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The role of incentive learning and cognitive regulation in sexual arousal

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Chapter 5

Extinction of Aversive Classically Conditioned Human Sexual Response

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Abstract

Research has shown that acquired subjective likes and dislikes are quite resistant to extinction. Moreover, studies on female sexual response demonstrated that diminished genital arousal and positive affect towards erotic stimuli due to aversive classical conditioning did not extinguish during an extinction phase. Possible resistance to extinction of aversive conditioned sexual responses may have important clinical implications. However, resistance to extinction of aversive conditioned human sexual response has not been studied using extensive extinction trials. The aim of the present study is to investigate resistance to extinction of aversive conditioned sexual responses in sexually functional men and women. Penile circumference and vaginal pulse amplitude were assessed and ratings of affective value and subjective sexual arousal were obtained. Also a stimulus response compatibility task was included to assess automatic approach and avoidance tendencies. A differential conditioning experiment was conducted, with two erotic pictures as CSs and a painful stimulus as USs. Only one CS (the CS+) was followed by the US during the acquisition phase. Conditioned responses were assessed during the extinction phase. Men and women rated the CS+ more negative as compared to the CS-. During the first trials of the extinction phase vaginal pulse amplitude was lower in response to the CS+ than in response to the CS-, and on the first extinction trial women rated the CS+ as less sexually arousing. Intriguingly, men did not demonstrate attenuated genital and subjective sexual response. Aversive conditioning, by means of painful stimuli, only affects sexual responses in women, whereas it does not in men. Although conditioned sexual likes and dislikes are relatively persistent, conditioned affect eventually does extinguish.

5.1. Introduction

Lack of sexual interest is the most common sexual problem among women and is often accompanied by the experience of low sexual arousal (Mercer et al., 2003; West et al., 2008). Although low sexual interest is most common in women, it may also manifest itself in men as psychogenic erectile dysfunction (Georgiadis & Kringelbach, 2012). Disorders in sexual motivation, like hypoactive sexual desire disorder (HSDD), are linked to complex interplay of psychological and biological factors, and are generally considered as difficult to treat. Regrettably, empirically validated treatments are lacking (ter Kuile, Both & van Lankveld, 2010). Insight in the underlying mechanisms of sexual motivation is essential to understand these disorders, and may guide treatment thereof.

In the aetiology of sexual dysfunction, basic learning processes like conditioning are hypothesized to play a pivotal role. 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). According to incentive motivation models, sexual motivation is the result of the interplay of a sensitive internal sexual system with external motivational stimuli or the mental representation thereof. External stimuli that can promote motivation are called incentive stimuli (Ågmo, 1999; Singer & Toates, 1987). Sexual incentives are stimuli that elicit sexual responses and approach behaviour. Hence, sexual motivation may be investigated by studying responses within various response systems involved in sexual behaviour (Both et al., 2005a; Robbins & Everitt, 1999). Sexual arousal can be seen as an evolutionary preserved emotion (Everaerd, 1988), which is characterized by specific bodily reactions, like enhanced genital blood flow, by preparation of behavioural action (Both et al., 2005b), and by the experience of feelings of lust, excitement, and sexual desire. In addition, sexual arousal can eventually result in overt behaviour such as approach and consumption (Dekker & Everaerd, 1989).

Important to note is that in women, genital arousal is not per se accompanied by subjective desire or arousal (Laan & Everaerd, 1995a, b; Laan, Everaerd & Evers, 1995). However, the agreement between physiological sexual arousal and subjective report seems to increase as a function of the strength of the physiological response (Laan, Everaerd & Evers, 1995). The incentive motivation model of sexual desire suggests that the experience of sexual desire may follow rather than precede sexual excitement, and suggests that sexual desire emerges following sexual arousal initiated by a sexually meaningful stimulus (Laan & Both, 2008).

The motivational valence of incentive stimuli can be unconditioned (primary) or conditioned (secondary) as a result of associative learning (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 trigger the same reaction as the US (Pavlov, 1927; Bindra, 1974). 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 as a result of aversive conditioned learning, sexual arousal may decrease after negative sexual experiences, such as sexual assault or repeated experiences with painful coitus (van Berlo & Ensink, 2000; Brauer et al., 2007). Therefore, the role of aversive experiences and memories in sexual desire and arousal problems is likely to be important. However, there is only limited empirical research on classical conditioning of sexual arousal in humans, while it is likely to yield important knowledge about mechanisms underlying sexual motivation and related disorders such as hyposexuality.

Despite its clinical relevance, studies on aversive sexual conditioning in humans are scarce in the literature (Brom et al., 2014a; O'Donohue & Plaud, 1994; Quinn, Harbison & McAllister, 1970; Rosen & Kopel, 1997). In a study in women (Both et al., 2008a), making use of an erotic picture as the CS and a painful stimulus at the wrist as the US, diminished genital arousal and increased

negative affect in response to the CS+ were observed. This was the first study that provided evidence for attenuation of sexual response in women by aversive conditioning. Generally, when the CS is repeatedly presented without the US, and the CS no longer predicts the aversive or appetitive outcome (Delamater et al., 2004), this will yield in a loss of conditioned responding. Intriguing, in this study (Both et al., 2008a) conditioned genital responses and subjective affect did not diminish significantly during the extinction phase suggesting resistance to extinction. This *extinction* learning process has obvious clinical relevance, since it is thought to be the core mechanism for therapeutic interventions such as exposure therapy (Hermans et al., 2006; Myers, Carlezon & Davis, 2001; Rescorla, 2001). In such therapeutic protocols, conditioned responses are lessened or inhibited by repeated or prolonged exposure to a cue (the CS) in absence of the event it used to predict (the US). This results in a decrease in the magnitude or frequency of the conditioned response (CR). This observation that conditioned subjective affect did not extinguish is in line with research on evaluative conditioning, which has shown that acquired subjective likes and dislikes are relatively resistant to extinction (DeHouwer, Thomas & Baeyens, 2001). Research has demonstrated that exposure treatment is often unsuccessful in reducing feelings of dislike (Baeyens et al., 1992). In classical conditioning the CS elicits a US expectancy and CR (i.e. signal learning), whereas in evaluative learning, it is thought that the CS automatically evokes the representation of the US (Diaz, Ruiz & Baeyens, 2005). As a result, evaluative learning effects are difficult to modify through the procedure of extinction alone. Therefore, research on resistance to extinction of different measures of conditioned sexual responses is needed as it may have important clinical implications.

At present, it is unclear if gender differences in sexual conditionability and in resistance to extinction of aversive conditioned responses do exist. Only few studies have addressed sexual conditioning in both men and women in

appetitive paradigms (Brom et al., 2014b; Hoffmann, Janssen & Turner, 2004; Klucken et al., 2009), with mixed results, and none have examined aversive conditioning in both sexes. In addition, results from animal studies are also mixed. Some have demonstrated that intense electrical shock inhibits male rat sexual performance (Beach et al., 1956), while other research demonstrated that the pairing of a CS with a painful shock can also induce copulation in noncopulating male rats (Barfield & Sachs, 1968; Caggiula & Eibergen, 1969; Crowley, Popolow & Ward, 1973). Recently, an intriguing study by Farmer et al. (2014) demonstrated that inflammatory pain reduces sexual motivation in female but not in male laboratory mice.

To investigate resistance to extinction of aversively conditioned sexual responses systematically, in the present study an aversive conditioning paradigm was applied in sexually functional men and women. A painful electric stimulus at the wrist served as US, and two erotic pictures served as CS. It was expected that after repeated pairing of the CS and US, genital blood flow would be attenuated following the erotic picture that was paired with the painful electric stimulus (CS+), compared to following the erotic picture that was not paired with the US (CS-), at least in women. In addition, it was expected that pairing of the erotic CS+ with painful stimulation would result in more negative affective value and lower sexual arousability ratings of the CS+ as compared with the CS-. Resistance to extinction was studied by inclusion of a large series of extinction trials (Vansteenwegen et al., 2006). Based on evaluative conditioning theory it was expected that genital responses and sexual arousal ratings would show a loss of conditioned responding, while valence ratings (conditioned positive and negative affect) would show no loss. Since affect ratings are susceptible to demand characteristics, in addition a stimulus response compatibility task was included to assess implicit approach and avoidance tendencies towards the CSs. In this task, participants responded to stimuli either by pushing or pulling a lever. Former research has shown that

participants are faster to respond to negatively valenced stimuli when pushing the lever away (avoid) than when pulling it toward them (approach) but were faster to respond to positive stimuli by pulling than pushing the lever (Chen & Bargh, 1999). It was predicted that repeated associations between the CS+ and the painful stimulation will result in a stronger avoid tendency to this CS+, compared to other stimuli on this task, even after the large number of extinction trials.

5.2. Method

5.2.1. Participants

Research participants were 38 men and 34 women. Participants were paid €35,- or received course credit for their participation. Participants between the age of 18 and 45 were recruited through online advertisements at social networks and through advertisements at the Leiden University Medical Centre, and at the Universities of Leiden and Amsterdam. Due to the nature of the CSs only participants with a heterosexual orientation were included. 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, a medical illness or use of medication that could interfere with sexual response, and sexual fetishes or abnormal sexual preferences. In addition, participants reporting a history of sexual abuse and related subsequent psychological problems were also excluded. Before participation all subjects received written information, including a description of the procedure, the pain stimulus, and the genital response measurement. Women were not tested during menstruation. Confidentiality, anonymity, and the opportunity to withdraw from the experiment without penalty were assured to all participants. The study was approved by the Ethical Committee of the Medical Center.

5.2.2. Design

The experimental design involved differential conditioning with one stimulus (the CS+) being followed by the painful stimulation (US) during the acquisition phase, whereas the other stimulus (CS-) was never followed by a painful shock. Which of the two pictures served as the reinforced CS (the CS+), or the nonreinforced CS (the CS-) was counterbalanced across participants. During the whole experiment measurements of genital arousal were recorded. During the preconditioning-, and extinction- phases ratings of subjective affect and subjective sexual arousal were collected. In the preconditioning phase, participants saw four nonreinforced presentations of the CS+ and four presentations of the CS-, for 9s each (see Figure 1). Subsequently, in the acquisition phase the contingency between CS+ and US was learned: the CS+ and CS- were presented 10 times each and the CS+ was always followed by the US. The US was delivered for 50ms, starting 8s after the onset of the CS+. The extinction phase consisted of 24 unreinforced CS+ presentations and 24 unreinforced CS- presentations. There were two random orders for each phase; with the restriction of only two successive presentations of each CS. Half of the participants saw the pictures in order 1, the other half in order 2. There was no interval between the preconditioning, acquisition, and extinction phases. During the whole procedure inter-trial intervals (ITIs) were 20, 25, or 30s. These intervals allowed sufficient time for the genital response not to interfere with subsequent stimulus presentation, since data from our laboratory has shown that vaginal blood engorgement is a relatively slow physiological response (Both et al., 2008a,b). The order of the length of the ITI was random, with the restriction of only two successive lengths. Procedure, timing of US, and ITI were adapted from previous studies that demonstrated conditioned sexual response (Both et al., 2008a, 2011). The basic design for testing conditioning effects was a 2 (CS+ vs. CS-) x 24 (trial) within subjects design.

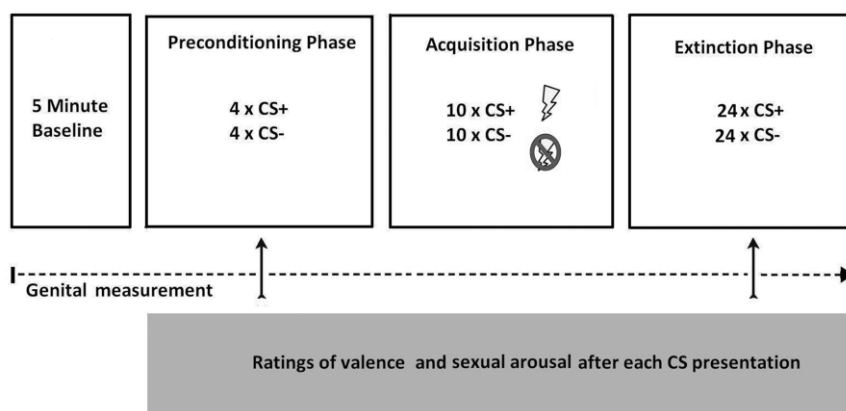


Figure 1. Schematic representation of the conditioning procedure and extinction phase.

5.2.3. Materials

Stimulus Materials

Conditioned Stimuli Two explicit erotic pictures as used by Both et al. (2008a) served as CSs. Both pictures portrayed a nude heterosexual couple engaging in sexual intercourse with the woman in superior position. The pictures differed with regard to the male and female actors involved. 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. During the intervals between the pictures, a white screen was presented. One of the pictures (CS+) was followed by the US, while the other picture (CS-) was never followed by the US. Assignment of the pictures as CS+ and CS- was counterbalanced across participants.

Pain stimulus The pain stimulus (US) was an electrocutaneous stimulus with a duration of 50 milliseconds, delivered by a safe muscle stimulation apparatus (Digitimer, DS7A, Digitimer Ltd, Hertfordshire, England) with an isolation unit. The pain stimulus was administered by electrodes, fastened at the

wrist of the nondominant arm. The pain stimulus produces a painful, stinging sensation, and has been used in several experimental studies (Both et al., 2008a; Brauer et al., 2007; Effting & Kindt, 2007). The intensity of the US was set at a level that the participant described as *painful and demanding some effort to tolerate*.

Physiological Measures

Male genital sexual arousal Changes in circumference of the penis were measured using an indium/gallium-in-rubber penile gauge (Bancroft, Jones & Pullan, 1966). Increases in penile circumference result in a corresponding change in resistance. Changes in electrical output caused by expansion of the gauge were recorded by a continuous DC signal. Participants were instructed to place the gauge midway along the penile shaft. The Indium-Gallium penile gauges were disinfected after each use, according to Sekusept plus disinfection procedure.

Women's genital sexual arousal was measured using a vaginal photoplethysmograph assessing vaginal pulse amplitude (VPA) (Laan, Everaerd & Evers, 1995). The photoplethysmograph is a menstrual tampon-sized device containing an orange-red light source and a photocell. The light source illuminates the capillary bed of the vaginal wall and the blood circulation within it. VPA can be measured when the signal is connected to an alternating current amplifier. VPA reflects the phasic changes in vaginal engorgement accompanying each heartbeat, with larger amplitudes reflecting higher levels of vasocongestion. 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 within 5 cm of the light sensor. Participants were instructed to insert the photoplethysmograph until the plate touched their labia. The vaginal photoplethysmograph was sterilized by plasma sterilization. Genital response was measured continuously during resting baseline, preconditioning-, acquisition- and extinction phases.

Subjective Measures

Subjective ratings of affective value and sexual arousal in response to the CSs were collected during the preconditioning- and extinction phase. Participants were asked to rate, after each stimulus presentation, the affective value of the CSs by answering the question “*What kind of feeling does this picture evoke in you?*” With a keyboard the question could be answered on a seven-point Likert-scale that varied from *very negative* to *very positive*. 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*. The first question was presented at the monitor one second following the end of picture presentation. The time the question was shown was paced by the participant’s response; the time to respond was maximally 11 seconds. When the participant answered the first question, the next question was presented after 15 second. For the benefit of the conditioning procedure, a constant time interval between the CS presentations was kept. After the participants answered the questions, a white screen remained until the next picture was presented.

Other measures

Approach Avoidance Task (AAT) After the extinction phase, participants performed the implicit approach/avoidance task (Cousijn, Goudriaan & Wiers, 2011). This task assesses approach and avoidance motivational processes by requiring participants to respond to irrelevant features of the pictures by either pulling a joystick handle toward them or by pushing it away. Pulling and pushing the joystick gradually increased and decreased image-size. All images were rotated 3° left or right. Image content was irrelevant to the task: participants were instructed to pull or push a joystick in response to rotation direction. Half the participants pushed images rotated left and pulled images rotated right, while the other half received opposite instructions. Pulling and

pushing the joystick gradually increased and decreased image-size. Appetitive images should facilitate pull (i.e., approach) responses, and aversive images should facilitate (push) (avoidance) responses. The amount of time required to execute these actions is the dependent variable. The task was programmed making use of the stimulus presentation program E-prime 2.0. The CS+ and CS- pictures from the experiment were presented, as well as other explicit erotic pictures resembling the CSs (CS-alike), and neutral pictures (i.e., always a man and a women engaged in neutral activity, such as reading or walking). Participants were randomly assigned to one of the two stimulus-response conditions. Literature supports the AAT's validity in measuring approach/avoidance motivational processes (Wiers et al., 2011).

International Index of Erectile Function (IIEF) Male sexual functioning was assessed by the 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) (Rosen et al., 1997; Rosen, 1998). Higher scores (25-30) indicate better sexual function. Psychometric properties of the IIEF are good (Rosen et al., 1997).

The Female Sexual Function Index (FSFI) Female sexual arousal was assessed by the FSFI. (ter Kuile, Brauer & Laan, 2006; Rosen et al., 2000). This is a validated 19-question questionnaire that examines 6 main domains of female sexual function: desire (2 items; range 1–5), arousal (4 items; range 0–5), lubrication (4 items; range 0–5), orgasm (3 items; range 0–5), satisfaction (3 items; range 0–5), and pain (3 items; range 0–5). Higher scores indicate better sexual functioning. Psychometric properties of the FSFI are good (Wiegel, Meston & Rosen, 2005).

5.2.4. Procedure

After participants had given informed consent, they were tested individually by a trained experimenter of the same sex, in a sound-attenuated room. Participants were instructed that the purpose of the experiment was to measure physiological responses to different erotic pictures and to pain stimuli. They were told that during picture viewing, brief periods of painful stimulation would be provided. After extensive instructions were given, the experimenter left the room to allow the participant to insert the vaginal probe, or place the penile gauge privately. The participants were instructed to lay a blanket on their lap after insertion of the probe or placement of the penile gauge, so the experimenter could enter the participant room to attach the pain stimulus electrodes. Subsequently, for each participant individually, the level of the pain stimulus was determined. The participant was exposed to repeated pain stimuli (50ms) of increasing intensity until he/she determined the pain stimulus as *painful and demanding some effort to tolerate*. It was emphasized that the intensity of the stimulus would not be changed during the experiment. Further instructions were given through an intercom and through written instructions on the monitor. 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. After the baseline period, the preconditioning, acquisition, and extinction phases followed. Immediately after the experimental procedure had finished and after the participant removed the genital devices and was fully dressed again, the AAT was presented in the experimental room. Lastly, after completion of this task, participants completed privately a questionnaire about demographics, sexual orientation and sexual functioning (e.g., FSFI/IIEF). Finally, an exit interview questionnaire was administered. Participants were asked about their reactions to the experimental procedure, the use of the genital device, and their evaluation of the pain stimulus.

5.2.5. Data Reduction, Scoring, and Analysis

A software program (VSRRP98) developed by the Technical Support Department of Psychology (University of Amsterdam) was used to reduce the genital data. The software program enables off-line graphical inspection of the data. Artifacts in the channel monitoring penile circumference and VPA can be caused by movements of the lower part of the body or by voluntary or involuntary contractions of the pelvic muscles. After artifact removal, mean penile circumference or mean VPA level during the 2-minute resting baseline period was calculated. Based on previous studies (Both et al., 2008a,b; Both, Brauer & Laan, 2011) 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). This means that in the extinction phase SIR and TIR overlapped with the moment participants were answering the questions. The timeframe of SIR and TIR were included to analyze genital responding during and following (expected) US delivery. For FIR, SIR and TIR, change scores were calculated for each CS presentation by subtracting mean genital resting baseline from genital measurements following CS presentation. Preconditioning and acquisition phases were both analyzed as a whole, whereas the extinction phase was analyzed in steps of 5 trials at a time, in order to determine thoroughly when extinction of conditioned responding occurred.

Direct gender comparison of genital responses cannot be made because of the use of different measures to assess genital response. Therefore genital data for men and women was analyzed separately, and effects were tested with repeated measures univariate analysis of variance procedures (General Linear Model in SPSS), with Stimulus and Trial as within-subject factors. Analyses of subjective measures were conducted for men and women combined, with Gender as between subjects factor. The Greenhouse–Geisser correction was applied to adjust for violation of the sphericity assumption in

testing repeated measures effects. Preconditioning, acquisition, and extinction phases were analyzed separately. Effect sizes are reported as proportion of partial variance (η_p^2) (Cohen et al., 1988).

Data from the AAT were corrected for outliers: Response Times (RTs) below 200ms, above 2000ms and more than 3 standard deviations (SD) above and below the mean were removed for each participant. Error trials were removed. The bias score was calculated by subtracting median approach RT from median avoid RT for each image category. The subtraction resulted in a bias score for CS+ images, CS- images, CSs alike images and neutral images for each participant. Median RTs were used because they are less sensitive to outliers than means (Cousijn, Goudriaan & Wiers, 2011). A positive bias score indicated a relatively faster approach compared to avoid RTs, whereas a negative score indicated a relatively faster avoid compared to approach RTs for the concerned image category. 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 analyzed using standard analysis of variance (ANOVA).

With a chosen p -value of .05, a power of 80% and an effect size of .5, a minimal number of 26 subjects was needed for within-subject effects (Cohen, 1988). Since we only explored possible gender differences, it was sufficient to include a minimum of 30 women and 30 men for these within subjects analyses.

5.3. Results

The results for men's and women's genital data are based on 36 men and 31 women. Data of two men and one woman were lost due to technical error. Data from another female participant were left out, because due to an experimental error this participant did not receive the painful stimulation. This person was removed from all further analysis. Data of another woman were

discarded because genital data were 3 SD above from the Mean. The results for the subjective ratings are based on 35 men and 32 women. For a female participant and for three male participants the subjective data was lost due to technical error. With respect to the Approach and Avoidance Task, due to technical error, data of one female participant were lost.

5.3.1. Study sample characteristics

Men and women did not differ in age, $p = .93$ (see Table 1 for subject characteristics). For men, the International Index of Erectile Function Questionnaire (IIEF) mean score was 33.53 (SD = 4.57, range 22–41), indicating sexual functioning within the normal range (Rosen, 1998). Mean Female Sexual Function Index (FSFI) score was 26.32 (SD = 3.82, range 15.2–30.6), indicating sexual functioning slightly below the normal range (Rosen et al., 2000). However, 11 women indicated not to have a stable relationship at the time of the study, six participants indicated not having had sexual activity with a partner during the last weeks, and one participant indicated no sexual activity during the last 4 weeks, resulting in a low FSFI score, which may explain the relatively low FSFI group score. Mean FSFI score without participants that indicated no sexual activity with a partner the last 4 weeks was 26.96 (SD 3.19, range 18.30–30.60), indicating sexual functioning within the normal range.

5.3.2. Evaluation and Effect of US

Prior to the experiment, men and women differed in set US intensity, $t(70) = 3.81$, $p < .01$, and the evaluation in terms of painfulness thereof, $t(67) = 9.31$, $p < .01$. In the exit interview, 84.2% of the male participants and 70.5% of the women rated the US as fairly unpleasant. Of the men, 81.6% and 76.4% of the women rated the US as moderate to very painful. There were no differences between men and women in the way they had experienced the US during conditioning, see Table 1.

Variable	Men (N= 38)		Women (N= 34)		<i>p</i>
	M	SD	M	SD	
Age (years)	24.5	5.5	24.7	6.4	.93
Sexual Functioning (IIEF/ FSFI-score)	33.5	4.6	26.3	3.8	
Intensity US (mA)	1200.3	244.0	903.9	403.9	<.001*
Ratings US as painful	6.8	0.4	5.5	0.7	<.001*
CSs perceived as sexually arousing	3.0	0.9	1.24	0.7	<.01*
Pleasantness watching CSs	3.2	0.8	2.7	0.8	.02*
Unpleasantness US	3.3	0.9	3.0	1.0	.17
US perceived as painful	3.1	0.7	3.0	0.8	.31
US perceived as sexually arousing	1.7	0.9	1.7	0.9	.98
Strongest genital reaction	30.5	28.1	39.6	24.8	.15
Prior experience erotic material	4.3	0.6	3.6	0.7	<.001*
Erotic fantasies	2.6	1.1	2.6	1.1	.89

Table 1. Descriptive subject variables for men and women. Notes: Scale Rating US as painful (directly after intensity of US was set): 1 (not very painful at all) – 7 (very painful). Questions from the Exit interview: CSs perceived as sexually arousing: 1 (not sexually arousing at all) – 5 (very sexually arousing); Pleasantness watching CSs: 1 (not pleasant at all) - 5 (very pleasant); Scale unpleasantness US: 1 (not unpleasant at all) - 5 (very unpleasant); US perceived as painful (exit interview): 1 (not painful at all) – 5 (very painful); US perceived as sexually arousing : 1 (not sexually arousing at all) – 5 (very sexually arousing); Strongest genital reaction in %; Scale Prior experience erotic material: 1 (never) – 5 (very often); Erotic fantasies during the experiment: 1 (not at all) – 5 (very much); * $p < .05$.

5.3.3. Preconditioning phase

Genital Sexual Arousal Analyses were conducted to verify equal levels of penile circumference and VPA in response to the CS+ and CS- during the preconditioning phase. For all latency windows (FIR, SIR and TIR), no

difference in circumference following presentation of the CS+ and CS- was found, all $ps > .40$, nor in VPA, all $ps > .11$.

Subjective Measures The 2 (Stimulus) X 4 (Trial) X 2 (Gender) Mixed ANOVA was conducted to verify equal levels of subjective responses to the CS+ and CS- preceding the acquisition phase. For affective value and subjective sexual arousal, no difference in responding following presentation of the CS+ and CS- was found between conditions and between men and women, all $ps > .48$. However, for both measures a main effect for Gender was seen, with men rating the CSs as more positive, $F(1, 59) = 9.27, p < .01, \eta_p^2 = .14$, and as more sexually arousing, $F(1, 64) = 9.09, p < .01, \eta_p^2 = .12$, as can be seen in Figure 3 and 4.

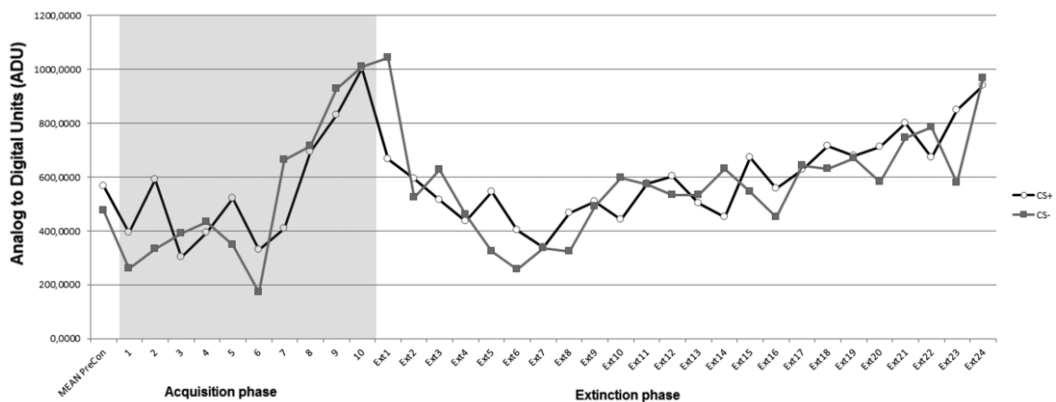


Figure 2. Mean penile circumference change scores during the second interval response window (SIR) following CS+ and CS- during the preconditioning phase, acquisition phase and extinction phase. Note that during the acquisition phase, the response represents responding to the CS+ plus the US.³

³ Since not all indium-gallium gauges could be calibrated before data collection, to avoid bias results were calculated with digital output units.

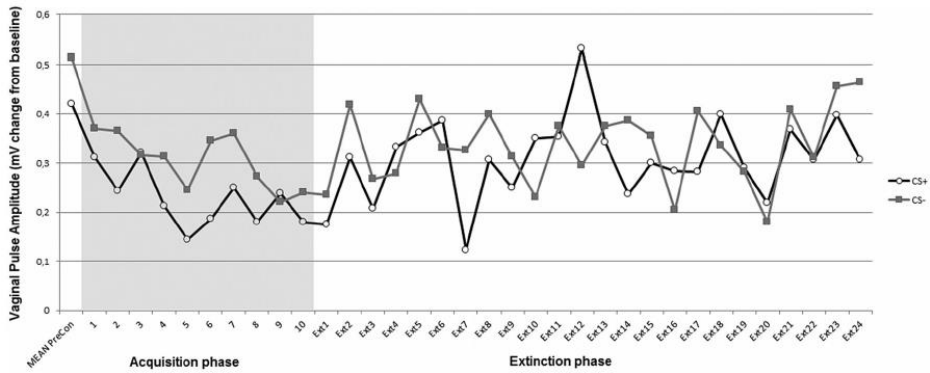


Figure 3. Mean vaginal pulse amplitude (VPA) change scores during the second interval response window (SIR) following CS+ and CS- during the preconditioning phase, acquisition phase and extinction phase. Note that during the acquisition phase, the response represents responding to the CS+ plus the US.

5.3.4. Acquisition phase

Genital Sexual Arousal Penile circumference and VPA in response to the painful stimulation during the acquisition phase was determined in order to verify whether the electric shock diminished genital responses. Genital responses in the second and third latency windows (SIR, TIR) were considered as responses to the painful stimulation.

Men Figure 2 summarizes penile circumference (SIR) to CS+ and CS- across trials. Contrary to expectation, the analysis of penile circumference in the acquisition phase revealed no main effect of Stimulus at all time latencies, FIR, $p = .85$, $\eta_p^2 < .01$; SIR, $p = .77$, $\eta_p^2 < .01$; TIR, $p = .76$, $\eta_p^2 < .01$, meaning the painful stimulus did not result in a decreased genital response. Also, the 2 (Stimulus) X 10 (Trial) interaction was not significant, FIR $p = .82$, $\eta_p^2 < .01$, SIR, $p = .81$, $\eta_p^2 < .01$, and TIR, $p = .71$, $\eta_p^2 = .01$. Analysis of penile circumference during the preconditioning phase (Mean precon trial 1-4) and the first acquisition trial yielded a significant main effect for Stimulus on TIR, $F(1,$

35)= 4.22, $p < .05$, $\eta_p^2 = .11$. Additional analysis of penile circumference during the preconditioning phase (Mean precon trial 1-4) and the last acquisition trial yielded no main effect for Trial on all time latencies, all $ps > .64$. In sum, the painful stimulation only resulted in a marginally decrease of penile circumference at the first trials of the acquisition phase as compared with the preconditioning phase. However, as can be seen in Figure 2, after the initial decrease in penile circumference during the first trials of the acquisition phase, contrary to the expectations, a trend was seen for an increase in penile circumference in response to the two CSs on all time latencies.

Women The 2 (Stimulus) X 10 (Trial) repeated measures ANOVA of VPA FIR during the acquisition phase revealed no significant main effect for Stimulus, $p = .14$, $\eta_p^2 = .08$ (see also Both et al., 2008b; Both, Brauer & Laan, 2011). For SIR this analysis yielded a significant main effect for Stimulus, $F(1, 27) = 10.92$, $p < .01$, $\eta_p^2 = .29$, and for TIR a trend, $F(1, 28) = 6.63$, $p < .07$, $\eta_p^2 = .12$. As can be seen in Figure 3, the painful stimulation resulted in a robust decreased genital arousal response. On all time latencies, no interaction for Stimulus X Trial was found, FIR, $p = .47$, $\eta_p^2 = .03$; SIR, $p = .61$, $\eta_p^2 = .03$; TIR, $p = .80$, $\eta_p^2 = .02$.

5.3.5. Extinction phase

Genital Sexual Arousal

Men Analysis of the first extinction trial revealed smaller penile responses towards CS+ than to CS-, although this difference only approached conventional level of significance, FIR, $F(1, 35) = 3.12$, $p < .09$, $\eta_p^2 = .09$; SIR, $F(1, 35) = 3.33$, $p < .08$, $\eta_p^2 = .09$; TIR, $F(1, 35) = 2.85$, $p = .10$, $\eta_p^2 = .08$.

Analysis of penile circumference during the preconditioning phase (Mean precon trial 1-4) and the first extinction trial yielded no significant main effect for Stimulus, all $ps > .45$, nor significant interaction effects for Stimulus X Trial, all $ps > .12$. On SIR and TIR this analysis yielded a trend for Trial, SIR $F(1, 35) = 3.36, p < .08, \eta_p^2 = .09$, TIR, $F(1, 35) = 2.86, p < .10, \eta_p^2 = .08$. The 2 (Stimulus) X 5 (Trial) repeated measures ANOVA of the first five extinction trials yielded a main effect for Trial approaching significance, on the time latency FIR, $F(2, 78) = 2.85, p < .06, \eta_p^2 = .08$, and a trend for Stimulus X Trial on SIR, $F(3, 89) = 2.51, p = .07, \eta_p^2 = .07$, and TIR $F(2, 68) = 2.64, p = .08, \eta_p^2 = .07$. This indicates there was only a marginally difference in penile responding towards the CS+ and CS-, and this pattern of responding slightly changed across extinction trials, meaning extinction. Analysis of the whole extinction phase yielded no significant interaction effect for Stimulus X Trial, all $ps > .24$. Not surprisingly, additional analysis of the last extinction trial did not yield significance for Stimulus, all $ps > .52$, indicating no conditioned differential responding towards the CS+ and CS-. In sum, the picture that was reinforced by painful stimulation during the acquisition phase did not elicit smaller penile circumference during the extinction phase, although trends in that direction were seen during the first extinction trials.

Women Analysis of VPA during the preconditioning phase (Mean precon trial 1-4) and the first extinction trial yielded a significant main effect for Stimulus on all time latencies, FIR, $F(1, 28) = 11.25, p < .01, \eta_p^2 = .29$; SIR, $F(1, 28) = 28.04, p < .01, \eta_p^2 = .50$; TIR, $F(1, 29) = 6.53, p < .02, \eta_p^2 = .18$. The 2 (Stimulus) X 5 (Trial) repeated measures ANOVA of VPA of the first five extinction trails revealed no main effect of Stimulus on FIR, $F(1, 30) = 0.13, p = .73, \eta_p^2 < .01$, but yielded a significant main effect of Stimulus on the time

latency SIR, $F(1, 30) = 4.69, p < .04, \eta_p^2 = .14$, indicating a conditioning effect. Additional analysis of the first 10 extinction trials on SIR also yielded a significant main effect for Stimulus, $F(1, 27) = 4.96, p < .04, \eta_p^2 = .16$. This means that the picture that was reinforced by painful stimulation during the acquisition phase did elicit lower vaginal pulse amplitudes during the first extinction trials compared to the picture that was not paired with the US, as can be seen in Figure 3. Contrary to the hypothesis however, this analysis did not yield a main effect for Stimulus on the time latency TIR, $p = .44, \eta_p^2 = .20$. Although not entirely surprising, since no main effect for Stimulus was found on FIR and TIR, the ANOVA showed no significant interaction effect for Stimulus and Trial on FIR, $p = .15, \eta_p^2 = .06$, and TIR, $p = .28, \eta_p^2 = .04$. But crucial to the hypothesis this analysis also did not show a significant interaction effect for Stimulus and Trial on SIR, $p = .68, \eta_p^2 = .01$, indicating no extinction effect. However, analysis of the whole extinction phase yielded no significant main effect for Stimulus, FIR, $p = .37, \eta_p^2 = .04$; SIR, $p = .44, \eta_p^2 = .04$; TIR, $p = .47, \eta_p^2 = .03$, nor significant interaction effects for Stimulus X Trial on SIR, $p = .48, \eta_p^2 = .05$, and TIR, $p = .42, \eta_p^2 = .05$, although on FIR a trend was seen, $F(9, 178) = 1.77, p < .08, \eta_p^2 = .09$. These results indicate that the differential VPA responding towards the picture that was reinforced by painful stimulation during the acquisition phase (CS+) and the picture that was not followed by painful stimulation (CS-) did not endure during the whole extinction phase. The conditioned differential responding gradually decreased across extinction trials, and this is considered as evidence of extinction. Additional analysis of the last extinction trial did not yield significance for Stimulus on FIR, $p = .96, \eta_p^2 < .01$, and TIR, $p = .66, \eta_p^2 = .01$, indicating extinction of conditioned responding.

However for SIR, a trend for Stimulus was detected, $F(1, 20) = 3.29, p < .09, \eta_p^2 = .14$, although this finding does not lend itself to unambiguous interpretation as resistance to extinction.

Subjective Measures

Subjective Affect

As can be seen in Figure 4, men and women showed an increase of differential responding towards CS+ and CS- after the acquisition phase. Analysis of the affective value ratings during the preconditioning phase (Mean precon trial 1-4) and the first extinction trial, revealed an interaction effect for Stimulus X Trial, $F(1, 57) = 7.74, p < .01, \eta_p^2 = .12$. No differences were seen between men and women, reflected by the non-significant Stimulus X Trial X Gender interaction, $p = .35, \eta_p^2 = .02$. In line with the hypothesis, the analyses of the first five extinction trials yielded a significant main effect for Stimulus, $F(1, 61) = 6.47, p < .02, \eta_p^2 = .10$, indicating a conditioning effect. Men and women showed stronger negative affect towards the CS+ after the acquisition phase. The 2 (Stimulus) X 5 (Trial) X 2 (Gender) Mixed ANOVA yielded a significant interaction effect for Stimulus X Trial, $F(3, 196) = 4.91, p < .01, \eta_p^2 = .07$, indicating extinction effect. No differences in differential responding were seen between men and women, as reflected by the non-significant interaction effects for Stimulus X Gender, $p = .87, \eta_p^2 < .01$, and Stimulus X Trial X Gender, $p = .86, \eta_p^2 < .01$. Analysis of the first 10 extinction trials yielded a main effect for Stimulus, $F(1, 59) = 4.15, p < .05, \eta_p^2 = .07$, and for Stimulus X Trial, $F(5, 293) = 4.40, p < .01, \eta_p^2 = .07$. Again, no differences between men and women were seen, Stimulus X Gender, $p = .69, \eta_p^2 < .01$; Stimulus X Trial X Gender, $p = .94$,

$\eta_p^2 < .01$. This indicates that up to 10 extinction trials men and women showed less positive affect towards the CS+. However, as reflected by the significant Stimulus X Trial interaction, this difference in rated subjective affect between CS+ and CS- gradually decreased across extinction trials. Analysis of all 24 extinction trials revealed no main effect for Stimulus, $p = .32$, $\eta_p^2 = .02$, but an interaction effect for Stimulus X Trial, $F(6, 282) = 3.98$, $p < .01$, $\eta_p^2 = .08$, indicating extinction. For Trial a trend was seen, $F(3, 152) = 2.14$, $p = .09$, $\eta_p^2 = .04$, indicating rated subjective affect changed over trials. Again, no differences were seen between men and women, Stimulus X Gender, $p = .90$, $\eta_p^2 < .01$; Stimulus X Trial X Gender, $p = .83$, $\eta_p^2 = .01$. Additional analysis of the first extinction trial, revealed a main effect for Stimulus, $F(1, 63) = 11.55$, $p < .01$, $\eta_p^2 = .16$, whereas analysis of the last extinction trial did not yield significance for Stimulus, $p = .65$, $\eta_p^2 < .01$, indicating extinction of conditioned responding.

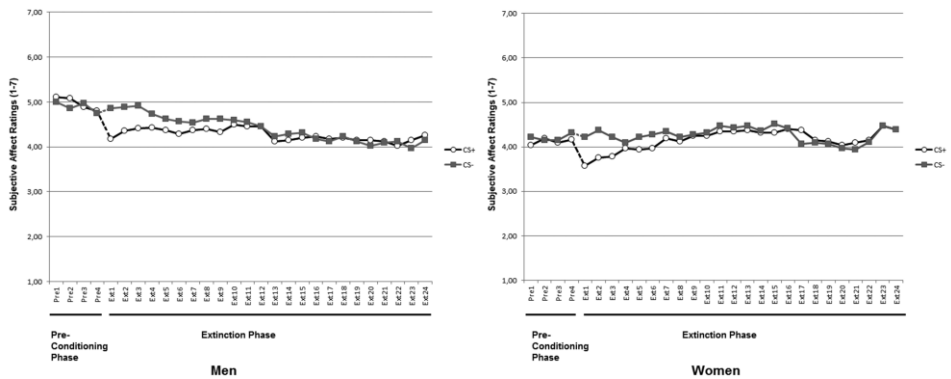


Figure 4. Subjective affect ratings following the CS+ and CS- during the preconditioning phase and extinction phase for men (left) and women (right).

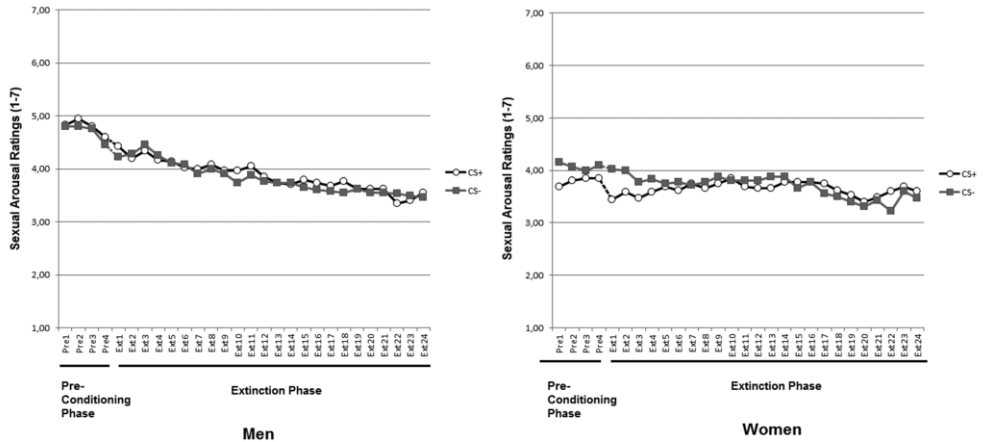


Figure 5. Ratings of subjective sexual arousal following the CS+ and CS- during the preconditioning phase and extinction phase for men (left) and women (right).

Subjective Sexual Arousal

Figure 5 shows the ratings of subjective sexual arousal across all trials. Additional analysis of the first extinction trial, revealed no main effect for Stimulus, $p = .26$, $\eta_p^2 = .02$, although a significant interaction effect for Stimulus X Gender was seen, $F(1, 65) = 5.29$, $p = .03$, $\eta_p^2 = .08$. Men and women differed in conditioned responding on the first extinction trial, with only women showing conditioned differential responding. Inspection of Figure 5 reveals that compared to men, women rated the CS+ as less sexually arousing as compared to the CS-. Analysis of the ratings of subjective sexual arousal during the preconditioning phase (Mean precon trial 1-4) and the first extinction trial, revealed a main effect for Stimulus, $F(1, 64) = 6.18$, $p < .02$, $\eta_p^2 = .09$, but no interaction effect for Stimulus X Trial, $p = .49$, $\eta_p^2 = .01$. No differences were seen between men and women, as reflected by non-significant interactions, Stimulus X Gender, $p = .36$, $\eta_p^2 = .01$, and Stimulus X Trial X Gender, $p = .17$,

$\eta_p^2 = .03$. Contrary to the hypothesis, the analyses of the first five extinction trials did not yield a significant main effect for Stimulus, $p = .19$, $\eta_p^2 = .03$. However, the analysis did yield an interaction effect for Stimulus X Trial X Gender approaching significance, $F(3, 193) = 2.37$, $p = .07$, $\eta_p^2 = .04$. As can be seen in Figure 5, women demonstrated more differential responding on the first five extinction trials towards CS+ and CS- as compared to men. Analysis of the first 10 extinction trials yielded no significant main effect for Stimulus, $p = .45$, $\eta_p^2 < .01$, or significant interaction effects for Stimulus X Trial, $p = .11$, $\eta_p^2 = .03$, Stimulus X Trial X Gender, $p = .27$, $\eta_p^2 = .02$. Analysis of the last extinction trial did not yield significance for Stimulus, $p = .40$, $\eta_p^2 = .01$, indicating extinction of conditioned responding. No differences were seen between men and women on this last extinction trial, as reflected by the non-significant Stimulus X Gender interaction, $p = .86$, $\eta_p^2 < .01$.

Approach Avoidance Tendencies

One-sample t -tests were used to test if bias scores deviated significantly from zero within each condition, see Table 2. Differences in AAT bias scores were analyzed with a mixed ANOVA with Gender as between-subject factor and Image as within-subject factor with four levels (CS+, CS-, CS-alike and neutral objects). Contrary to the expectations, no main effect was found for Image, $F(2, 161) = 0.27$, $p = .81$, $\eta_p^2 < .01$. Participants did not differ in approach and avoidance tendencies across all stimuli. In addition, no interaction effect was found for Image and Gender, $F(2, 161) = 1.54$, $p = .21$, $\eta_p^2 = .02$, meaning men and women did not differ in their bias scores.

	Bias Score	M	SD	<i>p</i>
Men	CS+	24.5	76.0	.06
N= 38	CS-	24.1	67.4	.03*
	CS-alike	41.6	130.9	< .05*
	Neutral	37.4	70.5	.01*
Women	CS+	45.6	51.7	< .01*
N= 32	CS-	40.9	58.8	< .01*
	CS-alike	35.5	65.8	< .01*
	Neutral	22.6	49.9	< .02*

Table 2. One-sample *t*-test results for Mean Approach Avoidance Task (AAT) bias scores for CS+, CS-, CS-alike and neutral images in men and women. A positive score indicates faster reaction times on approach (pull) trials compared to avoid (push) trials. * *p* < .05.

5.4. Discussion

The present study contributes to the existing and growing literature on learning mechanisms in sexual behaviours, and provides further support for attenuation of sexual response through aversive conditioning, especially in women. The present study replicated the study by Both and colleagues (Both et al., 2008a) who provided the first evidence for the effect of aversive conditioning on female sexual response. However, contrary to the hypotheses, the present study does not provide evidence that sexual evaluative learning effects are difficult to modify through the procedure of extinction alone, at least in an aversive sexual paradigm, in heterosexual healthy men and women. Yet the results do corroborate the notion that conditioned sexual likes and dislikes can be persistent. In addition, the present study also revealed some remarkable gender differences in aversive conditioned sexual responding.

In accordance with the expectations, women's genital blood flow in the extinction phase was attenuated in response to the erotic picture that was previously paired with the painful electric stimulus (the CS+) as compared to the erotic picture that was never paired with the US (the CS-). However, no such conditioned response in men was detected. Contrary to the expectations, men did not demonstrate a difference in penile circumference in response to the picture that was followed by painful stimulation during the acquisition phase. In fact, men displayed a slight increase in penile circumference over trials during the acquisition phase in response to the two CSs, even though the CS+ was followed by the painful stimulation. In addition, it was expected that the pairing of the erotic picture with painful stimulation would result in lower sexual arousability ratings of this picture. However, only women rated the CS+ as slightly less sexually arousing compared to the erotic picture that was never followed by painful stimulation, while men did not demonstrate attenuated subjective sexual response in response to the CS+ during the first trials of the extinction phase.

Crucial to the hypothesis, subjective affective value was successfully modulated by repeated association of the erotic stimulus with pain. Men and women rated the erotic picture that was paired with pain stimulation during the acquisition phase as more negative than the erotic picture that was not paired with pain. Remarkably, this conditioned differential responding lasted 10 extinction trials. Thus, classical conditioning using an erotic CS and an aversive pain US results in a conditioned response not only at the physiological level in women, but also at the subjective affective level in men and women. The present study demonstrated that although the attenuated genital response in men was absent, the more negative evaluation of the erotic stimulus seemed to remain over quite a number of extinction trials in men and women. However, crucial to the hypothesis and not corroborating earlier research (Vansteenwegen et al., 2006), in the present study the difference in affective evaluation of the

CS+ and the CS did decrease over time during the extinction phase, suggesting that conditioned sexual likes and dislikes are not entirely resistant to extinction.

In the present study, the habituation to the US and the nature of the CSs may have been potentially important confounding variables. First, after repeated exposure to the US, it is most likely that the US itself became less aversive leading to smaller conditioned affective value. Although a majority of the participants rated the US as highly unpleasant directly after the level of the pain stimulus was determined, in the exit interview afterwards the majority of participants reported that they perceived the pain stimulus as only moderately painful. Thus, although it may safely be concluded that the pain stimulus elicited an unconditional aversive emotional response, it should also be mentioned that the intensity of the US was only moderate.

Nevertheless, the finding that aversively conditioned sexual responses to sexual stimuli are affected by an extinction procedure whereas aversively conditioned responses to neutral pictures are not (Vansteenwegen et al., 2006) suggests a difference in the underlying learning processes. Research has shown that resistance to extinction in animal related and socially related fears (Mallan, Sax & Lipp, 2009; Rowles, Lipp & Mallan, 2012) is mediated by different evolutionary learning systems (Öhman, 1986). Like the proposed concept of evolved fear modules by Öhman and colleagues (Mineka & Öhman, 2002; Öhman & Mineka, 2001), it seems plausible that sexual arousal can also have a phylogenetic or evolutionary basis for sexual arousal-relevant selective associations. Indeed, it has been hypothesized that humans are born with sensitivity to what we call sexual stimuli and may be prepared to form particular associations between stimuli and sexual arousal (Everaerd, Laan & Spiering, 2000; Janssen et al., 2000). A characteristic of this proposed sexual arousal module is its tendency to be preferentially automatically activated by sex-relevant stimuli. Like the fear module, this sexual arousal module is relatively independent of higher cognitive influences such as expectancies. Results from

animal research suggest that conditioned responses toward sexually relevant CSs might be highly resistant to extinction (Domjan, O'Vary & Greene, 1988). This has led to the assumption that CS-US similarity is an important factor in conditioning (Krause, Cusato & Domjan, 2003; Rescorla & Furrow, 1977). It is thought that those 'prepared' associations are acquired more easily and that, additionally, these associations are thought to obey different laws of learning than nonprepared associations do. Derived from this, one could speculate that in combination with the independency of higher cognitive influences such as expectancies on the module of sexual arousal, the association between sexual stimuli and the suppression of sexual arousal (i.e. CS-US dissimilarity) like in the present study, may therefore not be straightforward, especially in healthy sexually functional men and women.

In addition, results from the Approach and Avoidance task did also not show clear resistance of extinction of evaluative learning. The pairing of the CS+ with the pain stimulus did not result in avoid tendencies towards this CS in men and women. Apparently the CS+ retained or regained enough sexual rewarding properties to even elicit approach tendencies in men and women. In addition, the introduction of new explicit erotic stimuli (i.e. the CS-alike stimuli) may have compromised the performance on this task, especially for men. Research has demonstrated that for men, more than for women, visual erotic stimuli preferentially recruit an amygdalo-hypothalamic pathway (Hamann et al., 2004). When limited in cognitive resources as a result of distraction and strong activation of reward structures, this plausibly could have led to difficulties in performance at the AAT. The newly introduced appetitive and biologically salient stimuli may have resulted in a generalized approach bias towards all stimuli, not only in men, but also in women. Therefore, in further research, distraction has to be limited by restricting the content of stimuli to only CS+ and CS- stimuli and eventual neutral pictures.

The results from the present study support the view that in women aversive sexual experiences, like in dyspareunia or in sexual assault, may result in decreased sexual arousal as a result of associative learning (van Berlo & Ensink, 2000; Both et al., 2008a; Brauer et al., 2007). However, the results from the present study do not corroborate the limited evidence in men for suppression of erectile responses through pairing of erotic stimuli with painful stimulation (Brom et al., 2014a). Important to note and mentioned before, is that studies providing such evidence were poorly controlled. Yet, the results concerning male genital measurements and sexual arousability ratings of the erotic picture in the extinction phase corroborates with results from animal studies (Barfield & Sachs, 1968; Caggiula & Eibergen, 1969; Crowley, Popolow & Ward, 1973; Farmer et al., 2014). First, in the present study conditioned attenuated subjective sexual arousal was demonstrated only in women. Intriguingly, in men, the pairing of the CS+ with the pain stimulus rendered that specific erotic picture subjectively more negative, but not less sexually arousing. Second, men did not demonstrate attenuated conditioned genital response in response to the CS+, but even demonstrated a trend for increased penile circumference during the acquisition phase. These results provide the first experimental evidence for sex differences in the disruption of sexual motivation by pain in humans. In women pain seems to diminish the rewarding properties of sexual activity and to adversely influence sexual motivation (Basson et al., 2010; Farmer et al., 2014; Fine, 2011). In contrast, male sexual behaviour seems to be unaffected by pain, or at least painful stimulation. Sexual pain disorders have been reported in 10% to 15% of women and less than 5% of men (Rosen et al., 2000), and are often accompanied by low sexual arousal, especially in women. Farmer et al. (2014) speculate that the pain induced reduction in sexual interest in female mice may be explained by the current incompatible physiological state with respect to a possible pregnancy. The results from the present study may indeed also be explained by this, as women,

just like female mice, have higher parental investment (Trivers, 1972). In contrast, also from an evolutionary perspective, the fittest individuals in a population are those that pass their genes on with the greatest frequency. Therefore male mice and men that copulate regardless of their or their partner's current circumstances, will increase the chances of producing offspring.

It could be that the general arousal response in men resulted in a spill-over effect in genital arousal in men in some way. Beach et al. (1956) administered shocks to rats in an attempt to inhibit mating tendencies. Interestingly, they found that while high levels of shocks did inhibit copulatory behaviour in male rats, low levels actually enhanced copulation. Results from those animal studies were explained in terms of excitement from the shock being summated with sexual stimulation to influence sexual arousal: the stimulation of mounting can be attributed to the increase in arousal caused by the shock. Results from the present study can be interpreted in a similar way. Second, as stated before, research (Hamann et al., 2004) has demonstrated that in men, visual erotic stimuli result in greater amygdalo-hypothalamic response as compared to women, making it plausible that the erotic pictures that were used as CSs in the present study were more rewarding for men than for women. Indeed, derived from analyses of the preconditioning phase and results from the exit interview, men rated the CSs as more positive and more sexually arousing and also declared afterwards to have liked watching the CSs more than women. This in combination with a moderate US, can potentially also explain why men did not demonstrate attenuated conditioned genital and subjective sexual response.

Women's subjective arousal is thought to appear to be largely reflective of how sexually exciting they find a stimulus and context (Everaerd et al., 2000; Laan, van Driel & van Lunsen, 2008), and genital engorgement does not reflect per se how women appreciate a sexual stimulus or context (Laan & Everaerd, 1995). In contrast, men's subjective sexual arousal is thought to correlate

closely with their degree of genital arousal. As studies in women with arousal disorders have demonstrated, they typically report no subjective arousal or minimal sexual arousal accompanied by negative emotions, but are found to display identical genital arousal reactions as compared to women who are acting as controls, and who are subjectively aroused by visual erotic stimulation (Everaerd et al., 2000; Laan van Driel & van Lunsen, 2008; van Lunsen & Laan, 2004).

For future studies it would be interesting to include a between subjects (unpaired) control group. With such a control group one can determine even more precisely whether and what learning has occurred. At present it is unclear if the decreased genital arousal towards the CS+ and CS- was due to conditioning or to pseudo conditioning (Hoffmann et al., 2014). Furthermore, in the present study, due to the use of different measures to assess genital response, direct comparison of genital response between men and women could not be made. Genital temperature reflects blood flow which is thought to be the physiological basis for sexual arousal, and has been shown to reliably increase with exposure to erotic stimuli and correlate significantly and highly with subjective reports of sexual arousal (Payne & Binik, 2006). Thermal imaging or devices such as labial thermistor clips and equivalent penile thermistor allow for comparison between the sexes. Therefore, it may be interesting for future studies to use other methodology like thermal imaging or genital thermistor clips. In addition, to increase ecological validity of conditioning studies, future research may use mild painful stimulation to the genitals (e.g. labia) as US. Furthermore, research has demonstrated that disgust may be an important aversive factor involved in sexual dysfunction in women (de Jong et al., 2010). In women with vaginismus (Genito-pelvic pain disorder/penetration disorder) sex related stimuli elicit disgust responses rather than sexual arousal (Borg, de Jong & Schultz, 2010). Therefore, it would be interesting for future studies to make use of an US with a disgusting nature.

Likewise, it is suggested that the amount of attention captured by sexual stimuli is a stronger predictor of an individual's sexual desire level than the valence of the emotional responses elicited by such stimuli (de Jong et al., 2010). Prause and colleagues (Prause, Janssen & Hetrick, 2008) demonstrated that participants with high levels of sexual desire were slower to detect targets in a dot detection task that replaced sexual images. Derived from this, it would be interesting for future studies on the conditioning of sexual response to also incorporate measures of attention.

The time frames SIR and TIR that were used for registration of genital response overlapped with the moment participants answered the questions regarding affective value and subjective sexual arousal. The answering of questions could have been distracting for participants, possibly negatively impacting genital response magnitude, especially in men. Research has shown that contiguously using a device such as a lever with processing of a sexual stimulus does not affect genital responding in women, whereas in men, it does result in lower genital responses (Chivers et al., 2010). However, notwithstanding any possible distraction, this possible distraction accounts for both CSs, making detection of differential responding clearly not impossible.

Results from the present study suggest that women are more sensitive to aversive sexual conditioning than men. However, it is unclear if this sensitivity has anything to do with experience in masturbation to erotic imagery, as this possibly may act as a kind of sensory preconditioning in men that overrides subsequent attempts at mild aversive conditioning. Furthermore, it is possible that the erotic pictures that were used as CSs in the present study were more rewarding for men than for women (Hamann et al., 2004). Future studies should investigate if stronger CRs can be obtained using erotic film clips as CSs. Although research has demonstrated that male sexual arousal can be conditioned making use of erotic explicit slides (Klucken et al., 2009; Plaud &

Martini, 1999), film clips generally elicit strong sexual response (Rupp & Wallen, 2008).

Results from the present study have some important implications for the treatment of sexual motivation problems in women. It seems beneficial to focus especially on subjective affect in the treatment of low sexual desire in women. As the present study has demonstrated, acquired sexual likes and dislikes can be persistent, but eventually do extinct. Therefore, in the treatment of sexual disorders with a learned component like low sexual desire, a combination of cue exposure and counterconditioning would be advisable. In counterconditioning, the CS is paired with a stimulus evoking a response that is incompatible with the original unconditioned response, thereby altering the valence of a stimulus (Baeyens et al., 1992). Research on appetitive conditioning has shown that counterconditioning is more effective than extinction alone in changing evaluations of the CS (van Gucht et al., 2010). In addition, as research has demonstrated that resilient women with a history of sexual trauma are more successful at cognitively enhancing emotional responses to aversive pictures as compared to women with PTSD after sexual trauma and even to healthy, non-traumatized controls (New et al., 2009), it is suggested that resilience is associated with the ability to sustain attention to unpleasant stimuli, leading to a more accurate or optimistic appraisal of the perceived threats. This makes clear that next to the technique of counter-conditioning, there is a role for cue-exposure therapy in the treatment of sexual arousal disorders with a learning history. And although extinction procedures do not seem to erase the originally learned CS-US association (Bouton & Moody, 2004; Brom et al., 2014b), CS-alone presentations may extinguish conditioned responses, as demonstrated. It is speculated that an extinction procedure makes the original CS-US associations less retrievable from memory, whereas it does enhance the accessibility of a new CS-no US association (Delemater, 2004). Therefore, depending on how strong and how easily available CS-US associations are, cue

exposure therapy seems relevant for the treatment of sexual disorders with a learned component, like hypo or hypersexuality. In addition, the finding that sexual conditioned responses extinguish dependent upon context (Brom et al., 2014b) make clear that extinction procedures may best be applied in the context in which the problematic behaviour is experienced, generalizing to other contexts and with multiple stimuli.

To conclude, in the present study genital and subjective sexual responses in women were successfully modulated by the aversive conditioning procedure, but intriguingly men did not demonstrate attenuated genital and subjective sexual response. The use of erotic pictures as CS (that are possibly more rewarding for men than for women) in combination with a moderate US, can potentially account for this. Results from the present study provide evidence that conditioned sexual likes and dislikes can be persistent, although conditioned affect eventually does extinguish. A combination of extinction and counter-conditioning (learning a new opposite response) would plausibly be more effective than extinction alone in the treatment of sexual arousal disorders with a learned component.

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