The role of incentive learning and cognitive regulation in sexual arousal

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Chapter 9

The influence of Emotion Up-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 down-regulate expectations of reward arising from conditioned stimuli, including sexual stimuli. However, little is known about whether such strategies can also efficiently up-regulate expectations of sexual reward arising from conditioned stimuli, and possible gender differences therein. In the present study it was examined whether a cognitive up-regulatory strategy could successfully up-regulate sexual arousal elicited by sexual reward-conditioned cues in men and women. Men (n= 40) and women (n= 53) participated in a study using a differential conditioning paradigm, with genital vibrostimulation as unconditioned stimulus (US) and sexually relevant pictures as conditional stimuli (CSs). Penile circumference and vaginal pulse amplitude were assessed and ratings of US expectancy, affective value and sexual arousal value were obtained. Also a stimulus response compatibility task was included to assess automatic approach and avoidance tendencies. Evidence was found for emotion up-regulation to increase genital arousal response in the acquisition phase in both sexes, and to enhance resistance to extinction of conditioned genital responding in women. In men, the emotion up-regulatory strategy resulted in increased conditioned positive affect. 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, such as low sexual arousal and desire.

9.1. Introduction

According to incentive motivation models, aetiology and maintenance of low sexual arousal and desire, such as in Female Sexual Interest/Arousal Disorder (Diagnostic and Statistical Manual of Mental Disorders, DSM-5), can be explained from a classical conditioning perspective (Ågmo, 1999; Bindra, 1974; Brom et al., 2014a; Laan & Both, 2008). Learning about sexual cues may encompass learning of positive expectations of pleasure and sexual reward, but may also include the learning of negative expectations (Ågmo, 1999; Brom et al., 2014). External stimuli that can elicit sexual motivational responses are called sexual incentive stimuli (Ågmo, 1999; Singer & Toates, 1987). The motivational valence of incentive stimuli can be unconditioned (primary) or conditioned (secondary) as a result of associative leaning (Di Chiara, 1995). In associative learning processes like classical conditioning, a neutral stimulus (NS) is repeatedly paired with an unconditioned stimulus (US) (Pavlov, 1927), and eventually the NS is able to 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). It is suggested that the contingent pairing of negative emotional experiences (e.g. sexual assault or repeated experiences with painful coitus) with stimuli that used to have sexual incentive value, may result in less attraction or even aversion to these incentives (Both et al., 2008; Brom et al., 2015a). This lack of a positive sexual learning history, or even a more negative learning history, may result in a limited number and/or in limited strength of potential sexual incentives that can activate the sexual response system, and subsequently in reduced or lacking feelings of sexual desire and arousal (often in the absence of disturbed genital response) (Basson, et al., 2003; Both, Everaerd & Laan, 2007; Both, Laan & Schultz, 2010; Brauer et al., 2012; Everaerd & Laan, 1995).

Although there is limited empirical support, cognitive behavioural therapy (CBT) based on associative learning principles has emerged as the psychological treatment of choice for disorders in sexual interest and desire (Basson, 2005; Both, Laan & Schultz, 2010; Laan & Both, 2008; Trudel, Marchand, Ravart, 2001). Core components of CBT are cognitive techniques such as cognitive restructuring of negative and sexually inhibiting thoughts, and behavioural techniques such as sex therapeutic exercises to (re)create different, more varied, or prolonged sexual stimulation to enhance sexually pleasurable experiences. It is thought that the interaction with pleasurable sexual stimuli and events desensitizes possible negative associations and facilitates sexual response acquisition and maintenance, and that memories of positive sexual experiences result in expectations of sexual reward, which may subsequently enhance sexual interest and arousal (Basson, 2005; Both, Laan & Schultz, 2010; Laan & Both, 2008). It is likely that cognitive and behavioural processes interact during CBT. Experiences during sex therapeutic exercises may change cognitions, and cognitive restructuring, in turn, may facilitate acquisition of pleasurable sexual associations. The term emotion regulation (ER) signifies any process that serves to initiate, inhibit or modulate (e.g. cognitively re-evaluate) emotional feelings or behaviour (Aldao, 2013; Gross, 2002; Gross & Thompson, 2007). The ER techniques 'reappraisal' (i.e. cognitive change, yielding an altered interpretation of an emotional situation) and attentional focus (decreasing or increasing attention to the emotional and physical impact of the stimulus) have been proposed to be effective regulatory strategies because their influence begins at an early stage of emotion generation, before emotional responses have fully unfolded (Ochsner & Gross, 2005). Insight in the mechanisms of these cognition-emotion interactions can help in the development of effective CBT interventions. In the present study it was investigated whether deployment of an emotion up regulatory strategy can facilitate the acquisition of conditioned sexual responses. The present study

created a laboratory analogue of CBT by applying a key feature of cognitive restructuring (i.e. cognitive up-regulation of sexual arousal response evoked by US/CS by means of reappraisal and attentional focus) to the laboratory analogue of basic sexual reward learning (i.e. classical conditioning).

There is growing evidence that cognitive strategies like attentional deployment can down-regulate expectations of reward arising from conditioned stimuli (Delgado, Gillis & Phelps, 2008), including sexual conditioned stimuli (Brom et al., 2015b). However, less is known about the efficacy of up-regulatory strategies in sexual arousal. Nevertheless, studies on positive emotion up-regulation have demonstrated that reappraisal of positive images (i.e. up-regulation of positive affect) influenced the early stage of emotional response, and was associated with adaptive hemodynamic profiles both during anticipation and during viewing of affective images depending on their valence and the regulatory goal (Pavlov et al., 2014). In addition, in another study (Moholy et al., 2015), before each sexual film, participants were instructed to increase their sexual arousal, decrease their sexual arousal or respond as usual. They found that on average, participants performed the task as instructed. However, individuals with higher sexual desire for a partner exhibited less change in their sexual arousal to regulation instructions. Moreover, in a neuroimaging study from our lab (*in preparation*) 40 healthy male participants had to increase (´Up´), decrease (´Down´) or maintain ('Equal') their sexual arousal response evoked by sexual explicit pictures inside a MRI-scanner. Down-regulation of sexual arousal activated prefrontal regions, while up-regulation activated reward-related structures such as the nucleus accumbens and amygdala. These studies suggest that men and women can effectively enhance sexual arousal levels making use of up-regulatory strategies. However, despite its presumed importance, research on the regulation of reward expectations elicited by sexual conditioned stimuli is lacking in the literature. In addition, it is unclear whether men and women are equally prone to

conditioning of sexual response and whether sex differences do exist in the emotion regulation of positive emotions, like sexual arousal (Brom et al., 2014; 2015a,b; Domjan, 2005; Hoffmann, Janssen & Turner, 2004; Klucken et al., 2009; Moholy et al., 2015; Pfaus, Kippin & Centeno, 2001). However, regarding possible gender differences in emotion regulation, the general assertion is that women tend to use more emotion-focused strategies, while men are thought to use more effective cognitive (rational) cognitive strategies (Whittle et al., 2011). To be specific, in their review of neuroimaging research, Whittle et al. (2011) suggests that women may recruit different brain regions compared to men during emotion perception. In general this seems to be associated with greater levels of limbic/subcortical and temporal activation in women compared to men, and greater levels of frontal and parietal activation in men compared to women. Moreover, the authors suggest that men and women use different strategies to down-regulate negative emotions, and that these strategies might be mediated by different neural circuitry. Men seem to engage in automatic or unconscious emotion regulation when exposed to emotional stimuli, which may result from greater integration of cognitive and emotional neural circuits. However, most of these results on gender differences in ER relate to the regulation of particularly negative emotions (Mak et al., 2009; McRae et al., 2008; Gross, 2007; Whittle et al., 2011).

A recent study demonstrated that women may indeed use less effective cognitive strategies compared to men also in the regulation of positive emotions (Brom et al., 2015b). Making use of a differential sexual conditioning paradigm, evidence was found for the deployment of a cognitive emotion down-regulation strategy to effectively enhance extinction of conditioned affective value and subjective sexual arousal in men, whereas this cognitive strategy in women resulted in overall higher ratings of affective value and subjective sexual arousal towards the CS+ and CS- in the extinction phase compared to a control condition. Compared to men, women also reported

experiencing more difficulties with the deployment of the cognitive down-regulatory strategy. The fact that this study only investigated the influence of emotion down-regulation on conditioned sexual response (Brom et al., 2015b), combined with the lack of studies on sex differences in positive emotion up-regulation, point to the importance for further investigation of possible gender differences in sexual learning and cognitive (up-)regulation thereof.

As a result of classical conditioning, a CS cannot only become a signal of upcoming reward, it can also acquire the hedonic valence of the US. This form of learning involves the transfer of affective value to an initially neutral stimulus as a result of its contingent presentation with (dis)liked stimuli, and is called evaluative conditioning (De Houwer, Thomas & Baeyens, 2001; Hermans et al., 2002). While in classical conditioning the CS elicits a US expectancy and CR (i.e. signal learning), in evaluative learning it is thought that the CS automatically comes to evoke the representation of the US (Diaz, Ruiz & Baeyens, 2005). Research has demonstrated that evaluative conditioning is more resistant to extinction than expectancy learning (i.e. autonomic physiological responses and ratings of US expectancy) (Baeyens et al., 1992; Brom et al., 2015a; *submitted*; De Houwer, Thomas & Baeyens, 2001), and is associated with reinstatement of conditioned responding (Dirkx et al., 2004; Hermans et al., 2005) which makes evaluative conditioning particularly relevant for the long term outcome of CBT.

The present study is the first to investigate whether a cognitive up-regulatory strategy can efficiently increase sexual arousal elicited by sexual reward-conditioned cues in healthy men and women. Applying a differential conditioning paradigm, it was predicted that participants in two conditions (the control *Attend* condition and the experimental *Up-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. It was predicted that an emotion up-regulatory strategy should increase sexual arousal elicited by the sexual reward-conditioned cue compared to the control condition, in men and women, in both the acquisition and extinction phases. Furthermore, it was predicted that deployment of the emotion up-regulation strategy would affect evaluative learning, as measured by ratings of subjective affective value and sexual arousal value, rather than expectancy learning, as measured by physiological genital sexual response and ratings of US expectancy (Blechert et al., 2015). Since subjective ratings are susceptible to demand characteristics, in addition a task was included to assess implicit approach and avoidance tendencies towards the CSs (Cousijn, Goudriaan & Wiers, 2011). We assumed that after the conditioning procedure, 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 that an emotion up-regulation strategy should increase these responses.

9.2. Methods

9.2.1. 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 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 (DSM-5) 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 Centre.

9.2.2. Design and conditioning procedure

Participants were randomly assigned to one of the two conditions: *Up-Regulate* or *Attend*, with restriction that conditions matched on sex as close as possible. During conditioning, 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. 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 9s 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, consisting of 4 trials, 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 *Up-regulate*) on screen for 2s that reminded participants to either attend to- or up-regulate (i.e. increase) sexual arousal when seeing their CS+. 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 30s. The order of the length of the ITI was random, with the restriction of only two successive lengths.

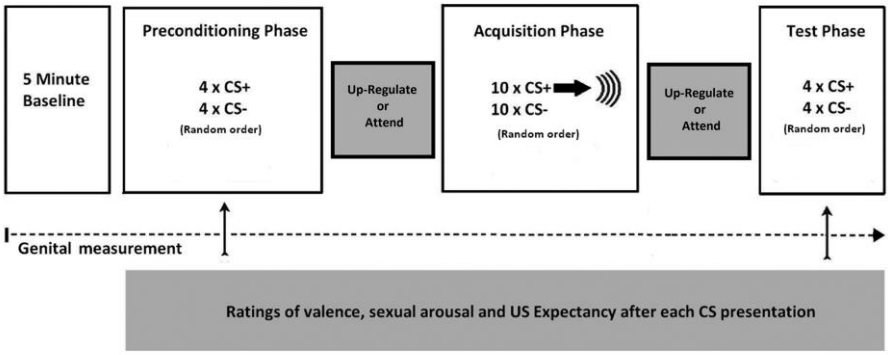

Figure 1. Schematic representation of the experimental procedure in both conditions. In the acquisition and extinction phase, before every CS presentation a written cue was presented: participants in the Up-Regulate condition received the instruction Up-Regulate whereas participants in the control condition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

9.2.3. Materials, Apparatus, and Recording

Stimulus materials. Two identical pictures served as CSs, and portrayed a torso of an individual of the opposite sex (a female torso with clothed breasts and genitals, or a men's exposed chest and clothed genitals), with the colour of the underwear in the picture (Blue or Yellow) being the only difference (Brom et al., 2015b). 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. Stimuli and cues were presented by using E-prime 2.0 Software (Psychology Software Tools Inc., Sharpsburg, USA).

Written instructions. Prior to each trial in the acquisition and extinction phases, participants received a written cue on screen. In the *Attend* condition participants received the written cue *Attend*, and they were instructed to '*just pay attention'* to the CSs when they were presented this cue. In contrast, in the *Up-Regulate* condition participants were presented with the cue '*Up-Regulate'* in the acquisition and extinction phases, and were instructed that when this cue appeared on the monitor, they should increase any experienced/felt sexual response and arousal the CSs might elicit. Specifically, they were instructed to: *'concentrate on the bodily sensations you may feel such as genital sensations, changes in heartbeat, or tingles in your body, and increase any positive feelings you may experience such as sexual arousal and excitement when receiving the genital vibrostimulation and seeing the CS+. For instance, you could imagine as if you are engaged in actual sexual activities*.' Participants were aware of the contingencies and well-practiced the instructions before commencing the experimental session. Participants were asked to verbalize their strategy when being presented with the written cues *Attend* and *Up-Regulate* to assure that they were following the instructions they were given.

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 (Brom et al., 2015b) and to position the vibrator as *most sexually stimulating*. For women, a small hands-off vibrator (2 cm diameter) was used (Laan & van Lunsen, 2002). The vibrator was placed on the clitoris using lycra underwear that had an opening for the vaginal plethysmograph. Women were also instructed to position the vibrator as *most sexually stimulating*.

9.2.4. Main Outcome Measures

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 (De Geyter & Morent, 2012). Research provides support for the notion that VPA is a reliable measure specific to sexual arousal (Laan, Everaerd & Evers, 1995; Suschinsky, Lalumière & Chivers, 2009).

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, sexual arousal value 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 labelled from '*certainly no vibration'* through '*certainly a vibration'*. The questions were presented at the monitor 1 second following the end of picture presentation.

9.2.5. Other Measures

Approach Avoidance Task (AAT (Cousijn, Goudriaan & Wiers, 2011), E-prime 2.0 Software, Psychology Software Tools Inc., Sharpsburg, USA). Participants were presented with the CS+, CS-, and neutral pictures from the International Affective Picture System (IAPS) (Lang, Bradley & 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 respectively gradually increased and decreased image size. Half the participants pushed images rotated left and pulled images rotated right, while the other half received opposite instructions. 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). Participants

were instructed to perform as quickly and as accurately as possible. Participants completed the AAT before (preconditioning) and after (post conditioning) the experimental conditioning procedure.

The International Index of Erectile Function (IIEF). This is a validated 15-question questionnaire that examines four 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 (Wiegel, Meston & Rosen, 2005).

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 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).

9.2.6. Procedure

After participants completed the first session of the AAT, they 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 informed 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). Participants well-practiced the instructions before commencing the experimental session, and participants were notified that regardless of the written cue, the CS+ always indicated the possibility of receiving genital vibrostimulation. Then the experimenter left the room to allow the participant to place the genital devices privately. Further instructions were given through written instructions on the monitor, and before the experimental procedure started participants were exposed to vibrostimulation for 3 times (periods of 2 s) during which he/she could place the vibrator in the way it was '*most sexually arousing*'. Then a 5-minute resting period followed, during which a neutral film was played and baseline measurements of genital response were collected during the last 2 minutes. Subsequently, the experimental conditioning experiment followed, starting with the preconditioning phase, followed by the acquisition and extinction phases. Directly after this experimental procedure the second session of the AAT was completed. Then participants privately filled in questionnaires (e.g., IIEF, FSFI) and the exit interview questionnaire was administered.

9.2.7. Data Reduction, Scoring and Analysis

Genital data were entered into a computer program (developed by the Technical Support Department of Psychology, University of Amsterdam) that enables offline graphical inspection of the data. A two-pass algorithm for automatic artefact removal was used to analyse the genital data. Artefacts in the channel monitoring VPA and penile circumference are caused by movements of the lower part of the body or by voluntary or involuntary contractions of the pelvic muscles. 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 13-16s following CS onset, respectively FIR (first interval response; during CS presentation), SIR (second interval response; during CS and possible US presentation) and TIR (third interval response; after CS and possible US presentation) (Brom et al., 2014b; Brom et al., 2015a,b). 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. The first and second halves of the acquisition phase were also analysed separately. The first extinction trials were analysed separately, since sexual conditioning effects have generally been found to be small and are expected to be strongest on the

first trial directly following the acquisition phase (Brom et al., 2014b, 2015a; Hoffmann, Janssen & Turner, 2004). Also the last extinction trial was analysed separately, since deployment of the emotion regulation strategy is expected to affect not only the magnitude of conditioned responding (extinction trial 1) but also the extinction of conditioned responding (trial 4 of the extinction phase). To correct for outliers, RTs below 200 ms, above 2000 ms and more than 3 standard deviations (SD) above and below the mean were removed for each participant. Error trials were removed. Median RTs were used because they are less sensitive to outliers than means (Cousijn, Goudriaan & Wiers, 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), with Gender and Condition as between-subject factor and Stimulus as within-subject factor with three levels (CS+, CS-, and neutral pictures), and Trial as within-subjects factor with one and two levels (preconditioning and post conditioning). Effect sizes are reported as proportion of partial variance (η_p^2) (Cohen, 1988).

9.3. Results

Men and women differed in age (Men M= 24.26, SD= 6.06; Women M= 28.55, SD= 8.07), $t(90)= -2.79$, $p< .01$, and in prior experience with vibrostimulation (Men M= 1.64, SD= 0.93; Women M= 3.83, SD=1.12), $t(90)= -9.92$, $p< .01$ (see Table 1 for *subject characteristics*). For men, the International Index of Erectile Function Questionnaire (IIEF) Mean score was 35.33 (SD= 5.49), and for women the Mean Female Sexual Function Score was 27.14 (SD = 2.84), indicating sexual functioning within the normal range for both sexes (Rosen et al., 1997, 2000; Ter Kuile, Brauer & Laan, 2006).

Variable:	Men					Women					Men & Women					
	Attend (*n*= 20)		Up-Regulate (*n*= 20)			Attend (*n*= 26)		Up-Regulate (*n*= 27)			Men (N= 40)		Women (N= 53)			Effect size (Cohen's *d*)
	M	SD	M	SD	*p*	M	SD	M	*SD*	*p*	M	SD	M	SD	*p*	
Age (years)	25.00	6.07	23.55	6.13	*.46*	29.04	8.20	28.07	8.07	*.67*	24.26	6.06	28.55	8.07	*<.01*	0.55
Sexual Functioning (IIEF/ FSFI- score)	36.16	5.62	34.55	5.39	*.37*	27.34	2.78	26.96	2.94	*.65*						
Prior Experience Vibrostimulation	1.68	1.06	1.60	0.82	*.78*	3.81	1.30	3.85	0.95	*.89*	1.64	0.93	3.83	1.12	*<.00*	2.12
Pleasantness US	3.16	1.43	3.65	1.04	*.23*	3.50	0.71	3.33	1.04	*.50*	3.41	1.25	3.42	0.89	*.98*	0.01
US Perceived as Sexually Arousing	3.05	1.22	3.35	1.23	*.45*	3.15	0.88	3.15	1.01	*.98*	3.21	1.22	3.15	0.99	*.82*	0.06
Declared Sexual Arousal	2.47	1.43	2.70	0.98	*.57*	2.50	0.76	2.74	1.10	*.36*	2.59	1.21	2.62	.95	*.89*	0.03
Instructions: Able to concentrate	4.11	0.57	3.70	.80	*.08*	3.96	0.45	3.93	.62	*.81*	3.90	0.72	3.94	0.53	*.73*	0.07
Instructions: successful deployment of cognitive strategies	3.95	0.91	3.60	0.88	*.23*	3.92	0.48	3.89	0.64	*.83*	3.77	.90	3.91	0.56	*.41*	0.2

Table 1. Subject characteristics. Descriptive subject variables for men and women, and for each condition.
Notes: IIEF= International Index of Erectile Function FSFI= Female Sexual Function Index. 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); * $p < .05$.

9.3.1. Genital Sexual Arousal

Preconditioning phase.

For all latency windows (FIR, SIR and TIR), no difference in penile circumference following presentation of the CS+ and CS- was found, all *p*s > .47. Likewise, for women, no difference in VPA following presentation of the CS+ and CS- was found, all *p*s > .51.

Acquisition phase.

Men. Figure 2 summarizes penile circumference (SIR) to CS+ and CS- across trials for the conditions *Attend* and *Up-Regulate*. A main effect for Stimulus was found on FIR, $F(1, 38)= 12.71$, $p< .01$, $\eta_p^2 =.25$; and SIR, $F(1, 38)= 94.95$, $p< .01$, $\eta_p^2 = .71$, indicating the vibrostimulation resulted in a genital response. In line with earlier studies (Brom et al., 2014b; 2015b) penile circumference was smaller in response to the CS+ and vibrostimulation than in response to the CS-. On TIR no main effect for Stimulus was found, $p= .71$. No interaction effects were found for Stimulus X Condition or Stimulus X Trial X Condition on all time latencies, all *p*s> .19. Additional analysis of only the first 5 trials of the acquisition phase revealed no differences between the two conditions on all time latencies, all *p*s> .16. However, analysis of the last 5 acquisition trials revealed main effects for Condition on all time latencies, FIR $F(1, 38)= 5.24$, $p< .03$, $\eta_p^2 = .12$, SIR $F(1, 38)= 5.45$, $p< .03$, $\eta_p^2 = .13$, TIR $F(1, 38)= 5.64$, $p= .02$, $\eta_p^2 = .13$. This suggests the emotion up-regulatory strategy increased penile responding towards both CSs during the second part of the acquisition phase.

Women. Figure 3 summarizes VPA (SIR) to CS+ and CS- across trials for both conditions separately. The 2 (Stimulus) X 10 (Trial) X 2 (Condition) mixed ANOVA of VPA revealed a significant main effect of Stimulus on FIR, $F(1, 51)= 8.76$, $p< .01$, $\eta_p^2 = .15$, on SIR, $F(1, 50)= 19.42$, $p< .01$, $\eta_p^2 = .28$, and

TIR, $F(1, 50) = 34.24$, $p < .01$, $\eta_p^2 = .41$. No significant Stimulus X Condition, FIR $p = .30$; SIR $p = .65$; TIR $p = .60$, nor Stimulus X Trial X Condition interaction was observed, FIR $p = .38$; SIR $p = .22$; TIR $p = .56$. No main effect of Condition was found, all ps $> .19$. Additional analysis of the first 5 extinction trials of the acquisition phase revealed a significant Stimulus X Trial X Condition effect on SIR, $F(3, 172) = 4.30$, $p < .01$, $\eta_p^2 = .08$. Analyses of the last 5 extinction trials revealed no significant differences between conditions, all ps $>.21$. Meaning in women, the deployment of the emotion up-regulatory strategy increased genital arousal response towards the CS+ and vibrostimulation compared to responses towards the CS- only during the first trials of the acquisition phase.

Extinction phase.

Men. Analysis of the first extinction trial did not reveal a significant main effect of Stimulus, FIR $p = .39$, SIR $p = .29$, TIR $p = .22$, no significant Stimulus X Condition interaction, FIR $p = .14$, SIR $p = .12$, TIR $p = .16$, and no significant main effect of Condition on FIR $p < .07$, SIR $p < .06$, and TIR $p < .06$. The additional 2 (Stimulus) X 2 (Trial; Mean trial 1–4 preconditioning phase and the first extinction trial) Mixed ANOVA revealed no significant Stimulus X Trial X Condition interaction on all time latencies, all ps $> .12$, and no main effect of Condition FIR $p = .08$; SIR $p < .07$; TIR $p = .07$. Analysis of the last extinction trial revealed a significant Stimulus X Condition interaction effect on FIR, $F(1, 38) = 5.99$, $p = .02$, $\eta_p^2 = .14$, and SIR $F(1. 38) = 5.01$, $p = .03$, $\eta_p^2 = .12$, but not on TIR, $p < .06$. As can be seen in Figure 2, men in the *Up-Regulate* condition showed slight increased responding towards the CS- compared to the CS+, whereas men in the *Attend* condition demonstrated increased genital responding towards the CS+ compared to the CS- on the last extinction trial.

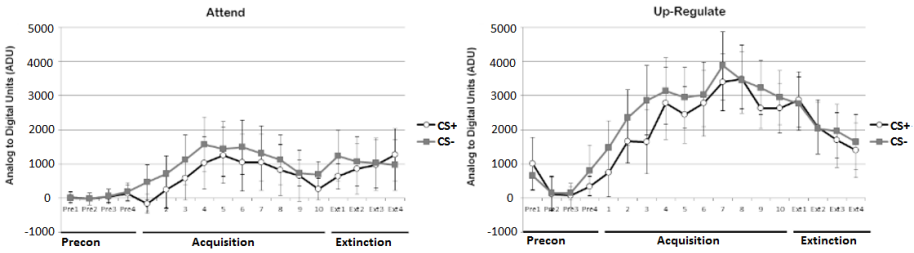

Figure 2. Mean penile circumference change scores (with standard error bars) during the second interval response window (SIR) following the CS+ and CS- during the preconditioning phase, acquisition phase, and extinction phase for the two conditions Attend and Up-Regulate. Note that during the acquisition phase, the response represents responding to the CS+ plus the US. Since not all indium-gallium gauges could be calibrated before data collection, to avoid bias results are calculated with digital output units.

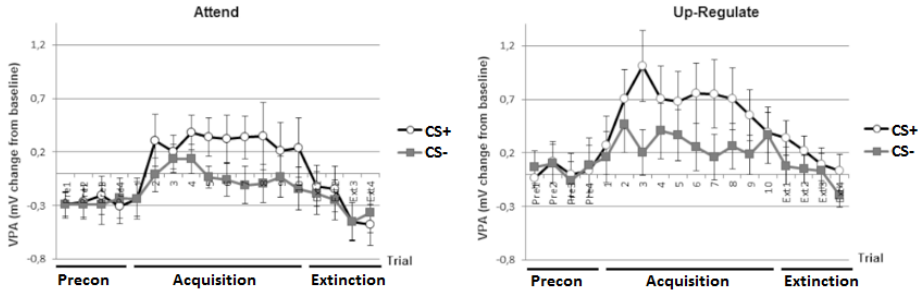

Figure 3. Mean vaginal pulse amplitude (VPA) change scores (with standard error bars) during the second interval response window (SIR) following the CS+ and CS- during the preconditioning phase, acquisition phase, and extinction phase for the two conditions Attend and Up-Regulate. Note that during the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

Women. Analysis of the first extinction trial revealed no significant main effect of Stimulus on FIR, p= .26, and TIR, p< .08, but did on SIR, F(1, 52)= 4.86, p= .03, η_p^2 = .09, indicating conditioned responding. No significant Stimulus X Condition interaction was found, FIR p= .93; SIR, p= .20; TIR p= .23, and no main effect of Condition, all ps> .15. The additional 2 (Stimulus) X

2 (Trial; Mean trial 1–4 preconditioning phase and the first extinction trial) Mixed ANOVA revealed no significant differences between conditions on all time latencies, all *p*s> .09.

Analysis of the last extinction trial revealed no main effect of Stimulus on all time latencies, all *p*s> .40, but did reveal a significant Stimulus X Condition interaction effect on SIR, $F(1, 51)= 5.88$, $p<.02$, $\eta_p^2 = .10$. As can be seen in Figure 3, women in the *Up-Regulate* condition showed increased genital response towards the CS+ as compared to the CS- on this last extinction trial, compared to women in the *Attend* condition.

9.3.2. Subjective Measures

Preconditioning phase.

The 2 (Stimulus) X 4 (Trial) X 2 (Condition) X 2 (Gender) mixed ANOVA to verify equal levels of responding to the CSs revealed no difference in responding following presentation of the CS+ and CS- on US expectancy, affective value and sexual arousal value, between conditions and sexes, all *p*s > .15.

Extinction phase.

US expectancy. As can be seen in Figure 4, men and women in both conditions showed a robust differential responding towards CS+ and CS- after the acquisition phase, and both conditions showed a decrease in this differential responding over trials. With other words, men and women expected the US would follow after presentation of the CS+. Analysis of the first extinction trial revealed a significant effect of Stimulus, $F(1, 87)= 233, 55$, $p< .01$, $\eta_p^2 = .73$,

and a significant Stimulus X Gender effect, $F(1, 87) = 32.01$, $p < .01$, $\eta_p^2 = .10$, but no significant Stimulus X Condition interaction, $p = .84$, and no main effect of Gender, $p = .91$. Subsequent analyses for men and women separately, did not reveal differences in conditioned responding between the two conditions, as reflected by non-significant Stimulus X Condition interactions in men, $p = .92$ and women, $p = .84$. The additional 2 (Stimulus) X 2 (Trial; Mean trial 1–4 preconditioning phase and the first extinction trial) Mixed ANOVA revealed no significant Stimulus X Trial X Condition interaction in men, $p = .75$, and women, $p = .77$, and no main effect of Gender, $p = .59$. Analysis of the last extinction trial revealed no significant Stimulus X Condition interactions in men $p = .62$ and women, $p = .51$. No main effects of Condition were found, all ps $> .12$.

Affective value. As can be seen in Figure 5, participants rated the CS+ as more positive compared to the CS- on the first trial of the extinction phase, and this difference in rated subjective affect between CS+ and CS- gradually decreased across trials. Analysis of the first extinction trial revealed a main effect of Stimulus, $F(1, 82) = 37.57$, $p < .01$, $\eta_p^2 = .32$, and an interaction effect of Stimulus X Gender, $F(1, 82) = 7.54$, $p < .01$, $\eta_p^2 = .08$, indicating that men and women differed in conditioned responding after the acquisition phase. Also a main effect of Condition was found, $F(1, 82) = 7.11$, $p < .01$, $\eta_p^2 = .08$. No main effect of Gender was found, $p = .07$.

Analysis of the first extinction trial for men and women separately revealed a significant Stimulus X Condition interaction effect in men, $F(1, 34) = 4.67$, $p < .04$, $\eta_p^2 = .12$, whereas in women it did not, $p = .70$. Meaning, men in the *Up-Regulate* condition demonstrated increased differential responding towards the CS+ and CS- on the first extinction trial as compared with men in

the *Attend* condition. In addition, for men also a main effect for Condition was seen on this first extinction trial, $F(1, 34) = 4.44$, $p = .04$, $\eta_p^2 = .12$. As can be seen in Figure 5, in men the emotion up-regulatory strategy not only resulted in increased differential conditioned responding towards the CS+ and CS- on this first extinction trial, but also resulted in overall higher ratings of affective value towards both CSs.

The additional 2 (Stimulus) X 2 (Trial; Mean trial 1–4 preconditioning phase and the first extinction trial) Mixed ANOVA revealed a significant Stimulus X Trial X Gender interaction, $F(1, 74) = 7.80$, $p < .01$, $\eta_p^2 = .10$, and also a main effect of Gender, $F(1, 80) = 7.17$, $p < .01$, $\eta_p^2 = .08$. This analysis for men and women separately revealed a significant Stimulus X Trial X Condition interaction in men, $F(1, 33) = 4.72$, $p < .04$, $\eta_p^2 = .13$, whereas it did not in women, $p = .94$.

Analysis of the last extinction trial revealed no significant interaction of Stimulus X Condition, $p = .28$, or Stimulus X Gender, $p = .18$, but still revealed a main effect of Stimulus, $F(1, 89) = 5.66$, $p < .01$, $\eta_p^2 = .23$, indicating a difference in rated subjective affect between CS+ and CS- on the last extinction trial with no differences therein between conditions or men and women. However, again a main effect of Condition was found, $F(1, 89) = 4.33$, $p = .04$, $\eta_p^2 = .05$, but no main effect of Gender, $p = .08$. As can be seen in Figure 5, participants in the *Up-Regulate* condition demonstrated overall higher ratings of affective value towards both the CS+ and CS- on the last extinction trial as compared to participants in the *Attend* condition.

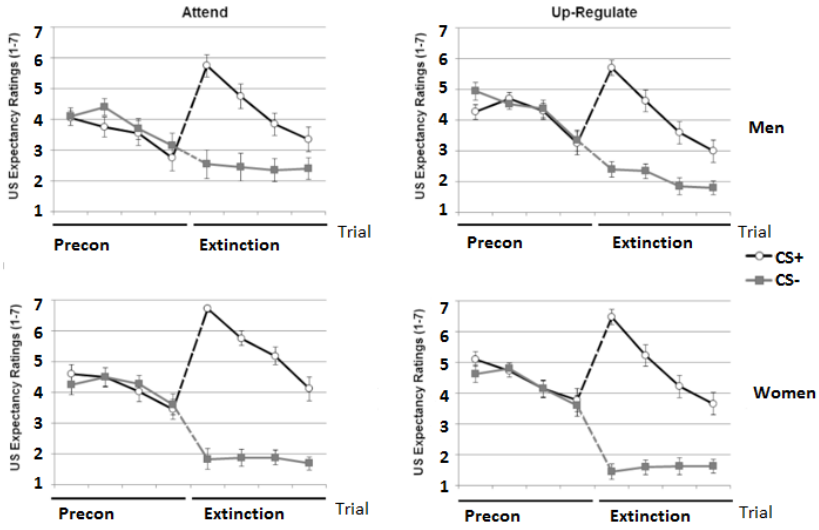

Figure 4. US expectancy ratings (with standard error bars) following the CS+ and CS- during the preconditioning phase and extinction phase for men (top) and women (bottom) in the two conditions Attend (left) and Up-Regulate (right).

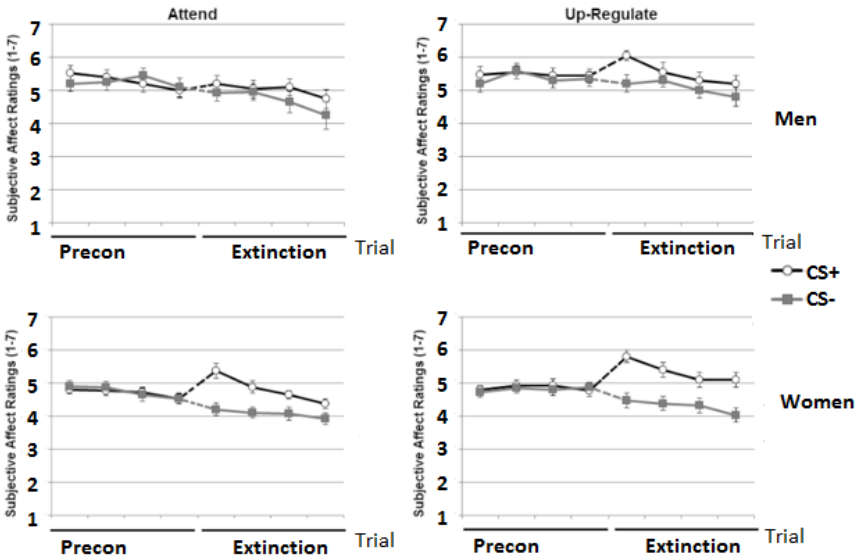

Figure 5. Subjective affect ratings (with standard error bars) following the CS+ and CS- during the preconditioning phase and extinction phase for men (top) and women (bottom) in the two conditions Attend (left) and Up-Regulate (right).

Sexual Arousal Value. 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 2 (Condition) X 2 (Gender) mixed ANOVA of the first extinction trial revealed a significant main effect of Stimulus, $F(1, 85) = 46.67$, $p < .01$, $\eta_p^2 = .35$, and a significant Stimulus X Gender interaction, $F(1, 85) = 4.87$, $p = .03$, $\eta_p^2 = .05$, but no Stimulus X Condition interaction, $p = .75$, and no main effect of Gender, $p = .17$. Further analysis for men and women separately also revealed no significant Stimulus X Condition interactions in both sexes, ps > .81. For men a trend of Condition was seen, $p < .06$.

The additional 2 (Stimulus) X 2 (Trial; Mean trial 1–4 preconditioning phase and the first extinction trial) Mixed ANOVA revealed no Stimulus X Trial X Condition interaction, $p = .51$, and no main effect of Gender, $p = .16$, whereas it did reveal a significant Stimulus X Trial X Gender interaction, $F(1, 80) = 4.48$, $p < .04$, $\eta_p^2 = .05$. Further analyses for men and women separately, revealed no Stimulus X Trial X Condition interaction in men, $p = .78$, and women, $p = .51$. Analysis of the last extinction trial indicated that there was still differential conditioned responding on the last extinction trial, $F(1, 88) = 23.76$, $p < .01$, $\eta_p^2 = .21$. The analysis did not reveal significant Stimulus X Condition and Stimulus X Gender interactions, all ps > .11. Also no main effect of Condition, $p = .08$ or Gender, $p = .07$ was found.

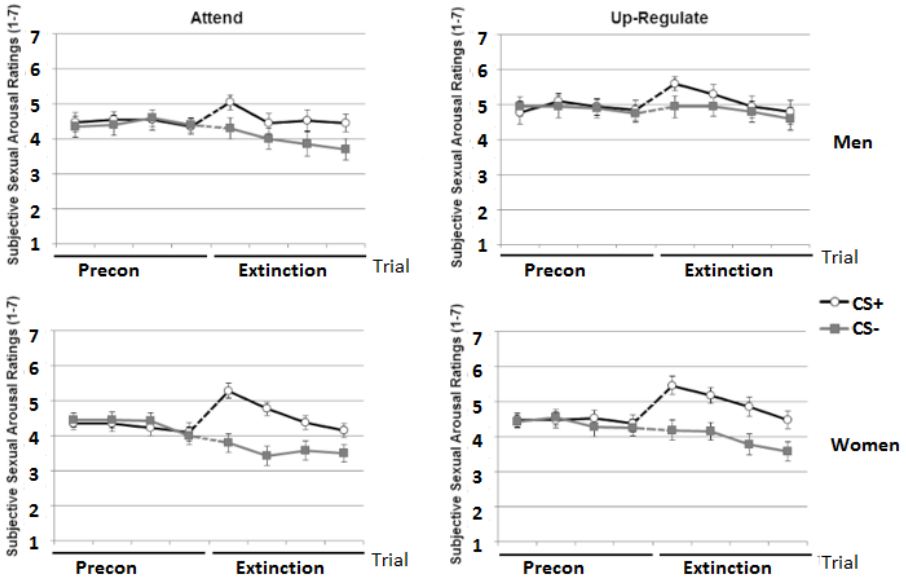

Figure 6. Ratings (with standard error bars) of sexual arousal value towards the CS+ and CS- during the preconditioning phase and extinction phase for men (top) and women (bottom) in the two conditions Attend (left) and Up-Regulate (right).

9.3.3. Approach and Avoidance Tendencies

The preconditioning AAT bias scores were analysed with a mixed ANOVA with Gender and Condition as between-subject factor and Stimulus as within-subject factor with three levels (CS+, CS-, and neutral pictures). In line with the expectations, no interaction effect was found for Stimulus and Condition, p= .98, and 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 Stimulus X Gender interaction, p= .85.

The mixed ANOVA with Gender and Condition as between-subject factor, and Stimulus 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 bias scores, revealed a Stimulus X Trial X Gender, $F(1, 145) = 24.08$, $p < .01$, $\eta_p^2 = .22$, and Gender X Condition interaction effect, $F(1, 88) = 5.22$, $p < .03$, $\eta_p^2 = .06$. No Stimulus X Trial X Condition effect was observed, $p = .47$. Analysis for men and women separately, revealed no significant effects of Stimulus or Stimulus X Trial for men, all ps $> .07$, whereas for women a significant Stimulus X Trial interaction, $F(2, 82) = 61.74$, $p < .01$, $\eta_p^2 = .54$, and significant main effect of Stimulus, $F(1, 81) = 64.48$, $p < .01$, $\eta_p^2 = .55$, was found. In men only a main effect of Condition was found, $F(1, 37) = 4.32$, $p < .05$, $\eta_p^2 = .10$. As can be seen in Figure 7, men in the *Up-Regulate* condition had overall higher bias scores towards all stimuli, both preconditioning and post conditioning.

Analysis of only the post conditioning AAT scores demonstrated a significant main effect of Stimulus, $F(1, 132) = 40.81$, $p < .01$, $\eta_p^2 = .31$, and interactions of Stimulus X Gender, $F(1, 132) = 43.32$, $p < .01$, $\eta_p^2 = .32$, and of Gender X Condition, $F(1, 89) = 5.27$, $p = .02$, $\eta_p^2 = .06$. No significant Stimulus X Condition interaction was found, $p = .20$. Analysis of post conditioning bias scores for men and women separately, demonstrated a main effect of Stimulus in women, $F(1, 65) = 87.14$, $p < .01$, $\eta_p^2 = .63$, indicating conditioned responding, whereas in men it did not, $p = .62$. As can be seen in Figure 7, in line with the expectations, women in both conditions demonstrated a conditioned approach bias towards the CS+ compared to the other stimuli (i.e. CS- and neutral pictures). However, no Stimulus X Condition interaction effects were found in both sexes, men $p = .75$, women $p = .40$, indicating the

emotion regulatory strategy did not affect conditioned differential behavioural approach and avoidance tendencies towards the CS+, CS- and neutral stimuli.

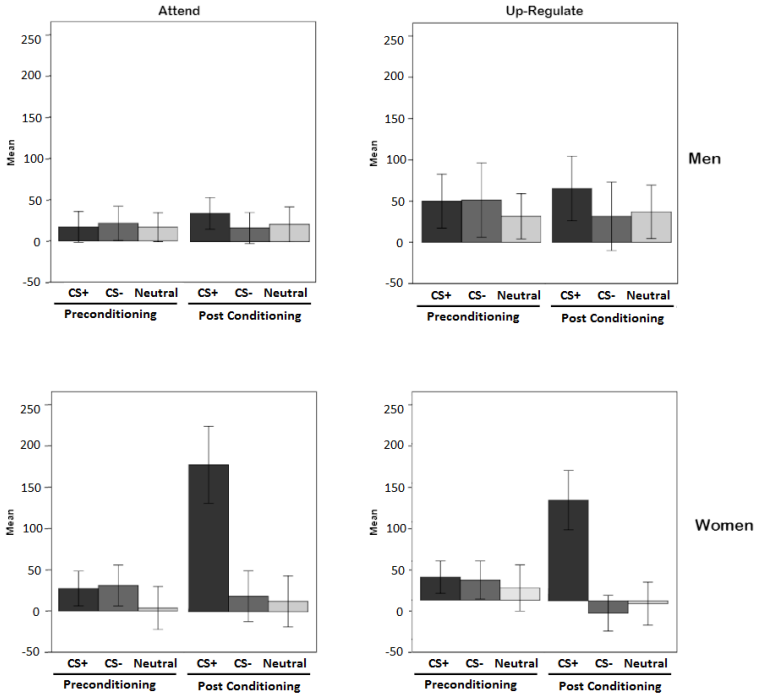

Figure 7. Approach Avoidance Task (AAT) bias scores for CS+, CS-, and neutral images in men (above) and women in the Attend and Up-Regulate condition (ms with standard error bars), preconditioning and post conditioning. A positive score indicates faster reaction times on approach (pull) trials compared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

9.4. Conclusions

In the current study, genital, subjective and behavioural correlates of the interaction of emotion up-regulation with sexual conditioning were investigated. Consistent with findings from previous studies, conditioning

effects were observed (Both et al., 2008; Brom et al., 2014a,b, 2015b) and in line with findings from a previous emotion regulation study on conditioned sexual response (Brom et al., 2015b), sexual arousal could be modulated in line with participants' regulatory goals. In men, CRs were found on measures of subjective affect, sexual arousal value, and US expectancy, and no extinction thereof on the last extinction trial. However, no evidence was found for conditioned genital response or conditioned approach tendencies towards the CS+. In women, CRs were seen on all measures, and like in men, on all subjective measures no complete extinction of conditioned responding was seen. Thus, in both men and women, a picture of the opposite sex that was repeatedly followed by genital stimulation was evaluated as more positive and as more sexually arousing, and in women, this picture also elicited conditioned genital response and approach tendencies.

Second, regarding the sexual arousal emotion up-regulatory strategy, in men and women, the deployment of such a strategy did not increase genital arousal responses in response to the CS+ (and vibrostimulation) compared to the CS-, but the cognitive up-regulatory strategy increased overall genital responding towards both CSs in the acquisition phase. However, the sexual arousal up-regulatory strategy did not seem to affect the magnitude of conditioned responding in men and women on the first extinction trial. Nevertheless, the deployment of the cognitive up-regulatory strategy seemed to result in enhanced resistance to extinction of conditioned genital responding in women, since only women in the *Up-Regulate* condition still showed conditioned genital response on the last extinction trial, whereas women in the *Attend* condition did not. With respect to the subjective measures, in men, the emotion up-regulatory strategy not only resulted in increased conditioned positive affect on the first extinction trial, but also resulted in overall higher ratings of positive value towards both CSs. These results indicate that in men, affective value can

be up-regulated by cognitive strategies. In contrast, in women, the cognitive up-regulation strategies did not seem to have an effect on subjective affective value. On measures of sexual arousal value and US expectancy the emotion up-regulatory strategy did not seem to affect conditioned responding or extinction thereof, in both sexes. And lastly, the emotion up-regulation strategy did not result in increased approach tendencies towards the CS+ in men and women. In line with earlier studies (Brom et al., 2015b) the cognitive regulatory strategy mainly operated on physiological measures of sexual response and valence, leaving the more cognitive aspects (US expectancy) of conditioning intact (Boddez et al., 2013). And although, based on the literature, effects on autonomic physiological responses (i.e. expectancy learning) were not expected (Baeyens et al., 1992; Blechert et al., 2015; De Houwer, Thomas & Baeyens, 2001) results from the present study and a former study (Brom et al., 2015b) demonstrate that cognitive regulatory strategies seem to be able to affect extinction of conditioned physiological responding.

Although it is speculated that women may use less effective cognitive strategies compared to men (Brom et al., 2015b; Whittle et al., 2011), 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, and the actual deployed ER technique it is far too early to infer that women indeed are less efficient in the up-regulation of positive (sexual) emotions than men. Some ER strategies are likely less costly to implement (e.g., distraction or increasing attentional focus), which may offer advantages even when these strategies are less effective long-term (e.g., compared to reappraisal) (Moyal, Henik & Anholt, 2013). Importantly, Moholy and colleagues (Moholy et al., 2015) demonstrated that the level of sexual desire was shown a primary predictor of sexual regulation. Since it is widely accepted that men and women differ in strength of sex drive (Baumeister et al., 2001),

this difference in level of sexual desire and sex drive may account for the found differences between men and women in research on the regulation of sexual arousal.

Second, it is important to keep in mind that the effect of the emotional up-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 up-regulatory strategies, including more response-focused strategies (Gross & Thompson, 2007). However, in a study on the regulation of sexual arousal by means of attentional focus in healthy sexually functional men and women, Both, Laan and Everaerd (2011) found interesting gender differences. When taking a participant and emotion-oriented ('hot') focus rather than a spectator and stimulus-oriented ('cool') focus while viewing erotic stimuli, participants were able to enhance feelings of sexual arousal. Intriguingly, women reported stronger absorption (i.e. the extent to which the participant experienced him or herself as a participant in the sexual activity shown in the film) in the cool attentional focus condition than in the no-instruction control condition, whereas men, as expected, reported lower absorption levels in the cool attentional focus condition than in the no-instruction control condition. A possible more pronounced difficulty in emotion regulation in women while processing sexual (conditioned) stimuli (Both et al., 2011; Brom et al., 2015b), may be the result of anatomical differences between men and women (Laan & Everaerd, 1995). Bodily responses and changes therein are an apparent aspect of emotional response (Damasio, 2003). The association between genital and subjective sexual arousal is generally lower for women than for men (Chivers et al., 2004). Men are likely to have more (visual and tactile) cues they can use to detect genital response

than women do (Sakheim et al., 1984). Nevertheless, in women the emotion up-regulatory strategy did result in enhanced resistance to extinction of conditioned genital response, and in men, the only prominent effect of the up-regulatory strategy was seen on affective value and not on conditioned genital sexual response. Maybe the fact that only healthy sexually functioning subjects participated in this study can contribute for this. Healthy young men likely have less experience with the up-regulation of sexual arousal compared to down-regulation of sexual arousal, since the expression of sexuality is not always accepted or appreciated in daily life, and instances of needing to increase sexual arousal are likely less common in healthy participants. 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 clinical samples, such as individuals with low sexual arousal and desire.

In the present study no ratings of US expectancy, affective value and sexual arousal value were collected during the acquisition phase. Since this information is essential in clarifying which type of measures of sexual response cognitive up-regulatory strategies are effective, future studies on the effectiveness of cognitive strategies on sexual arousal should also collect those subjective measures during acquisition. Furthermore, 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 which type of learning has occurred. At present it is unclear if the observed 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. Additionally, in the present study the genital arousal results during acquisition and extinction could be influenced by carry-over effects, also resulting into overall increased genital responses across trials. Future studies should consider implementing a return-to-baseline design. Although the random presentation of CS+ (plus vibrostimulation) and CS- in the acquisition phase can only control to a certain extent for potential carry-over effects, these possible effects are equally expected in the *Attend* and *Up-Regulate* condition. Therefore, any effects of the experimental conditions may be attributed to the experimental manipulation (i.e. deployment of the Up-Regulatory strategy) rather than carry-over effects. Furthermore, in the present study, vaginal photoplethysmography and penile circumference was used as indicator of physiological sexual arousal. Vaginal and penile engorgement, however, is only one of many co-occurring processes during the sexual arousal response. Ideally, future studies should incorporate other methodology, such as thermal imaging or neuroimaging to allow for better investigation of small sexual CRs and comparison between men and women. Next, the present study did not control or quantify the used regulation strategies. However, despite these limitations in design, differences between conditions in differential responding towards the CS+ and CS- could be observed, suggesting that making use of this less stringent control design (i.e. only the CS- as control measure) still enabled to test for effects of the experimental conditions.

To conclude, the present results suggest that in the treatment of problematic low sexual arousal, cognitive up-regulatory strategies of sexual arousal may be applied during initial conditioning stages in CBT in men and

women. Results from the acquisition phase point to the utility of up-regulatory training for enhancing genital sexual arousal during the learning of new associations of sexually rewarding experiences and stimuli. In addition, the cognitive strategy also substantially enhanced resistance to extinction of conditioned genital response in women, and increased conditioned positive valence in men, making it a promising add-on tool during therapeutic exercises in order to (re)create and enhance sexually pleasurable experiences. However, future studies should assess the clinical efficacy of cognitive up- and down-regulatory strategies by including clinical samples, such as individuals with low sexual arousal and desire. Additionally, future studies should also investigate the (clinical) effectiveness of other strategies such as mindfulness (Goldin & Gross, 2010; Kumar, Feldman & Hayes, 2008), or hot/cool focus on conditioned sexual response.

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