); with the restriction of only two successive presentations of each CS. During the whole procedure inter-trial intervals (ITIs) were 20, 25, or 30 seconds. The order of the length of the ITI was random, with the restriction of only two successive lengths. Stimuli and cues were presented by using E-prime 2.0 Software (Psychology Software Tools, Inc).

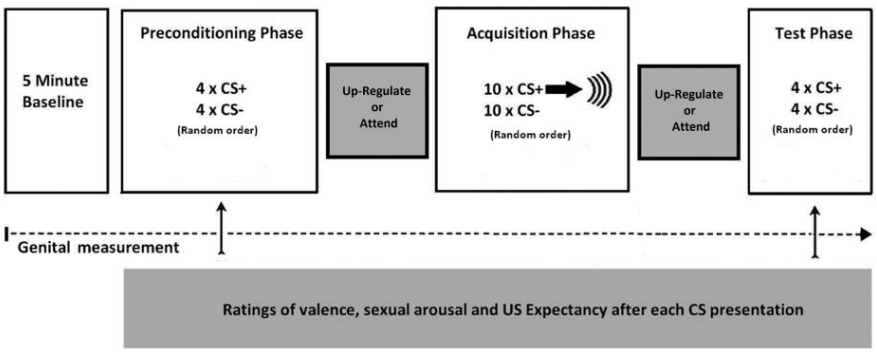

Figure 1. Schematic representation of the experimental procedure in both conditions. In the acquisition and extinction phase, before every CS presentation a written cue was presented: participants in the Down-Regulate condition received the instruction "Regulate" whereas participants in the control condition received the written cue "Attend" prior to each CS+. Assignment of the colour of the pictures (blue or yellow) as CS+ and CS− was counterbalanced across participants and conditions.

8.2.3. Materials, Apparatus, and Recording

Stimulus materials. Two identical pictures served as CSs, and portrayed an abdomen of an individual of the opposite sex (wearing underwear), with the colour of the underwear in the picture (Blue or Yellow) being the only difference. The CSs were shown in the middle of a computer monitor, approximately 1.5 m in front of the participant. The size of the presented pictures was 14 X 21 cm. Assignment of the pictures as CS+ and CS- was counterbalanced across participants and conditions.

Written instructions. In the *Attend* condition participants received the written cue *Attend* prior to each trial in the acquisition and extinction phases. They were instructed to '*just pay attention'* to the CSs when they were presented this cue. In contrast, in the Down-Regulate condition participants were only presented with the *Regulate* cue in the acquisition and extinction phases, and were instructed that when the cue *Regulate* appeared on the monitor, they should conjure a soothing image from nature prompted by the colour of the CS. For example, upon seeing the blue CS, participant could imagine the ocean or blue sky, while imagining a sunny beach or a field of flowers for the yellow CS. Participants were asked to generate the same image every time each colour CS was presented.

Genital vibrostimulation (US). Genital vibrostimulation was provided 8s following the start of the CS+ for 2s. For men, the US was administered by means of a ring-shaped vibrator. They were instructed to place the vibrator just below the coronal ridge (Janssen, 1994). For women, a small hands-off vibrator (2 cm diameter) was used (Laan & van Lunsen, 2002). The vibrator was placed on the clitoris using a lycra panties that had an opening for the vaginal

plethysmograph. All participants were instructed to position the vibrator as *most sexually stimulating*.

Male genital sexual arousal. An indium/gallium-in-rubber penile gauge assessed changes in penile circumference (Bancroft, Jones, & Pullan, 1966). The gauges were calibrated before each laboratory session using a set of calibrated rings (Janssen, Prause, & Geer, 2007). The penile gauge was positioned two-thirds of the way down the shaft of the penis toward the base. Changes in electrical output caused by expansion of the gauge were recorded by a continuous DC signal. The Indium-Gallium penile gauges were disinfected after each use, according to Sekusept plus disinfection procedure (MedCaT B.V.). Sekusept plus contains Glucoprotamine, which action spectrum covers bacteria including mycobacteria, fungi and viruses (e.g. Human Papillomavirus [HPV]) (MedCaT B.V.).

Women's genital arousal. Vaginal photoplethysmography assessed vaginal pulse amplitude (VPA) (Laan, Everaerd & Evers, 1995). Depth of the probe and orientation of the light emitting diode were controlled by a device (a 6- X 2-cm plate) attached to the cable. The vaginal photoplethysmograph was disinfected by means of a plasma sterilization procedure between uses. Plasma sterilization is a highly effective method for the complete removal of all organic (and certain in-organic) materials.

Subjective ratings. Ratings of affective value, sexual arousal and US expectancy were collected during the preconditioning- and extinction phases. Participants were first asked to rate, after each CS presentation, the affective value of the CSs by answering the question "*What kind of feeling does this picture evoke in you*?" The question could be answered on a seven-point Likert scale on a keyboard that varied from *very negative* to *very positive*. Then, subjective sexual

arousal was rated by answering the question "*How sexually arousing is this picture to you*?" The question could be answered on a seven-point scale that varied from *not sexually arousing at all* to *very sexually arousing*. Then, participants were required to rate the expectancy of a vibration following the presentation of each CS on a seven-point scale by answering the question "*To what extent did you expect a vibration after this picture*"? The scale consisted of seven points labeled from '*certainly no vibration'* through '*certainly a vibration'*. The questions were presented at the monitor 1 second following the end of picture presentation.

8.2.4. Other Measures

Approach avoidance task (AAT, see Cousijn et al., 2011; E-prime 2.0 Software, Psychology Software Tools, Inc)**.** Participants were presented with the CS+, CS-, and neutral pictures from the International Affective Picture System (IAPS; Lang, Bradley and Cuthbert, 2005). All images were rotated 3° left or right. Image content was irrelevant to the task: participants were instructed to pull or push the joystick in response to rotation direction. Pulling and pushing the joystick gradually increased and decreased image-size. The CS+, CS- and the neutral pictures were presented 80 times each, 40 times in push- and 40 times in pull-format, resulting in 240 test trials. The latency was recorded between picture onset and completion of a full push or pull response. Literature supports the AAT's validity in measuring approach/avoidance motivational processes (Wiers et al., 2011).

The international index of erectile function (IIEF). This is a validated 15-question questionnaire that examines 4 main domains of male sexual function: erectile function (6 questions, range 0-5), orgasmic function (2 questions, range 0-5), sexual desire (2 questions, range 0-5), and intercourse satisfaction (3

questions, range 0-5). Higher scores indicate better sexual function. Psychometric properties of the IIEF are good (Rosen et al., 1997).

The female sexual function index (FSFI). Women's sexual functioning was assessed by the FSFI (Rosen et al., 2000; Ter Kuile, Brauer & Laan, 2006), consisting of six subscales: desire (two items; range 1–5), arousal (four items; range 0–5), lubrication (four items; range 0–5), orgasm (three items; range 0–5), satisfaction (three items; range 0–5), and pain (three items; range 0–5). A higher score indicates better sexual functioning. The FSFI has good internal reliability and is able to differentiate between clinical samples and nondysfunctional controls.

Exit interview. Participants were asked, among others things, about their reactions to the experimental procedure, the use of the genital device, and their evaluation of the genital vibrostimulation. For instance, participants were asked to what extent they liked the vibrostimulation. This could be rated at a 5-point scale ranging from (1) not pleasant at all, to (5) very pleasant. Likewise, participants were asked how sexually aroused they became by the vibration. In addition, they were asked about any prior experience with vibrostimulation. Participants were also asked about the used cognitive strategies, and they were asked to rate how successful they were in concentrating and in the deployment of the cognitive strategy on a scale from 1 to 5 (i.e. 1 (trouble keeping concentrated) – 5 (well capable keeping concentrated); and 1 (not successful at all) – 5 (very successful).

8.2.5. Procedure

After participants completed the first session of the AAT, participants were instructed that the purpose of the experiment was to measure physiological responses to different pictures and to genital vibrostimulation. Before entering

the experimental conditioning session, participants were instructed about the vibrostimulation, the colours of the CSs, and the written cues that would appear on screen. Participants were made aware of the contingencies (e.g., only the colour blue or yellow predicted a potential genital vibrostimulation). Then *Attend* or *Regulate* instructions were explained. Participants were asked to verbalize what they were planning to think about when being presented with the written cues Attend and Regulate to assure that they were following the instructions they were given. In addition, participants were notified that regardless of the instruction, the CS+ always indicated the possibility of receiving genital vibrostimulation. Subsequently, the experimental conditioning experiment followed (see Both et al., 2008, 2011; Brom et al., 2014b for conditioning procedure), starting with the preconditioning phase, followed by the acquisition and extinction phases. In the acquisition and extinction phase participants were presented with the written cue Attend or Regulate prior to each CS. Directly after this experimental procedure, the second session of the AAT was completed. Then participants privately filled in questionnaires (e.g., FSFI, Rosen et al., 2000; IIEF, Rosen, 1997) and an exit interview questionnaire was administered.

8.2.6. Data Reduction, Scoring and Analysis

After artefact removal, mean penile circumference or mean VPA level during the 2-minute resting baseline period was calculated. Genital responses to the CSs were scored in three latency windows: during 4-8, 9-12 and 13-16 seconds following CS onset, respectively FIR (first interval response), SIR (second interval response) and TIR (third interval response) (see also Both et al., 2008; 2011) For FIR, SIR and TIR, change scores were calculated for each CS presentation by subtracting mean genital resting baseline from genital measures following CS presentation. Since direct gender comparison of genital responses

cannot be made because of the different measures used, genital data for men and women was analysed separately. For genital responses, effects were tested with mixed factor univariate analysis of variance procedures (General Linear Model in SPSS), with Stimulus and Trial as within-subject factors and Condition as between subjects factor. Analyses of subjective measurements and AAT scores were conducted for men and women combined, with Condition and Gender as between subjects factor (General Linear Model in SPSS). The Greenhouse–Geisser correction was applied to adjust for violation of the sphericity assumption in testing repeated measures effects. All phases were analysed separately. Preconditioning and acquisition phases were both analysed as a whole, whereas individual extinction trials were analysed separately, since sexual conditioning effects have generally been found to be small (Brom et al., 2014b; Hoffmann, Janssen & Turner, 2004), and the deployment of the emotion regulation strategy is expected to affect not only the magnitude of conditioned responding (trial 1 and 2 of the extinction phase) but also the extinction of conditioned responding (trial 3 and 4 of the extinction phase). Effect sizes are reported as proportion of partial variance (η_p^2) or as Cohen's *d* for paired comparisons (Cohen, 1988). Data from the AAT were corrected for outliers. Median RTs were used because they are less sensitive to outliers than means (see Cousijn et al., 2011). Bias scores (median push – pull) were computed for CS+, CS- and the neutral pictures. A positive bias score will be referred to further as an approach-bias and a negative bias score as an avoid-bias. AAT bias scores were analysed using standard analysis of variance (ANOVA).

8.3. Results

Participants were randomly assigned to one of the two conditions with the restriction that conditions were matched on sex as close as possible: Down-Regulate (N=46; Men, n = 20) and Attend (N= 47; Men, n = 20), see Table 1 *Subject characteristics*.

8.3.1. Genital Sexual Arousal

Preconditioning phase.

For all latency windows (FIR, SIR and TIR), no difference in circumference following presentation of the CS+ and CS- was found, all ps > .42. In addition, for women, on all time latencies, no difference in VPA following presentation of the CS+ and CS- was found, all ps > .20.

Table 1. Subject characteristics (p. 312)**.** Descriptive subject variables for men and women, and for each condition. Notes: IIEF= *International Index of Erectile Function* (Rosen et al.. 1997); FSFI= *Female Sexual Function Index* (Rosen et al., 2000; Ter Kuile, Brauer & Laan, 2006). Questions from exit interview. Scales: Prior experience vibrostimulation: 1 (never) – 5 (very often); Pleasantness US: 1 (not pleasant at all) - 5 (very pleasant); US perceived as sexually arousing: 1 (not sexually arousing at all) – 5 (very sexually arousing); Declared sexual arousal: 1 (not sexually aroused) – 5 (very sexually aroused); Instructions: Able to concentrate: 1 (trouble keeping concentrated) – 5 (well capable keeping concentrated); Instructions: successful deployment of cognitive strategies: 1 (not successful at all) – 5 (very successful); Examples of what participants thought of in the *Regulate* condition when presented with their CS+ are: seeing a blue sky with contrails, the sea, a yellow beach, or a yellow dessert. * p < .05.

Variable	Men						Women						Men & Women					
	Attend (n=20)		Down-Regulate (n=20)			Effect Size	Attend (n= 29)		Down-Regulate (n= 33)			Effect Size	Men (N= 40)		Women (N= 52)			Effect Size
	M	SD	M	SD	*p*	Cohen's *d*	M	SD	M	SD	*p*	Cohen's *d*	M	SD	M	SD	*p*	Cohen's *d*
Age (years)	25	6.1	22	2.6	.08	.66	28.8	8.2	27.7	8.1	.64	.14	23.6	4.8	28.2	8.0	< .01*	.70
Sexual Functioning (IIEF/FSFI score)	36.2	5.6	34.9	5.8	.69	.41	27.3	2.8	28.1	2.8	.32	.29						
Prior Experience Vibrostimulation	1.7	1.1	1.7	0.9	.96	.00	3.8	1.3	3.7	1.1	.87	.08	1.7	1.0	3.8	1.1	< .01*	2.0
Pleasantness US	3.2	1.4	3.3	0.9	.81	.09	3.5	0.7	3.2	0.6	.21	.47	3.2	1.2	3.4	0.8	.48	.03
US Perceived as Sexually Arousing	3.1	1.2	3.0	1.1	.89	.09	3.2	0.9	3.1	0.8	.90	.11	3.0	1.2	3.1	0.9	.59	.10
Declared Sexual Arousal	2.5	1.4	2.5	1.0	.95	.00	2.5	0.8	2.5	0.8	.86	.00	2.5	1.2	2.6	0.9	.66	.10
Instructions: Able to concentrate	4.3	0.5	3.93	0.6	0.9	.69	4.0	0.4	3.5	0.6	< .01*	.98	4.1	0.6	3.8	0.6	< .01*	.50
Instructions: Successful delployment of cognitive strategy	4.2	0.7	4.0	0.5	.36	.34	3.5	0.6	3.7	0.5	0.8	.37	.41	0.6	3.8	0.5	0.2	.56

Acquisition phase.

Men. Figure 2 summarizes penile circumference (SIR) to CS+ and CS- across trials for the conditions Attend and Down-Regulate. A main effect of Stimulus was found on FIR, $F(1, 38) = 8.29$, $p < .01$, $\eta_p^2 = .18$; and SIR, $F(1, 38) = 90.88$, $p < .01$, $\eta_p^2 = .71$, indicating the vibrostimulation resulted in a genital response. In line with Brom et al. (2014b) penile circumference was smaller in response to the CS+ and vibrostimulation than in response to the CS-. On TIR no main effect of Stimulus was found, $p = .23$. No differences in differential responding were observed between the conditions, FIR $p = .47$; SIR $p = .40$; TIR $p = .38$, and no main effect of Condition was found, FIR $p = .68$; SIR $p = .71$; TIR $p = .71$.

Women. Figure 3 summarizes VPA (SIR) to CS+ and CS- across trials for both conditions separately. In line with previous studies (Both et al., 2008; 2011), the 2 (Stimulus) X 10 (Trial) X 2 (Condition) mixed ANOVA of VPA revealed no significant main effect of Stimulus on FIR, $p = .07$, but did on SIR, $F(1, 51) = 18.77$, $p < .01$, $\eta_p^2 = .27$, and TIR, $F(1, 50) = 50.51$, $p < .01$, $\eta_p^2 = .50$. A Stimulus X Condition interaction was not found, FIR $p = .15$; SIR $p = .15$; TIR $p = .34$, nor of Stimulus X Trial X Condition, FIR $p = .25$; SIR $p = .59$; TIR $p = .38$.

Extinction phase.

Men. Analysis of the first extinction trial revealed a significant main effect of Stimulus on FIR $F(1, 38) = 4.19$, $p < .05$, $\eta_p^2 = .10$; and SIR, $F(1, 38) = 4.16$, $p < .05$, $\eta_p^2 = .10$, indicating conditioned responding. A Stimulus X Condition interaction was not found, FIR $p = .27$; SIR $p = .25$, TIR $p = .30$. Analysis of the entire extinction phase revealed overall smaller penile responses to CS+ than to

CS-, as reflected by the significant main effect of Stimulus on SIR, $F(1, 38) = 4.29$, $p < .05$, $\eta_p^2 = .10$, indicating conditioned responding. No interaction effects of Stimulus X Trial X Condition, and Stimulus X Condition were seen, all ps > .17. On FIR and TIR a significant interaction effect of Stimulus X Trial was found, FIR $F(2, 79) = 3.46$, $p < .04$, $\eta_p^2 = .08$; TIR $F(2, 80) = 3.07$, $p < .05$, $\eta_p^2 = .08$, indicating extinction. On the last extinction trial no significant main effect of Stimulus was found, FIR $p = .13$, SIR $p = .36$, TIR $p = .21$. Analysis of only responses towards the CS+ during the preconditioning trials and the extinction trials revealed no differences in conditioned responding between the Attend and Down-Regulate condition, as reflected by non-significant Trial X Condition interactions, all ps > .10.

Women. On the first extinction trial no significant main effect of Stimulus was found, FIR $p = .45$, SIR $p = .35$, TIR $p = .47$. No differences were seen between the conditions, Stimulus X Condition, FIR $p = .60$; SIR, $p = .88$; TIR $p = .98$. Analysis of the entire extinction phase, revealed no significant effect of Stimulus, FIR $p = .97$, SIR $p = .13$, TIR, $p = .71$. Analysis of the preconditioning phase (MEAN precon 1-4) and the first extinction trial demonstrated no significant main effect of Stimulus, with no differences between the two conditions, all ps > .31. On the last extinction trial, no significant main effect was found of Stimulus, FIR $p = .74$; SIR $p = .61$; TIR $p = .54$, and no differences therein between conditions, all ps > .18.

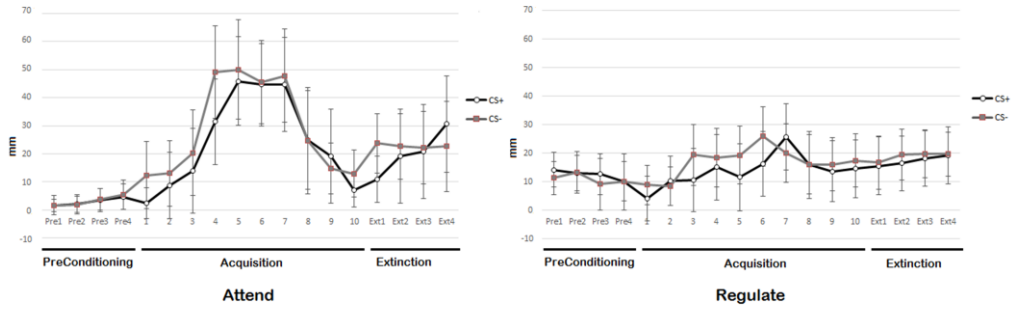

Figure 2. Mean penile circumference change scores (with standard error bars) during the second interval response window (SIR) following the CS+ and CS- during the preconditioning phase, acquisition phase, and extinction phase for the two conditions Attend and Down-Regulate. Note that during the acquisition phase, the response represents responding to the CS+ plus the US.

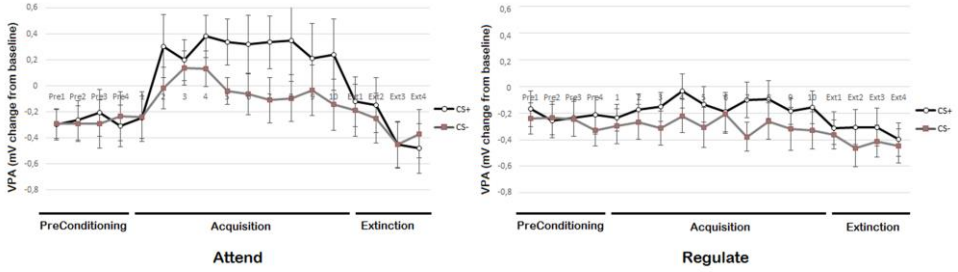

Figure 3. Mean vaginal pulse amplitude (VPA) change scores (with standard error bars) during the second interval response window (SIR) following the CS+ and CS- during the preconditioning phase, acquisition phase, and extinction phase for the two conditions Attend and Down-Regulate. Note that during the acquisition phase, the response represents responding to the CS+ plus the US.

8.3.2. Subjective Measures

Preconditioning phase. The 2 (Stimulus) X 4 (Trial) X 2 (Condition) X 2 (Gender) mixed factor ANOVA to verify equal levels of responding to the CSs revealed no difference in responding following presentation of the CS+ and CS- on affective value and subjective sexual arousal and US expectancy between conditions and sexes, all *p*s > .05.

Extinction phase.

US Expectancy. As can be seen in Figure 4, both conditions showed a robust increase of differential responding towards CS+ and CS- after the acquisition phase, and both conditions showed a decrease in this differential responding over trials. Indeed, the 2 (Stimulus) X 4 (Trial) X 2 (Condition) X 2 (Gender) mixed factor ANOVA revealed a main effect of Stimulus, $F(1, 86) = 227.09$, $p < .01$, $\eta_p^2 = .73$, and a significant interaction effect of Stimulus X Trial $F(2, 212) = 43.97$, $p < .01$, $\eta_p^2 = .34$. No differences were seen between conditions, Stimulus X Condition, $p = .73$, and Stimulus X Trial X Condition, $p = .59$. An interaction of Stimulus X Gender was observed, $F(1, 86) = 8.96$, $p < .01$, $\eta_p^2 = .09$. Women in both conditions showed increased differential responding towards the CS+ and CS-after the acquisition phase compared to men. Analysis of the extinction phase for men and women separately did not reveal significant differences between the two conditions, all *p*s > .18. Analysis of the first extinction trial did not reveal differences in conditioned responding between the two conditions, as reflected by non-significant Stimulus X Condition interactions, men $p = .25$ and women $p = .32$, and neither did analysis of the last extinction trial, men $p = .78$ and women, $p = .15$.

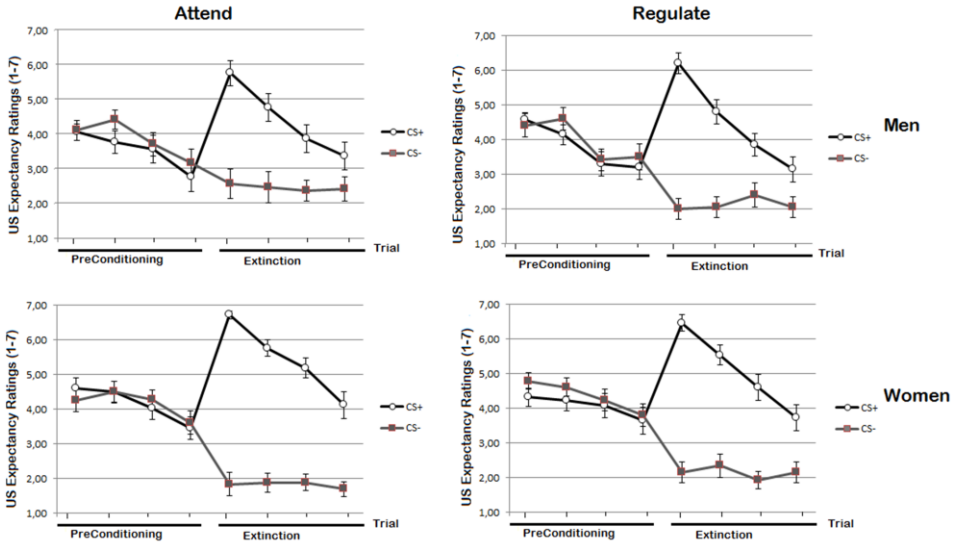

Figure 4. US expectancy ratings (with standard error bars) following the CS+ and CS- during the preconditioning phase and extinction phase for men (top) and women (bottom) in the two conditions Attend (left) and Down-Regulate (right).

Affective Value. As can be seen in Figure 5, men and women differed in conditioned responding after the acquisition phase. The 2 (Stimulus) X 4 (Trial) X 2 (Condition) X 2 (Gender) mixed factor ANOVA revealed a main effect of Stimulus, $F(1, 75) = 27.15$, $p < .01$, $\eta_p^2 = .27$, and an interaction effect of Stimulus X Trial, $F(2, 166) = 4.05$, $p < .02$, $\eta_p^2 = .05$. Also a significant interaction of Stimulus X Trial X Condition X Gender was found, $F(2, 166) = 4,31$, $p < .02$, $\eta_p^2 = .05$. Additional analyses for men and women separately, revealed a significant main effect of Stimulus in men, $F(1, 32) = 11.39$, $p < .01$, $\eta_p^2 = .26$. No interaction of Stimulus X Trial was found, $p = .36$, indicating no

extinction of conditioned responding in men. A significant interaction was found of Stimulus X Trial X Condition, $F(2, 75) = 3.31$, $p < .04$, $\eta_p^2 = .09$, and as can be seen in Figure 5, the Down-Regulate condition demonstrated enhanced extinction of conditioned responding compared to the Attend condition. Analysis of the last extinction trial revealed no significant interaction of Stimulus X Condition, $p = .34$, but a main effect was found of Stimulus, $F(1, 37) = 5.66$, $p < .03$, $\eta_p^2 = .13$, indicating incomplete extinction of conditioned responding with no differences therein between conditions.

For women a main effect of Stimulus was found, $F(1, 43) = 20.01$, $p < .01$, $\eta_p^2 = .32$, and an interaction effect of Stimulus X Trial, $F(2, 88) = 5.06$, $p < .01$, $\eta_p^2 = .11$. Also a main effect of Condition was found, $F(1, 43) = 4.41$, $p = .04$, $\eta_p^2 = .09$. As can be seen in Figure 5, compared to the Attend condition, women in the Down-Regulate condition demonstrated overall higher responses towards the CS+ and CS- in the extinction phase. No interaction effects of Stimulus X Condition and Stimulus X Trial X Condition were seen, ps > .33. Analysis of the first extinction trial for women revealed no significant interaction of Stimulus X Condition, $p = .33$. Analysis of the last extinction trial did also not reveal differences in conditioned differential responding towards the CS+ and CS- between the two conditions, $p = .60$. On this last trial there was still a main effect of Stimulus, $F(1, 50) = 13.32$, $p < .01$, $\eta_p^2 = .21$, indicating no extinction of conditioned differential responding.

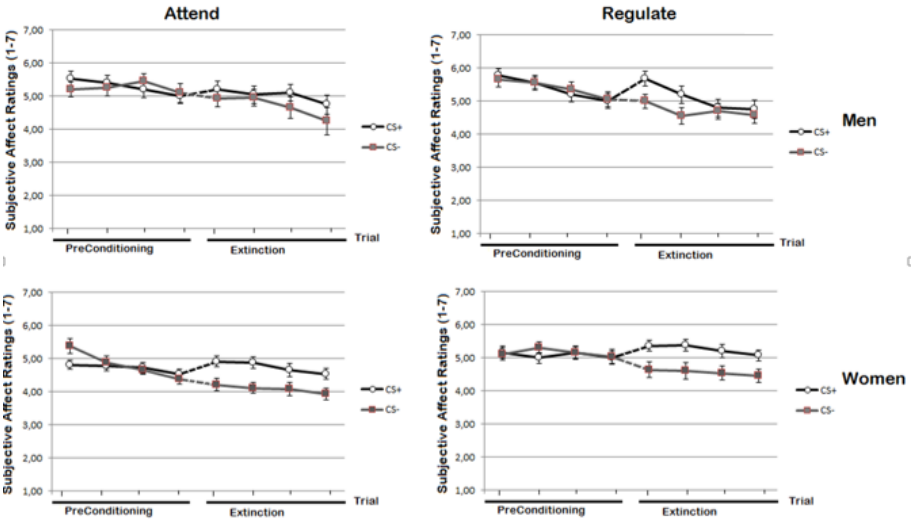

Figure 5. Subjective affect ratings (with standard error bars) following the CS+ and CS- during the preconditioning phase and extinction phase for men (top) and women (bottom) in the two conditions Attend (left) and Down-Regulate (right).

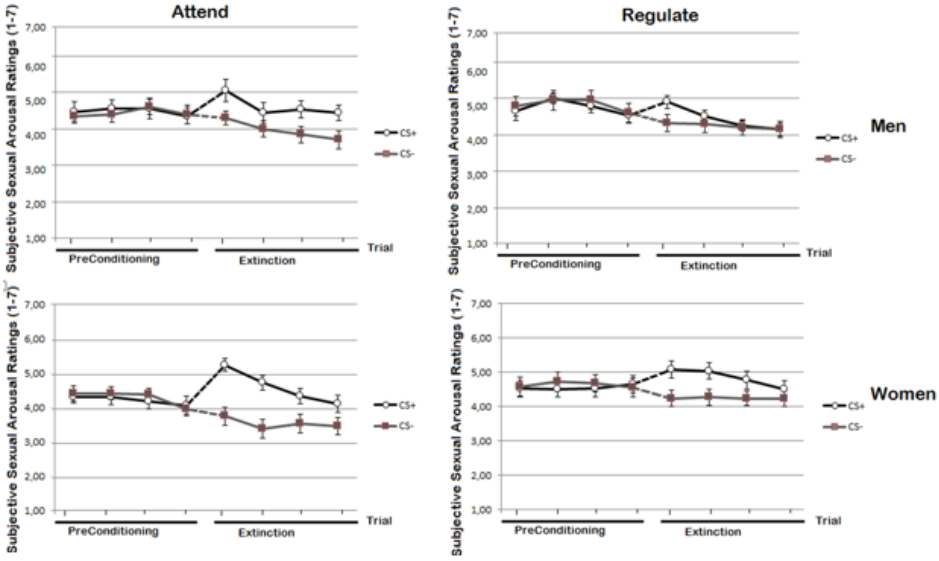

Figure 6. Ratings (with standard error bars) of subjective sexual arousal following the CS+ and CS- during the preconditioning phase and extinction phase for men (top) and women (bottom) in the two conditions Attend (left) and Down-Regulate (right).

Subjective Sexual Arousal. Figure 6 shows increased ratings of subjective sexual arousal towards the CS+ on the first trials of the extinction phase in men and women. The 2 (Stimulus) X 4 (Trial) X 2 (Condition) X 2 (Gender) mixed factor ANOVA revealed a significant main effect of Stimulus, $F(1, 81) = 23.22$, $p < .01$, $\eta_p^2 = .23$, and an interaction effect of Stimulus X Trial, $F(3, 213) = 8.05$, $p < .01$, $\eta_p^2 = .09$, and Stimulus X Trial X Condition X Gender, $F(3, 213) = 2.85$, $p < .05$, $\eta_p^2 = .03$. Therefore, additional analyses were conducted for men and women separately. In men, no significant interaction of Stimulus X Condition was found, $p = .12$, nor of Stimulus X Trial X Condition, $p = .15$. However, analysis of the last two extinction trials revealed a significant interaction of Stimulus X Condition, $F(1, 37) = 4.34$, $p < .05$, $\eta_p^2 = .11$. Analysis of the last extinction trial also revealed a significant Stimulus X Condition interaction, $F(1, 38) = 5.12$, $p < .03$, $\eta_p^2 = .12$.

For women, analysis of the extinction phase revealed a significant Stimulus X Trial interaction effect, $F(2, 106) = 2.91$, $p < .01$, $\eta_p^2 = .15$. No significant interaction effects of Stimulus X Condition, $p = .38$, or Stimulus X Trial X Condition, $p = .19$, were observed. A main effect of Condition was seen, $F(1, 45) = 4.16$, $p < .05$, $\eta_p^2 = .09$. As can be seen in Figure 6, women in the Down-Regulate condition demonstrated overall higher ratings of subjective sexual arousal towards both CS+ and CS- in the extinction phase, as compared with women in the Attend condition. Additional analysis of only the first extinction trial for men and women separately did not reveal a significant Stimulus X Condition interaction, men $p = .55$, women $p = .13$. Analysis of the last preconditioning trial and the first extinction trial for only CS+ responses, revealed a main effect of Stimulus in men, $F(1, 37) = 8.39$, $p < .01$, $\eta_p^2 = .19$, and

women, $F(1, 47) = 24.97$, $p < .01$, $\eta_p^2 = .35$, and a significant interaction effect of Stimulus X Condition in women, $F(1, 47) = 5.11$, $p < .03$, $\eta_p^2 = .10$. The Down-Regulate condition demonstrated attenuated responding towards the CS+ compared to women in the Attend condition. Analysis of the last extinction trial did not reveal a significant Stimulus X Condition interaction, $p = .28$, but a significant main effect was observed of Stimulus, $F(1, 50) = 6.84$, $p < .02$, $\eta_p^2 = .12$, indicating there was still differential conditioned responding on the last extinction trial, with no differences therein between conditions.

8.3.3. Approach and Avoidance Tendencies

The preconditioning AAT bias scores were analysed with a mixed factor ANOVA with Gender and Condition as between-subjects factors and Image as within-subject factor with three levels (CS+, CS-, and neutral pictures). In line with the expectations, no interaction effect of Image and Condition was found, $p = .45$. Men and women also did not seem to behave differently in approach and avoidance tendencies towards the stimuli before the conditioning procedure, as reflected by the non-significant Image X Gender interaction, $p = .60$.

The mixed factor ANOVA with Gender and Condition as between-subjects factors and Image as within-subject factor with three levels (CS+, CS-, and neutral pictures) and Trial as within-subjects factor with two levels (preconditioning and post conditioning), of the AAT preconditioning and AAT post conditioning bias scores, revealed an interaction of Image X Trial X Gender, $F(1, 127) = 22.07$, $p < .01$, $\eta_p^2 = .20$. No Image X Trial X Condition effect was observed, $p = .37$. Analysis for men and women separately, revealed

no significant results for men, all *p*s> .31, whereas for women a significant Image X Trial interaction was found, $F(2, 81) = 61.52$, $p < .01$, $\eta_p^2 = .55$.

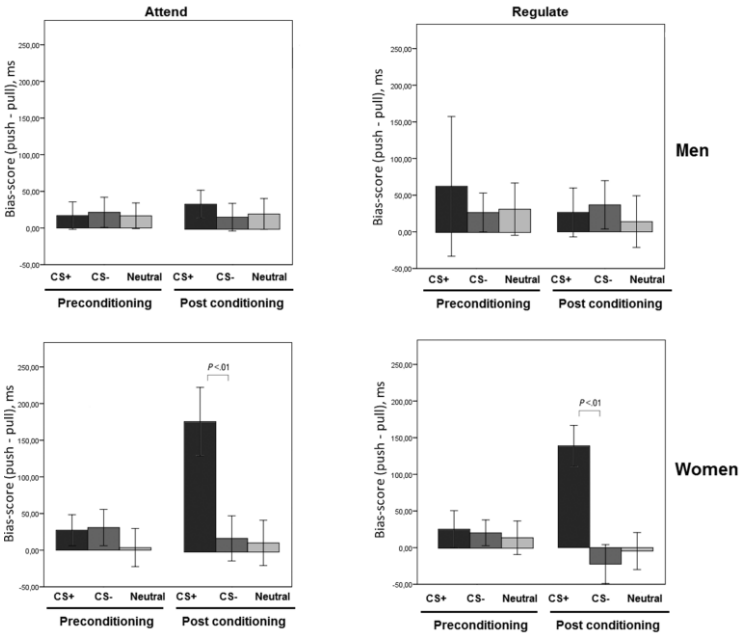

Figure 7. Approach Avoidance Task (AAT) bias scores for CS+, CS-, and neutral images in men (above) and women in the Attend and Down-Regulate condition (ms with standard error bars), preconditioning and post conditioning. A positive score indicates faster reaction times on approach (pull) trials compared to avoid (push) trials.

Analysis of only the post conditioning AAT scores demonstrated a significant main effect of Image, $F(2, 137) = 55.97$, $p < .01$, $\eta_p^2 = .39$, and of Image X Gender, $F(2, 137) = 52.64$, $p < .01$, $\eta_p^2 = .37$. No significant interaction of Image X Condition was found, $p = .61$. Analysis of post conditioning bias scores for men and women separately, demonstrated a main effect of Image in women, $F(1, 68) = 91.46$, $p < .01$, $\eta_p^2 = .64$, whereas in men it did not, $p = .41$. For

women, also a main effect of Condition was seen, $F(1, 51)= 4.19$, $p< .05$, $\eta_p^2 = .08$. Compared to women in the Attend condition, women in the Down-Regulate condition had attenuated approach biases towards all stimuli, as can be seen in Figure 7.

			Affective Value	Subjective Sexual Arousal	US Expectancy	Condtioned Genital Response SIR	Condtioned Genital Response TIR	Bias Score CS+	Bias Score CS-
Men	**Attend**	Affective Value		.67**	.45	-.19	-.18	-.34	-.39
		Subjective Sexual Arousal	.67**		.45*	.14	.14	-.32	-.12
		US Expectancy	.45	.45*		.14	.13	.01	.12
		Conditioned Genital Response SIR	-.19	.14	.14		.99**	.07	.31
		Conditioned Genital Response TIR	-.18	-.14	.13	.99**		.06	.30
		Bias Score CS+	-.34	-.32	.01	.07	.06		.49*
		Bias Score CS-	-.39	-.12	.12	.31	.30	.49*	.18
	Regulate	Affective Value		.49*	.11	.30	.18	-.17	.18
		Subjective Sexual Arousal	.49*		.12	.14	-.21	.14	.13
		US Expectancy	.11	.12		-.01	-.13	.42	.13
		Conditioned Genital Response SIR	.30	.14	-.01		.73**	-.13	-.05
		Conditioned Genital Response TIR	.18	-.21	-.13	.73**		.01	.07
		Bias Score CS+	-.17	.14	.42	-.13	.01		.60**
		Bias Score CS-	.18	.13	.13	-.05	.07	.60**	
Women	**Attend**	Affective Value		.71**	.38	-.40	-.31	.10	-.17
		Subjective Sexual Arousal	.71**		.40	-.14	-.20	-.16	-.31
		US Expectancy	.38	.40		-.11	-.15	-.15	.05
		Conditioned Genital Response SIR	-.40	-.14	-.11		.48*	-.25	-.14
		Conditioned Genital Response TIR	-.31	-.20	-.15	.48*		.15	.08
		Bias Score CS+	.10	-.16	-.15	-.25	.15		.20
		Bias Score CS-	-.17	-.31	.05	-.14	.08	.20	

		Affective Value	Subjective Sexual Arousal	US Expectancy	Condtioned Genital Response SIR	Condtioned Genital Response TIR	Bias Score CS+	Bias Score CS-
Regulate	Affective Value		.32	.13	-.18	.22	-.20	.11
	Subjective Sexual Arousal	.32		.39	.04	.07	.01	-.11
	US Expectancy	.13	.39		-.26	.07	-.32	.18
	Conditioned Genital Response SIR	-.18	.04	-.26		-.35	.26	.16
	Conditioned Genital Response TIR	.22	.07	.07	-.35		-.33	-.23
	Bias Score CS+	-.20	.01	-.32	.26	-.33		.12
	Bias Score CS-	.11	-.11	.18	.16	-.23	.12	

Table 2. Correlations between conditioned genital response, conditioned affective change, conditioned subjective sexual arousal, conditioned US expectancy and conditioned approach and avoidance tendencies towards the CS+ and CS- for men and women, in the Attend and Regulate condition. Notes: ** Correlation is significant at the .01 level (2-tailed), * Correlation is significant at the .05 level (2-tailed).

8.3.4. Correlations between Conditioned Responses

To investigate relationships between conditioned responses additional correlational analyses were conducted. We expected that the strength of the conditioned genital response would be positively related to the amount of change in subjective affect and subjective arousal and US expectancy. In addition, it was expected that the strength of the conditioned genital response would be positively related to the CS+ bias score. To investigate these relationships, for genital responses on SIR and TIR and ratings of affect, and subjective sexual arousal and US expectancy, the difference between the response to the CS+ and the CS− during the first trial in the extinction phase was calculated by subtracting the response to the CS− from the response to the CS+. Pearson product-moment correlations between genital difference scores, affect difference score, subjective sexual arousal difference score, and US expectancy difference scores, were calculated (see Table 2). Table 2 shows that there were no significant correlations between the strength of the conditioned genital response and conditioned subjective and behavioural measures in men and women, in both the *Attend* and *Regulate* condition

8.4. Discussion

The present study is the first that included men and women in the same experimental conditioning design on emotion regulation, and it is remarkable that a gender difference in subjective and behavioural sexual response was observed. First, the deployment of a cognitive emotion down-regulation strategy effectively enhanced extinction of conditioned affective value and subjective sexual arousal in men as compared to men in the *Attend* condition. This difference in enhanced extinction of conditioned subjective sexual arousal between the two conditions in men is substantial given the found effect sizes. Intriguingly, in women no evidence was found that cognitive down-regulation results in enhanced extinction of conditioned differential affect value or

subjective sexual arousal towards the CS+ and CS-. Surprisingly, and contrary to the expectations, women in the Down-Regulate condition demonstrated overall higher ratings of affective value and subjective sexual arousal towards the CS+ and CS- in the extinction phase, compared with women in the Attend condition. Second, compared with an attend stimulus strategy, cognitive down-regulation strategies resulted in attenuated approach tendencies towards conditioned stimuli that predicted potential sexual reward in women, but not in men. Although men demonstrated more robust conditioned genital response, strong approach tendencies were not observed. However, such tendencies need not per se translate into overt behaviour, since although emotions involve an automatic tendency to act, emotional impulses can be regulated by cognitive evaluation processes operating under cognitive control (Frijda. 2010).

It is crucial to mention that not all hypotheses were confirmed. First, no evidence for cognitive emotion down-regulation strategies to affect acquisition of conditioned genital response in men and women was found. Additionally, compared with an attend stimulus strategy, cognitive down-regulation strategies did not result in decreased conditioned genital sexual arousal, or subjective affect and sexual arousal in both sexes. Lastly, it seems US expectancy in men and women is not affected at all by cognitive emotion down-regulation strategies. Results also showed that no significant correlations existed between the strength of the conditioned genital, subjective and behavioural response, with no differences therein between men and women.

It is tempting to speculate that women may indeed use less efficient cognitive strategies compared to men (Whittle et al., 2011). Results from the exit interview also revealed that women experienced more difficulties with the deployment of the cognitive down-regulatory strategy. It is postulated that in primary emotions, which arise as a result of processing innately significant environmental stimuli, like sexual cues, the limbic structures are primary involved. Secondary emotions -that are evoked by environmental and

experiential stimuli that have acquired significance through learning- are thought to involve the additional participation of the prefrontal and somatosensory cortices, which also function to modulate limbic system activation (Damasio, 1994; LeDoux, 2000). Research revealed that men rely more on prefrontal and somatosensory cortices (especially the dorsolateral prefrontal cortex) during emotion regulation, whereas women rely more on limbic regions including the left hippocampus, the left amygdala and insular cortex (Kong et al., 2014; Whittle, 2011). The observed greater limbic activation in women (Whittle, 2011) might suggest that their emotional perception may be more of the primary than the secondary type, and this may facilitate quicker and more accurate perception. In men, emotional perception may be more impacted upon by regulatory and associative processes, leading to a greater ability to regulate emotions, including sexual arousal (Whittle, 2011). Research on the regulation of sexual arousal in men showed that experienced sexual arousal is associated with activation in "limbic" and paralimbic structures, whereas inhibition of sexual arousal is associated with activation of the right superior frontal gyrus and right anterior cingulate gyrus (Beauregard, Lévesque & Bourgouin, 2001). Intriguingly, no activation was found in limbic areas during inhibition of sexual arousal. Unfortunately, at present no imaging studies have been conducted that have investigated down- or up regulation of sexual arousal in women. However, an imaging study by Klucken et al. (2014) revealed that the Val^{158}Met-ploymorphism in the Catechol-O-Methyl-Transferase (COMT) is associated with the alteration of neural processes of appetitive conditioning. Individuals who carried the Val/Val-allele demonstrated increased hemodynamic responses in the amygdala compared with the Met/Met-allele group in a differential conditioning paradigm. Although participants were not explicitly instructed to use emotion regulation strategies in this study, in Met/Met-allele carriers an increased effective amygdala-ventromedial prefrontal cortex connectivity was found, and this could be

regarded as a marker for altered emotion regulation during conditioning. These findings emphasize the importance of genetic variations on appetitive conditioning, and subsequent increased vulnerability for addiction disorders or maladaptive sexual behaviours.

Given the problems in comparing genital responses of men and women directly, and possible differences between sexes with regard to responses to specific types of stimulus materials, it is far too early to infer that women indeed are less efficient in down regulation of positive (sexual) emotions than men. In addition, the effect of the emotional down-regulatory strategy in the present study is relative to the other (*Attend*) strategy with which it is compared and does therefore not reflect the complexities of the emotion regulation repertoire (Aldao, 2013). Future studies should therefore investigate if the found gender differences are also seen making use of multiple cognitive down-regulatory strategies (like cognitive reappraisal, or concentrating on the neutral and asexual aspects of the CSs). In addition, another limitation of the present study is the absence of a between subjects (unpaired) control group. Without such a control group it is difficult to determine whether and what learning has occurred. At present it is unclear if the differential response towards the CS+ and CS− was due to conditioning or to pseudo conditioning. The possibility of sensitization of sexual arousal would translate into increased genital responses across trials, and not in differential responding towards the CS+ and CS− per se (Domjan, 2010; Hoffmann et al., 2014). Therefore, making use of such a control group in future research is desirable.

It is suggested that antecedent-focused strategies like attentional deployment are more effective than response-focused strategies (Gross & Thompson, 2007). In the meta-analysis by Webb, Miles and Sheeran (2012), passive distraction strategies (where participants are provided with materials or a task that is unrelated to the emotion or emotional stimulus) had small effects on emotional outcomes, whereas active distraction strategies (where the

emphasis is on participants to bring to mind something unrelated to the emotion or emotional stimulus to serve as a distraction) had small-to-medium-sized effects. It was postulated that explicitly instructing participants to think about something unrelated to the emotion is more effective than simply providing a distracting task. More research is needed since research on the regulation of positive emotions like sexual arousal is extremely scarce. Moreover, the majority of the empirical investigations on emotion regulation (Aldao. 2013), including the present study, have examined processes in healthy individuals, and only little attention has been devoted to how those processes might differ as a function of variability in psychopathology status. As it is suggested that personality facets and dispositional and state-level psychological processes influence emotion regulatory processes (Aldao, 2013), an important venue for future research is the tailoring of the emotion regulation strategies to the individual patient.

The present study is the first that found conditioned genital response in men making use of a tactile US. In line with Brom et al. (2014b) men showed a smaller penile circumference in response to the CS+ during the acquisition phase and when vibrostimulation no longer was applied. Former research on automatic and controlled cognitive processing of sexual stimuli also found male genital responses to be opposite to the predictions: genital responses towards sexually primed targets were lower than responses to neutrally primed targets (Janssen et al., 2000). Those results were explained by physiological processes of penile erection. During the initial phases of erectile response, the penis undergoes an increase in length, and this is associated with a simultaneous decrease in circumference. Therefore, the physiology of penile erection may also account for the results found in the present study, with the smaller penile circumference in response to the CS+ reflecting the initial stage of penile erection.

Our results suggest that in the treatment of problematic strong sexual arousal and appetite, cognitive strategies in the processing of conditioned sexual stimuli may be helpful. It is important to mention that in the present study, instructions to regulate were given also during the acquisition phase, which would not reflect how regulation instructions would be offered in a clinical setting. In the treatment of problematic sexual arousal, clients are taught regulation strategies after having developed problematic behaviours via maladaptive conditioning. Nevertheless, learning to obtain effective emotion regulation strategies in circumstances in which sexual stimuli cannot be avoided may be useful to diminish undesirable feelings of sexual arousal and desire and to exert control over sexual behaviour. Therefore, future studies should incorporate clinical samples, like individuals with hypersexuality or deviant sexual preferences that manifest perturbed motivation. Second, as mentioned before, future conditioning studies should also make use of a design in which the instructions to regulate are given only after acquisition has occurred, herewith resembling to the clinical setting more closely. Still, results from the present study suggest that cognitive emotion regulatory strategies may be more effective in controlling unwanted sexual feelings than extinction by cue-exposure treatment alone, as research from our lab has shown that diminished sexual responses can return (Brom et al., 2014b). On the other hand, in case of hyposexuality, increasing sexual arousal by making use of up-regulatory cognitive strategies may be effective. Therefore, future research should investigate if cognitive up-regulatory strategies can indeed be helpful in increasing sexual arousal elicited by conditioned sexual cues.

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