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THE EFFECTS OF ACUTE AND CHRONIC STRESS ON SEXUAL AROUSAL IN WOMEN

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THE EFFECTS OF ACUTE AND CHRONIC STRESS ON SEXUAL AROUSAL IN WOMEN

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To my paternal grandmother, Lillian Hamilton. Although she passed many years ago, her loving spirit lives on in all of those she touched.

To my parents who have loved and supported me unconditionally for my whole life.

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The Effects of Acute and Chronic Stress on Sexual Arousal in Women

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In most adult animals, stress is generally thought to be detrimental to reproductive (sexual) function. However, in humans, there is a limited body of literature that indicates some stress can potentially be beneficial for sexual function. One theory is that there is an inverted U relationship between stress and sexual function with low and high levels of stress (or anxiety) causing an impairment of sexual response, while a moderate level of stress facilitates sexual arousal. This aim of this dissertation is to identify the mechanisms through which both acute and chronic stress may facilitate or impair sexual arousal in women. In particular, I examined the role of adrenal hormones, the autonomic nervous system (ANS), and psychological factors. To test these mechanisms, I measured cortisol, dehydroepiandrosterone sulfate (DHEAS), heart rate, distraction, and misattribution of arousal during stressful and sexual laboratory situations. Two of the studies examined the effects of acute stress, and the final study focused on chronic stress. Results indicated that acute stress is beneficial for genital arousal in women, and that the sympathetic branch of the ANS is the key mechanism involved in that relationship. High levels of chronic stress were found to significantly impair genital arousal compared to average levels of chronic

stress. Increased levels of cortisol and distractions contributed to this effect. DHEAS did not appear to play a role in the relationship between stress and sexual arousal, and there was no evidence for misattribution of arousal. Neither acute nor chronic stress affected women's subjective (psychological) arousal. Acute and chronic stressors affect sexual arousal in different ways and through separate mechanisms. The findings from these studies can inform treatment approaches for women with sexual arousal difficulties.

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Chapter 1: Introduction

Overview of the effects of stress on sexual functioning

Both acute and chronic stress can be detrimental to reproduction, as has been demonstrated in many species. Stress interferes with reproduction because pregnancy is very costly in terms of energy, and because young are less likely to survive in a stressful environment. Stressors can affect sexual behavior, conception, or the ability to carry a fetus to term. For ethical reasons, there have been no controlled experiments on the effects of stress on reproduction in humans, but correlational research provides evidence for a negative effect. For many humans, sexual arousal and desire precede sexual intercourse, and are the mechanisms that lead to reproduction. The effects of stress on these components of sexual functioning are relatively understudied.

Stress can interfere with sexual functioning through both physiological and psychological mechanisms. Physiologically, stressors can affect sexual functioning by altering both the sympathetic/parasympathetic nervous system balance and the interactions between the hypothalamic-pituitary-gonadal (HPG) and the hypothalamic-pituitary-adrenal (HPA) axes. Psychologically, stress can interfere with sexual activity through both emotional and cognitive changes that distract from the focus on sexual activity. The present studies examine the link between physiological and psychological components of stress and sexual function in women. First, I will review the components of sexual arousal and stress and the mechanisms by which stress can affect sexual arousal.

Female sexual arousal: Definition, problems, & measurement

Physiological sexual arousal was first defined and explained in a detailed manner by Masters and Johnson (1969) who described the observable physical components of sexual arousal. They proposed a linear four stage model of physiological sexual response starting with excitement and then progressing to the plateau, orgasm and resolution stages. Of particular relevance to the present research is the first stage, excitement. During the excitement stage, genital tissues become engorged with blood, or vasocongested. For women, genital vasocongestion includes the spongy tissues of the labia and vagina and erectile tissues within the vestibular bulbs and clitoris. Vasocongestion causes the vaginal canal to extend and vaginal fluids to increase. Several non-genital physical changes also occur during sexual arousal including erection of nipples, sex flush, and increased heart rate, blood pressure, and muscle tension (myotonia). Many of these components are shared with the stress response. There are also psychological components of sexual arousal, which were not explicitly studied until much later. The psychological components include feelings of sexual excitement and pleasure and a heightened awareness of the changing sensations within the body and the stimuli causing the sexual excitement (Basson et al., 2003). An explicit definition of psychological or subjective sexual arousal is still under debate, as discussed below.

Some women have difficulties with sexual arousal, and when these difficulties are severe, a woman may be diagnosed with Female Sexual Arousal Disorder (FSAD). Stress may be a contributing factor to arousal problems, including FSAD. Although sexual arousal involves both psychological (subjective) and physiological components, the

current diagnostic criteria listed in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR; American Psychological Association, 2000) for FSAD focus almost exclusively on the physiological components of female sexual response. For a diagnosis of FSAD, the woman must have problems with genital vasocongestion and lubrication that cause her distress. Theorists have criticized this narrow focus on the genital components of sexual arousal and argued for the inclusion of the subjective components in the definition of sexual arousal (e.g., Tiefer, 1991; Basson, 2001). Following these criticisms, more research attention has been paid to subjective sexual arousal.

Increased research attention has led to a current debate about the definition of subjective sexual arousal and whether it is a separate construct from sexual desire in women. In the development of the Female Sexual Function Index (FSFI; Rosen et al., 2000), a widely used, clinically validated measure of sexual dysfunction in women, the constructs of genital arousal (lubrication), subjective arousal, and desire were created as independent subfactors on the basis of theoretical assumptions. A factor analysis did not differentiate between questions related to subjective arousal and sexual desire in women. In fact, the correlations between subjective arousal and desire were higher than the correlations for subjective arousal and genital arousal (Rosen et al., 2000). Additionally, numerous laboratory studies have shown low or no correlation between genital and subjective arousal, indicating that they are unique components of sexual arousal. For the purposes of this dissertation, I will use genital arousal to refer to the physiological

components of sexual arousal, and subjective sexual arousal to refer to both sexual desire and psychological sexual arousal.

An overwhelming majority of the research on sexual arousal is done in a laboratory setting. This is also true for the present studies. In the laboratory, sexual arousal is usually induced via erotic films, narrations, or the participants' own fantasies. Genital arousal is most commonly measured with a vaginal photoplethysmograph, a device consisting of a light source and a phototransistor encased in a clear, acrylic, tampon-shaped tube (Sintchak & Geer, 1975). The photoplethysmograph is inserted into the vagina so that the light shines into the vaginal wall. The phototransistor measures the amount of light reflected back from the vaginal wall, which is indirectly related to the amount of vasocongestion. The photoplethysmograph can yield two different measures of vasocongestion. When measured via direct current (D/C), the signal is a measure of the increasing amount of blood pooling in the vagina, called vaginal blood volume (VBV). When measured on alternating current (A/C), the photoplethysmograph measures the changes in vasocongestion (represented by the amplitude of the signal) between each heartbeat, called vaginal pulse amplitude (VPA). VPA is considered a more accurate and specific measure of sexual arousal (Laan, Everaerd, & Evers, 1995), and it is the measure used in most modern studies.

Less common methods to measure genital arousal include the labial thermistor (Henson, Rubin, Henson, & Williams, 1977) and the thermal imaging camera (Seeley, Abramson, Perry, Rothblatt, & Seeley, 1980), both of which measure temperature changes in the vulvar area in response to erotic stimuli. MRI technologies can also be

used to measure blood flow changes in the genitals, but this method is rarely used due to the expense (Maravilla et al., 2005). Some researchers have also begun to use Doppler imaging, which measures changes in vaginal or clitoral blood volume (Garcia Nader, Maitland, Munarriz, & Goldstein, 2006). All of the methods indirectly measure blood flow, or vasocongestion in the genital area, and all have their strengths and weaknesses. For the present studies, I will be using vaginal photoplethysmography because it is inexpensive, relatively non-invasive, and specifically responsive to sexual arousal. A key drawback with this method is the measurement artifacts that result from movement, so this method cannot be used in conjunction with masturbation.

Subjective sexual arousal is most commonly measured retrospectively by questionnaire. This involves having participants fill out a questionnaire after viewing the erotic stimuli. Participants usually report their subjective experience of physiological arousal as well as their psychological arousal, and this is often compared to a baseline questionnaire administered before the erotic stimuli (e.g., Heiman, 1980, Heiman & Rowland, 1983). Some researchers have measured subjective sexual arousal continuously and simultaneously with the stimuli, using a movable device to indicate arousal level (e.g., Wincze, Hoon, & Hoon, 1977; Laan, Everaerd, van Aanhold, & Rebel, 1993; Rellini, McCall, Randall, & Meston, 2005). Methodologically, measuring arousal continuously is superior because it allows for measurement of moment-to-moment changes. However, a key drawback of continuous measurement is that it may increase distraction during sexual stimuli and potentially reduce levels of arousal. Concordance between subjective and genital arousal varies depending on the method of data analysis

(Rellini et al., 2005), participant characteristics (Brody, Laan, & van Lunsen, 2003), and the device used to measure arousal (Kukkonen, Binik, Amsel, & Carrier, 2007). So far there has been no consensus on the best method to measure subjective arousal. I will use both continuous and retrospective methods to measure subjective sexual arousal.

Stress

The term "stress" as we use it today was defined by Hans Selye in 1950. The original, biological definition, based on Selye's work with animals, was "the non-specific response of the body to any demand for change" (Selye, 1950; 1974). Psychologists narrowed the focus of Selye's original general definition by framing stress as a response to primarily negative psychological stressors (e.g., Lazarus, 1966). The present research focuses specifically on psychological stress. Physiologically, the response to psychological stressors usually includes the following components: activation of the sympathetic nervous system, activation of the HPA axis resulting in the release of cortisol, decreased activity in the HPG axis resulting in reduced secretion of gonadal steroids, and a release of prolactin (for a review, see Sapolsky, Romero, & Munck, 2000; Sapolsky, 2002). Both the reduction in gonadal steroids and the increase in prolactin can interfere with normal sexual functioning (Sapolsky, 2002). The generally accepted purpose of the stress response is to first mobilize resources to help an organism respond to an acute stressor and then to return the organism to homeostasis. The physiological components of the initial alarm phase of the stress response are automatically activated and are designed to activate the energy resources necessary for survival (e.g. transport glucose to muscles), increase cardiovascular activity (e.g. increase blood flow to

muscles), and suppress all unnecessary functions (e.g., digestive and reproductive functions). If the stressor is removed and the body is able to return to homeostasis fairly rapidly, these responses are adaptive, but if the stressor is prolonged, it can be very damaging to an organism.

Psychological components of stress are even more difficult to define, but generally involve an appraisal of threat (Lazarus, 1966). The response to the threat is usually negative feelings, such as fear, anxiety, anger or depression. There are also changes in cognitive function that occur. These changes seem to have an inverted-U relationship with stress, such that moderate levels of stress improve cognitive functioning and performance, while high levels can impair performance (Duffy, 1957). A key component in the impairment of cognitive functioning by stress is increased distractibility, or an inability to focus on the task at hand. The present studies examined both physiological and psychological components of stress and their effects on sexual arousal.

Previous research on the relationship between stress and sexual arousal

Survey studies

There have been several surveys conducted that examine the relationship between stress and sexual problems. Of these studies, all except one have found a negative relationship between sexual functioning and at least one type of stressor for women. The first study examined the relationship between various components of sexual function and three categories of stressors: daily hassles (Hassles Scale; Kanner, Coyne, Schaefer, & Lazarus, 1981), major stressful life events over the past six months (Life Experiences

Survey; Sarason, Johnson, & Siegel, 1978), and unemployment. Half of the men and women in their sample of 165 people were unemployed. For men, erectile problems were linked with the stress of unemployment. For men and women, daily hassles and stressful life experiences were positively correlated with desired frequency of intercourse and frequency of sexual desire. There was no correlation between the two stress questionnaires and actual frequency of intercourse, indicating that although desire might increase in relation to stress, sexual intercourse does not (Morokoff & Gillilland, 1993). This was the only study that found any positive correlations between stress and sexual functioning in women.

A large-scale survey was conducted with 789 men and 979 women recruited from the patient lists of four general practices in England. The researchers found that men who reported higher levels of anxiety had a higher level of reported premature ejaculation. For women, marital difficulties, depression, and anxiety were all positively correlated with problems with arousal and orgasm (Dunn, Croft, & Hackett, 1999).

A survey conducted on a sample of 198 Swiss couples (Bodenmann, Ledermann, Blather, & Galluzzo, 2006) categorized stressors as internal or external to the relationship, using the Hassles Scale and the Life Experiences Scale. For men, both higher levels of internal relationship stress and life events predicted higher levels of premature ejaculation, while higher levels of external stress actually predicted lower levels of erectile problems. For women, higher levels of internal relationship stress predicted more problems with sexual arousal, desire, and sexual aversion. These results held after controlling for psychological symptoms and overall relationship quality. This is

the second study to demonstrate that stressors within the relationship are related to sexual problems in women, as Dunn and colleagues (Dunn et al., 1999) found that marital difficulties also correlated with sexual problems.

The Nurses Sexuality Study (Sand & Fisher, 2007) provided a detailed exploration of the sexual problems of a random sample of 133 nurses living in the United States. One component of the study was to examine potential differences between women who had scores above and below the clinical cutoff for Female Sexual Dysfunction (FSD) on the FSFI. They found that women below the cutoff (i.e. those who had lower levels of sexual functioning) had higher levels of life stress than women who were above the cutoff.

Three of the four survey studies on the relationship between stress and sexual functioning discussed above found positive relationships between stress and sexual problems. Two of them (Dunn et al., 1999; Bodenmann et al., 2006) also found that relationship stress in particular was an important predictor of sexual problems for women. Although one study (Morokoff & Gillilland, 1993) found positive links between stress and sexual desire, this study had the smallest sample, and approximately 50% of the sample was unemployed. This level of unemployment is not representative of the general population, which indicates that the people within the sample are also not an accurate representation of the population. This difference from the other samples could explain the divergent findings.

Laboratory studies

Most of the laboratory studies examining the effects of stress or anxiety on sexual arousal have been conducted in men, and most of them focus on sexual performance-related anxiety. Of the laboratory studies conducted in women, all have focused on acute stress, although one of these acute stress studies also included a measure of chronic stress. Acute stress research is often framed in terms of anxiety. Since there has been no distinction made in these studies about the differences between stress and anxiety, I am considering any external potential stressful or anxiety producing stimuli as a stressor. I have excluded all studies that use sexual anxiety as a stressor because I believe this is a separate construct.

For women, the first studies on stress and sexual arousal arose out of a debate about which components of the autonomic nervous system (ANS) were active in sexual arousal. Wolpe (1958) theorized that because parasympathetic and sympathetic activity were reciprocally inhibitory, any anxiety would necessarily inhibit sexual arousal. His theory was based on the assumption that the sympathetic nervous system (SNS) was active during anxiety, stress, and other negative experiences, while the parasympathetic nervous system (PNS) was active for humor and sexual arousal. Hoon, Wincze, and Hoon (1977) noted that there was no evidence that either laughter or sexual arousal were dominated by parasympathetic activity, and they designed a study to examine the reciprocal effects of stressful and erotic stimuli on female genital responding. Their stimuli were a series of short (two minute) film clips: the aftermath of a car crash (anxiety), a travelogue (neutral), and an erotic film. The film clips were shown in all six

possible pair orders with two minutes of neutral stimuli between each pair. There were no significant differences in heart rate between the conditions. VBV, a marker of genital arousal, was higher during the erotic clip that was presented after the anxiety clip, compared to when the erotic clip followed the neutral clip. These findings were the first to suggest that anxiety or stress did not necessarily inhibit sexual arousal, but actually seemed to enhance it.

These findings were replicated in a study of sexually functional and dysfunctional women (Palace & Gorzalka, 1990). In this study there were only two pairs of films: a neutral film followed by an erotic film, and an anxiety-inducing (stressful) film followed by an erotic film. These film pairs were shown in a counterbalanced order with at least 10 minutes between them. All four films were three minutes in length. Both sexually functional and dysfunctional women had significantly higher VBV during the erotic film that followed the anxiety-inducing film, compared to the erotic film that followed the neutral film. Palace and Gorzalka also measured subjective sexual arousal with a questionnaire and found that in contrast to the genital arousal results, subjective arousal was lower for the anxiety condition.

Although the stressful films induced an increase in genital sexual arousal for women, other stressors have been shown to decrease or have no effect on sexual arousal. All of the following studies in this section report genital arousal as VPA, which has been determined to be more sensitive and specific to sexual arousal than VBV (Laan et al., 1995). One study used the threat of a painful electric shock as a stressor. Female participants watched two erotic videos six minutes apart. Prior to one of the videos

participants were told there was a 60% chance they would receive the pain stimuli. Genital arousal for the shock threat video was lower than in the no threat condition. Subjective perceptions of genital sexual arousal were lower in the shock threat condition, but the difference was not significant (Brauer, ter Kuile, Janssen, & Laan, 2007). A between-subjects study had one group of women complete a frustrating intelligence and skill testing computer task (stress condition) before watching an erotic video, while a second group answered easy questions about pictures shown on a computer screen (control condition) before watching an erotic video. The women in the stress condition had significantly lower levels of genital and subjective arousal (ter Kuile, Vigeveno, & Laan, 2007).

Elliot & O'Donohue (1997) used a video camera in an attempt to induce anxiety in participants. Participants were assigned to either an anxiety or control group, and the anxiety group believed they were being filmed from the shoulders up while they listened to an erotic audiotape. They were told that the footage would be reviewed by a research assistant who would rank the participant on various attributes. Each participant in both groups also was exposed to three levels of distraction. The women who were being filmed showed no difference in genital arousal compared to women who were not being filmed at any level of distraction. The "no distraction" condition revealed the results for the anxiety manipulation alone, without the confounding influence of the distraction variable. When there was no distraction, there was no difference in self-reported anxiety between the anxiety group and the control group, indicating that the manipulation was not anxiety-inducing. The lack of anxiety experienced by participants could explain the lack

of difference in genital arousal. Subjective sexual arousal, however, was higher in the anxiety group compared to controls. The distraction findings will be discussed in more detail below.

Although the findings from laboratory studies of the effects of stress on sexual arousal are mixed, there seems to be a pattern emerging. In the studies that used the anxiety-inducing films that do not personally involve or reflect upon the women, genital arousal was enhanced compared to when a neutral film was shown. In the studies that used a stressor that was personally relevant to the woman, when she was going to be given a shock or when she had to complete a stressful task, her genital arousal was impaired. It is likely that the more generic, non-personally relevant stressors are less stressful to the women in these studies compared to personally relevant stressors. The only personally relevant stressor study that showed no difference between the anxiety and no-anxiety conditions did not adequately induce anxiety, which can explain the lack of effect.

The degree of stress resulting from the different stressors used in the studies above may explain the differences in the effects on arousal. Similar to other stress-related effects (e.g., cognitive performance), there seems to be an inverted U-relationship between anxiety and sexual arousal. This evidence comes from a study where the researchers did not manipulate anxiety or stress, but simply measured participants naturally occurring state and trait levels of anxiety. Participants then watched an erotic film and women who reported a moderate level of state anxiety had higher levels of genital arousal to an erotic film than did women with low or high state anxiety.

Subjective arousal, measured retrospectively, was not related to anxiety. This study provides evidence that the degree of stress or anxiety may explain why some studies show increased genital arousal in response to stress while others show decreased arousal (Bradford & Meston, 2006).

With regards to chronic stress, to my knowledge there has been only one laboratory study conducted in women (ter Kuile et al., 2007). In this study, participants filled out the Everyday Problems Checklist (EPCL), a Dutch questionnaire that was derived from several English chronic stress questionnaires (cf. Vingerhoets, Jeninga, & Menges, 1989). Participants were then assigned to the high and low chronic stress group through a median split of the EPCL scores. Women in the high chronic stress group had lower levels of genital arousal in response to an erotic video compared to the women in the low chronic stress group. There was no difference between the groups on subjective sexual arousal. These laboratory findings support the survey results that showed similar measures of stress were correlated with lower sexual functioning (e.g., Bodenmann et al., 2006). The effect of stress on subjective sexual arousal seems more unclear with some studies showing decreased subjective arousal, one showing increased subjective arousal, and some showing no relationship between stress and subjective arousal.

The mechanisms by which stress may impact sexual functioning

Physiological mechanisms

Autonomic nervous system. A key component of the stress response is the activation of the sympathetic nervous system, something that was long believed to interfere with sexual arousal. For decades, sexual physiologists working with female

animals and women hypothesized that the PNS was active during sexual arousal, and the SNS only became active during the later stages of arousal or at the point of orgasm. More recently, evidence for the important role of the SNS in women is mounting. The genital and pelvic regions of women are highly innervated with both sympathetic and parasympathetic fibers, and the role of each of these systems in genital arousal is complex and still not well understood (Meston & Bradford, 2007). Evidence in support of a facilitatory role of the SNS in female arousal comes from studies on the role of epinephrine and norepinephrine, the key transmitters released from the SNS.

Most of the work on the response of epinephrine and norepinephrine to sexual behavior in animals has focused on central and particularly, hypothalamic release of these neurotransmitters. For the purposes of the present studies I am interested in the effects of peripheral epinephrine and norepinephrine released by the SNS. In humans, alterations in plasma levels of epinephrine and norepinephrine in response to sexual stimulation have been measured in several studies. An early study used an indwelling catheter to measure plasma norepinephrine release every three minutes in two women while they had sexual intercourse with their male partners in their homes. Norepinephrine increased a small amount during arousal, but orgasm was accompanied by a much larger increase. Within six minutes of orgasm, both participants' norepinephrine levels returned to baseline levels (Wiedking, Ziegler, & Lake, 1979). Similar findings emerged from a laboratory study in which 20 women watched a 60 minute film that consisted of 20 minutes neutral content, 20 minutes of erotic content, and another 20 minutes of neutral content. Ten minutes into the erotic portion of the film, participants were instructed to masturbate until orgasm.

Plasma epinephrine and norepinephrine (among other hormones) were sampled every 10 minutes from indwelling catheters (Exton, Bindert, Kruger, Scheller, Hartmann, & Schedlowski, 1999). The same women also came in for a control condition where they watched a neutral video for 60 minutes while having their blood sampled. Compared to the control condition, while watching the erotic film, participants' epinephrine levels increased significantly. Both epinephrine and norepinephrine were significantly higher at orgasm compared to both the control condition and the pre-orgasm state of arousal.

Using a similar paradigm, but without allowing participants to masturbate or experience orgasm, the same group of researchers found that norepinephrine was elevated during sexual arousal alone compared to the control condition, but there was no significant difference in epinephrine (Exton et al., 2000). These studies provide evidence for the increase of SNS activity during both sexual arousal and orgasm.

Without directly measuring SNS activity, several studies have used methods that are known to increase SNS activity, such as exercise (e.g., Meston & Gorzalka, 1995) and hyperventilation (Brotto & Gorzalka, 2002). These studies also showed increased genital arousal in premenopausal, sexually functional women when the SNS activation was followed by an erotic film. A recent study examining the effects of exercise on sexual arousal found that exercise increased alpha-amylase activity, which stayed elevated even after the erotic film (Hamilton, Fogle, & Meston, 2008). Alpha-amylase is an enzyme found in saliva that is highly correlated with norepinephrine release. The recent general consensus is that SNS activation is beneficial for genital arousal in sexually functional women. However, similar to the anxiety and sexual arousal findings,

it seems that there is an optimal level at which SNS activity can increase arousal. When women watched an erotic video 5, 15 or 30 minutes after exercise, they had significantly lower levels of genital arousal 5 minutes after exercise, compared to a non-exercise control condition. The biggest difference between the control and exercise conditions was 15 minutes after exercise. SNS activity was highest 5 minutes after sexual activity, indicating that high levels of SNS activity can impair sexual arousal, while moderate levels seem to facilitate it. Regarding the lowered levels of sexual arousal immediately after exercise, the authors noted that during and shortly after exercise, blood flow is increased to the exercising muscles, which would have limited the blood available to flow to the genitals even if the person was highly aroused (Meston & Gorzalka, 1996a).

Pharmacological manipulations of the SNS have also been employed to examine the link with sexual arousal. Administering ephedrine, a sympathomimetic, to healthy, sexually functional women before they watched an erotic film was also found to increase genital but not subjective arousal compared to placebo (Meston & Heiman, 1998). However in rats (Thody & Wilson, 1983) and mice (deCatanzaro & Graham, 2002), peripheral injections of epinephrine to ovariectomized estrogen and progesterone treated females reduced lordosis behavior. Epinephrine had no effect on the lordosis response when the rats were only treated with estrogens (Thody & Wilson, 1983). Although administering epinephrine did not increase sexual behavior in rats and mice, administration of peripheral norepinephrine antagonists significantly reduced rat sexual behaviors. A series of studies examining the effects of clonidine, guanethidine, and naphazoline on sexual responding in female rats found that all three drugs inhibited

lordosis (Meston, Moe, & Gorzalka, 1997). The mechanism of action for the three drugs was slightly different, but all resulted in reduced norepinephrine release. Clonidine can also have an inhibitory effect on genital sexual arousal in women. Two studies examining the effects of clonidine versus placebo found that if clonidine was administered before activating the SNS via exercise, there was a significant reduction in genital arousal to a subsequent sexual film compared to when participants were administered a placebo before exercise. Clonidine did not inhibit genital arousal compared to placebo when participants did not exercise prior to viewing an erotic film (Meston, Gorzalka, & Wright, 1997).

HPA and HPG axis hormones. Numerous animal studies have demonstrated the detrimental effects of both acute and chronic stress during adulthood on subsequent female sexual behavior and reproduction (e.g., Donadio et al., 2007; Rivier & Vale, 1984). There have also been studies showing that chronic stress resulted in increased sexual behavior (e.g., Gorzalka, Hansen, & Brotto, 1998; Williams, McGinnis, & Lumia, 1992), but the general consensus seems to be that both acute and chronic stress have a negative effect on sexual behavior (Rivier & Rivest, 1991; Welsh, Kemper-Green, & Livingston, 1999). The impairment of sexual behavior by stress is thought to be mediated by the suppressive effects of the hypothalamic-pituitary-adrenal (HPA) axis on the hypothalamic-pituitary-gonadal (HPG) axis. Glucorticoids released from the adrenal gland are thought to inhibit release of gonadotropin releasing hormone (GnRH), luteinizing hormone (LH) and follicle stimulating hormone (FSH) at the hypothalamic and pituitary levels (for review, see Welsh et al., 1999). This model or similar disruptions

of the HPG axis by hormones release from the HPA axis has been demonstrated in several species (e.g., Breen & Karsch, 2004; Gore, Attardi, & DeFranco, 2006; Olster & Ferin, 1987). Reduced GnRH release directly decreases gonadotropin release (LH & FSH), which in turn results in less production and release of gonadal testosterone.

Testosterone has been shown to affect women's genital and subjective arousal. One study found a positive correlation between testosterone and genital arousal over the menstrual cycle in healthy, premenopausal women. (Schreiner-Engel, Schiavi, Smith, & White, 1981). More directly, administration of testosterone to premenopausal women can increase genital arousal (Tuiten, van Honk, Verbaten, Laan, Everaerd, & Stam, 2002). There have been several studies that have attempted to understand how testosterone affects genital tissues in women, but the mechanisms are still not well understood (for a review see Traish, Kim, Min, Munarriz, & Goldstein, 2002).

With regards to subjective arousal, researchers have theorized that androgens can affect subjective sexual arousal and desire indirectly by moderating mood, energy, and overall well being (Traish & Kim, 2006). Also, studies have shown that increased levels of gonadal steroid hormones (both estrogens and androgens) may increase sensitivity and arousability to sexual stimuli, acting in the brain to increase attention to sexually related incentives, emotions, and potential rewards (Caldwell, 2002; Guay & Davis, 2002). Women with abnormally low levels of testosterone report reduced desire (Davis, 2000), which, as noted earlier, is strongly related to subjective arousal.

If stress reduces testosterone release, then it would be expected that both genital and subjective arousal would be negatively impacted. The activation of the HPA axis,

resulting in the release of cortisol, can suppress the HPG axis resulting in lower levels of testosterone secreted from the ovaries. As reviewed above, testosterone plays a facilitatory role in women's subjective and genital sexual arousal. In women, the ovaries are the source of 25% of circulating testosterone. Another 25% is released from the adrenal glands, and the final 50% comes from prohormones released from both the adrenals and ovaries (Yen, 1991).

Adrenal androgens have also been implicated as playing a key role in sexual arousal and desire in women (Spark, 2002). Of particular interest to the relationship between stress and sexual arousal is both dehydroepiandrosterone (DHEA), an androgenic prohormone, and its sulfated metabolite DHEAS, both of which are primarily secreted from the adrenal cortex. Of the few studies directly assessing the effects of DHEA on sexual arousal, administration of exogenous DHEA resulted in increased laboratory measures of subjective, but not genital arousal in postmenopausal women (Hackbert & Heiman, 2002) but had no influence on genital or subjective arousal in premenopausal women (Meston & Heiman, 2002). Low levels of endogenous DHEAS have been implicated in arousal and desire problems in women who show no differences in testosterone or androstenedione (Davis, Davison, Donath, & Bell, 2005; Guay et al., 2004). DHEA is found in low quantities in women and has a fairly short half-life, as much of it is converted to DHEAS within the cell. DHEAS is present in much higher levels than DHEA in plasma, making it easier to measure. DHEAS is derived solely from the adrenal glands, distinguishing it from the gonadal androgens. It is believed that DHEAS is released from the adrenal glands in response to a stressor (Nelson, 2005) and,

thus, may also affect genital arousal by altering HPG responses or acting directly on genital tissues (Welsh et al., 1999).

Psychological mechanisms

Distraction. Cognitive factors have long been implicated in sexual problems (e.g., Masters & Johnson, 1970). Of particular relation to stress is the role of distraction, as it may cause women to be focused on the stressor and other nonsexual stimuli during sexual activity. The deleterious effects of distraction on both genital and sexual arousal in women have been well documented. As noted earlier, a study was done on the effects of anxiety and distraction on laboratory sexual arousal in women (Elliot & O'Donohue, 1997). The distraction task was a within subject factor that involved a no distraction condition and two distraction conditions in which participants listened to sentences read aloud and repeated them either forwards (Condition 1) or backwards (Condition 2). These sentences played in one ear while an erotic story played in the other. Distraction significantly impaired genital and subjective sexual arousal. These findings were replicated in a study that used visual addition tasks as a distracter (Adams, Haynes, & Brayer, 1985), and in a study of sexually functional and dysfunctional women who watched erotic videos with auditory distractions (Salemink & van Lankveld, 2006). A questionnaire-based study on women's distraction during sexual arousal found that the women who reported higher levels of cognitive distraction also reported less sexual satisfaction and a higher likelihood of faking orgasms (Dove & Wiederman, 2000). Distraction is a potential mechanism through which stress can interfere with sexual arousal.

Misattribution. Moderate levels of anxiety or stress have been shown to be facilitatory to female sexual arousal (e.g., Bradford & Meston, 2006). The two factor model of emotion states that there is both a physiological and a cognitive component to emotion. The physiological component is general to all emotions, so what determines the response is the cognitive interpretation of the situation (Schacter & Singer, 1962). A classic pair of social psychology experiments demonstrated how stress or anxiety can be misattributed as sexual arousal or attraction in specific situations. In these studies, men were approached by a researcher in either a fear-arousing context or non-fear-arousing context and asked to fill out a questionnaire. After the completion of the questionnaire, the researcher offered a phone number where he or she could be contacted for results of the study. When the researcher was a female and the study took place in a fear arousing situation, the men were significantly more likely to call and they had more sexual imagery in the stories they wrote on their questionnaires compared to the men who were approached in a non-fear arousing situation (Dutton & Aron, 1974). This study provided the first evidence that fear or anxiety could be reinterpreted as sexual attraction.

The Dutton and Aron study was based on Aron's previously developed theory (Aron, 1970, as cited in Dutton & Aron, 1974) of the relationship between emotion and sexual or romantic attraction. Aron theorized that when a person was placed in an emotionally arousing situation combined with a sexual or romantic stimulus, that the sexual or romantic stimulus would often be more salient than the alternative emotion. In this case, the emotional arousal would be misattributed to the sexual object. However, in the cases where the emotion was more salient, then the arousal would not be

misattributed. In regards to stress and arousal, women in the studies employing less salient stressors, such as film stimuli would be more likely to misattribute the physiological arousal resulting from films as sexual arousal. This would increase the woman's subjective perception of arousal and by association, possibly increase her genital arousal. With a highly salient, personally relevant stressor any anxiety resulting from the stressor would be less likely to be misattributed in a positive manner because the source of the anxiety is more obvious. Any sexual arousal could also be misinterpreted as anxiety, which would further detract from the sexual response.

Experimental overview

The primary goal of this dissertation is to understand the relationship between stress and sexual arousal and the potential mechanisms by which stress can enhance or impair arousal. The focus of the subsequent studies will be the role of the cardiovascular autonomic nervous system, the adrenal hormones cortisol and DHEAS, and distraction in the relationship between stress and sexual arousal. Each study aims to answer a question related to this relationship.

Chapter 2 addresses the question, what are the underlying similarities and differences in sexual, stressful and humorous arousal? Emotionally, these three conditions are quite distinct, but they do share some common physiological components. This study will address the commonalities among these states of arousal to understand how stress and sexual arousal can be complementary.

Chapter 3 investigates the role of acute stressors induced in the laboratory on sexual arousal. The goal of this study is to understand if increases and decreases in sexual

arousal in response to stress can be predicted by the type of stressor (generic or personally relevant) and the physiological and psychological components that are related to it.

Chapter 4 addresses the role of chronic stress on sexual arousal in women. The goal of this study is to understand the effects of stress in a woman's day to day life on her sexual function outside of the laboratory and her sexual arousal in the laboratory. Baseline levels of cortisol and DHEAS will be assessed to understand how these hormones are related to both stress and the sexual response.

Chapter 2: The Relationship between Acute Stress and Sexual Arousal

Introduction

As reviewed in Chapter 1, in most adult mammals, stress is thought to impair reproductive function. Studies of women that induce anxiety in the laboratory have shown mixed results with several studies demonstrating that stress can inhibit women's sexual arousal (e.g., Brauer et al., 1993; ter Kuile, et al., 2007) and others finding moderate levels of stress or anxiety can enhance sexual arousal (e.g., Bradford & Meston, 2006; Hoon et al., 1977, Palace & Gorzalka, 1990). There are numerous studies spanning both the animal and human literature outlining the reasons for the negative relationship between stress and sexual functioning, specifically that corticosteroids can interfere with hypothalamic-pituitary-gonadal (HPG) axis functioning (for reviews see Rivier & Rivest, 1991; Welsh et al., 1999). To date, little is known about how stress might have a facilitatory effect on sexual arousal.

Previous research has shown that exposure to both sexual (Heiman, Rowland, Hatch, & Gladue, 1991) and stressful (Hoon et al., 1977) stimuli can enhance subsequent sexual arousal. It is likely, then, that the two states of arousal share similar physiological responses. One hypothesis is related to activation of the sympathetic nervous system (SNS). Methods known to increase SNS activity, such as exercise (Meston & Gorzalka, 1995), administration of ephedrine (Meston & Heiman, 1998), and hyperventilating (Brotto & Gorzalka, 2002) all lead to increased genital arousal in the laboratory. Further support for the role of the SNS in sexual arousal was found in a study showing an

increase in alpha-amylase (a marker of norepinephrine) after exercise that continued to increase during a sexually arousing film (Hamilton, Fogle, & Meston, 2008). Although there is debate about the mechanisms by which the SNS and the parasympathetic nervous system (PNS) respond to sexual arousal (for a review see Meston & Bradford, 2007), it is clear that a moderate increase in SNS results in increased genital arousal in most women.

An integral question is whether the activity of norepinephrine from the SNS is enough to counter the negative effects of cortisol on the HPG axis? Some evidence has shown that dehydroepiandrosterone (DHEA) and DHEAS, which seem to play a facilitatory role sexual function (Spark, 2002), may be co-released with cortisol from the adrenal cortex during stress (e.g., Welsh et al., 1999). DHEAS is present in much higher levels than DHEA in plasma, making it easier to measure. Studies have been done to examine the role of exogenous administration of DHEAS, but the response of DHEAS to sexual arousal has not yet been studied. If DHEAS increases in the stressful condition, it could be one of the mechanisms by which stress can increase subsequent sexual arousal.

As a first step in exploring the relationship between stress and sexual arousal, the present study was designed to examine the underlying autonomic and hormonal components of these states of arousal, induced via film stimuli. Film clips were chosen because two previous studies have shown that stressful film clips can enhance subsequent arousal (Hoon et al. 1977, Palace & Gorzalka, 1990). Previous studies have either looked at only one state of arousal or have looked at stress and sexual arousal within the same experimental session, making it difficult to determine which physiological effects can be attributed to which affective state. In the present study, I was able to isolate these states

of arousal in separate sessions, using the same type of stimuli to examine the physiological responses to each condition individually. The goal of the study was to understand the shared and unique components between different states of arousal. In addition to the sexual and stressful arousal, I included a humorous condition as a positive-affect control to aid in determining which components of the physiological response were due to specifically to the state of sexual arousal and which were due to positive affect in general. I measured the cardiovascular autonomic nervous system response and adrenal hormones that have been linked with stress (cortisol and DHEAS).

The goal of this study was to identify similarities between stress and sexual arousal to identify potential mechanisms by which this type of stressor can enhance sexual arousal. The study strives to answer two questions: 1) To what degree does this stressor increase SNS/decrease PNS compared to other arousing stimuli?; and 2) What is the relationship between cortisol and DHEAS in the response to the arousing stimuli? I expect to see similar increases in SNS activity and/or decreases in PNS activity in the stressful and sexual conditions. I would expect to see a decrease in cortisol in the humorous and sexual condition as has been demonstrated in previous studies (Fry, 2002; Exton et al., 2000, respectively) and a small increase in cortisol in the stress condition. I am hypothesizing that DHEAS will increase in response to both the sexual and stress conditions.

Method

Participants

Twenty-five women were enrolled in the study. Data from five women were incomplete and thus, excluded from analyses: three did not complete all sessions and two experienced problems during data collection. The remaining participants were 20 women between the ages of 18-47 (M = 24.7, SD = 6.5) who were recruited from the community via flyers and online advertisements. All women had been sexually active with a male partner within the month before the study began and reported being exclusively or predominantly heterosexual. Five women were single and 15 were in committed relationships ranging in length from six months to five years. Reported ethnicity was Caucasian (10), Latina (5), African American or Black (3), and Asian (2). All participants were screened over the phone before their initial appointment to verify that they meet the inclusion and exclusion criteria for the study.

Inclusion Criteria

1) Premenopausal women between the ages of 18-50.
2) Currently sexually involved with men.
3) Sexual intercourse within the past month.
4) Fluent in English.

Exclusion Criteria

Self-report of any of the following.

1) Problems with sexual arousal.

2) Use of hormonal contraceptives or any exogenous hormones (within 3 months prior to study participation).
3) Currently pregnant or breastfeeding.
4) Use of medications known to affect sexual or vascular functioning.
5) Current HIV infection, untreated pelvic or urinary tract infection or sexually transmitted infections such as chlamydia, HPV, genital herpes, gonorrhea, or syphilis.
6) Major pelvic surgery that may have caused nerve damage, or serious bladder, rectal, or abdominal surgery.
7) Neurological impairment due to diabetes, stroke, pelvic nerve damage secondary to trauma, cancer treatments, myasthenia gravis, multiple sclerosis or spinal cord damage.
8) Untreated renal or endocrine disease.
9) Untreated or unstable mental disorder.
10) Experiencing current distress from a history of sexual abuse (self-defined).
11) Eating, drinking, smoking, or exercising within one hour of coming to the lab.

Materials and apparatus

Stimuli

Film sequences. All three film sequences were approximately 12 minutes long, and all began with a one minute display of the word "Relax" on a black screen and three minutes of a neutral film (a travel documentary). In the erotic condition, the introductory sequence was followed by 8 minutes of a woman-centered erotic film. The erotic film

was drawn from the Sexual Psychophysiology Laboratory film library. All films in this library have been standardized in terms of length of different types of sexual scenes (i.e. foreplay, oral sex and vaginal intercourse). None of the films show sexual violence or fellatio. These films were selected from erotic films produced and directed by women and are intended to be sexually appealing to women. The stressful film consisted of an 8 minute film clip from the movie *Bully* (Clark, 2001). The clip depicts the lead up to and murder of a teen bully by a group of other teens. It was ranked as unpleasant and moderately stressful during a pilot test. The humorous film clip was 8 minutes of stand-up comedy by Dane Cook. The clip is the unedited version of Cook's appearance at the Bar Mitzvah Bash from his *Retaliation* DVD (2005). This film has been used by other labs to induce a positive state of arousal (David Gilden, personal communication, November 15, 2005).

Questionnaires

Phone Screen (Appendix A). Prior to coming in for their first appointment, all participants were screened over the phone to ensure they qualified under all of the inclusion and exclusion criteria.

Demographics (Appendix B.). The demographics questionnaire asked participants their age, level of education, relationship status, sexual orientation, ethnicity, and length of relationship with their current partner.

Screening Questionnaire (Appendix C). The screening questionnaire was intended to verify that participants meet inclusion/exclusion criteria. It was a shortened version of the phone screen and included items on current drug use, distress from sexual abuse,

menstrual cycle dates and irregularities, and whether the participant had eaten, drank, smoked or exercised in the past hour. To verify that participants were free of sexual arousal problems, I also included the arousal subscale of the Female Sexual Function Index (FSFI; Rosen et al., 2000). The FSFI is a validated 19-item questionnaire designed to assess sexual functioning in women (Wiegel, Meston, & Rosen, 2005).

Subjective Response Scale (Appendix D). Subjective response to the films was measured using the Subjective Response Scale, which is derived from the Film Scale (Heiman & Rowland, 1983) and the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). There are 58 items, which can be divided into four subscales: subjective experience of physiological sexual arousal (e.g., "genital sensations"), mental sexual arousal (e.g., "turned on"), positive affect (e.g., "excited"), and negative affect (e.g., "guilty"). Items are rated on a 7-point Likert scale ranging from "not at all" to "intensely."

Apparatus

Vaginal photoplethysmograph. Genital arousal was measured using a vaginal photoplethysmograph (Sintchak & Geer, 1975). The vaginal photoplethysmograph is a clear, acrylic, tampon-shaped device that contains an infrared light-emitting diode as a light source, and a photosensitive light detector. When inserted into the vagina, the light source illuminates the capillary bed of the vaginal wall and the blood circulating within it. Upon contact with the vaginal wall, some of the light is absorbed, while the rest is backscattered. The amount of backscattered light is related to the transparency of engorged tissue and serves as an indirect measure of vasoengorgement. The measure of

interest from the photoplethysmograph is the pulse amplitude (VPA), which is received through the A/C signal and band pass filtered at 0.5 to 30 Hz. VPA was sampled 80 times per second. Results were measured in millivolts (mV). VPA was acquired using the software program AcqKnowledge III, Version 3.7.3 (BIOPAC Systems, Inc., Santa Barbara, CA) and a Model MP100WS data acquisition unit (BIOPAC Systems, Inc., Santa Barbara, CA) for analog/digital conversion.

Electrocardiograph (ECG). Heart rate and heart rate variability were measured via an ECG, which consisted of three disposable electrodes that were attached to the participant's body (upper right chest, lower left chest, and right ankle) and connected by cables to a BIOPAC Systems ECG100 module. The signal from the ECG100 module was recorded in real time using the AcqKnowledge software program. ECG was also sampled at 80 times per second.

Saliva samples. Salivary assays are a relatively noninvasive way to examine biomarkers of interest. Participants salivated without stimulation directly into untreated, polystyrene centrifuge tubes. Saliva samples were then frozen until assay. The hormones of interest were assayed in-house using commercially available kits purchased from Salimetrics (State College, PA). All assays were run in duplicate. For DHEAS, inter-assay C.V. was 8.42% at 9.43 pg/ml and 5.62% at 538 pg/ml, and intra-assay C.V. was 2.65%. For cortisol inter-assay C.V. was 4.2% at .02 µg/dl and 5.3% at .95 µg/dl, and intra-assay C.V. was 3.4%.

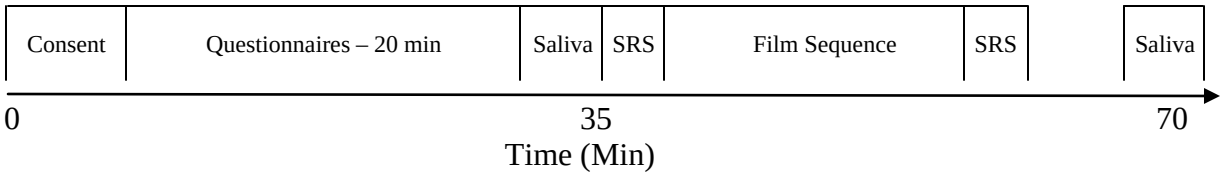
Procedures

After the initial phone screening, participants were scheduled to come into the lab between the hours of 2:00 pm and 6:00 pm for three separate visits during days 5-10 of their menstrual cycle. Participants were asked to refrain from eating or drinking anything but water, smoking, or exercising for at least one hour prior to their arrival in the lab.

Upon arrival, the participants were asked to drink a glass of water while the study procedures were explained. All participants read and signed a consent form. Once they consented, the participants had three electrodes applied to their skin for the ECG. After the placement of the electrodes, the participants were left alone in the research room until the completion of the study. All subsequent communication was done via intercom. While in the research room, participants first filled out the demographics and screening questionnaires. Twenty minutes after they began the questionnaires, they provided the first saliva sample. After completion of the first saliva sample, participants inserted the vaginal photoplethysmograph and attached the electrode wires for the ECG, as previously instructed. Once the vaginal photoplethysmograph signal stabilized, they were asked to fill out the pre-film Subjective Response Scale indicating their feelings of affect and arousal at that moment. Participants then watched one of the three film sequences. Immediately following the film sequence, they filled out the post-film Subjective Response Scale, indicating their affect and arousal during the last film. Upon completion of the Subjective Response Scale, the participants were told to remove the photoplethysmograph and the electrodes and get dressed. Ten minutes after the end of the film, they provided a second saliva sample.

Sessions 2 and 3 proceeded in the same sequence as the first session, with the exception of the Demographics questionnaire which was only administered at the start of the first session. The Screening Questionnaire was also be shortened to ask only about drug use and eating, drinking, smoking and exercising behavior. During each of the three sessions, participants saw one of three different films after the neutral film: stressful, sexual, or humorous. The three films were presented in a counterbalanced order.

Figure 2.1. Timeline of Study Procedures



SRS = Subjective Response Scale

Data analysis

Preprocessing

VPA data. VPA data were reduced by calculating the total change in amplitude for each heart beat. This was done by finding the peak and nadir for each pulse wave and computing the differences between the two, using AcqKnowledge software. Artifacts in the data were identified visually by the researcher and removed manually, as per past studies of this nature (Laan et al., 1995, Rellini et al., 2005). VPA was averaged across the neutral film and final three minutes of the experimental portions of each film. In order to control for individual variability in VPA signals, a VPA difference score for each

person and each condition was calculated as the percent change in VPA during the experimental film over the neutral film.

EGC data. Heart rate was determined by calculating the difference in the average heart rate between the neutral and experimental portions of the film for each participant. Heart rate variability was calculated from the ECG signal by determining the time interval between each heart beat (R-R interval). The R-R intervals from the neutral segment (three minutes) and from the experimental segment (final three minutes) were entered into a MATLAB based program, Biosignal (Niskanen, Taravainen, Ranta-aho, & Karjalainen, 2002). This program analyzed several aspects of heart rate variability, including the standard deviation of the R-R intervals (SDRR). The SDRR is a measure of vagal or parasympathetic activity, and increases in response to parasympathetic activation (Task Force of the European Society of Cardiology the North American Society of Pacing Electrophysiology [Task Force], 1996). The difference in SDRR between the neutral and the experimental portions of the film was calculated to be used for analyses.

Hormonal data. In order to control for individual variability in basal hormone levels, hormonal data was calculated as percent change over baseline.

Subjective Response Scale. For each item on the Subjective Response Scale, a difference score was calculated by subtracting the pre-film score from the post-film score. These difference scores were averaged over all of the items within each of the four subscales.

Statistical analyses

All of the change scores were entered as dependent variables into separate repeated measures ANOVAs with Condition (Erotic, Humorous, Stressful) as the independent variable. Any significant effects in the overall ANOVAs were tested with paired samples t-tests. I was also interested in change across conditions, so I tested whether the change scores for each condition and dependent variable differed from zero using one sample t-tests. A Bonferroni correction was used for each set of tests to control familywise error at .05. The significance level for all post hoc tests was rounded to .02.

Results

Manipulation check

Affect

The means for the four subscales of the Subjective Response Scale are show in Table 2.1. The overall ANOVAs were significant for all four subscales: subjective perceptions of physical arousal, $F(2, 36) = 39.58$, $p < .001$, mental arousal, $F(2, 36) = 28.01$, $p < .001$, positive affect, $F(2, 36) = 6.32$, $p = .004$, negative affect, $F(2, 36) = 10.16$, $p < .001$. As expected, only the erotic film showed a significant increase in subjective perceptions of physical arousal, and in mental arousal. The erotic and humorous films showed increases in positive affect and no change in negative affect. The stressful film showed an increase in negative affect and a small, non-significant decrease in positive affect.

Genital arousal

As noted earlier, the vaginal photoplethysmograph is specific to sexual arousal and does not change in response to non-sexual arousal. Thus, as expected the VPA signal was significantly different between conditions, $F(2, 36) = 19.85$, $p < .001$. VPA was significantly higher in the sexual condition compared to the stressful condition, $t(18) = 4.44$, $p < .001$, and the humorous condition, $t(18) = 4.57$, $p < .001$. There were no significant differences between the stressful and humorous conditions, $t(18) = -.55$, $p = .59$. VPA in both the stressful and humorous conditions was not significantly different from zero.

Table 2.1 Mean Difference Scores for VPA & Subjective Response Scale.

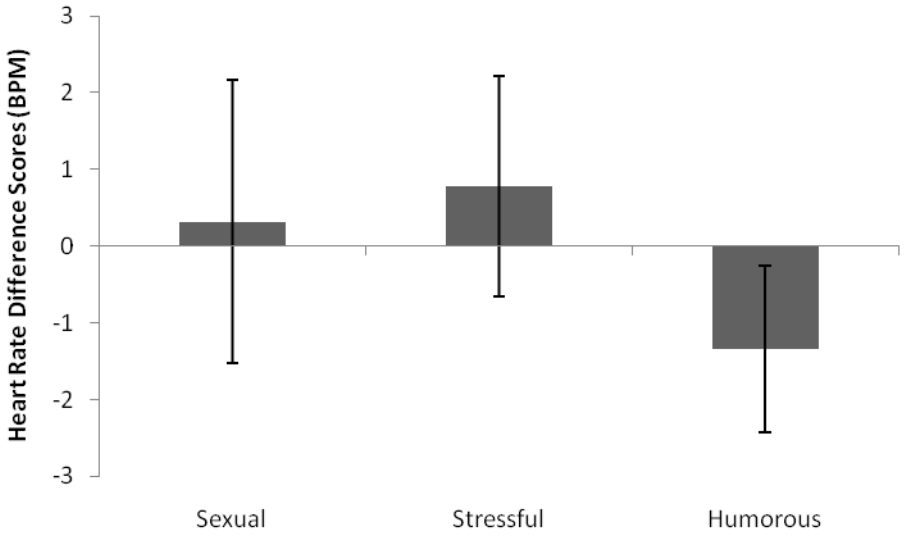
	Mean difference scores (SEM)					
	Sexual		Stressful		Humorous	
VPA percent change	37.92 %	(8.35)[b,c]	-0.02%	(1.63)[a]	1.11%	(1.71)[a]
SRS - Physical Arousal	3.31	(0.58)b,c	0.26	(0.12)[a]	0.15	(0.07)[a]
SRS – Mental Arousal	2.54	(0.77)b,c	-0.31	(0.13)[a]	0.25	(0.14)[a]
SRS – Positive Affect	2.40	(0.93)b	-0.44	(0.13)[a,c]	2.33	(0.76)[b]
SRS – Negative Affect	-0.07	(0.09)b	2.77	(0.58)[c]	-0.09	(0.12)[b]

[a] significantly different from the sexual condition at $p \leq .02$
[b] significantly different from the stressful condition at $p \leq .02$
[c] significantly different from the humorous condition at $p \leq .02$

Autonomic responses

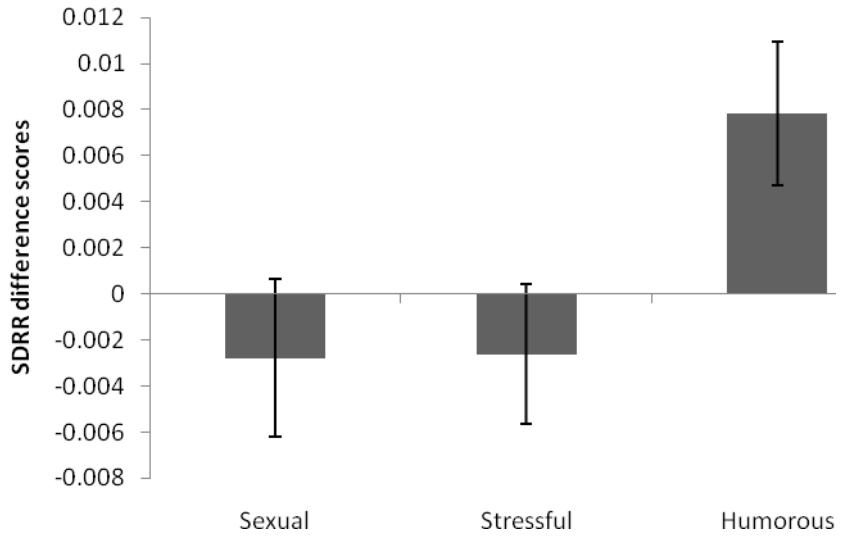
The change in heart rate was not significantly different between conditions, $F(2, 36) = 2.67$, $p = .09$, and none of the conditions showed any significant increase or decrease above neutral (Figure 2.2). The measure of heart rate variability, SDRR, was significantly different across conditions, $F(2, 36) = 4.16$, $p = .02$. The sexual and stressful conditions were not significantly different from one another, $t(18) = .04$, $p = .97$, indicating that the cardiovascular components of the PNS were similar during these two affective states. The increase in the humorous condition was significantly higher than both the sexual, $t(18) = 2.43$, $p = .02$ and the stressful conditions, $t(18) = 2.56$, $p = .02$, indicating increased PNS activation (Figure 2.3).

Figure 2.2 Heart Rate Change across Film Conditions



Mean difference scores (Experimental – Neutral) for Heart Rate (BPM) (+/- *SEM*). There were no significant differences between conditions.

Figure 2.3 Heart Rate Variability across Film Conditions



Mean difference scores (Experimental – Neutral) for the Standard Deviation of the R-R intervals (SDRR) (+/- *SEM*). The humorous film induced an increase in SDRR, which is indicative of increased parasympathetic nervous system activity. There was no change for the sexual or stressful films.

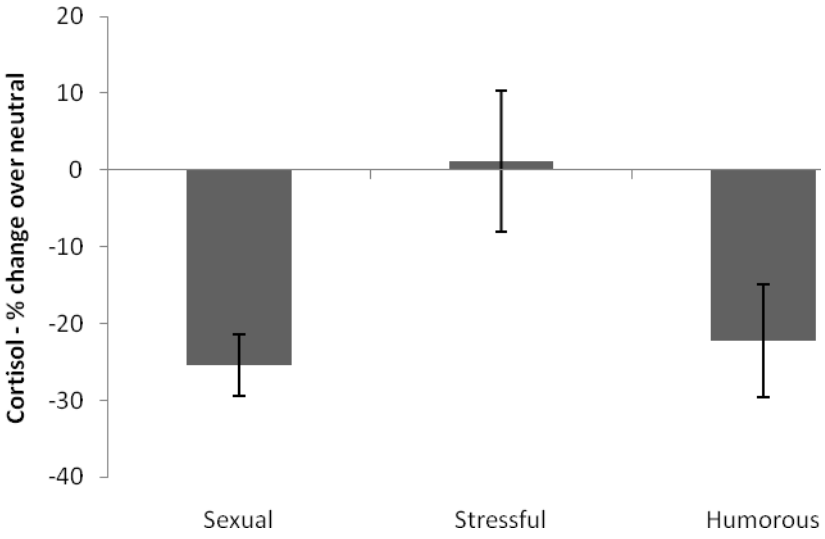
Hormonal responses

The change in cortisol in response to the experimental films was also significantly different across conditions, $F(2, 36) = 4.06$, $p = .03$ (Figure 2.4). Post hoc tests showed that the stressful film was significantly different from the sexual film, $t(18) = -2.93$, $p = .01$, but not the humorous film, $t(18) = 1.64$, $p = .12$. Cortisol decreased significantly in the sexual, $t(18) = 6.37$, $p < .001$ and the humorous conditions, $t(18) = 2.97$, $p = .01$. There was no significant change in the stressful condition, $t(18) = 0.18$, $p = .86$.

One participant had DHEAS levels that were too high to read in one sample; her data were excluded from these analyses. The change in DHEAS in response to the experimental films was not significantly different across conditions, $F(2, 34) = 1.29$, $p =$

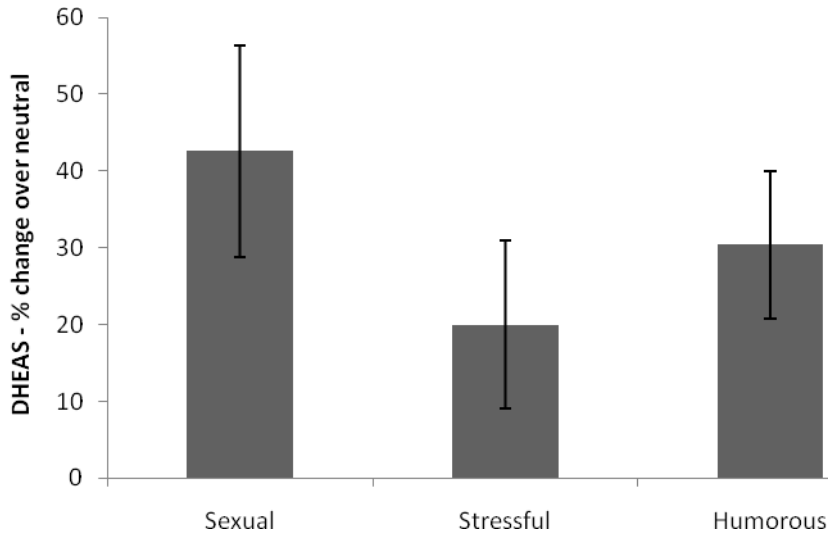
.29. Although DHEAS increased in all three conditions, the increase was only significant for the sexual, $t(17) = 3.09$, $p = .001$ and humorous, $t(17) = 3.39$, $p = .004$ conditions. The stressful video did not significantly change DHEAS, $t(17) = 1.38$, $p = .19$ (Figure 2.5).

Figure 2.4 Salivary Cortisol Changes across Film Conditions



Mean percent change over neutral (+/- *SEM*). Cortisol declined significantly in the sexual and humorous conditions, but did not change in the stressful condition.

Figure 2.5 Salivary DHEAS Changes across Film Conditions



Mean percent change over neutral (+/- *SEM*). DHEAS increased significantly in the sexual and humorous conditions, but did not change in the stressful condition.

Discussion

The present study examined the underlying autonomic and hormonal components of three distinct types of arousal, sexual, stressful, and humorous. The primary purpose was to understand how DHEAS and cortisol release might explain the relationship between stress and sexual arousal over and above the role of the SNS. Manipulation checks of VPA and subjective reports of arousal and affect showed responses in the expected directions. Participants were more sexually aroused in the sexual condition compared to the stressful and humorous conditions. Positive affect was highest for the sexual and humorous conditions, while negative affect was highest for the stressful condition. Surprisingly, neither the sexual or stressful conditions showed a significant

increase in SNS activity. Some previous studies have shown no change in SNS activity in response to sexual stimuli (e.g., Hamilton, Fogle, & Meston, 2008; Hoon et al., 1977), but the lack of change for the stressful film was unexpected.

Cortisol response was significantly different between the sexual and the stressful conditions. As expected, in both the sexual condition and the humorous condition participants showed sharp decreases in cortisol over the course of the film. Unexpectedly, there was no significant change in the level of cortisol in response to the stressful film, suggesting that a film may not be a strong enough stressor to elicit a cortisol response. Cortisol has been demonstrated to interfere with sexual function in animals by reducing the production of gonadotropins (e.g., Breen & Karsch, 2004, Gore et al., 2006; Olster & Ferin, 1987). A lack of cortisol response to this stressful stimulus could explain why moderate stressors similar to the one used in the present study do not necessarily interfere with sexual arousal.

The DHEAS response was not significantly different across conditions, but the pattern of response indicated there was a similar response (increase) for the sexual and humorous conditions. Similar to the cortisol results, there was no significant change in DHEAS in response to the stressful film. That DHEAS did not increase in response to the stressful film indicated that it alone cannot explain the relationship between stress and sexual arousal. This is the first study to examine the effects of sexual arousal on DHEAS, and the first to show a significant increase in an androgenic hormone in response to sexual arousal in women. Previous studies of testosterone response to film-induced sexual arousal have repeatedly shown no change in testosterone (e.g., Exton et al., 2000;

Hamilton, Fogle, & Meston, 2008). The increase in DHEAS further supports the theory that this hormone may play an important role in female sexual function (e.g., Spark, 2002).

The present study found that the stressful stimulus did not increase cortisol or SNS activity. Although it is possible that both SNS and cortisol were slightly elevated when participants arrived at the lab for their session, this effect would likely have only occurred at the first session. Counterbalancing the order of films would have averaged this effect across conditions, so that the majority of sessions would have started at a true baseline. Participants reported an increase in negative affect and an increase in positive affect in response to the stressful film, indicating that it was an unpleasant experience. As cortisol and DHEAS were expected to be co-released, it is not surprising that there was also not an increase in DHEAS in the stressful condition. Essentially, the results of this study demonstrate that the film stimuli was a mild stressor that would likely not interfere with sexual arousal, but there is still not a clear answer as to why it might enhance sexual arousal.

The stressful film was used in Chapter 3 as a generic stressor that participants were exposed to before watching an erotic film. This stressor was compared to a more severe stressor known to increase both cortisol and SNS activity to determine whether they have different effects on subsequent sexual arousal.

Chapter 3: The Effect of Acute Stress on Sexual Arousal

Introduction

Several laboratory studies have examined the effects of acute stressors on women's sexual response. Although these studies have had mixed results, there seems to be two distinct types of stressors being used in the laboratory that differ in the extent to which they are personally relevant to participants and may explain the discrepant results. Two studies have used film stimuli as a stressor, similar to the one described in Chapter 2. This type of stressor is not tailored to the individual participants, and therefore, has no personal relevance for them. As such, it is not as likely to be perceived to be as stressful compared to a stimulus that has personal relevance. The lack of a cortisol response to the film stimuli in the previous chapter supports the notion that film stimuli is not stressful enough to elicit a cortisol response.

Previous studies that have shown a link between impaired sexual arousal and stress have used personally relevant stimuli, such as a frustrating computer task (ter Kuile et al., 2007) or mildly painful electric shocks (Brauer et al., 2007). In the study involving the frustrating computer task, participants either engaged in an easy computer task or a very difficult one, both while having a stern looking researcher watch over their shoulder. Once they completed the assigned task, participants were shown an erotic film. Those in the easy-task condition showed significantly higher genital and subjective sexual arousal than those in the frustrating-task condition. In this case, the stressor preceded the erotic film, but it was likely that the frustration from the personally relevant stressor continued

to distract them from focusing on the erotic stimuli. In the study that used electric shocks as the stressor, participants had the threat of electric shock present throughout the erotic film, so it was likely even more distracting. When no threat of electric shock was present, women showed much higher genital, but not subjective, arousal in response to the erotic film.

My hypothesis is that a stressor that actively involves the participant will be more personally relevant, will be perceived as more stressful, and will impair sexual arousal. A moderate level of SNS activity has been repeatedly shown to be beneficial for sexual arousal in sexually healthy women (e.g., Meston & Gorzalka, 1995; 1996b; Rellini & Meston, 2006). If a stressor induces a release of cortisol, it will trigger the activation of the PNS after a brief period of time, which could feasibly dampen sexual arousal. Additionally, increased cortisol could interfere with the release of gonadal steroids that are important for sexual arousal. For this study I used both personally relevant and non-personally relevant stressors to examine how each affects genital and subjective sexual arousal during a subsequent erotic film. The personally relevant stressor was a modified version of the Trier Social Stress Task (TSST stressor; Kirschbaum, Pirke, & Hellhammer, 1993) that has been shown to reliably increase cortisol (Dickerson & Kemeny, 2004), heart rate, and blood pressure (Hamilton, Newman, Delville, & Delville, 2008). This task involved participants giving a speech in front of a small audience and a video camera. The generic stressor was the stressful video from Chapter 2 (Movie stressor). The two stressors comprised the Stress condition and their effects were compared to a Control condition where no stressor is present.

In addition to the physiological effects of stress, there are also psychological effects, such as distraction. Being distracted and unable to focus on sexual stimuli is one of the most commonly reported psychological contributors to arousal disorders (Barlow, 1986; Koukounas & McCabe, 1997). Distraction is also a key component of stress (Lazarus, 1966). Assessing participants' level of distraction during the erotic film will allow me to examine whether distraction is a contributor to sexual arousal problems with acute stressors.

The goal of the present study was to determine whether stressors of differing relevance to participants would have different effects on their sexual arousal to subsequent sexual stimuli and, if so, to examine some of the potential mechanisms contributing to those differences. Based on previous findings that moderate stressors may enhance genital arousal while more severe stressors may inhibit it, I expect that the level of genital arousal during the erotic films will be increased in response to the Movie stressor and impaired in response to the TSST stressor compared to the Control condition. In regards to subjective sexual arousal, I anticipate that the TSST stressor will be most distracting and will interfere with subjective arousal. Misattribution of arousal may occur for the Movie stressor because the sexual stimuli will be more salient for the participants in this Stress condition compared to the TSST stressor. Misattribution of arousal will lead to increased subjective arousal in response to the Movie stressor. In regards to ANS activity, I expect that both the Movie and TSST stressors will show higher levels of SNS activity compared to the Control condition during both the neutral and the erotic portions of the film.

Method

Participants

Participants were 40 women who were recruited from the community via flyers and online advertisements. They ranged in age from 18-43 with an average age of 24 years (*SD* = 5.1). All women had been sexually active with a male partner within the month before the study began and reported being exclusively or predominantly heterosexual. Seven women reported they were single, 33 were in committed relationships ranging in length from three months to eleven years. Reported ethnicities were Caucasian (27), Latina (4), African American or Black (5), and Asian (4). All participants were screened over the phone before their initial appointment to verify that they met the inclusion and exclusion criteria for the study.

Materials and apparatus

Stimuli

Erotic film sequences. Two erotic film sequences were presented in a counterbalanced order between the Control and Stress conditions. Film sequences were 12 minutes long, and consisted of a one minute display of the word “Relax” on a black screen, three minutes of a neutral film, followed by eight minutes of an erotic film.

Stressors. The Movie stressor was the same violent 8-minute clip from the movie *Bully* (Clark, 2001) that was used in the previous study. The clip depicts the lead up to and murder of a teen bully by a group of other teens. The personally relevant stressor was a modified version of the TSST (TSST stressor; Kirschbaum et al., 1993). For the TSST, participants were given a sheet of paper that read as follows.

> You are leaving a department store when two security officers stop you. They ask to search the grocery bag that you're carrying as there is some suspicion that you may have taken an item. When they search the bag, they find a $200 watch in the bag along with the grocery items that you purchased at another store. The price tag is on the watch and shows that it is from the department store. The police are called and because this appears to be your first offense, you are not arrested but are charged with theft and you are told that you will need to appear in court.

Participants were given three minutes to prepare their "defense" to this allegation of theft, but were not told the amount of time they would have to speak. Once three minutes of preparation time were up, the "judge" entered the room with a video camera. The "judge" was instructed to appear neutral throughout the speech and only spoke to prompt the participant to start, stop, or continue speaking until 5 minutes had elapsed.

Questionnaires

Phone Screen (Appendix A). Prior to coming to the laboratory for their initial appointment, all participants were screened over the phone to ensure they met the inclusion and exclusion criteria.

Demographics (Appendix B.). Participants provided their age, level of education, relationship status, sexual orientation, ethnicity, and length of relationship with their current partner.

Screening Questionnaire (Appendix C). The screening questionnaire was intended to verify that participants met inclusion/exclusion criteria. It was a shortened version of the phone screen and included items on current drug use, distress from sexual abuse, menstrual cycle dates and irregularities, and whether the participant had eaten, drank, smoked or exercised in the past hour.

Positive and Negative Affect Scale (PANAS; Appendix D). Subjective emotional responses were measured prior to watching the erotic film (but after the stressor) using the PANAS (Watson et al., 1988). The PANAS consistes of 20 items that were divided into two subscales, positive affect (e.g., "excited"), and negative affect (e.g., "guilty"). Items are rated on a 7-point Likert scale ranging from "not at all" to "intensely." Added to the PANAS was a question asking participants to report how stressful they found the previous task to be.

Experiences with Maltreatment Questionnaire (Appendix E). The Experiences with Maltreatment Questionnaire was used to identify participants who have had potentially traumatic experiences in their past that may have altered their ability to respond to stress.

Female Sexual Function Index (Appendix F). To verify that participants were free of sexual problems, they completed the FSFI, a validated 19-item questionnaire designed to assess sexual functioning in women (Rosen et al. 2000). In addition to a total score, the FSFI measures sexual functioning in six domains: Desire, Arousal, Lubrication, Orgasm, Satisfaction, and Pain. A clinical cut-off score of 26.55 has been established to reliably discriminate between women with and without sexual dysfunction (Wiegel et al., 2005). For this study, women with any form of sexual dysfunction were excluded because I was specifically interested in genital and subjective arousal after a stressor, and sexually dysfunctional women may respond differently to stressful stimuli (e.g., Brotto & Gorzalka, 2002). All participants scored above the clinical cutoff.

Distraction Quiz (Appendix G). Cognitive distraction was assessed with a multiple-choice quiz administered following the erotic films. The quiz consisted of 7 questions that assessed the participants' attention to the content of the erotic segments of the videotapes. Each question had three multiple-choice responses from which participants were instructed to choose the best answer. Multiple-choice questions have been previously used to assess for level of distraction during exposure to auditory tapes in a laboratory setting (e.g., Adams et al., 1985; Seal & Meston, 2007).

Apparatus

Vaginal photoplethysmograph. Genital arousal was measured using a vaginal photoplethysmograph (Sintchak & Geer, 1975). The vaginal photoplethysmograph is a clear, acrylic, tampon-shaped device that contains an infrared light-emitting diode as a light source, and a photosensitive light detector. When inserted into the vagina, the light source illuminates the capillary bed of the vaginal wall and the blood circulating within it. Upon contact with the vaginal wall, some of the light is absorbed, while the rest is backscattered. The amount of backscattered light is related to the transparency of engorged tissue and serves as an indirect measure of vasoengorgement. The measure of interest from the photoplethysmograph is the pulse amplitude (VPA), which is received through the A/C signal and band pass filtered at 0.5 to 30 Hz. VPA was sampled 200 times per second. Results were measured in millivolts (mV). VPA was acquired using the software program AcqKnowledge III, Version 3.7.3 (BIOPAC Systems, Inc., Santa Barbara, CA) and a Model MP100WS data acquisition unit (BIOPAC Systems, Inc., Santa Barbara, CA) for analog/digital conversion.

Electrocardiograph (ECG). Heart rate and heart rate variability were measured via an ECG, which consisted of three disposable electrodes that were attached to the participant's body (upper right chest, lower left chest, and right ankle) and connected by cables to a BIOPAC Systems ECG100 module. The signal from the ECG100 module was recorded in real time using the AcqKnowledge software program. ECG was also sampled at 200 times per second.

Arousometer. Continuous subjective sexual arousal was measured during the erotic film using a hand-controlled device (Rellini et al., 2005) that consists of a computer optical mouse mounted on a wooden track divided into seven equally spaced intervals, where 0 indicated neutral, and 1–7 reflected increasingly higher levels of sexual arousal. A software program written in MatLab (The MathWorks, Inc, Natick, MA, USA) detects the position of the pointer with respect to the y-axis of the computer's monitor twice per second.

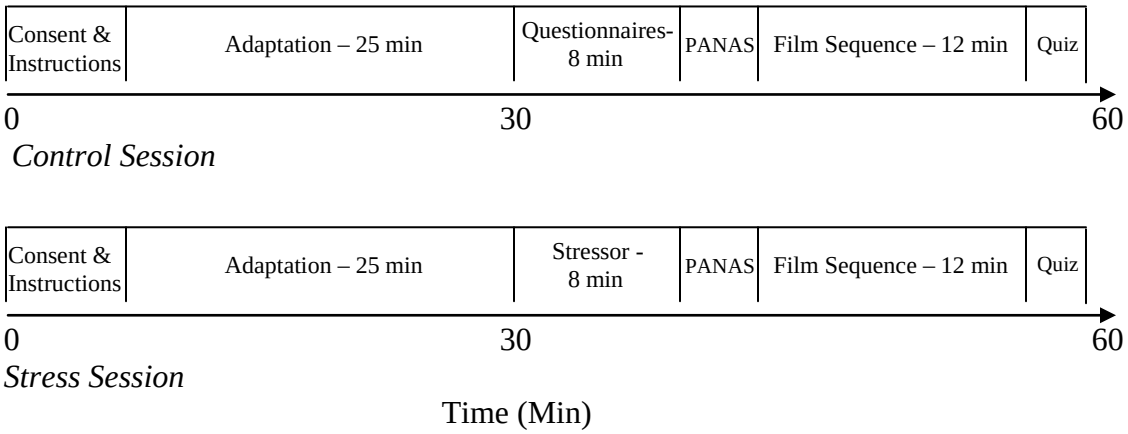
Procedures

After the initial phone screening, participants were scheduled to come into the lab for two sessions during days 5-10 of their menstrual cycle. All participants took part in the Control condition and one of the two Stress conditions (Movie or TSST). The order of the Control and Stress conditions and the erotic film presented for each was counterbalanced.

Upon arrival for the first session participants had the study explained to them and read and signed the consent form. At both sessions, participants were instructed on the use of the photoplethysmograph and the ECG and had the electrodes attached to their

skin. Participants were asked to sit quietly (and read nonsexual material if they wished) until 30 minutes had passed since their arrival. The waiting period was to help adapt them to the laboratory setting, so that any stress response was the result of the stressor and not the stress of coming into the lab. After the 30-minute adaptation period (including the consent and instructions), participants in the Control condition were given the questionnaire battery to complete for eight minutes. Participants in the Stress condition were randomly assigned to either the Movie stressor or the TSST stressor, both of which took eight minutes. After completion of the questionnaires or the stressor, participants were instructed to insert the photoplethysmograph and attach the electrode wires. Once comfortable, participants completed the PANAS. Then the erotic film sequence was played during which participants indicated their subjective sexual arousal using the Arousometer.

Figure 3.1 Timeline of Study Procedures



Data Analysis

Preprocessing

VPA data. VPA data were reduced by calculating the total change in amplitude for each heart beat. This was done by finding the peak and nadir for each pulse wave and computing the differences between the two, using AcqKnowledge software. Artifacts in the data were identified visually by the researcher and removed manually. VPA was averaged across the neutral film and the erotic film. In order to control for individual variability in VPA signals, a VPA difference score for each person and each condition was calculated as the percent change in VPA during the experimental film over the neutral film.

EGC data. Heart rate was determined by calculating the average beats per minute from the ECG signal for the neutral and erotic portions of each film for each participant. Heart rate variability was calculated from the ECG signal by determining the time interval between each heart beat (R-R interval). The R-R intervals from the neutral segment (three minutes) and from the experimental segment (final three minutes) were entered into a MATLAB based program, Biosignal (Niskanen et al., 2002). This program analyzed several aspects of heart rate variability, including the standard deviation of the R-R intervals (SDRR). The SDRR is a measure of vagal or parasympathetic activity, and increases in response to parasympathetic activation (Task Force, 1996). For heart rate and heart rate variability, raw scores were entered into the analyses instead of difference scores. This allowed for detection of differences between the Control and Stress conditions at baseline.

Subjective arousal. Data gathered from the Arousometer were calculated as a mean over the course of the erotic film for each session for each participant.

PANAS. The positive and negative subscales of the PANAS were calculated by taking the average of the items in each category.

Statistical analyses

All scores of interest were entered separately as the dependent variable into a mixed model ANOVA with type of stressor (Movie, TSST) as the between-subjects variable and the Control vs. Stress condition as the within-subjects variable. Main effects examined the overall difference between the Control and Stress conditions and significant interactions indicated differences between the two Stress conditions. Post-hoc t-tests were conducted as follow-up tests on statistically significant interactions. For the Distraction Quiz, participants may have had an advantage at their second session because they would be anticipating a quiz after having filled one out at the first session. To control for this effect, I included the condition order as a covariate for the Distraction Quiz ANOVA.

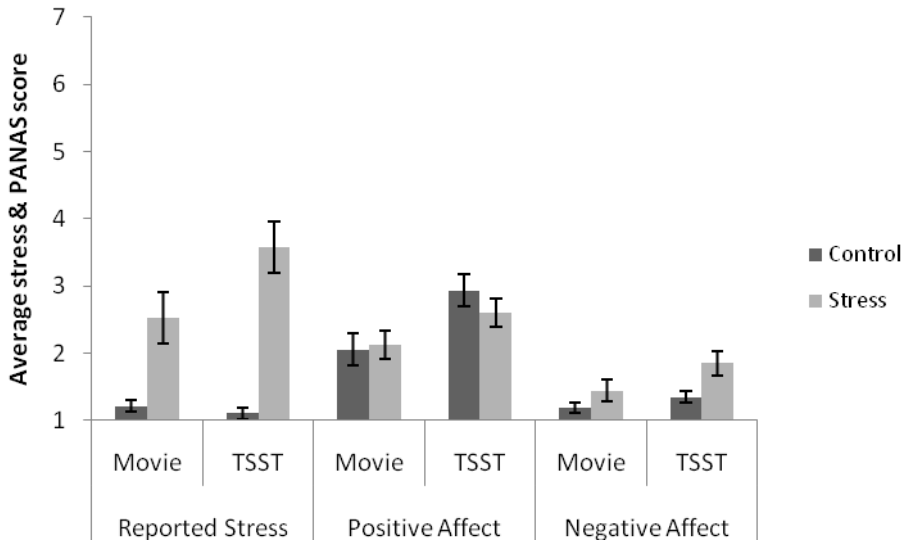
Results

Manipulation check

As expected, participants reported that overall the Stress condition was more stressful than the Control condition, $F(1, 36) = 49.68$, $p < .001$. There was also an interaction for the specific stressor, $F(1, 36) = 4.6$, $p = .04$. Post-hoc tests of the interaction showed that the TSST was reported as more stressful than the Movie, $t(37) = 6.73$, $p < .001$. Participants also reported higher levels of negative affect in the Stress condition compared to the Control condition, $F(1, 35) = 12.44$, $p = .001$, with no

interaction effect of stressor, $F(1, 35) = 1.31$, $p = .26$. Positive affect was not significantly different between the Control and Stress conditions, $F(1, 35) = .66$, $p = .42$, nor was there an interaction between the two Stress conditions, $F(1, 35) = 1.52$, $p = .23$ (Figure 3.2).

Figure 3.2 Subjective Response to Control and Stress Stimuli



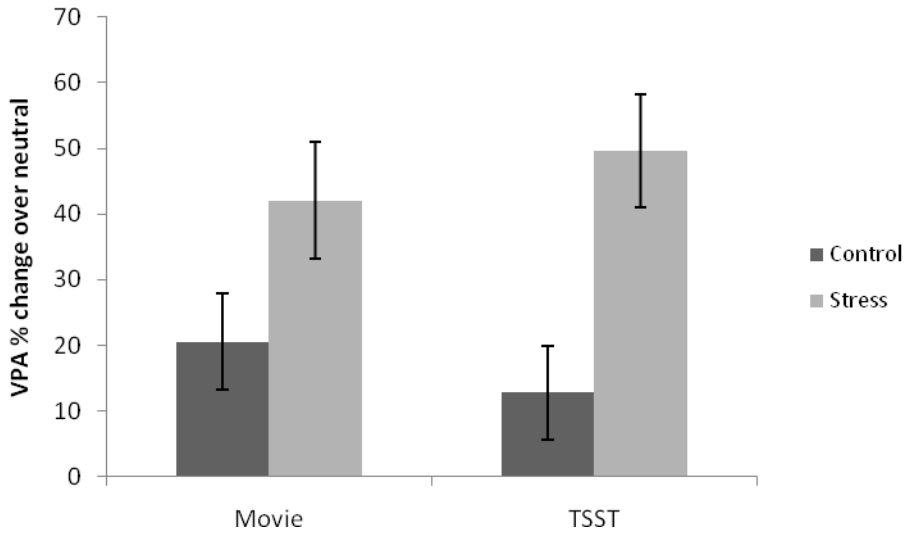
Average score on stress and PANAS questions (out of 7) (+/- *SEM*). Participants reported that the Stress condition was significantly more stressful and resulted in higher negative affect than the Control condition. Within the Stress condition, the TSST was ranked as more stressful than the Movie.

Genital arousal

The Stress condition showed a significantly larger VPA increase over baseline compared to the Control condition, $F(1, 37) = 21.38$, $p < .001$. The mean increase in VPA for the Control condition was 17% (*SEM* = 5.12) and the mean increase for the Stress condition was 46% (*SEM* = 6.2). There was no interaction, $F(1, 37) = 1.76$, $p = 19$,

indicating that both the Movie stressor and the TSST stressor increased genital arousal (Figure 3.3).

Figure 3.3 Genital Arousal in the Control and Stress Conditions

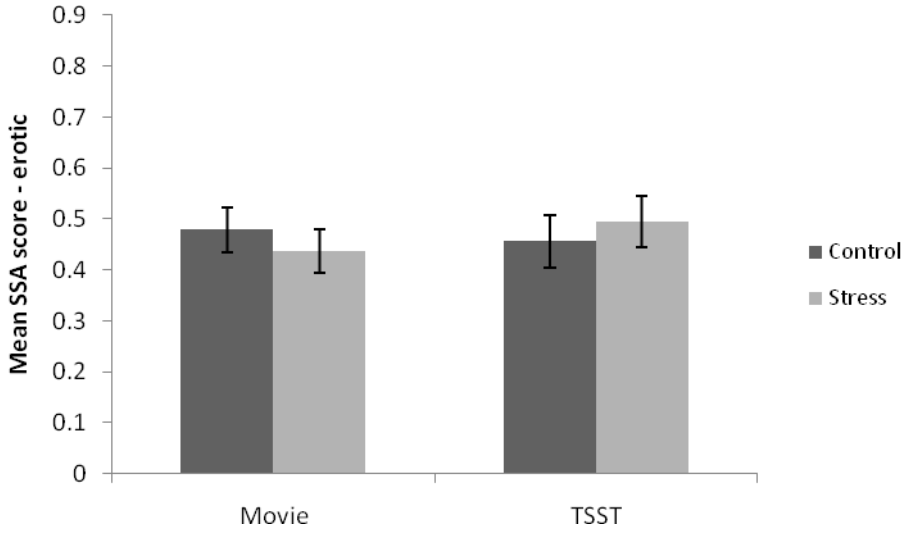


VPA percent change over neutral (+/- *SEM*). Genital arousal was significantly increased for both the Movie and TSST compared to the Control condition.

Subjective Arousal

Arousometer data were incomplete for 10 participants, so their data are not included in these analyses. There was no significant difference between the Control and Stress conditions in average subjective arousal as measured by the Arousometer, $F(1, 26) = .01$, $p = .92$, nor was there an interaction with the type of stressor, $F(1, 26) = 2.40$, $p = .13$ (Figure 3.4).

Figure 3.4 Subjective Arousal in the Control and Stress Conditions



Mean subjective sexual arousal (SSA) score from the arousometer (+/- *SEM*). Subjective sexual arousal did not show any difference between any of the conditions.

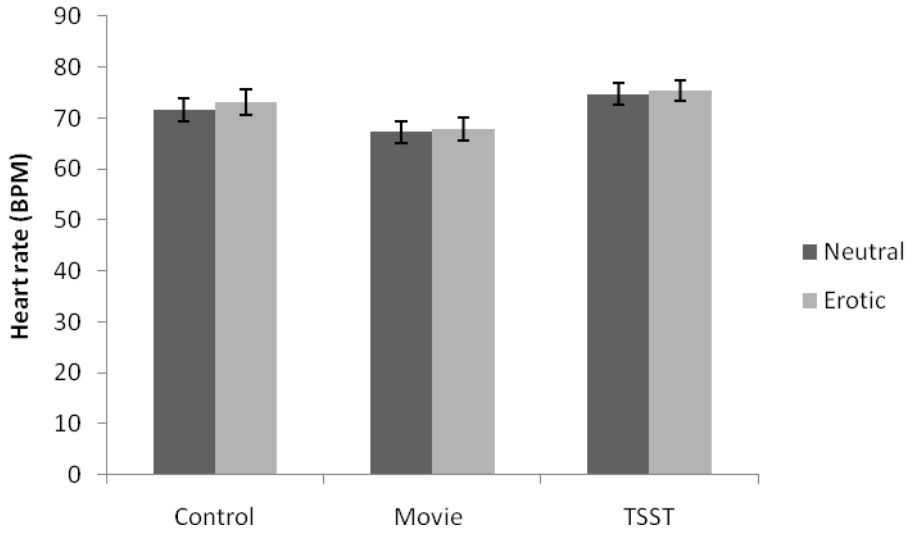
Autonomic Activity

There were no significant differences in heart rate between the Control and Stress conditions overall, $F(1, 35) = .49$, $p = .49$. There were no significant changes in heart rate between the neutral and erotic films for the Control condition, $F(1, 35) = .05$, $p = .82$ or the Stress condition, $F(1, 35) = 2.8$, $p = .08$. There was also no difference in heart rate for the neutral clips between the control and stress conditions, $t(37) = .14$, $p = .89$ (Figure 3.5).

There was an overall change in HRV (as measured by SDRR) between the neutral and erotic videos, such that the SDRR decreased from 0.056 (*SEM* = .004) to 0.051 (SEM = .004), $F(1, 35) = 8.93$, $p = .005$. There was also a significant interaction with the between the type of film (neutral and erotic) and the stressor participants were exposed

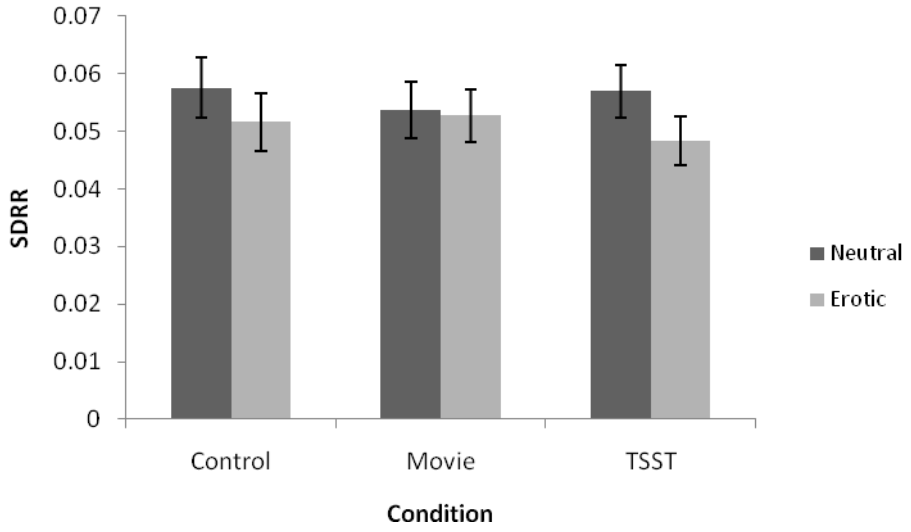
to, $F(1, 35) = 4.86$, $p = .03$. Post hoc tests of this interaction found that the decrease in HRV was only significant for the TSST stressor, $t(19) = 3.50$, $p = .002$. There were no significant decreases for the Movie stressor, $t(17) = .37$, $p = .71$, or the Control condition, $t(36) = 1.9$, $p = .11$ (Figure 3.6). There was also no difference in the SDRR between the Control and Stress conditions for the neutral film, $t(37) = .91$, $p = .37$, indicating that the stressors did not significantly increase HRV before the erotic video was shown.

Figure 3.5 Heart Rate across Conditions



Heart rate (BPM) (+/- *SEM*) for the neutral and erotic film clips by condition. There were no significant differences across any of the conditions or films.

Figure 3.6 Heart Rate Variability across Conditions

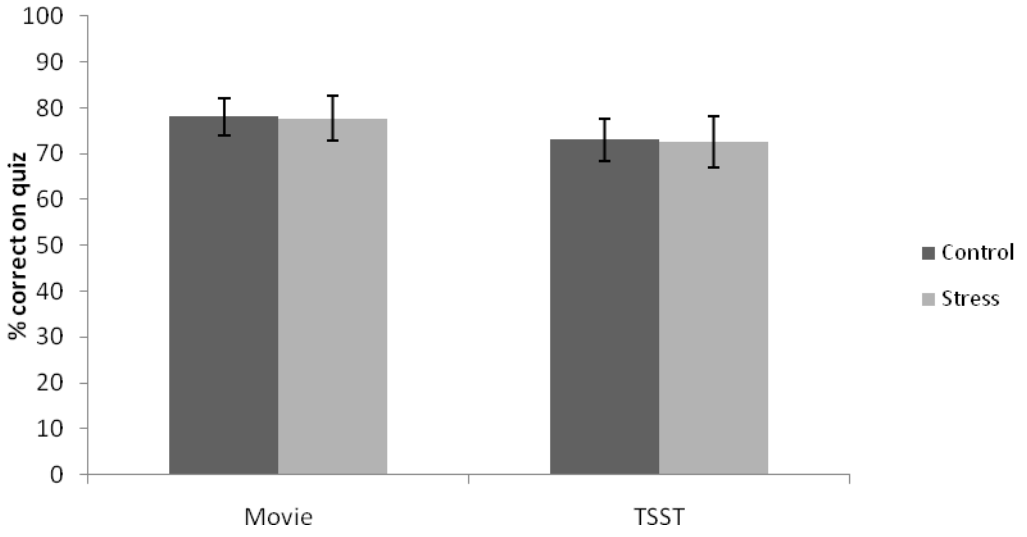


SDRR score (+/- *SEM*) for the neutral and erotic film clips by condition. The TSST condition showed the biggest decrease in SDRR (a measure of PNS activity) from neutral to erotic, indicating it also had the biggest increase in SNS activity.

Distraction

There was no significant difference in distraction between the Control and Stress conditions, $F(1, 32) = .01$, $p = .92$. There was also no interaction between the two stressors, $F(1, 32) = .01$ $p = .92$, indicating that the TSST did not cause participants to be more distracted than the Control condition or Movie stressor (Figure 3.7).

Figure 3.7 Scores on the Distraction Quiz



Percent correct on the Distraction Quiz (+/- *SEM*). Although there was a wide range of scores (from 43% -100%) on the quiz, there was no significant difference between any of the conditions on distraction scores.

Discussion

The present study explored the effects of different acute stressors on women's sexual arousal to subsequent sexual stimuli. I hypothesized that a generic stressor (i.e., watching a violent film) would increase genital and subjective arousal, as has been seen in previous studies, while a personally relevant stressor (i.e., public speaking) would interfere with both genital and subjective arousal. The generic stressor did not affect cortisol in the previous chapter, while the personally relevant stressor has been repeatedly demonstrated to increase cortisol in other studies (Kirschbaum et al., 1993; Hamilton, Rivers, Josephs, & Delville, in prep). It was hypothesized that the personally relevant stressor would interfere with subsequent sexual arousal either through hormonal means or

through psychological distraction. The results of the study indicate that both stressors increased genital sexual arousal compared to the Control condition. Neither stressor had an effect on subjective sexual arousal compared to Control.

Genital and subjective sexual arousal are known to be discordant in women, or at least less synchronized than they are for males. So, although I predicted that the genital and subjective arousal responses would be in the same direction for the two stressors, it is not surprising that the increase in genital arousal during the stress condition was not accompanied by an increase in subjective arousal. Several studies have addressed this topic (e.g., Rellini et al., 2005) including a recent meta-analysis (Chivers, Seto, Lalumiere, Laan, & Grimbos, 2010). One theory for the desynchrony between womens's genital and subjective arousal put forth in the meta-analysis is that women's genital arousal is less noticeable than men's, so it is not as likely to inform their subjective sexual arousal. In addition, women's genital arousal is believed to be more automatic than their subjective arousal, the latter of which is a more conscious experience that is more prone to bias.

As expected, women reported that the TSST was more stressful than both the Movie and the Control condition. Both stressors also significantly increased self-reported negative affect. However, the increase in subjective stress and negative affect did not interfere with the women's genital or subjective sexual arousal. The increased stress also did not have a significant effect on distraction, as scores on the Distraction Quiz were very similar across conditions. Scores on the Distraction Quiz were reasonably normally distributed and ranged from 43% correct to 100% correct. There was a fair amount of

variability in the scores, indicating that the lack of difference in the scores was not due to a ceiling or floor effect.

ANS activity appears to be the mechanism that plays the largest role in the increase in genital arousal observed in response to the TSST stressor. There was a significant decrease in HRV (increase in SNS) from the neutral film to the erotic film. This increase in SNS activity is particularly interesting because it did not occur immediately after the stressor, but only when participants were presented with sexually arousing stimuli. This suggests that the more stressful stimulus may prime the SNS to be more responsive when presented with additional arousing stimuli. A similar effect was demonstrated in a study that measured alpha-amylase (a norepinephrine marker) response in women who either exercised or filled out questionnaires before watching an erotic film. Alpha-amylase was slightly elevated after exercise, but continued to increase even after the erotic film, indicating a synergistic effect of exercise and sexual arousal (Hamilton, Fogle, & Meston, 2008). It has been suggested in the past that effects on women's sexual arousal observed after SNS activation are the result of PNS activation that occurs to counteract the SNS activity. This is one of several studies, however, to indicate that increased PNS is not responsible for the increase in genital arousal that occurs after physically or psychologically stressful events (Meston & Heiman, 1998; Hamilton, Fogle, & Meston, 2008).

Similar to the results of the previous study, the differences seen in the ANS response were only apparent in measures of HRV and not heart rate. Although some studies that examined the effects of stress or increased SNS on sexual arousal have shown

that their manipulations resulted in higher heart rate (Meston & Gorzalka, 1995; Hamilton, Fogle, & Meston, 2008), others have not shown any change in heart rate (Hoon et al., 1977; Palace & Gorzalka, 1990). All of the studies resulted in increases in genital arousal, so it is not unexpected that the present study showed increased genital arousal in the absence of increased heart rate. Both the present study and the study reported in Chapter 2 also found that there were significant differences in HRV when none existed in heart rate. These findings contribute to a growing literature showing that HRV is a more sensitive measure of ANS activity than measuring changes in heart rate alone. (e.g., Malpas & Maling, 1990; Stein & Kleiger, 1999).

The finding that the personally relevant stressor increased subsequent genital arousal was unexpected. That the personally relevant stressor did not impair genital and subjective arousal contradicts findings of prior studies investigating the effects of personally relevant acute stressors on sexual arousal. One of those previous studies used shock-threat during the presentation of the sexual film stimuli (Brauer et al., 2007). Having a stressor occur concurrently with sexual stimuli would result in the stress response coming to its peak at the same time as the sexual arousal responses. The effect of this particular timing of the stressor would be different from other studies (including the present study) in which the stressor occurred *prior to* the onset of sexual stimuli. In these studies, because the peak stress response would have already occurred, the physiological and psychological effects of the stress response would be relatively less strong. Among these studies in which the acute stressor preceded the sexual stimuli, only one did not find an increase in genital arousal (frustrating computer task; ter Kuile et al.,

2007). Taken together, four stressors (including the present study; 3 different stressful films and the TSST) have been shown to increase, rather than decrease, genital arousal in response to subsequent sexual stimuli (Hoon et al., 1977; Palace & Gorzalka, 1990).

Although a meta-analysis of stress inducing stimuli found that the TSST was the best task for inducing social stress (Dickerson & Kemeny, 2004), the review did not include the frustrating computer task from the ter Kuile et al. (2007) study. It is possibly that this stressor is even more stressful than the TSST. The mechanisms through which the frustrating computer task might impair sexual arousal are not presently known. A future study should compare this task directly with the TSST to identify the mechanisms that might differentiate the two personally relevant stressors.

To the extent that the TSST increased cortisol, as has been demonstrated in previous studies, the present study would indicate that increased cortisol does not immediately impair sexual arousal. A previous study also concluded that increases in cortisol did not impair genital arousal in the laboratory (Hamilton, Rellini, & Meston, 2008). Together, these studies suggest that increased cortisol may not be detrimental to sexual arousal in the short term. Alternatively (or in addition), the increase in SNS activity that is released in response to acute stressors could potentially counteract any negative effect cortisol may have on genital arousal. It is possible that stressors need to be chronic in order to have a negative effect on sexual arousal. If this is the case, it would not be unique to sexual arousal. Numerous studies have demonstrated that immune responses are enhanced by acute stress and impaired by chronic stress (e.g., Dhabhar &

McEwen, 1997; McEwen & Stellar, 1993), and these studies speculate that the SNS could play a protective role during acute stress.

The study described in Chapter 4 expanded on the previous studies by shifting the focus from acute stress to the effects of chronic daily stress on sexual arousal. Although acute laboratory stressors are ideal for experimental studies because they allow for greater experimental control, chronic stress that occurs in women's lives is both more personally relevant than any artificial stressor, and more ecologically valid.

Chapter 4: The Effect of Chronic Stress on Sexual Arousal

Introduction

The stress response is an adaptive behavior that evolved for responding to acute stress situations that would have occurred in our evolutionary history, such as being chased by a tiger. Once the source of stress has been removed and the person is out of danger, the body should return to homeostasis. When a stressor is chronic or repeated, as many psychological stressors are, the organism is unable to return to homeostasis (Sapolsky, 1998). The effects of having the stress response constantly "turned on" can be very damaging to an organism (Selye, 1974; Sapolsky, 1992; Weiner, 1992). Chronic stress has been related to many health problems, such as cardiovascular disease, heart attacks, and higher susceptibility to infectious diseases (Sapolsky, 1998). Chronic stress can be defined as major negative life events that induce an extended period of stress, such as a death in the family or being diagnosed with cancer (Sarason et al., 1978). More commonly, chronic stress is an accumulation of small stressors that are constantly or frequently present, such as deadlines that never seem to be met, traffic jams, and financial worries (Kanner et al., 1981; Lazarus, 1966). Kanner et al. found that chronic everyday hassles have more of a negative effect on health than more severe but less common stressors, such as the death of a loved one.

Previous studies of chronic stress and sexual arousal provide fairly consistent support for a negative effect of chronic stress on sexual arousal. With the exception of one study (Gillilland & Morokoff, 1993), survey studies have shown that chronic

stressors negatively affect sexual function in women (Bodenmann et al., 2006; Dunn et al., 1999; Sand & Fisher, 2007). One of these studies specifically examined the effects of both daily hassles and major life events on sexual function and concluded that higher levels of daily hassles predict more sexual problems for women, while life events were not related to sexual function (Bodenmann et al., 2006).

To my knowledge, the only laboratory study to examine the relationship between chronic stress and women's sexual arousal had participants complete the Everyday Problems Checklist (EPCL), which is a Dutch measure similar to the Hassles Scale. The researchers categorized participants into high and low stress groups by conducting a median split of participants based on their EPCL scores. Women in the high stress group had lower levels of genital arousal than those in the low stress group. There were no differences between the groups on subjective sexual arousal (ter Kuile et al., 2007). In the ter Kuile et al. study, however, half of the participants were exposed to an acute stressor, so the effect of chronic stress may have been masked by the influence of the added stress. Additionally, their participants were not chosen based on their level of chronic stress; the researchers just conducted a median split of stress scores to separate them into high and low chronic stress groups. The present study examined the effects of chronic stress on sexual arousal by studying chronic stress in isolation, without the added factor of acute stress. The present study also pre-screened participants for their level of stress, allowing for the creation of two distinct groups of women with different levels of chronic stress.

Many of the physiological and psychological changes involved in the acute stress response, such as release of cortisol, increased heart rate, & altered cognition, also occur for chronic stress. The body uses a lot of energy attempting to return the body to a homeostatic state, which leaves fewer resources for other less important needs, such as mating (Selye, 1974). Even with the body's attempts to maintain homeostasis, corticosteroids (cortisol in humans) often remain elevated (Sapolsky et al., 2000). Although cortisol release in response to acute stress did not seem to be detrimental to sexual arousal in the previous study, prolonged cortisol elevation could be responsible for impairing sexual arousal. High levels of cortisol can inhibit the production of testosterone (e.g., Welsh et al., 1999). Lowered levels of testosterone may have a negative effect on sexual arousal, as testosterone has shown some links with women's sexual arousal (Traish & Kim, 2006). Also of interest is the role of DHEAS, which is thought to be released in response to stress, and has been demonstrated to play a facilitatory role in women's sexual function. Psychologically, distraction will likely be a mechanism contributing to the negative effects of chronic stress on sexual arousal. In addition to having more negative physiological effects than acute stress, chronic stress has been demonstrated to have more negative effects on cognitive processes, including distraction (Sapolsky, 1998).

Research on the effects of chronic stress on sexual function has been fairly consistent in demonstrating a negative relationship between the two. The present study selected women based on their reported levels of chronic stress and compared women reporting average levels of stress and high levels of stress. Several studies have

demonstrated that there is an inverted-U shaped relationship between stress or SNS activity and genital sexual arousal, such that a moderate level of stress enhances arousal, while high or low levels can impair arousal (Bradford & Meston, 2006; Meston & Gorzalka, 1996a). Based on this relationship, women with below average levels of stress were excluded from the present study.

To examine the mechanisms that might explain the effects of chronic stress on sexual arousal, this study measured women's levels of distraction, as well as cortisol, DHEAS, and testosterone. I expect that women with high levels of chronic stress will be more distracted than women with an average level of chronic stress. Prior to the coming to the lab, these women provided a saliva sample that was assayed for basal levels of DHEAS and cortisol. Women reporting high levels of chronic stress were predicted to have higher levels of cortisol and lower levels of DHEAS compared to women with average levels of chronic stress. These mechanisms will result in lower levels of genital and subjective arousal for women in the high chronic stress group.

Method

Participants

Participants were 30 women recruited from the Austin community, 15 of whom qualified as high chronic stress (High Stress group) and 15 of whom qualified as average chronic stress (Average Stress group) based on their scores from the Hassles Scale (see below). Women were recruited from the community via flyers and online advertisements. All women were in relationships with men and had been sexually active within the month before the study. Relationships ranged in length from 3 months to 10 years with an

average of 4.6 (*SD* = 2.2) years. Participants reported being mostly heterosexual with one person reporting bisexual orientation. Reported ethnicities were Caucasian (18), Asian (6), Latina (4), and African American or Black (2). All participants were screened over the phone before coming into the lab to verify that they met the inclusion and exclusion criteria. These criteria were the same as the two previous studies with the exception of exclusion criteria (1), which stated that participants must be free from sexual arousal problems. It was expected that women experiencing high chronic stress might have problems related to sexual arousal, and were therefore not excluded. Participants were not asked about their level of sexual functioning prior to participating in the study.

Materials and apparatus

Stimuli

Film sequences. Two erotic film sequences were used for this study. Film sequences were 12 minutes long and consisted of a one minute display of the word "Relax" on a black screen, three minutes of a neutral film, and then eight minutes of an erotic film. The two film sequences were counterbalanced between the High Stress and Average Stress groups.

Questionnaires

Phone Screen (Appendix A). Prior to scheduling their appointment, all participants were screened over the phone to ensure they met all of the inclusion and exclusion criteria.

Demographics (Appendix B.). Participants provided their age, level of education, relationship status, sexual orientation, ethnicity, and length of relationship with their current partner.

Life Experiences Scale (LES; Appendix H). The LES survey assessed 47 major life events for the general population and an additional 10 major school-related events for students. Participants indicated whether or not they had experienced each event in the past year and reported the effect it had on them. The 7-point scale ranged from -3 (extremely negative) to +3 (extremely positive). The scores were summed across all experiences that participants reported (*Sarason et al., 1978).*

Hassles Scale (Appendix I). Based on the hypothesis of Lazarus (1966) that daily hassles may actually be more stressful as chronic stressors than life experiences, the Hassles Scale was developed to measure 117 possible hassles. If the hassle occurred during the past month, participants indicated how severe of a stressor they found the hassle to be on a scale from 1 (Somewhat severe) to 3 (Extremely severe). The scale can be scored by counting the number of hassles or by summing the total score for each hassle. The two methods are highly correlated with one another and show similar correlations with measures of interest (Kanner et al., 1981). The present study used the summed total score. The average score for this measure in an adult population is 20.25.

Pre-Study Screening. Prior to being contacted for the Phone Screen, participants completed an online Pre-Study Screening survey that included basic demographics and health information along with the Hassles Scale. Previously determined means from the Hassles scale were used to categorize participants into Average Stress and High Stress

groups. Those reporting a score of 15-30 were considered to be in the Average Stress category, while those reporting a score of over 45 (1.5 SDs above the mean of 20.25) were considered to be in the High Stress category.

Female Sexual Function Index (Appendix F). The FSFI is a validated 19-item questionnaire designed to assess sexual functioning in women (Rosen et al. 2000). In addition to a total score, the FSFI measures sexual functioning in six domains: Desire, Arousal, Lubrication, Orgasm, Satisfaction, and Pain. A clinical cut-off score of 26.55 has been established to reliably discriminate between women with and without sexual dysfunction (Wiegel et al., 2005).

Distraction Quiz (Appendix G). Cognitive distraction was assessed with a multiple-choice quiz administered following the erotic film. The test consisted of five questions from the neutral portion of the film sequence and seven questions from the erotic portion of the film sequence to assess participants' attention to the content of each film. Each question had three multiple-choice response options from which participants were instructed to choose the best answer. The quizzes were scored by calculating the percent correct.

Apparatus

Vaginal photoplethysmograph. Genital arousal was measured using a vaginal photoplethysmograph (Sintchak & Geer, 1975). The vaginal photoplethysmograph is a clear, acrylic, tampon-shaped device that contains an infrared light-emitting diode as a light source, and a photosensitive light detector. When inserted into the vagina, the light source illuminates the capillary bed of the vaginal wall and the blood circulating within

it. Upon contact with the vaginal wall, some of the light is absorbed, while the rest is backscattered. The amount of backscattered light is related to the transparency of engorged tissue and serves as an indirect measure of vasoengorgement. The measure of interest from the photoplethysmograph is the pulse amplitude (VPA), which is received through the A/C signal and band pass filtered at 0.5 to 30 Hz. VPA was sampled 200 times per second. Results were measured in millivolts (mV). VPA was acquired using the software program AcqKnowledge III, Version 3.7.3 (BIOPAC Systems, Inc., Santa Barbara, CA) and a Model MP100WS data acquisition unit (BIOPAC Systems, Inc., Santa Barbara, CA) for analog/digital conversion.

Electrocardiograph (ECG). Heart rate and heart rate variability were measured via an ECG, which consisted of three disposable electrodes that were attached to the participant's body (upper right chest, lower left chest, and right ankle) and connected by cables to a BIOPAC Systems ECG100 module. The signal from the ECG100 module was recorded in real time using the AcqKnowledge software program. ECG was also sampled at 200 times per second.

Arousometer. Continuous subjective sexual arousal was measured during the erotic film using a hand-controlled device (Rellini et al., 2005) that consists of an optical computer mouse mounted on a wooden track divided into seven equally spaced intervals, where 0 indicated neutral, and 1–7 reflected increasingly higher levels of sexual arousal. A software program written in MatLab (The MathWorks, Inc, Natick, MA, USA) detects the position of the pointer with respect to the y-axis of the computer's monitor twice per second.

Saliva samples. For the purposes of this study, basal levels of hormones were needed, so participants were asked to provide a saliva sample prior to eating dinner (between 2:00 pm and 6:00 pm) the day before their session. Participants were instructed to freeze the test tube until their appointment. The instructions that were sent with the test tube can be found in Appendix J. Samples were assayed for cortisol and DHEA-S using enzyme-immunoassay kits from Salimetrics.

Procedures

After completing the online Pre-Study Screening, qualified women in the High Stress or Average Stress categories were contacted to schedule an appointment to come to the lab for psychophysiological testing. They were also mailed a test tube with instructions on how and when to provide the saliva sample. Once in the lab, participants had the study procedures explained to them and provided their consent to participate. Before leaving the room, the researcher attached the three ECG electrodes to them. Participants completed the questionnaire packet that consisted of the Demographics questionnaire, LES, Hassles Scale and FSFI. These questionnaires took approximately 20-30 minutes to complete. Participants were then asked to provide a second saliva sample. Once they had completed the saliva sample, participants were instructed to insert the photoplethysmograph and attach the electrode leads. The researcher verified that the photoplethysmograph and ECG signals were clear and then began the film sequence. After the film sequence, participants completed the Distraction Quiz, removed the photoplethysmograph and electrodes and got dressed.

Figure 4.1 Timeline of Study Procedures

Data analysis

Preprocessing

VPA data. VPA data were reduced by calculating the total change in amplitude for each heart beat. This was done by finding the peak and nadir for each pulse wave and computing the differences between the two, using AcqKnowledge software. Artifacts in the data were identified visually by the researcher and removed manually. VPA was averaged across the neutral film and the erotic film. In order to control for individual variability in VPA signals, a VPA difference score for each person and each condition was calculated as the percent change in VPA during the experimental film over the neutral film.

Subjective Arousal. Data gathered from the Arousometer were calculated as a percent change over neutral.

EGC data. Heart rate was determined by calculating the average beats per minute from the ECG signal for the neutral and erotic portions of each film for each participant. Heart rate variability was calculated from the ECG signal by determining the time interval between each heart beat (R-R interval). The R-R intervals from the neutral segment (three minutes) and from the experimental segment (final three minutes) were entered into a MATLAB based program, Biosignal (Niskanen et al., 2002). This program

analyzed several aspects of heart rate variability, including the standard deviation of the R-R intervals (SDRR). The SDRR is a measure of vagal or parasympathetic activity, and increases in response to parasympathetic activation (Task Force, 1996). For heart rate and heart rate variability, raw scores were entered into the analyses instead of difference scores. This allowed for detection of differences between the Average Stress and High Stress groups at baseline.

Statistical analyses

For the genital arousal, subjective arousal, hormonal, Distraction Quiz, and FSFI data, all scores of interest were entered separately as the dependent variable into an independent samples t-test with stress group (Average or High) as the between-subjects variable. For heart rate and HRV, scores were entered into a mixed model ANOVA with film type (neutral or erotic) as the within-subjects variable and stress group as the between-subjects variable.

Results

Reported levels of stress

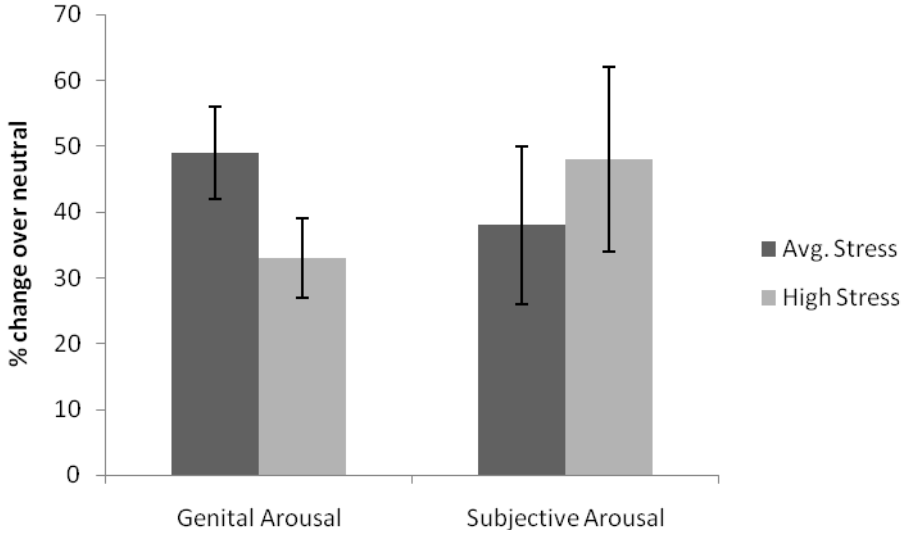
The mean score on the Hassles Scale was 25.11 (*SD* = 6.3) for the Average Stress group and 68.00 (*SD* = 6.0) for the High Stress group. Participants in both groups reported similar scores on the LES. The Average Stress group had an average of -1.3 (*SD* = 1.1) and the High Stress group had an average of -1.9 (*SD* = 1.3).

Genital and subjective arousal

As expected, women in the High Stress group showed significantly lower levels of genital arousal than the Average Stress group in response to the erotic film, *t*(28) =

2.85, p = .03. There was no significant difference between the groups on their subjective arousal, $t(26) = 1.26$, p = .21 (Figure 4.2).

Figure 4.2 Genital and Subjective Arousal for High and Average Stress Groups

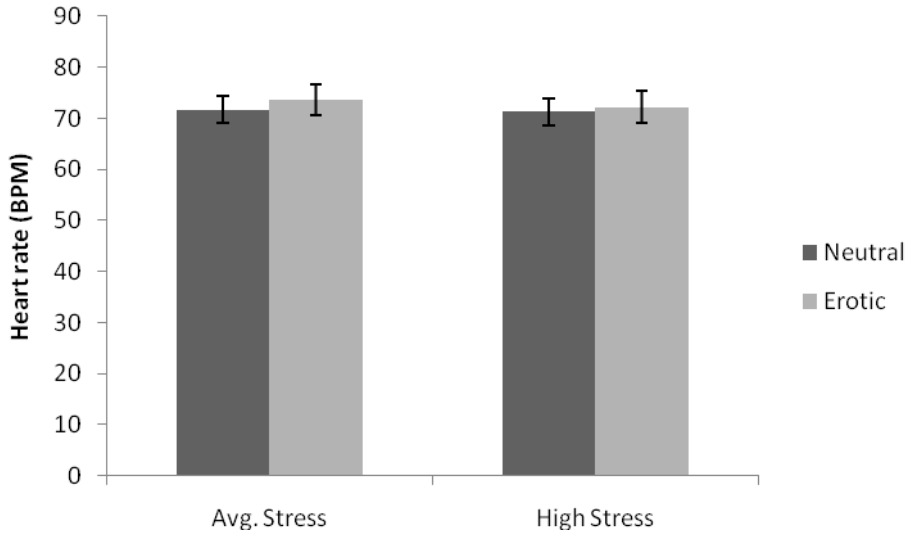


Percent change over baseline for genital and subjective arousal (+/- *SEM*). The women in the High Stress group showed significantly lower levels of genital arousal than the Average Stress group. There was no significant difference between the groups on their reported subjective arousal.

Autonomic activity

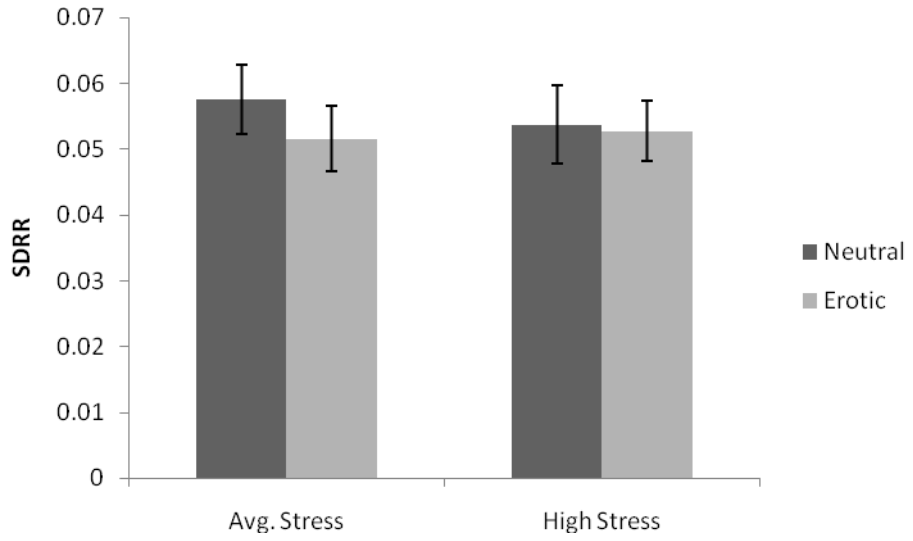
The women in the High and Average Stress groups did not show any significant differences in heart rate, $F(1, 28) = .95$, p = .65 or in HRV, $F(1, 28) = 1.9$, p = .12. There was also no change in heart rate, $F(1, 28) = 1.1$, p = .41 or HRV, $F(1, 28) = 1.8$, p = .14 across film type (neutral vs. erotic). (Figures 4.3 & 4.4).

Figure 4.3 Heart Rate in Response to Neutral and Erotic Films



Heart rate (BPM) (+/- *SEM*). There was no significant difference in heart rate across stress group or film type.

Figure 4.4. Heart Rate Variability in Response to Neutral and Erotic Films

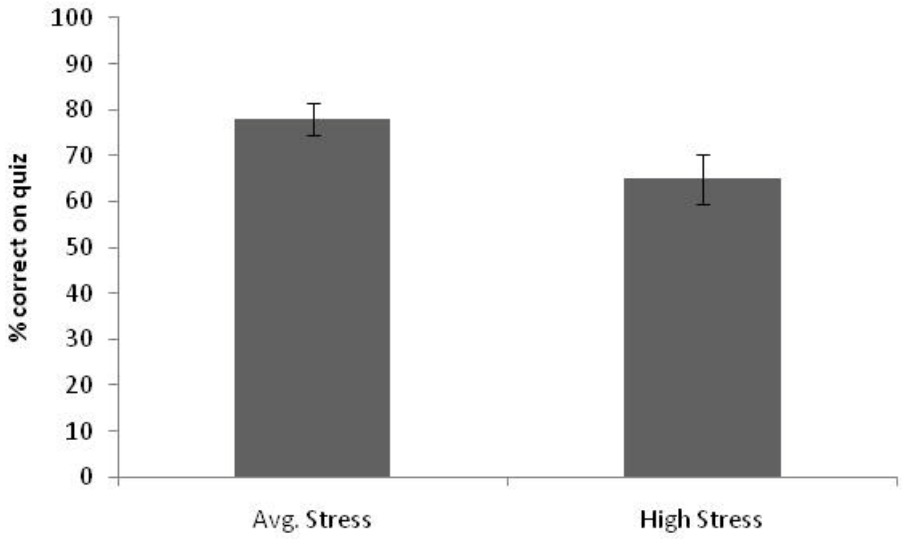


Heart rate variability (SDRR) (+/- *SEM*). There was no significant difference in HRV across stress group or film type.

Distraction Quiz

Participants in the High Stress group scored significantly lower on the Distraction Quiz than the Average Stress group, indicating higher levels of distraction while watching the film sequence, $t(27) = 3.14$, $p = .02$ (Figure 4.5).

Figure 4.5 Scores on the Distraction Quiz

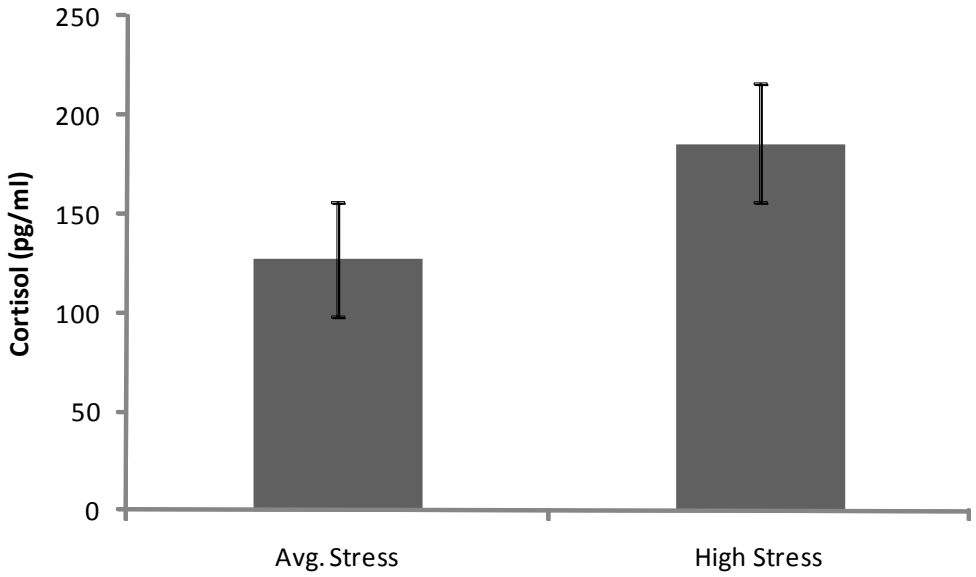


Percent correct on quiz (+/- *SEM*). Women reporting high levels of chronic stress scored significantly lower on the Distraction Quiz than women reporting average levels of chronic stress.

Basal Hormones

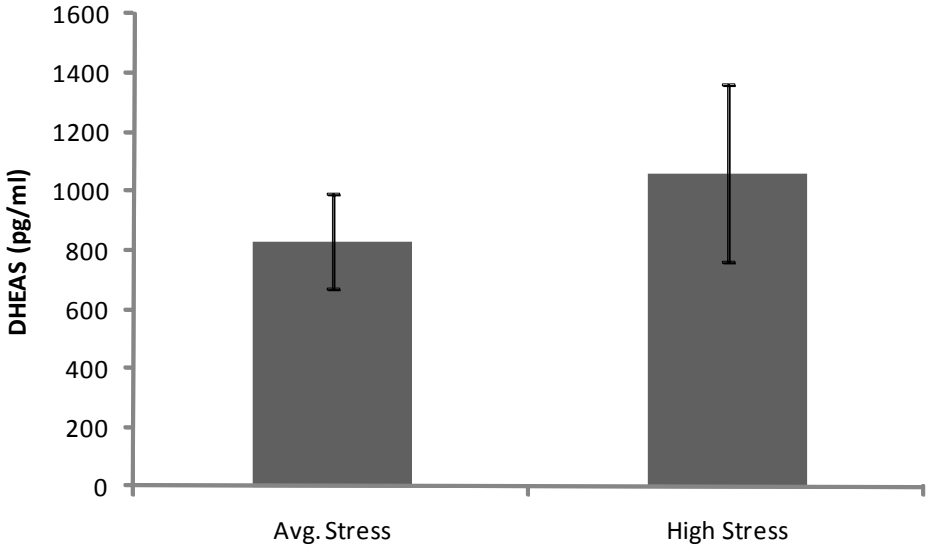
Using the saliva samples that participants provided the afternoon prior to coming to the lab, I completed assays for cortisol and DHEAS. Cortisol levels were significantly higher in the High Stress group compared to the Average Stress group, $t(26) = 2.86$, $p = .04$ (Figure 4.6). There were no significant differences between the groups on DHEAS levels $t(26) = .63$, $p = .54$ (Figure 4.7).

Figure 4.6. Basal Cortisol Levels



Cortisol (pg/ml) (+/- *SEM*). The High Stress group had significantly higher basal cortisol levels than the Average Stress group.

Figure 4.7. Basal DHEAS Levels

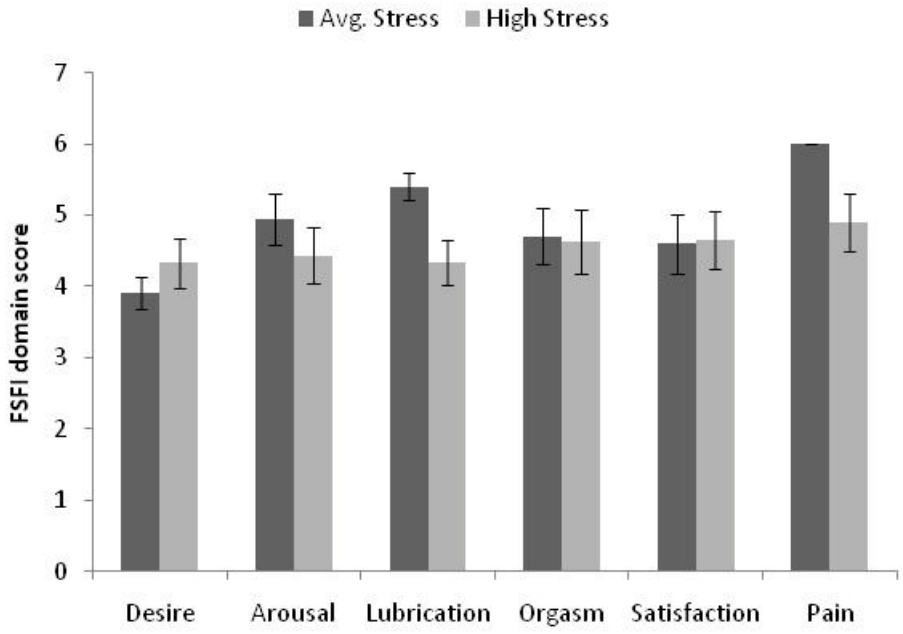


DHEAS (pg/ml) (+/- *SEM*). The High Stress and Average Stress groups did not significantly differ on their basal DHEAS levels.

Sexual Functioning

There were no significant differences in the FSFI total score between the High Stress and Average Stress groups *t(*28) = 1.44, p .27. Analyses done on the six domains of the FSFI found that the High Stress group reported more problems with Lubrication, *t*(28) = 2.11, *p* = .03 and Pain *t*(28) = 2.4, *p* = .02, than the women in the Average Stress group (Figure 4.8).

Figure 4.8 Scores on the Female Sexual Function Index Domains



Mean FSFI domain scores (+/- *SEM*). There were no significant differences between the groups on the Desire, Arousal, Orgasm, and Satisfaction domains. Lubrication and Pain were reported as more problematic for women in the High Stress group.

Discussion

The present study examined sexual arousal, ANS activity, basal hormones, and cognitive distraction in women categorized as high and average in chronic stress. The goal was to understand the role of chronic stress in women's sexual arousal and the mechanisms that might explain the relationship between the two. As expected, women reporting high levels of stress (as measured by daily hassles) had lower levels of genital arousal in response to an erotic film than women reporting average levels of stress. The women high in chronic stress also had higher levels of cortisol and distraction, as was predicted.

The finding of decreased genital, but not subjective arousal in women high in chronic stress replicated the results of ter Kuile et al. (2007). The present study isolated the effects of chronic stress to verify the effect of chronic stress alone on sexual arousal. That both laboratory studies found the same results in relation sexual arousal and that these laboratory results correspond with questionnaire-based studies indicates that the negative effect of chronic stress is fairly robust.

In addition to measuring women's sexual arousal response in the laboratory, the present study also measured their sexual functioning over the past four weeks with the FSFI. In the laboratory, women in the High Stress group showed impaired genital but not subjective arousal, and this finding corresponds with results of the FSFI. Women in the High Stress group reported more problems with the FSFI domains associated with genital arousal (Lubrication and Pain domains), but not subjective arousal (the Arousal domain). Since both the laboratory results and the FSFI results indicate problems with the

physiological components of arousal, it is likely that the physiological aspects of having higher chronic stress (i.e., high levels of cortisol) are the main mechanisms interfering with genital arousal. I would expect that the same mechanisms that link stress to problems with reproductive function (interactions between the HPA and HPG axes) also explain the relationship between chronic daily stress and sexual arousal.

Cortisol levels were higher for women in the High Stress group than for women in the Average Stress group. As outlined in Chapter 1, cortisol is known to impair reproductive function. When cortisol was increased in response to acute stress in the previous study, it did not impair sexual arousal in women. Based on the results from the present study, it appears that cortisol needs to be chronically high in order for it to elicit a negative effect on women's genital sexual arousal response. The higher levels of cortisol seen in women with high levels of stress in the present study did not impair their subjective arousal, however. This suggests that the physiological effects of cortisol affect only the physiological components of arousal.

There were no differences in DHEAS levels between the High Stress and Average Stress groups. If DHEAS is co-released with cortisol as has been hypothesized by Welsh et al. (1999), it is possible that the increase only occurs in response to an acute stressor and is not sustained over time in response to chronic stress. DHEAS has been shown to have health benefits that potentially counteract the negative effects of cortisol (e.g., Grillon, Pine, Baas, Lawley, Ellis, Charney, 2006), so having increased cortisol without the benefit of increased DHEAS could be an additional factor contributing to the negative effect of chronic stress on genital arousal.

Contrary to the previous studies on acute stress, there was no evidence for the role of the ANS in this study of chronic stress. The two previous studies were looking specifically at acute stress and the immediate response of the ANS related to the stressors. SNS activation is the first stage in the stress response and occurs immediately in response to a threatening situation. With chronic stress, there is no immediate threat, so it is likely that the SNS is not constantly active in the manner in which cortisol seems to be. The hormones released by the SNS, specifically NE, are generally considered to enhance genital arousal, so the lack of increase in SNS activity could contribute to the negative effect of chronic stress on genital arousal.

Surprisingly, the higher level of distraction seen in the High Stress group did not correspond with lower levels of subjective arousal as was expected. Inducing distraction experimentally has been repeatedly shown to have a significant negative effect on both genital and subjective arousal (Adams et al., 1985; Elliot & O'Donohue, 1997; Salemink & van Lankveld, 2006). Although the present study did find an effect of distraction on genital arousal, I expected that cognitive distraction to interfere more directly with the cognitive component of arousal. There are two possibilities for why the present study did not find an effect of distraction on subjective arousal. One is that chronic stress elicits a lower level of distraction compared to laboratory manipulations in which participants are required to attend to multiple sources of cognitive input at the same time. A second, related explanation is that in the present study distraction was not manipulated; it was simply measured as a response to stress. The measurement was also indirect and inferred through participants' scores on the Distraction Quiz. It is possible that participants were

able to pay attention to the arousing stimuli in the film clip, but perhaps not the smaller details they were asked about in the Distraction Quiz. A more direct measure of attention, such as participant self-report or even an eye-tracking device may show a stronger link between distraction and subjective sexual arousal.

Chronic daily hassles do impair women's genital sexual arousal response both in the laboratory and in the women's reports of their sexual functioning over the past four weeks. It appears that increased distraction, increased cortisol, as well as a lack of increase in SNS activity and DHEAS are mechanisms that contribute to this effect. Chronic stress, as measured in the present study, did not have an effect on subjective sexual arousal. While it is reassuring to know that chronic stress does not appear to interfere with subjective arousal, adequate genital arousal is necessary for a woman to be able to reach orgasm. Interventions to target the negative effects of chronic stress on genital arousal can perhaps include relaxation techniques or sensate focus, which encourages women to focus on erotic sensations in their body (Masters & Johnson, 1970). The former could reduce levels of cortisol, while the latter could reduce distraction.

Chapter 5: General Discussion

Summary

The goal of this dissertation was to explore the relationship between psychological stress and sexual arousal and the mechanisms that might explain this relationship. Study 1 exposed participants to three different types of arousing stimuli to explore the underlying physiological components involved in these states of arousal that might explain a facilitatory relationship between the stressful and sexual arousal. Cortisol and DHEAS responses were significantly different for stressful and sexual arousal, while the SNS responses for stress and sexual arousal were similar. Study 2 used two stressors to test the effects of personally relevant and generic stressors on subsequent sexual arousal. One of the stressors was known to increase cortisol while the other did not. In addition to measuring physiological mechanisms, the second study also added measures of psychological components (distraction and misattribution of arousal). Both stressors resulted in a significant increase in genital arousal, indicating that even an increase in cortisol did not have a negative effect on genital arousal. There was no evidence for changes in subjective arousal, nor for an effect of the psychological mechanisms. The third study compared women who reported that they experienced either high levels of chronic stress or average levels of chronic stress. Women in the High Stress group had significantly lower genital arousal, and higher levels of cortisol and distraction.

Mechanisms

Several mechanisms were proposed that might explain how stress could enhance or impair sexual arousal. The proposed physiological mechanisms included hormonal (cortisol, DHEAS) and ANS components. The proposed psychological mechanisms were distraction and misattribution of arousal. None of the stressors had any measurable effect on subjective arousal, so the discussion will be focused on the effects of stress on genital arousal.

Autonomic nervous system

ANS activity, specifically the activation of the SNS, seems to be most important for the relationship between acute stress and genital arousal. The SNS is the first system to respond to stressors. In addition to increasing blood flow throughout the body, the SNS also releases NE into the blood stream, which facilitates genital arousal. This release of NE, which occurs immediately after a stressor, is potentially a protective factor against any negative effects that a subsequent release of cortisol might have on genital arousal.

SNS activity does not seem to be related to genital arousal when women are high in chronic stress. Because there is no immediate stressor to respond to, there was no difference observed between women with high and average levels of stress in their SNS responses to sexual stimuli. This lack of increase in SNS activity could also play a role in the inhibition of genital arousal in women high in chronic stress. Without an increase in SNS, the elevated level of basal cortisol in this group is not counteracted by release of NE. The previous study that looked at both acute and chronic stress did not discuss any differences in response to acute stress between the high and low chronic stress

participants (ter Kuile et al., 2007). A future study should examine the sexual arousal responses of women high and low chronic stress when they are exposed to acute stress. If NE/SNS activity serves a protective function, then women high in chronic stress would not show impaired genital arousal to sexual stimuli that follows an acute stressor. Alternatively exposing women already high in chronic stress to an acute stressor may result in even more impaired sexual arousal.

Cortisol

Cortisol has been repeatedly demonstrated to have deleterious effects on reproductive function in both human and animal models. It was hypothesized for the present studies that it would also be detrimental to sexual function, as the same HPA and HPG axis components are involved in both reproductive and sexual function. In Study 1, cortisol was not increased in response to the stressful film, which led me to conclude that the lack of cortisol increase was a factor that could explain why stressful films did not impair arousal in previous studies. However, in Study 2, even a stressor known to increase cortisol was shown to increase arousal compared to the Control condition. The results of Study 2 indicated that increased cortisol in response to acute stress does not immediately impair genital arousal. This is consistent with previous research demonstrating that women whose cortisol increased in response to a sexual film did not show differences in genital arousal compared to women whose cortisol decreased (Hamilton, Rellini, & Meston, 2008). Acute stress, however, is an adaptive response to one's environment, whereas chronic stress has been associated with more negative effects because of the prolonged exposure to stress hormones, such as cortisol.

Cortisol does seem to have a negative impact when the stress is chronic and basal cortisol is elevated over longer periods of time. One explanation for the difference between acute and chronic stress could be the different corticosteroid receptor types that are activated by acute and chronic stress. In the brain, corticosteroid receptor type I has a high affinity for cortisol and responds to changes in basal levels of cortisol. corticosteroid receptor type II has a lower affinity for cortisol and is activated by large increases in cortisol that would occur in response to an acute stressor (e.g., McEwen, de Kloet, & Rostene, 1986; Sánchez, Young, Plotsky, & Insel, 2000). Activation of the difference receptor types could lead to cortisol having different effects on the HPG axis, which controls sexual function. This potential explanation should be explored further in animal models of stress and sexual response.

DHEAS

The role of DHEAS in the relationship between stress and sexual arousal is still somewhat unclear. Although DHEAS increased significantly in response to an erotic film, it also increased in response to a humorous film. Perhaps the release of DHEAS is linked with positive mood in general. Prior research has suggested that it is co-released with cortisol, but findings from the current studies did not suggest such a link. It is possible that the timing issues involved with saliva collection masked the relationship between the two hormones. Blood sampling would provide a more time-sensitive and accurate measure of any existing relationship.

Misattribution of arousal

In regards to psychological mechanisms, there was no evidence for cognitive misattribution in either the acute or chronic stress studies. Although the acute stressors increased subsequent genital arousal, they did not increase subjective arousal, which is what would be expected if there was a misattribution of arousal. The increased genital arousal seems more likely to be related to the physiological mechanisms (e.g., SNS activity) that are triggered by the acute stressors.

Distraction

Distraction did not seem to be a factor for the acute stress study. There were no differences in distraction in any of the conditions. It is possible that the moderate amount of acute stress actually enhances attention and focus, as has been shown in numerous other performance related domains, such as test-taking (e.g., Duffy, 1957). Individuals high in chronic stress had higher level of distraction during the film sequence. Contrary to my hypothesis, the heightened distraction was not related to subjective arousal. Perhaps distraction could be better assessed by measuring it directly. This could be done either by asking participants how distracted they felt during the sexual stimulus or by using a more objective measure such as eye-tracking to know the exact location of the participants' focus.

Conclusions

Neither acute nor chronic stress had an effect on subjective arousal, at least not as it was measured in the laboratory. The mechanisms by which acute and chronic stress affect genital sexual arousal appear to be different. Acute stress triggers the more

immediate SNS response, which appears to have a facilitatory effect on genital arousal. If the acute stressor is strong enough to elicit a cortisol response, it does not seem to have a negative effect on genital arousal in the short term. For chronic stress, however, the increased basal cortisol is likely a key mechanism impairing genital response. The ANS does not appear to play a role in the effects of chronic stress on genital arousal.

The role of distraction was also different for acute and chronic stress. High chronic stress was related to higher levels of distraction, while acute stress did not alter distraction scores. Misattribution of arousal did not play a role in the relationship between stress and sexual arousal for either acute or chronic stress.

Understanding that acute stress generally enhances genital arousal provides scientific support for such therapeutic recommendations as doing more novel and exciting things with one's partner to enhance their sex lives. It also lends credence to the anecdote that sexual activities are more enjoyable after a couple has an argument. The present studies demonstrate if the stressor is transient, then it is likely to be beneficial to sexual arousal.

Chronic stress has deleterious effects on sexual arousal for women. In order to address this negative effect, treatment studies could examine treatments targeted at the mechanisms behind the effects of chronic stress on sexual arousal. For example, a treatment could focus on having participants pay more attention to sexual cues (i.e. reduce distraction) through mindfulness therapy. Mindfulness therapy has previously been shown to be effective for sexual dysfunctions (Brotto, Basson, & Luria, 2008). In addition, the treatment could focus on techniques to reduce cortisol. Participants' cortisol

could be measured across time to see if reductions in cortisol lead to increases in sexual arousal. Of course, the ideal treatment would be to help women reduce their amount of stress, or at least learn to enhance coping abilities when confronted with high levels of chronic stress.

Overall, it is clear that acute and chronic stress affect sexual arousal in distinct ways. Acute stressors are beneficial for subsequent sexual arousal, even when they are personally relevant. Although there are mixed findings related to the effects of acute stress on arousal, when combined with evidence from physical acute stressors such as exercise (e.g., Meston & Gorzalka, 1995), the evidence seems to be in favor of a facilitatory effect of acute stress on arousal. The two laboratory studies on chronic stress and sexual arousal, as well as survey research almost unanimously indicate a negative effect of chronic stress on sexual arousal.

Appendices

APPENDIX A

Phone Screen Script

Hello, may I speak with (Name of Subject)?

This is (NAME) from the Female Sexuality Laboratory at the University of Texas at Austin.
Are you still interested in hearing more about the studies in our laboratory?

Is this a convenient time for me to tell you about the study and give you a chance to ask me any questions that you have?

To give you a bit of background on us, our lab is primarily interested in women's sexual arousal. We are one of the few laboratories within North America who study female sexuality.

Optional: Are you a Psychology 301 student? _____

The study consists of having you come into the laboratory on 2 separate occasions for one and a half hours each time.

If 301: At the end of the two sessions you will be compensated with 3 hours of credit

If non-301: At the end of the study you will be compensated with $30 as well as parking if you need to drive to campus.

How does that sound to you?

Now I am going to tell you more about the study:

There are two conditions that you will take part in if you decide to participate in the study: a control condition and an experimental condition. At the control condition you will fill out a questionnaire package that asks questions about you, including demographic information, and questions about your sexuality. These are very personal in nature, and include questions about your sexual history, behaviors, and sexual functioning. You are free not to answer any questions that you do not wish to answer. However, there is no identification of you personally on this questionnaire, only a code number. The information you give us here is strictly confidential. This questionnaire package will take approximately 10 minutes. During the experimental condition you will either watch a violent movie or participate in a short task. You will also provide saliva samples at the beginning and the end of the study.

After the questionnaires, movie or task, you will watch an adult pornographic video that features a heterosexual couple engaging in foreplay and vaginal intercourse. While you are watching each video, your physiological and psychological arousal will be measured. Psychological response will be measured with a computer mouse mounted on a track that you move to indicate how you are feeling.

Physical sexual arousal is measured with a device called a photoplethysmograph.

Have you heard of that before?

Okay, it's a small, tampon-shaped device that measures blood flow to the vagina in response to erotic material. You would insert it into your vagina yourself, in the privacy of a locked room. Once it's inserted, you won't be able to feel it there. Most women report that it's comfortable, and that they can't notice it at all. It is very safe, and has been used in sexuality research for over 35 years. Would you feel comfortable using this device? (If so-so response, "would you like to take some time to think about it and give us a call back?")

Do you have any questions about the photoplethysmograph at all?

After the erotic video, you will remove the photoplethysmograph, provide one more saliva sample and that will be the end of the session.

The second session and third sessions will be identical to the first, except you'll have a different video to watch each time.

Are you interested in participating?

IF NO – Thank you for your time.

IF YES – There are a couple of personal questions that I need to ask you. If you chose not to participate or if you do not fit the requirements of the study, the information you give me will be destroyed. Is it alright if I ask you some questions?

Phone Screen

How old are you?_____ *(must be over 18)*

Are you currently involved in a, sexually active relationship or have you had sexual intercourse with a partner in the past 4 weeks? _____ *(needs to be yes to one or the other)*

What is your sexual orientation? _____ *(Needs to be heterosexual or currently dating a man)*

Are you pregnant or have you recently breastfed? _____*(Must have stopped breastfeeding 3 or more months prior to participating.)*

Are you having regular menstrual periods? _____ *If no*, how irregular have they been?

_____
_____
_____
_____
(Not more than 1 missed menstrual period in the past 6 months)

Do you use a hormonal form of birth control?_____ *(If yes, exclude, but see if they qualify for Gardenia Study.)*

Have you had any surgical procedures involving your pelvic or reproductive organs, such as a hysterectomy or bladder surgery? *(Most minor procedures are OK, including cyst removal, "D&C", surgical abortion, C-section, LEEP procedure, and colposcopy.)*_____
_

Have you been diagnosed with a psychological disorder? *(Exclude if untreated, examples include bipolar disorder or schizophrenia)*

_____

Do you have any neurological impairments due to diabetes, stroke , pelvic nerve damage, cancer treatments , multiple sclerosis or spinal cord damage? *(Exclude if yes)*

_____

Do you have any untreated kidney or endocrine disease? *(Exclude if yes)*

_____

Are you taking any medications or herbal supplements at the present time?

_____-

(Women receiving any of the following medications will be excluded from the study):

- Dehydroepiandrosterone (DHEA), testosterone and other androgens, estrogens (except oral contraceptives), progesterone, tamoxifen, raloxifene, and other selective estrogen receptor modulators (SERMs)
- Beta blockers or other drugs that affect the autonomic nervous system and/or cardiovascular system

- Any approved or experimental medications or treatments used to enhance the sexual response (e.g., sildenafil).

Sexual arousal

Now I'm going to ask you about sexual arousal. There are two areas of arousal – mental sexual arousal and physical sexual arousal. Mental sexual arousal is being sexually aroused in your mind or "into it" during sexual activity.

a) Do you ever have a difficulty with **mental sexual arousal**?_____ (if yes, exclude)

Ok, now I'm going to ask you about physical sexual arousal, which is lubrication or wetness, or a swelling pulsing genital response

b) Do you ever have difficulty with **physical sexual arousa*l****?*_____ *(*if yes, exclude)

Do you ever experience a persistent or recurring difficulty in attaining or maintaining sexual arousal? _____

I am going to read a list of several conditions, and I would like you to tell me if you currently have any of the following: pelvic or vaginal infection, hepatitis, HIV, pelvic inflammatory disease, genital herpes, or any other sexually transmitted disease? *(Exclude if yes to any)*

_____
_

Now I need to ask you a couple of questions about your sexual history, <u>including questions about unwanted sexual contact</u>, is that OK?

Do you ever feel anxious or panicked when you are approached or touched sexually?_____ *(Exclude if yes)*

Are you currently experiencing any distress related to a history of sexual assault, abuse, or other unwanted sexual contact? *(OK if there is a history of sexual abuse/assault, but not experiencing current distress.)*_____

----------**END OF SCREENING**----------

<u>IF PARTICIPANT **DOES NOT** QUALIFY:</u>

"Unfortunately you did not meet our criteria for this particular study. I can shred the information we just discussed, or if you would like to be contacted for possible future studies, I can keep your information in our confidential file. Which would you prefer?"

IF PARTICIPANT **DOES** QUALIFY:

"You are qualified to enroll in this study. Would you like to schedule an appointment to participate? (*IF YES* →) OK, I'll need to look at our schedule and find out the times that are available, and also I need to schedule you between days 5-10 of your menstrual cycle, but not when you are having your period.
How long is your period usually? _____
When are you expecting your next period? _____ If she is not sure, Can you give me a rough estimate, and I can call you back around that time?_____
Try to schedule a date or make a date to call her back.

WHEN YOU DO BOOK THE APPOINTMENT:
Ask the participant not to eat, drink anything but water, smoke, or exercise for one hour before coming to the lab.

APPENDIX B

Demographics Questionnaire

1. Age: _____

2. Gender: _____

3. Ethnicity

American Indian or Alaska Native: A person having origins in any of the original peoples of North, Central, or South America, and who maintains tribal affiliations or community attachment.
Asian: A person having origins in any of the original people of the Far East, Southeast Asia, or the Indian subcontinent.
Black or African American: A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander: A person having origins in any of the original people of Hawaii, Guam, Samoa, or other Pacific Islands.
White: A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.
Hispanic or Latino: A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin.

Other: _____

4. Relationship Status (please check all that apply):

Single
Dating but not in a long-term relationship
In a long-term relationship but not monogamous
In a monogamous relationship but not living together
In a monogamous relationship and cohabiting (living and having a relationship with a same- or opposite sex individual for less than 12 months)
In a monogamous relationship and common-law (living and having a relationship with a same- or opposite-sex individual for 12 months or more)
Married

5. Have you ever been divorced / widowed / separated YES NO

6. If you are currently in a relationship, How long have you been in this relationship?

_____ years _____ months

7. a. Do you have children? YES NO

b. If you have children, how many children do you have? _____

8. Which of the following best describes your actual sexual experiences (including romantic kissing, petting, intercourse, etc) from puberty until now? Heterosexual refers to interaction with the opposite sex, homosexual refers to the same sex as yourself. Please check one.

Exclusively heterosexual with no homosexual contact
Predominantly heterosexual with only a few homosexual contacts
Predominantly heterosexual with more than a few homosexual contacts
Equally heterosexual and homosexual in contact
Predominantly homosexual with more than a few heterosexual contacts
Predominantly homosexual with only a few heterosexual contacts
Exclusively homosexual with no heterosexual contact

9. How would you define your sexual orientation? (please circle one).

Heterosexual Bisexual Lesbian/Gay Unlabeled Other _____

_____

APPENDIX C

Screening Questionnaire

The following questions will be used to determine any possible factors that could alter your physiological responses to the stimuli.

1. Are you currently taking any prescription or nonprescription medications, hormonal contraceptives, or other hormone supplements or preparations? If yes, please list them here.

   _____

   _____

   _____

2. Do you ever feel anxious or panicked when you are approached or touched sexually?

   YES NO

3. Are you currently experiencing any distress related to a history of sexual assault, abuse, or other unwanted sexual contact? YES NO

4. What is the normal length of your menstrual cycle in days, from the first day of one menstrual period to the first day of the next menstrual period? _____

5. How regular are your menstrual cycles in their time of onset? (Please circle one)

   # perfectly regular

   # varies by 1-2 days

   # varies by 3-4 days

   # varies by 5-6 days

   # varies by 7 days or more

   # completely unpredictable

6. Are you pregnant or breast-feeding an infant at present? YES NO

7. Do you ever go through long periods of time without having menstrual periods (for reasons other than pregnancy)? YES NO

If yes, has this happened in the last 12 months? YES NO

8. Are you currently menstruating? YES NO

If yes, what date did your current period begin? _____

If no, what date did your last period begin? _____

9. Do you have any untreated endocrine disease? YES NO

10. In the past hour have you done any of the following.

Had anything to eat? YES NO

Had anything to drink besides water? YES NO

Had a cigarette? YES NO

Brushed your teeth? YES NO

APPENDIX D

Subjective Response Scale

Please use the following scale to evaluate how you feel right now. Please answer honestly and carefully. On the scale, circle the number which best describes how you are feeling/how you felt during the last film from 1 (not at all) to 7 (intensely).

Currently, I feel/During the film I felt:	Not at all						Intensely
1. Faster breathing_____	1	2	3	4	5	6	7
2. Faster heart beat_____	1	2	3	4	5	6	7
3. Perspiration _____	1	2	3	4	5	6	7
4. Feelings of warmth_____	1	2	3	4	5	6	7
5. Any physical reaction at all_____	1	2	3	4	5	6	7
6. Breast sensation_____	1	2	3	4	5	6	7
7. Warmth in genitals_____	1	2	3	4	5	6	7
8. Genital wetness or lubrication_____	1	2	3	4	5	6	7
9. Genital pulsing or throbbing_____	1	2	3	4	5	6	7
10. Genital tenseness or tightness_____	1	2	3	4	5	6	7
11. Any genital feeling_____	1	2	3	4	5	6	7
12. Sexually aroused_____	1	2	3	4	5	6	7
13. Sexual desire_____	1	2	3	4	5	6	7
14. Mental sexual arousal_____	1	2	3	4	5	6	7
15. Physical sexual arousal_____	1	2	3	4	5	6	7
16. Worried_____	1	2	3	4	5	6	7
17. Anxious_____	1	2	3	4	5	6	7
18. Angry_____	1	2	3	4	5	6	7
19. Disgusted _____	1	2	3	4	5	6	7
20. Embarrassed_____	1	2	3	4	5	6	7
21. Guilty_____	1	2	3	4	5	6	7
22. Sensuous_____	1	2	3	4	5	6	7
23. A desire to be close to someone____	1	2	3	4	5	6	7
24. Pleasure_____	1	2	3	4	5	6	7
25. Interested_____	1	2	3	4	5	6	7
26. Attracted_____	1	2	3	4	5	6	7

27. Excited_____	1	2	3	4	5	6	7
28. Sexy_____	1	2	3	4	5	6	7
29. Dirty_____	1	2	3	4	5	6	7
30. Loving_____	1	2	3	4	5	6	7
31. Sexually attractive_____	1	2	3	4	5	6	7
32. Inhibited_____	1	2	3	4	5	6	7
33. Easy to arouse_____	1	2	3	4	5	6	7
34. Incompetent_____	1	2	3	4	5	6	7
35. Sexually turned off_____	1	2	3	4	5	6	7
36. Offended_____	1	2	3	4	5	6	7
37. Bored_____	1	2	3	4	5	6	7
38. Feminine_____	1	2	3	4	5	6	7
39. Masculine_____	1	2	3	4	5	6	7
40. Aggressive_____	1	2	3	4	5	6	7
41. Relaxed_____	1	2	3	4	5	6	7
42. Distressed_____	1	2	3	4	5	6	7
43. Upset_____	1	2	3	4	5	6	7
44. Strong_____	1	2	3	4	5	6	7
45. Scared_____	1	2	3	4	5	6	7
46. Hostile_____	1	2	3	4	5	6	7
47. Enthusiastic_____	1	2	3	4	5	6	7
48. Proud_____	1	2	3	4	5	6	7
49. Irritable_____	1	2	3	4	5	6	7
50. Alert_____	1	2	3	4	5	6	7
51. Ashamed_____	1	2	3	4	5	6	7
52. Inspired_____	1	2	3	4	5	6	7
53. Nervous_____	1	2	3	4	5	6	7
54. Determined_____	1	2	3	4	5	6	7
55. Attentive_____	1	2	3	4	5	6	7
56. Jittery_____	1	2	3	4	5	6	7
57. Active_____	1	2	3	4	5	6	7
58. Afraid_____	1	2	3	4	5	6	7

APPENDIX E

Experiences with Maltreatment Questionnaire

1. I consider myself a survivor of physical child abuse.

   Yes No

2. I consider myself a survivor of sexual abuse.

   Yes No

3. I consider myself a survivor of neglect.

   Yes No

4. I consider myself a survivor of psychological maltreatment.

   Yes No

5. I have observed one (or both) of my parents being emotionally abusive toward the other.

   Yes No

6. I have observed one (or both) of my parents being physically abusive toward the other.

   Yes No

7. I consider myself a victim of dating violence.

   Yes No

8. I consider myself a victim of bullying

   Yes No

APPENDIX F

Female Sexual Function Index

INSTRUCTIONS: These questions ask about your sexual feelings and responses during the past 4 weeks. Please answer the following questions as honestly and clearly as possible. In answering these questions the following definitions apply:

Sexual activity includes intercourse, caressing, foreplay, and masturbation.

Sexual intercourse is defined as penile penetration (entry) of the vagina.

Sexual stimulation includes situations like foreplay with a partner, self-stimulation (masturbation), or sexual fantasy.

CIRCLE ONLY ONE CHOICE PER QUESTION:

Sexual desire or interest is a feeling that included wanting to have a sexual experience, feeling receptive to a partner's sexual initiation, and thinking or fantasizing about having sex.

1. Over the past 4 weeks, how often did you feel sexual desire or interest?	5 = Almost always or always 4 = Most times (more than half the time) 3 = Sometimes (about half the time) 2 = A few times (less than half the time) 1 = Almost never or never
2. Over the past 4 weeks, how would you rate your level (degree) of sexual desire or interest?	5 = Very high 4 = High 3 = Moderate 2 = Low 1 = Very low or none at all
3. Over the past 4 weeks, how often did you feel sexually aroused ("turned on") during sexual activity or intercourse?	5 = Almost always or always 4 = Most times (more than half the time) 3 = Sometimes (about half the time) 2 = A few times (less than half the time) 1 = Almost never or never N/A = No sexual activity
4. Over the past 4 weeks, how would you rate your level of sexual arousal ("turn on") during sexual activity or intercourse?	5 = Very high 4 = High 3 = Moderate 2 = Low 1 = Very low or none at all N/A = No sexual activity

5. Over the past 4 weeks, how confident were you about becoming sexually aroused during sexual activity or intercourse?	5 = Very high confidence 4 = High confidence 3 = Moderate confidence 2 = Low confidence 1 = Very low or no confidence N/A = No sexual activity
6. Over the past 4 weeks, how often have you been satisfied with your arousal (excitement) during sexual activity or intercourse?	5 = Almost always or always 4 = Most times (more than half the time) 3 = Sometimes (about half the time) 2 = A few times (less than half the time) 1 = Almost never or never
7. Over the past 4 weeks, how often did you become sexually aroused (females–lubricated or "wet"; males–attained an erection) during sexual activity or intercourse?	5 = Almost always or always 4 = Most times (more than half the time) 3 = Sometimes (about half the time) 2 = A few times (less than half the time) 1 = Almost never or never N/A = No sexual activity
8. Over the past 4 weeks, how difficult was it to become aroused (females–lubricated or “wet"; males–erection) during sexual activity or intercourse?	1 = Extremely difficult or impossible 2 = Very difficult 3 = Difficult 4 = Slightly difficult 5 = Not difficult N/A = No sexual activity
9. Over the past 4 weeks, how often did you maintain your arousal (females–lubrication or "wetness"; males–erection) until completion of sexual activity or intercourse?	5 = Almost always or always 4 = Most times (more than half the time) 3 = Sometimes (about half the time) 2 = A few times (less than half the time) 1 = Almost never or never N/A = No sexual activity
10. Over the past 4 weeks, how difficult was it to maintain your arousal (females–lubrication or "wetness"; males–erection) until completion of sexual activity or intercourse?	1 = Extremely difficult or impossible 2 = Very difficult 3 = Difficult 4 = Slightly difficult 5 = Not difficult N/A = No sexual activity
11. Over the past 4 weeks, when you had sexual stimulation or intercourse, how often did you reach orgasm (climax)?	5 = Almost always or always 4 = Most times (more than half the time) 3 = Sometimes (about half the time) 2 = A few times (less than half the time) 1 = Almost never or never N/A = No sexual activity

12. Over the past 4 weeks, when you had sexual stimulation or intercourse, how difficult was it for you to reach orgasm (climax)?	1 = Extremely difficult or impossible 2 = Very difficult 3 = Difficult 4 = Slightly difficult 5 = Not difficult N/A = No sexual activity
13. Over the past 4 weeks, how satisfied were you with your ability to reach orgasm (climax) during sexual activity or intercourse?	5 = Very satisfied 4 = Moderately satisfied 3 = About equally satisfied and dissatisfied 2 = Moderately dissatisfied 1 = Very dissatisfied N/A = No sexual activity
14. Over the past 4 weeks, how satisfied have you been with the amount of emotional closeness during sexual activity between you and your partner?	5 = Very satisfied 4 = Moderately satisfied 3 = About equally satisfied and dissatisfied 2 = Moderately dissatisfied 1 = Very dissatisfied N/A = No sexual activity
15. Over the past 4 weeks, how satisfied have you been with your sexual relationship with your partner?	5 = Very satisfied 4 = Moderately satisfied 3 = About equally satisfied and dissatisfied 2 = Moderately dissatisfied 1 = Very dissatisfied
16. Over the past 4 weeks, how satisfied have you been with your overall sexual life?	5 = Very satisfied 4 = Moderately satisfied 3 = About equally satisfied and dissatisfied 2 = Moderately dissatisfied 1 = Very dissatisfied
17. **Females only:** Over the past 4 weeks, how often did you experience discomfort or pain during vaginal penetration?	1 = Almost always or always 2 = Most times (more than half the time) 3 = Sometimes (about half the time) 4 = A few times (less than half the time) 5 = Almost never or never N/A = No vaginal penetration
18. **Females only:** Over the past 4 weeks, how often did you experience discomfort or pain following vaginal penetration?	1 = Almost always or always 2 = Most times (more than half the time) 3 = Sometimes (about half the time) 4 = A few times (less than half the time) 5 = Almost never or never N/A = No vaginal penetration

19. **Females only:** Over the past 4 weeks, how would you rate your level (degree) of discomfort or pain during or following vaginal penetration?	N/A = No sexual activity 1 = Very high 2 = High 3 = Moderate 4 = Low 5 = Very low or none at all N/A = No vaginal penetration

APPENDIX G

Distraction Quiz

Please answer the following questions about the Lewis and Clark video that you watched. Please select one answer choice for each question.

1. This expedition is known as the equivalent of
    a. the first walk on the moon
    b. the Kennedy assassination
    c. the Genome Project

2. What kind of creatures did they think they may find?
    a. penguins
    b. wooly mammoths
    c. mountain lions

3. The expedition was charged to
    a. find rare flowers used for curing consumption
    b. claim more land
    c. find passage to the western ocean

4. Thomas Jefferson appointed who on this expedition
    a. Meriwether Lewis
    b. William Clark
    c. Sacagawea

5. How old was William Clark when he embarked on the expedition
    a. 39
    b. 40
    c. 32

6. How old was Meriwether Lewis when he embarked on the expedition
    a. 32
    b. 28
    c. 30

7. What experience did William Clark bring to this expedition
    a. chief aid
    b. army commander
    c. blacksmith

Please answer the following questions about the erotic video that you watched. Please select one answer choice for each question.

8. Which of the following item was in the video
    a. fern
    b. pillows
    c. paintings

9. When the man gave the woman oral sex
    a. he took off her shoes
    b. lifted the woman and took her over to a couch
    c. straddled the woman, who was laying on the couch

10. When the man and woman first moved to the couch, he started to
    a. get on top of her to begin intercourse
    b. kiss her breasts and her clitoris
    c. take off all of her clothes

11. The woman wore all of the following throughout the movie EXCEPT:
    a. ring
    b. shoes
    c. skirt

12. The man and woman first engaged in sexual intercourse with
    a. the woman on top facing backwards from the man
    b. the woman standing and the man behind
    c. the woman sitting on the couch and the man on top

13. The woman was
    a. not at all shaved in her genital area
    b. completely shaved in her genital area
    c. partially shaved in her genital area

14. The color of the couch was
    a. red
    b. black
    c. blue

APPENDIX H

Life Experiences Scale

Listed below are a number of events which sometimes bring about change in the lives of those who experience them and which necessitate social readjustment. *Please check those events which you have experienced in the recent past and indicate the time period during which you have experienced each event.* Be sure that all check marks are directly across from the items they correspond to.

Also, for each item checked below, *please indicate the extent to which you viewed the event as having either a positive or negative impact on your life* at the time the event occurred. That is, *indicate the type and extent of impact the event had.* A rating of -3 would indicate an extremely negative impact. A rating of 0 suggests no impact either positive or negative. A rating of + 3 would indicate an extremely positive impact.

Section 1	Timing		Effect						
	0-6 Mos.	7-12 Mos.	Extremely Negative						Extremely Positive
1. Marriage			-3	-2	-1	0	1	2	3
2. Detention in jail or comparable institution			-3	-2	-1	0	1	2	3
3. Death of spouse			-3	-2	-1	0	1	2	3
4. Major change in sleeping habits (much more or much less sleep)			-3	-2	-1	0	1	2	3
5. Death of a close family member:									
a. Mother			-3	-2	-1	0	1	2	3
b. Father			-3	-2	-1	0	1	2	3
c. Brother			-3	-2	-1	0	1	2	3
d. Sister			-3	-2	-1	0	1	2	3
e. Grandmother			-3	-2	-1	0	1	2	3
f. Grandfather			-3	-2	-1	0	1	2	3
g. Other (specify)_____			-3	-2	-1	0	1	2	3
6. Major change in eating habits (much more or much less food intake)			-3	-2	-1	0	1	2	3
7. Foreclosure on mortgage or loan			-3	-2	-1	0	1	2	3
8. Death of close friend			-3	-2	-1	0	1	2	3
9. Outstanding personal achievement			-3	-2	-1	0	1	2	3
10. Minor law violations (traffic tickets disturbing the peace, etc.)			-3	-2	-1	0	1	2	3
11. *Male:* Wife/girlfriend's pregnancy			-3	-2	-1	0	1	2	3
12. *Female:* Pregnancy			-3	-2	-1	0	1	2	3
13. Changed work situation (different work responsibility, major change in working conditions, working hours, etc.			-3	-2	-1	0	1	2	3
14. New job			-3	-2	-1	0	1	2	3
15. Serious illness or injury of close family member:									
a. Father			-3	-2	-1	0	1	2	3
c. Sister			-3	-2	-1	0	1	2	3

	0-6 Mos.	7-12 Mos.	Extremely Negative						Extremely Positive
d. Brother			-3	-2	-1	0	1	2	3
e. Grandfather			-3	-2	-1	0	1	2	3
f. Grandmother			-3	-2	-1	0	1	2	3
g. Spouse			-3	-2	-1	0	1	2	3
h. Other (specify)_____			-3	-2	-1	0	1	2	3
16. Sexual Difficulties			-3	-2	-1	0	1	2	3
17. Trouble with employer (in danger of losing job, being suspended, demoted, etc.)			-3	-2	-1	0	1	2	3
18. Trouble with in-laws			-3	-2	-1	0	1	2	3
19. Major change in financial status (a lot better or a lot worse off)			-3	-2	-1	0	1	2	3
20. Major change in closeness of family members (increased or decreased closeness)			-3	-2	-1	0	1	2	3
21. Gaining a new family member (through birth, adoption, family member moving in, etc.)			-3	-2	-1	0	1	2	3
22. Change of residence			-3	-2	-1	0	1	2	3
23. Marital separation from mate (due to conflict)			-3	-2	-1	0	1	2	3
24. Major change in church activities (increased or decreased attendance)			-3	-2	-1	0	1	2	3
25. Marital reconciliation with mate			-3	-2	-1	0	1	2	3
26. Major change in number of arguments with spouse (a lot more or a lot less arguments)			-3	-2	-1	0	1	2	3
27. *Married male:* Change in wife's work outside the home (beginning work, ceasing work, changing to a new job, etc.)			-3	-2	-1	0	1	2	3
28. Married female: Change in husband's work (loss of job, beginning new job, retirement, etc.)			-3	-2	-1	0	1	2	3
29. Major change in usual type and/or amount of recreation			-3	-2	-1	0	1	2	3
30. Borrowing more than $20,000 (buying home, business, etc.)			-3	-2	-1	0	1	2	3
31. Borrowing less than $20,000			-3	-2	-1	0	1	2	3
32. Being fired from job			-3	-2	-1	0	1	2	3
33. *Male:* Wife/girlfriend having abortion			-3	-2	-1	0	1	2	3
34. *Female:* Having abortion			-3	-2	-1	0	1	2	3
35. Major personal illness or injury			-3	-2	-1	0	1	2	3
36. Major change in social activities, e.g., parties, movies, visiting (increased or decreased participation)			-3	-2	-1	0	1	2	3
37. Major change in living conditions of family (building new home, remodeling, deterioration of home, neighborhood, etc.)			-3	-2	-1	0	1	2	3

	0-6 Mos.	7-12 Mos.	Extremely Negative						Extremely Positive
38. Divorce			-3	-2	-1	0	1	2	3
39. Serious injury or illness of close friend			-3	-2	-1	0	1	2	3
40. Retirement from work			-3	-2	-1	0	1	2	3
41. Son or daughter leaving home (due to marriage, college, etc.)			-3	-2	-1	0	1	2	3
42. End of formal schooling			-3	-2	-1	0	1	2	3
43. Separation from spouse (due to work, travel, etc.)			-3	-2	-1	0	1	2	3
44. Engagement			-3	-2	-1	0	1	2	3
45. Breaking up with boyfriend/ girlfriend			-3	-2	-1	0	1	2	3
46. Leaving home for the first time			-3	-2	-1	0	1	2	3
47. Reconciliation with boyfriend/ girlfriend			-3	-2	-1	0	1	2	3
Other recent experiences which have had an impact on your life. List and rate.									
48. _____			-3	-2	-1	0	1	2	3
49. _____			-3	-2	-1	0	1	2	3
50. _____			-3	-2	-1	0	1	2	3
Section 2: Student Only									
51. Beginning a new school experience at a higher academic level (college, graduate school, professional school, etc.)			-3	-2	-1	0	1	2	3
52. Changing to a new school at same academic level (undergraduate, graduate, etc.)			-3	-2	-1	0	1	2	3
53. Academic probation			-3	-2	-1	0	1	2	3
54. Being dismissed from dormitory or other residence			-3	-2	-1	0	1	2	3
55. Failing an important exam			-3	-2	-1	0	1	2	3
56. Changing a major			-3	-2	-1	0	1	2	3
57. Failing a course			-3	-2	-1	0	1	2	3
58. Dropping a course			-3	-2	-1	0	1	2	3
59. Joining a fraternity/sorority			-3	-2	-1	0	1	2	3
60. Financial problems concerning school (in danger of not having sufficient money to continue)			-3	-2	-1	0	1	2	3

APPENDIX I

The Hassles Scale

Directions: Hassles are irritants that can range from minor annoyances to fairly major pressures, problems, or difficulties. They can occur few or many times. Listed in the center of the following pages are a number of ways in which a person can feel hassled. First, circle the hassles that have happened to you in the past month.
Then look at the numbers on the right of the items you circled. Indicate by circling a 1, 2, or 3 how SEVERE each of the circled hassles has been for you in the past month. If a hassle did not occur in the last month do NOT circle it.
SEVERITY
1 = Somewhat severe
2 = Moderately severe
3 = Extremely severe

(1) Misplacing or losing things	1	2	3
(2) Troublesome neighbors	1	2	3
(3) Social obligations	1	2	3
(4) Inconsiderate smokers	1	2	3
(5) Troubling thoughts about your future	1	2	3
(6) Thoughts about death	1	2	3
(7) Health of a family member	1	2	3
(8) Not enough money for clothing	1	2	3
(9) Not enough money for housing	1	2	3
(10) Concerns about owing money	1	2	3
(11) Concerns about getting credit	1	2	3
(12) Concerns about money for emergencies	1	2	3
(13) Someone owes you money	1	2	3
(14) Financial responsibility for someone who doesn't live with you	1	2	3
(15) Cutting down on electricity, water, etc.	1	2	3
(16) Smoking too much	1	2	3
(17) Use of alcohol	1	2	3
(18) Personal use of drugs	1	2	3
(19) Too many responsibilities	1	2	3
(20) Decisions about having children	1	2	3
(21) Non-family members living in your house	1	2	3
(22) Care for pet	1	2	3
(23) Planning for meals	1	2	3
(24) Concerned about the meaning of life	1	2	3
(25) Trouble relaxing	1	2	3
(26) Trouble making decisions	1	2	3
(27) Problems getting along with fellow workers	1	2	3

(28) Customers or clients give you a hard time	1	2	3
(29) Home maintenance (inside)	1	2	3
(30) Concerns about job security	1	2	3
(31) Concerns about retirement	1	2	3
(32) Laid-off or out of work	1	2	3
(33) Don't like current work duties	1	2	3
(34) Don't like fellow workers	1	2	3
(35) Not enough money for basic necessities	1	2	3
(36) Not enough money for food	1	2	3
(37) Too many interruptions	1	2	3
(38) Unexpected company	1	2	3
(39) Too much time on hands	1	2	3
(40) Having to wait	1	2	3
(41) Concern about accidents	1	2	3
(42) Being lonely	1	2	3
(43) Not enough money for health care	1	2	3
(44) Fear of confrontation	1	2	3
(45) Financial security	1	2	3
(46) Silly practical mistakes	1	2	3
(47) Inability to express yourself	1	2	3
(48) Physical illness	1	2	3
(49) Side effects of medication	1	2	3
(50) Concerns about medical treatment	1	2	3
(51) Physical appearance	1	2	3
(52) Fear of rejection	1	2	3
(53) Difficulties with getting pregnant	1	2	3
(54) Sexual problems that result from physical problems	1	2	3
(55) Sexual problems other than those resulting from physical problems	1	2	3
(56) Concerns about health in general	1	2	3
(57) Not seeing enough people	1	2	3
(58) Friends or relatives too far away	1	2	3
(59) Preparing meals	1	2	3
(60) Wasting time	1	2	3
(61) Auto maintenance	1	2	3
(62) Filling out forms	1	2	3
(63) Neighborhood deterioration	1	2	3
(64) Financing children's education	1	2	3
(65) Problems with employees	1	2	3
(66) Problems on job due to being a woman or man	1	2	3
(67) Declining physical abilities	1	2	3
(68) Being exploited	1	2	3

(69) Concerns about bodily functions	1	2	3
(70) Rising prices of common goods	1	2	3
(71) Not getting enough rest	1	2	3
(72) Not getting enough sleep	1	2	3
(73) Problems with aging parents	1	2	3
(74) Problems with your children	1	2	3
(75) Problems with persons younger than yourself	1	2	3
(76) Problems with your lover	1	2	3
(77) Difficulties seeing or hearing	1	2	3
(78) Overload with family responsibilities	1	2	3
(79) Too many things to do	1	2	3
(80) Unchallenging work	1	2	3
(81) Concerns about meeting high standards	1	2	3
(82) Financial dealings with friends or acquaintances	1	2	3
(83) Job dissatisfaction	1	2	3
(84) Worries about decisions to change jobs	1	2	3
(85) Trouble with reading, writing, or spelling abilities	1	2	3
(86) Too many meetings	1	2	3
(87) Problems with divorce or separation	1	2	3
(88) Trouble with arithmetic skills	1	2	3
(89) Gossip	1	2	3
(90) Legal problems	1	2	3
(91) Concerns about weight	1	2	3
(92) Not enough time to do the things you need to do	1	2	3
(93) Television	1	2	3
(94) Not enough personal energy	1	2	3
(95) Concerns about inner conflict	1	2	3
(96) Feel conflicted over what to do	1	2	3
(97) Regrets over past decisions	1	2	3
(98) Menstrual (period) problems	1	2	3
(99) The weather	1	2	3
(100) Nightmares	1	2	3
(101) Concerns about getting ahead	1	2	3
(102) Hassles from boss or supervisor	1	2	3
(103) Difficulties with friends	1	2	3
(104) Not enough time for family	1	2	3
(105) Transportation problems	1	2	3
(106) Not enough money for transportation	1	2	3
(107) Not enough money for entertainment and recreation	1	2	3
(108) Shopping	1	2	3

(109) Prejudice and discrimination from others	1	2	3
(110) Property, investments, or taxes	1	2	3
(111) Not enough time for entertainment and recreation	1	2	3
(112) Yardwork or outside home maintenance	1	2	3
(113) Concerns about news events	1	2	3
(114) Noise	1	2	3
(115) Crime	1	2	3
(116) Traffic	1	2	3
(117) Pollution	1	2	3

HAVE WE MISSED ANY OF YOUR HASSLES? IF SO, WRITE THEM IN BELOW:

APPENDIX J

Instructions for providing a saliva sample for the “Sexual Psychology” study.

This sample needs to be taken between the hours of 2:00 pm and 6:00 pm the day before your appointment at the Sexual Psychophysiology Lab.

Please do not eat (includes gum or candy), drink anything but water, smoke, exercise, or brush your teeth for one hour before providing this sample.

To provide the sample, you can remove the lid and drool or spit directly into the test tube. Please fill it until at least the 2 ml mark (not including bubbles). It helps if you think of something sour, like lemons, which should bring saliva into your mouth.

While providing the saliva sample, please time how long it took you to complete.

When the saliva sample is complete, please place it in your freezer until you bring it to the lab.

If you have any questions, please call Lisa Dawn Hamilton at XXX-XXX-XXXX.

Please complete the questions below and bring this form with you to the lab along with your saliva sample.

Date_____

Time of day _____

Length of time to complete the sample ____min ____sec

In the past hour have you

Had anything to eat	YES	NO
Had anything to drink	YES	NO
Smoked a cigarette	YES	NO
Engaged in exercise	YES	NO
Brushed your teeth	YES	NO

If you had any problems completing your sample, please note them here

_____
_____
_____
_____

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