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Excitation Transfer Between Sexual Arousal and Other Emotions: Study Protocol

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ABSTRACT

Background: Sexual deviance is regarded as an important risk factor for sexual offending. However, little is known about the development of deviant sexual interests. The transfer of arousal between emotions, i.e., excitation transfer, could attribute sexual salience to stimuli that would otherwise not be sexual in nature. As such, excitation transfer could contribute to the very beginning of unusual or deviant sexual interests. The current protocol proposes a study to investigate to what extent excitation transfer occurs, i.e., to what extent genital and subjective sexual arousal to sexual stimuli is higher in an emotional state than in a neutral state. Following a prior pilot study, several adjustments were made to the study protocol, including a stronger emotional manipulation by using 360-degree film clips and the inclusion of a larger and more sexually diverse sample.

Methods: We will recruit 50 adult male volunteers with diverse sexual interests. We will induce sexual arousal in four different emotional states (aggression/dominance, endearment, fear, disgust) and a neutral state. Sexual arousal will be measured genitally using penile plethysmography and subjectively via self-report. Using paired samples *t*-tests, sexual arousal in the emotional states will be compared with sexual arousal in the neutral state.

Discussion: We aim to show that arousal in response to emotional stimuli that are initially nonsexual in nature, can enhance sexual arousal. These findings have potentially important implications for the development of unusual and/or deviant sexual interests and possibly for the treatment of such sexual deviant interests in people who have committed sexual offenses.

Keywords

Emotional arousal, Excitation transfer, Sexual arousal, Virtual reality.

Introduction

Global prevalence estimates indicate that up to 31% of girls and 17% of boys have experienced some form of sexual abuse before their eighteenth birthday [1-3]. Sexual offenses and reoffenses seem mostly driven by sexual deviance and/or impulsive and antisocial behavior [4-6]. Sexual deviance can be defined as an interest in- or preference for anomalous or illegal sexual stimuli [7]. In terms of the DSM-5, these interests would be referred to as paraphilia [8]. To date, very little is known about the nature or the etiology of sexual interests per se and sexual deviance specifically [9], neither about interests with an illegal theme, such

as pedophilia or exhibitionism, nor about those with a legal theme, such as transvestic fetishism (cross-dressing) or autonepiophilia (adult baby). To support the efforts to reduce sexual (re)offending behavior, e.g., by providing treatment for (potential) offenders, it is crucial to increase our knowledge on the nature and development of sexual deviance.

Incentive Motivational Model of Sexual Deviance

In the previous century, the study of sexual desire often adopted a Freudian approach where desire was seen as an intrinsic urge or lust [10,11]. A different, more modern approach to sexual desire is the Incentive Motivational Model, which entails that sexual arousal and desire result from the processing of a competent stimulus, for example, an attractive member of the preferred sex [10,12,13]. Sexual arousal is seen as an emotional reaction to a

stimulus, comparable to other emotional responses such as fear, that is instigated by stimuli appraised as dangerous [4,10,13]. Processing stimuli with emotional significance results in excitation of emotion systems and in action readiness expressed in bodily reactions that prepare for adequate behavioral responses [14].

The incentive motivational approach of sexual arousal enables us to include insights acquired in emotion research, such as the process of *excitation transfer*, first described by Zillmann in 1971 [15]. If an emotion surges while another lingering emotion is still present it will “inseparably combine with the excitatory reaction to the present stimuli and thereby intensify both emotional behavior and emotional experience” [16]. In other words: excitation will transfer from one emotion to another, resulting in a stronger emotional experience, because the remaining arousal of one prior emotion is cognitively (mis)attributed to another subsequent emotional stimulus.

With regard to unusual or deviant sexual interests, excitation transfer provides a possible explanation for how certain stimuli that seem nonsexual in nature, such as young children, pain, or dead bodies, could trigger sexual desire. Sexual salience could be attributed to stimuli that would otherwise not be sexual in nature through excitation transfer [4]. As such, excitation transfer could contribute to the very beginning of the development of unusual sexual interests. Being in an emotional state facilitates emotional learning. Activated emotional systems facilitate the attention to emotionally significant stimuli, as well as retrieval of relevant memories and strengthening of previously learned responses, from which new learning occurs [14]. Repeatedly co-occurring experiences become associated at the brain level [17]. If an emotional stimulus is repeatedly coupled with a sexual stimulus, learning and conditioning processes might ultimately make the stimulus potent enough to induce sexual arousal by itself [18-20]. This repeated co-occurrence of sexual arousal and other emotional arousal does not have to be coincidental. An individual may purposefully strive for this because it worked well before, especially if other, more common stimuli, do not induce the desired level of sexual arousal. Sexual excitement and gratification are such strong reinforcers that even sexually irrelevant stimuli can become associated with sexual reward [18]. This way, unusual stimuli like pain (masochism) or emotions like disgust (coprophilia) may become associated with sexual arousal. It is unlikely and not claimed here that excitation transfer between sexual arousal and another emotion equals definite unusual sexual interests, however, it could be one of the working mechanisms in the very early stages of stimulus appreciation and appreciation motivation [21].

Empirical Evidence

Much research into excitation transfer is carried out in the media and advertisement domain, where the interaction between arousal from television shows and response to subsequent advertisements is researched [21]. Most of the research into *sexual* excitation transfer is quite dated. Yet, these studies indicate that sexual arousal can indeed transfer to or from other emotions such as aggression [15,22-24], fear and anxiety [25-27], or general

excitement or arousal [28-31]. Effects might be stronger in people with nonnormative sexual histories. For instance, men with a self-reported history of sexual aggression have shown stronger excitation transfer between positive affect and sexual arousal than men without such histories [32].

Normative Deficiency

Excitation transfer from nonsexual emotions to sexual arousal might, among other factors, explain the initial development of deviant sexual interests. It has been hypothesized that this effect is strengthened by a lack of sexual arousal to “normative”, nondeviant stimuli [4]. For instance, a recent meta-analysis concluded that men who had sexually offended against children showed higher sexual interest in children than control groups, but also showed lower sexual interest in adults than controls [33]. A deficiency for normative sexual stimuli might explain why some people persist in their unusual or deviant sexual behavior, even if it leads to offending. Interviews with people with pedophilia indicated that if they could have sexual activities with adults, this could offer an alternative for sexual satisfaction that attenuates their need for sexual stimuli involving children [34]. Similarly, it is suggested that when individuals lack the skills to reach intimacy with an adult, they might feel that children are easier and safer to approach [34-36]. In line with this “normative deficiency” hypothesis, it is expected that a proclivity for sexual excitation transfer might be inversely related to one’s level of normative sexual interests or functioning. People that respond less to normative sexual stimuli are expected to show more excitation transfer, i.e., increased response to deviant sexual stimuli.

Optimal Window of Arousal

There are indications that the effect of excitation transfer on genital sexual arousal is not linear. More sympathetic arousal does not simply facilitate more sexual arousal, but rather there appears to be an optimal window for sympathetic arousal levels to facilitate sexual arousal, neither too low nor too high [37]. Lalumière and colleagues found that the induction of either a happy or sad mood increased sexual response to sexually violent stimuli, but there was no effect of mood state on consensual sexual stimuli [38]. It is possible that a ceiling of sexual arousal to the consensual stimuli was already reached that could not be increased further by added emotions. Furthermore, there is ample evidence that sympathovagal balance (the autonomic state resulting from the sympathetic and parasympathetic influences) is important in genital sexual arousal [37,39-41]. An optimal sympathetic arousal window for sexual arousal, or an optimal ratio between sympathetic and parasympathetic arousal, has implications for excitation transfer. Hypothetically, both emotions associated with increased sympathetic arousal and emotions associated with decreased sympathetic arousal may be able to facilitate sexual arousal, depending on the subject’s baseline arousal levels. Relaxed people may become more sexually aroused following arousing emotions, while stressed people may become more sexually aroused following calming emotions. It is worthwhile to investigate if emotions with different sympathetic/ parasympathetic arousal patterns have different effects with regard to excitation transfer.

Pilot Study

In a prior pilot study, we investigated if we could induce excitation transfer between various emotions and sexual arousal in a laboratory setting with 30 male volunteers [42]. Additionally, we aimed to explore the optimal parameters to create this effect, to pave the way for the currently proposed follow-up study. In this prior pilot study, we induced sexual arousal in four different emotional states (aggression/dominance, endearment, fear, disgust) and a neutral state. Sexual arousal was measured genitally using penile plethysmography and subjectively via self-report. Although there was no mean group effect, possibly due to large interindividual variations, 60% of the subjects showed more sexual arousal in response to sexual stimulation in at least one of the emotional states than in the neutral state. Excitation transfer was most prominent with aggression/dominance and least prominent with disgust. In line with the normative deficiency hypothesis, greater genital excitation transfer was strongly related to lower penile reactivity. Greater genital and subjective excitation transfer was also related to more erotophilia, i.e., a general positive evaluation of sex.

The Current Study

Results from the pilot study warrant us to continue investigating excitation transfer with several adjustments to the experimental protocol (see “Protocol Adjustments”). The current follow-up study includes the following aims and hypotheses.

- The primary aim is to investigate to what extent excitation transfer occurs, i.e., to what extent sexual arousal to sexual stimuli is higher in an emotional state than in a neutral state. Sexual arousal is genitally assessed by means of penile circumference as well as subjective by means of self-report on a ten-point scale. We hypothesize that sexual arousal will be higher in an emotional state than in a neutral state.
- Second, we aim to assess whether there is an association between excitation transfer from specific emotions and specific unusual sexual interests, as measured with a checklist of unusual sexual interests [43,44]. We hypothesize that larger excitation transfer effects are related to more unusual/deviant sexual interests.
- Third, we aim to assess whether there is an association between excitation transfer and normative sexual functioning. Normative sexual functioning is assessed by means of self-reported sexual outlet [43,45,46] and the genital response to sexual stimuli in the neutral block. We hypothesize that larger excitation transfer effects are related to decrease normative sexual functioning.
- Fourth and exploratory, we aim to assess if there is an association between excitation transfer and sympathetic arousal (measured in the form of heart rate variability), and if so, to assess whether this association is linear or nonlinear.

Protocol Adjustments

The following adjustments will be incorporated in the current study. First, we aim to create a stronger emotional manipulation by displaying emotional film clips via Virtual Reality (VR)-goggles and 360-degree film. It is found that 3D/VR effectively can be used to induce emotions [47] and has led to more intense emotional experiences than 2D film fragments [48-50]. Second,

we aim to include a larger and more sexually diverse sample. The previous pilot study included male volunteers between 18 and 40 years old without any problems with sexual functioning. Given that we expect the mechanism to be more evident in more erotophilic, sexually diverse samples, we aim for more variation in the sample, including people with various nonnormative sexual interests. Third, the pilot study opposed two conditions based on a) consecutive presentation of emotional and sexual stimuli [16] or b) simultaneous presentation of these stimuli [27]. In the current design, we will adopt a consecutive design in which emotional stimuli are followed by sexual stimuli. Fourth, the current study uses a different battery of self-report questionnaires that fit better with the conclusions from the previous study, including a more thorough assessment of the occurrence and content of normative and unusual or deviant sexual interests.

Methods

Sample

We will recruit 50 male volunteers, aged 18 or older. In the prior pilot study, 50% of the participants showed some form of excitation transfer with medium to large effect sizes (Cohen's $f > .27$) [42]. We expect that the improvements implemented in the current study will increase this percentage. A power analysis with Cohen's $d = .50$ (medium effect), alpha level $\alpha = .006$ (Bonferroni-corrected for eight tests), and power $\beta = .85$, indicates that 50 participants should be included for the planned statistical analyses (see Statistical Analyses). Subjects will both be recruited from the general population by means of directed snowball sampling aimed at people with diverse sexual interests and from various sexual-themed online platforms, such as BDSM, fetish, etc. Five additional subjects, recruited among colleagues, take part in the feasibility phase of the study, which serves to test and optimize the lab settings. Potential subjects will be excluded if they report insufficient understanding of the Dutch language to complete questionnaires or have a visual handicap.

Study Procedures

The experimental intervention consists of inducing emotional arousal and sexual arousal in subsequent experimental blocks, separated by return-to-baseline assignments. Emotional arousal will be induced by means of 60-second 360-degree film clips. Four different emotions will be induced that reflect positive and negative valence and increasing as well as decreasing sympathetic arousal [51-53], displayed in the first two columns of Table 1. To select the appropriate emotional stimuli, 17 volunteers watched 13 different emotional films using VR goggles and rated for each of them how aggressive/dominant, fearful, endearing, or disgusting they were on a 1-10 scale. The film clips used for the experiment were those that scored highest for each emotion category (scores between 6.2 – 8.7) and discriminated best between emotions, see the final column of Table 1.

Table 1: Emotion Induction Film Clips.

Emotion	Valence and Arousal	Content Film Clip
Aggression/ Dominance	Positive valence, increases sympathetic arousal	You are having a street fight with someone.
Fear	Negative valence, increases sympathetic arousal	Horror nightmare, a ghost-like figure is approaching you as you lie in bed.
Endearment/ Affection	Positive valence, decreases sympathetic arousal	Kittens are playing around you.
Disgust	Negative valence, decreases sympathetic arousal	Zombies are approaching a corpse and eating it's flesh and intestines.

A neutral, nonemotional state will be induced by means of a film fragment with a moving dot accompanied by a follow-the-dot assignment. Sexual arousal will be induced with various 60-second erotic film fragments originating from the same erotic movie, depicting heterosexual interaction in 360-degrees from the man's point of view. Comparable homosexual film clips will be used for participants indicating a homosexual preference.

All subjects must provide written informed consent in order to participate. At the start of the experimental appointment, subjects will fill out the questions regarding demographic information, sexual functioning, and sexual interests. In a separate laboratory area, the researcher will then attach the electrodes for the heart rate measures. The researcher instructs the subject and then leaves the subject alone to adjust the penile strain gauge and VR headset. The researcher remains in a separate room from the subjects and can communicate with the subject via intercom. The experiment starts, following the study procedures described in Table 2. To prevent order effects and carry-over effects, the order of the specific emotional and neutral films and the erotic films will be pseudorandomized among subjects, meaning that each subject will receive a different order. Subjects will receive reimbursement for their participation (€ 35 + max. €40 travel reimbursement). At the end of the appointment, subjects will be debriefed on the purpose and expected effects of the study i.e., increased sexual arousal induced by emotions. Participants may experience nausea and dizziness from VR, this will diminish after use. No adverse effects are expected to occur. Participants are provided with the contact details of an independent expert in case they have any remaining questions or concerns that they do not wish to address to the researcher. The total expected duration of the appointment is approximately one hour.

Table 2: Study Procedures.

Block	Contents
Baseline Measurement	Neutral film (80 seconds)
Experimental Block 1	- Emotional manipulation: in counterbalanced order either the aggression/dominance, fear, endearment, disgust or neutral film (60 seconds)
	- Neutral film (10 seconds)
	- Sexual arousal manipulation: heterosexual or homosexual erotic film (60 seconds)
	- Neutral film (10 seconds)
	- Sexual arousal rating
	- Return to baseline: Follow the dot assignment
Experimental Block 2	Same as above
Experimental Block 3	Same as above
Experimental Block 4	Same as above
Experimental Block 5	Same as above

Measures

The used materials are described below. All devices are used for their intended use and are CE certified (Conformité Européenne).

Sexual Arousal

Genital sexual arousal is measured during the emotional and erotic film fragments using strain gauges that assess penile circumference (www.biopac.com). This is an often used and validated measure of sexual arousal [54-56]. The gauge measures the change in diameter of the penis and is placed halfway up the shaft of the penis by the participant himself. This method appears to be relatively non-intrusive to research participants: When asked how uncomfortable they felt during the assessment, 89% of the 27 men reported "not at all" and 11% reported "a little bit" [57]. Penile circumference during the neutral stimulus will be used as the baseline measure. Subjective sexual arousal is measured at the end of each experimental block. Participants will rate the extent to which they feel sexually aroused on a 10-point Likert scale, ranging from 1, *not at all sexually aroused*, to 10, *extremely sexually aroused*.

Unusual and Deviant Sexual Interests

Unusual and deviant sexual interests are assessed with a checklist of 32 items, including less rare interests, such as BDSM, as well as more rare interests, such as coprophilia and necrophilia [43,44]. A single item describing "sex with an intimate partner" is included as a reference point. Participants rate each item on a 7-point Likert scale ranging from 1, *very unappealing*, to 7, *very appealing*. It is explicitly specified that responses do not have to reflect actual sexual activities, but simply the level to which participants consider the described activities appealing or unappealing. In addition, participants are provided with the option to list and rate sexual interests not mentioned in the list, if so desired. The items on this checklist can be categorized in four factors representing: (1) extreme and illegal sexual activities such as with children, force, or corpses; (2) light BDSM such as being tied or blindfolded; (3) heavy BDSM that may include pain or suffering, such as gagging or seriously hurting someone; and (4) fetishistic and illegal but lower-sentenced sexual activities such as sex with a family member, exposing your genitals, or sex dressed as a plush animal. The internal consistency of these factors showed to be good to excellent [44].

Sexual Outlet

Sexual outlet is assessed using the following questions: "in the last month, how many orgasms did you have each week?", "in the last month, how many hours did you invest in sexual activity each week?", and "in the last month, how long were you involved in sexual activity before you reached orgasm?" Additionally, we asked about sex life satisfaction, and frequency and function of pornography use [43,45,46].

Demographic Information

A short demographic information form assesses age, current relationship status, cultural identification, educational level, and sexual orientation. Furthermore, we will ask subjects to report

recent or current use of medication or medical disorders that may affect erectile response or heart rate.

Heart Rate

Heart rate data will be recorded during the baseline measurement phase using Biopac software (www.biopac.com). Heart rate will be recorded using a standard Lead-II configuration [58], where electrodes are placed on the upper body using adhesive patches [59]. From heart rate, baseline heart rate variability will be calculated.

Statistical Analyses

The primary aim is to assess to what extent sexual arousal to sexual stimuli is higher in an emotional state than in a neutral state. Eight paired samples t-tests will be performed, comparing two measures of sexual arousal (genital and subjective) in four emotional manipulations to the neutral state. Effect sizes and 95% confidence intervals will be used to assess the size of excitation transfer. For the following aims, four excitation transfer scores will be calculated by subtracting sexual arousal in the neutral state from sexual arousal in each emotional manipulation (e.g., genital sexual arousal in fear manipulation minus genital sexual arousal in neutral state). The second aim is to assess the association between excitation transfer from specific emotions and specific unusual sexual interests. Pearson correlations and p-values will be calculated between excitation transfer scores and the items and factors from the checklist of unusual sexual interests. The third aim is to assess the association between excitation transfer and normative sexual functioning. This will be done by means of repeated measures analyses of covariance (RM ANCOVA) with the excitation transfer scores as within-subject variables, sexual outlet, and sexual response in the neutral state as covariates. The final aim is to explore the association between excitation transfer and baseline sympathetic arousal. This will be done by means of a RM ANCOVA with the excitation transfer scores as within-subject variables and baseline heart rate variability as covariate.

Discussion

Sexual deviance is an important risk factor for sexual (re)offenses. This study aims to add knowledge about the possible development of unusual sexual interests and sexual deviance via excitation transfer. We aim to show that arousal in response to emotional films that are initially nonsexual in nature, can enhance sexual arousal. These findings may have potential implications for the treatment of sexual deviance in people who have committed sexual offenses. If our hypotheses are supported, this would emphasize the importance of emotion regulation and sympathetic arousal regulation (stress reduction) in the treatment of unwanted deviant sexual interests.

It is a strength that the methodology described in this study protocol was first carefully tested in a pilot study [42]. Improvements from the pilot are incorporated in the current procedures, including Virtual Reality (VR) to present stronger stimuli, as well as the consecutive rather than simultaneous presentation of emotional

and sexual stimuli. It may be a limitation that no subgroups of specific sexually unusual backgrounds are contrasted. Rather, we aim for a heterogeneous group of people with diverse sexual backgrounds, to be able to deliver a proof of principle. Future efforts may contrast various subgroups, such as people with interest in BDSM, specific fetishes or pedophilia.

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Ethics Approval

Approval for this study was obtained from the medical research ethics committee METC azM/UM, NL80036.068.21 / METC21-087.

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