An Evaluation and Comparison of Methods Assessing Erectile Dysfunction

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ABSTRACT

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Thermography is a relatively new physiological technique that assesses erectile functioning using genital temperature in response to a sexually explicit stimulus. This technique is cost effective and can be performed by any trained health professional. The current study aimed to assess thermography in screening and differentiating between the two types of erectile dysfunction (organic and psychogenic) while comparing it to the Doppler ultrasounds; the current gold standard for diagnosing erectile dysfunction.

Participants (n=81) referred from their urologist underwent thermographic analysis. Genital temperature, continuous and discrete self-reported sexual arousal measures were obtained at baseline, during and after viewing a sexually explicit film segment. An ultrasound procedure was scheduled on a subsequent day where measures of vascular functioning were obtained.

Results revealed that men in the psychogenic ED group had on average higher genital temperature change in response to the sexually explicit film. Thermography was most accurate in identifying participants with normal vascular functioning as compared to men who were classified as having organic ED.

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Introduction

Overview

In Canada, erectile dysfunction (ED) affects approximately 49.4% of men over the age of 40 (Grover et al., 2006). In fact, it has been found that men between the ages of 50-60 years old are three times more likely to have ED as compared to men in their twenties (Laumann, Paik, & Rosen, 1999). Furthermore, in a study examining an aging male population between the ages of 40 and 70 in Massachusetts, 53% of aging men reported some degree of interference with sexual activity due to erectile problems, with degree of severity increasing with age (Feldman, Goldstein, Hatzichristou, Krane, & McKinaly, 1994).

ED is defined as the continuous inability to achieve and/or uphold an erection that is satisfactory enough for sexual intercourse (American Psychiatric Association, 2013). For many men and their partners, this is a problem that greatly impacts their quality of life and sexual satisfaction (MacDonagh, Ewings, & Porter, 2002; Rosen, 1998; Wagner, K.Fugl-Meyer, & A.Fugl-Meyer, 2000). ED is a complex health issue and may have several underlying etiologies. Common causes of ED include organic or physiological factors, which have been found to contribute to about 30-50% of all cases of ED (Aydin, Ünal, Erol, Karaman, Yılmaz, & Erdal, 2001; Venetikou, Lampou, & Gizani, 2012). Additionally, psychogenic factors have also been found to have substantial implications for ED. For example, epidemiologic studies revealed that depressed mood, loss of self-esteem, anxiety, and other psychosocial factors to be substantial contributors to the diagnosis of ED (Aydin et al., 2001; Caspari, Huebgen, & Derouet, 1999; Feldman, Goldstein, Hatzichristou, Kranes, & Makinlay, 1994; Melman, Tiefer, & Pederson, 1988; Seidman & Roose, 2001). Furthermore, some of the findings established by these studies revealed that psychogenic ED accounts for approximately 40-50% of men with ED (Aydin et al.,
Moreover, the Massachusetts Male aging study (MMAS) showed that men who were depressed were 1.82 times more likely to have ED than men who were not, regardless of other comorbid health and demographic factors (Araujo, Durante, Feldman, & McKinlay, 1998). The diagnosis of ED, however, is not clear cut and many men may present both organic and psychogenic symptoms that may contribute to the diagnosis of ED (Schellack & Schellack, 2013).

**Organic/Physical Causes of ED**

Before introducing the different causes of organic ED, it is important to understand the basic physiology of an erection. The penis is composed of an extensive arterial network. Blood supply comes in from branches of the internal pudental artery, which become the penile artery. The penile artery then branches out into the dorsal and cavernosal arteries which supply blood to the corpora cavernosa through helicine arteries. The corpora cavernosa contains many smooth muscle and endothelial line sinusoids (vascular tissue) which are supplied with blood via arterioles (see Figure 1) (Halls, Bydawell, & Patel, 2009).

During an erection, the smooth muscles of the cavernosal arteries and sinusoids relax allowing for a rise in blood flow. Blood flow eventually causes engorgement of the sinusoids which results in penile rigidity and lengthening. The engorgement of the sinusoids prevents venous outflow and a pressure build up occurs in the penis, which maintains the erection (Halls et al., 2009).

Different classes of physical and organic factors contribute to the etiology of ED. They can be classified in to the following categories; vasculogenic, neurogenic, endocrinological, drug-induced and general health and lifestyle (Lue, 1999; Shamloul & Ghanem, 2013).
Vasculogenic factors that lead to ED are associated with dysfunctions in the arterial, vascular or venous systems of the male reproductive system. As previously described, when an erection occurs, blood flow to the penis increases and vascular tissue called sinusoids become engorged, preventing venous blood outflow from occurring to maintain an erection. This process is referred to as venous-occlusion and dysfunction in this mechanism may cause ED. Additionally, conditions such hypertension, cardiovascular disease, cigarette smoking and diabetes can lead to inadequate arterial blood flow to the penis, a phenomenon referred to as penile arterial insufficiency (Schellack & Schellack, 2013; Shamloul & Ghanem, 2013). This
occurs primarily due to the adverse effects these conditions have on the circulatory system, which can ultimately prevent sufficient blood flow to the penis (Shamloul & Ghanem, 2013).

Neurogenic factors play a role in ED because erections occur due to a complex series of events involving the central nervous system. Consequently, any disease affecting this system may cause erectile problems (Lue, 1999). Factors such as spinal cord injury, multiple sclerosis, temporal lobe epilepsy, and strokes are amongst some of the neurogenic disease that can contribute to ED (Shamloul & Ghanem, 2013). For example, the medial preoptic area (MPOA) and the paraventricular nucleus in the brain are two areas that have been considered to be important for sexual drive in animal studies (Lue, 1999). Parkinson’s disease is a neurological illness that affects these areas; therefore, ED is a common comorbidity amongst Parkinson’s disease patients (Lue, 1999). Additionally, factors such as alcoholism and diabetes impact the cavernous or dorsal nerve endings of the penis and may lead to erectile problems.

Endocrinological factors are associated with any dysfunction in the endocrine system. Conditions such as diabetes mellitus, hypo and hyperthyroidism are amongst the common diseases of this system that may lead to ED. This may be due to the fact that erectile functioning heavily depends on changes in male sex hormones, which can be altered by problems in the endocrine system (Schellack & Schellack, 2013). For example, androgens are responsible for sexual desire and maintaining normal sleep-wake erection (Shamloul & Ghanem, 2013). Consequently, imbalances in androgenic hormones due to a physical condition may lead to erectile problems.

Certain classes of drugs may be associated with ED. Amongst those are psychotropic drugs such selective serotonin reuptake inhibitors (SSRIs) and venlafaxine. Furthermore, anti-psychotic drugs such as respiridone and olanzapine are also associated with ED and are the most
likely amongst all psychotropic drugs to have a negative impact on erectile functioning (Dean & Lue, 2005). Anti-hypertensive drugs such as thiazides and β-blockers are also amongst the common classes of drugs to cause ED (Thomas & Woodard, 2003). Finally, recreational drugs such as marijuana, opiates, cocaine, nicotine and alcohol are also associated with the manifestation of ED (Schellack & Schellack, 2013). These drugs may cause erectile dysfunction due to their adverse effects on certain neurotransmitter pathways that are responsible for sexual activity (Lue, 1999). Additionally, some classes of drugs also have an effect on the control of the penile smooth muscle, a structure that is essential for increased blood flow to the penis during an erection (Lue, 1999).

Factors such as obesity, a sedentary lifestyle, hypertension, metabolic and heart disease have been associated with incidences of ED (Cuzin et al., 2011; Shamloul, 2013). Moreover, aging has been highly associated with developing ED; in fact, it is known to be the primary risk factor for ED (Shamloul, 2013; Wylie & Kenney, 2010). Natural hormonal changes such as decreased levels of testosterone, increased levels of follicle-stimulating hormone (FSH) and Luteinising hormone (LH) affect sexual desire and erectile functioning in aging men (Wylie & Kenney, 2010).

To conclude, organic ED is a multifaceted health problem that could have many underlying causes. It can be explained by certain chronic illness that may have secondary side effects affecting the male reproductive system. Life style habits, drug use and natural age progression may also contribute to organic ED.
Psychogenic ED

Psychogenic ED is primarily defined as being caused by psychological or interpersonal factors (Lizza & Rosen, 1999). The involvement of psychogenic factors in patients with ED, however, is sometimes inevitable due to the distressing nature of the condition, thus even in evidently organic ED cases, subsequent psychological complications often develop (Gambescia, Sendak & Weeks, 2009). In the next section, a detailed explanation of the underlying causes and theories of psychogenic ED will be explained.

Three categories were suggested by Gambescia and colleagues (2009) that may explain the etiology of psychogenic ED. The first is due to individual factors such as mental illness, certain personality traits, and performance anxiety. The second is due to interpersonal factors between sexual partners. For example, it has been demonstrated that factors such as lack of communication, intimacy, and power conflicts between couples may lead to erectile problems (Rosen, 2001). The third reason proposed by Gambescia and colleagues is intergenerational conditions such as developmental issues and socio-economic influences. Research has found that early developmental causes of arousal problems may arise from factors such as child sexual abuse, sexual orientation and identity problems, and cultural/religious taboos (Lauman, Paik & Rosen, 1999; Munoz, Bancroft, & Marshall. 1993).

A few theories have attempted to explain psychogenic ED over the last four decades. For instance, Masters and Johnson (1970) explained psychogenic erectile dysfunction to be caused by performance anxiety. Individuals are more focused on their performance rather than the sexually explicit stimulus, which creates cognitive distraction, and consequently arousal and erectile problems. Another theory that explains psychogenic ED was proposed by Barlow (1986). In his theory, Barlow proposed that the experience of a sexual encounter for individuals with
sexual dysfunction is triggered by a negative feedback mechanism (Barlow, 1986; Cranston-Cuebas & Barlow, 1990; van den Hout & Barlow, 2000). For example, based on previous negative sexual encounters, the potential for a new one would trigger negative affect and expectancies, heightened anxiety and arousal, an underestimated subjective feeling of an erection and a lack of a sense of control. The heightened arousal of this individual will then narrow their attention span to focus on the negative outcomes and consequences of this encounter which will lead to dysfunctional sexual performance (Barlow, 1986). In contrast, potential sexual encounters for individuals without a sexual dysfunction trigger positive affect, success expectancies, an accurate subjective feeling of an erection, and a positive sense of control. The focus of this individual will be on sexual cues, which will lead to functional performance (Figure 2) (Barlow, 1986). A similar theory was proposed by Bancroft (1999), whereby psychogenic arousal is said to be a fine balance between central excitatory and inhibitory mechanisms. Too much inhibition would cause erectile issues while too little inhibition may cause sexually risky behavior. In a normal sexual response, sexual stimuli would activate the sexual excitatory system (SES), which results in a genital response, and eventually ejaculation (Bancroft, 1999). In men with psychogenic ED, sexual stimuli are seen as a “perceived threat” due to factors such as stress and anxiety, which activate the sexual inhibitory system (SIS), leading to a lack of genital arousal and ultimately erectile problems.
In conclusion, psychogenic ED can be explained by personal and social challenges in the past and present, as well as mental health issues that may contribute to the onset of the disorder. As previously mentioned, psychogenic factors alone may contribute to up to 50% of all cases of ED (Aydin et al., 2001; Caspari et al., 1999; Melman et al., 1988). With this substantial prevalence, identifying the underlying cause of the problem (psychogenic vs organic cause) may greatly aid in the diagnostic and therapeutic process.

**Physiological Assessments of ED**

Assessing erectile functioning using physiological tools involves targeting blood flow to the penis as a measure of sexual response. As previously explained, in a typical arousal response, sexual stimuli trigger the activation of different pathways from and to the central nervous system.
that results in the stimulation of the pelvic floor muscles, which in turn trigger an increase in blood flow to the penis and eventually resulting in an erection (Parada & Germé, 2015). There are a number of tools that have been and are currently used to assess male sexual functioning, such as Penile Plethysmography and Rigiscan. Penile Plethysmography is a physiological measure of penile circumference in response to sexually explicit material. This objective measure is widely used in studies that examine pedophilia, sexual orientation, and sexual function (Both, Laan & Everaerd, 2011; Freund & Blanchard, 1989; Rosenthal, Sylva, Safron, & Bailey, 2012). The Rigiscan is a physiological measure that is typically used to assess erections during sleep which is referred to as nocturnal penile tumescence and rigidity (NPTR) (Bradley, Timm, Ghallagher & Johnson, 1985). This device measures erection rigidity on a contiguous basis from the base and tip of the penis by means of a portable device that is attached to the inner thigh of the patient. (Bradley, Timm, Ghallagher, & Johnson, 1985). These tools, however, have not been widely implemented as they have been associated with a number of drawbacks (Parada & Germé, 2015). For example, Penile Plethysmography has been associated with compromised reliability and a lack of standardization in instrumentation and data analysis (Lalumière & Harris, 1998). Moreover, Rigiscan has been criticized in that it produces results that are sometimes hard to interpret. For example, the rigiscan may show normal NPTR but the number of events required to rule out an organic underlying etiology to ED is hard to determine (Jannini, Granata, Hatzimouratidis, & Goldstein, 2009). Additionally, both Penile Plethysmography and Rigiscan are considered intrusive techniques that may be bothersome to the patients as both must be fitted onto the penis for measurement (Parada & Germé, 2015).

Colour-Doppler Ultrasound is the most widely used technique in assessing erectile problems, particularly in diagnosing organic ED, and is a well-established and reliable tool (Lue,
Thermography is a new tool used to assess erectile functioning that is minimally intrusive and cost effective (Kukkonen, Binik, Amsel, & Carrier, 2007; Kukkonen, Binik, Amsel, & Carrier, 2010). These two techniques will be the focus of the current research and are described in more detail in the following sections.

**Colour Doppler Ultrasound.** Ultrasound, also referred to as sonography, has been widely used in the diagnosis of organic/physiological ED (Parada & Germé, 2015). Ultrasound works through the imaging subcutaneous structures such as blood vessels to detect any structural or blood flow abnormalities of the penis (Parada & Germé, 2015).

To control for diameter and blood flow rates during different stages of an erection, a Doppler ultrasound is performed under pharmacostimulation by means of vasoactive agents (Junuzovic et al., 2003). Parameters such as peak systolic velocity (PSV), the end diastolic velocity (EDV), and the resistance index (RI) are amongst the most common in assessing erectile functioning (Broderick & Arger, 1993).

PSV (expressed in cm/second) shows the greatest flow systolic velocity detectible within the two cavernous arteries of the penis (Aversa & Sarteschi, 2007). The lower range considered to be normal for PSV is 25-35 cm/second. A PSV of 35 cm/second or greater is indicative of arterial sufficiency whereas a PSV of 25 cm/second and lower is indicative of arterial insufficiency and can be a potential explanation for the erectile dysfunction (Aversa & Sarteschi, 2007). Problems may arise from these cut-offs as they vary based on the person's age (Caretta, Palego, Roverato, Ferlin & Foresta, 2006). PSV is also affected by factors such as antihypertensive and psychotropic drugs, cigarette smoking, and diabetes and is associated with a higher likelihood of poor responses to the first stimulant injection (Aversa, Isidori, Caprio, Cerilli, Frajese, & Fabbri, 2002).
In healthy men, an erection occurs when the arteries are dilated to allow blood in, sinusoids are engorged to establish rigidity, and the venous system is constricted to prevent blood from leaking back in and to maintain an erection (Balon & Segraves, 2005). Venous leakage occurs when the venous system is not constricted enough to maintain a full erection, which is something that men with ED may experience. The EDV and RI are measurements obtained from the Doppler ultrasound that may identify venous leakage in men with ED (Aversa & Sarteschi, 2007). Also measured in cm/second, an EDV of 5cm/second or more is indicative of venous leakage (Aversa & Sarteschi, 2007). RI is based on a ratio between PSV and EDV, with values less than .75 indicating a venous leak (Patel, Halls, & Patel, 2012).

The use of ultrasound in assessing erectile functioning has been shown to be a reliable tool in determining anatomical abnormalities that may lead to erectile dysfunction (Parada & Germé, 2015). The ultrasound test is limited in that it needs to be administered and interpreted by a professional such as a urologist or radiologist, which may be time consuming and expensive (Parada & Germé, 2015). Although self-report pain ratings during the procedure revealed that patients experience little to no pain, the administration of the intracavernosal injection may result in discomfort and aversive reactions in patients (Albaugh & Ferrans, 2009; Parada & Germé 2015).

**Thermography**

Thermography works by means of a thermal camera that detects and registers infrared radiation (Parada & Germé, 2015). This is a less invasive technique than existing measures as it requires no physical contact with the patient. Thermal cameras are directed towards a specific area of the body and temperature changes are detected based on blood flow to this area (Kukkonen et al., 2010; Parada & Germé, 2015). In sexual arousal studies, blood flow to the
genitals is detected by the thermal cameras and temperature changes are recorded. This technique can measure genital temperature change for continuous long periods of time and is used to ultimately measure vasocongestion in the genitals (Parada & Germé, 2015; Kukkonen et al., 2010). Current thermal cameras measure continuous temperature change at an accuracy of 0.06 degrees Celsius (Kukkonen et al., 2010). The study by Kukkonen et al., 2007 used thermography to look at sexual arousal in healthy young men and women. The sample consisted of undergraduate students with a mean age of 21.15 years. Participants were randomly assigned to either a sexual arousal, humorous mood arousal or neutral condition. Results revealed that participants in the sexual arousal condition showed significant genital temperature increases over participants in the two control groups, with an average temperature increase of 3.3 degrees Celsius in men who were in the sexual arousal condition. Temperature changes were specific to the genitals as they were compared to thigh temperature changes, which revealed no significant change over the designated study time. Furthermore, the relationship between physiological and subjective sexual arousal was evaluated and a moderate to strong, positive, significant correlation was established. In a subsequent study by Kukkonen et al., 2010, a similar design was employed with the addition of a few improvements to the previous study such as including an older population to account for age difference in sexual arousal, including a discrete as well as a continuous measure of sexual arousal throughout the study, which served to examine concurrent validity, and including an anxiety control condition which served to examine discriminant validity. Similar results were found, where temperature changes in the sexual arousal group showed significantly higher increases than the control groups. When compared to younger adults, however, mean temperature changes were lower in older adults.

The use of thermography has recently been used as a tool to differentiate between different
types of sexual dysfunction. A study conducted by Sarin, Amsel and Binik (2014) investigated whether thermography can differentiate between men with hypoactive sexual desire disorder (HSDD), ED and both HSDD and ED. A similar design to the Kukkonen et al., 2010 study was used. Results revealed that genital arousal, measured as temperature change in response to sexually-explicit material for men with ED and men with ED and HSDD, was significantly less than men with HSDD and controls. Additionally, correlations between genital arousal and subjective sexual arousal were examined. As expected, strong significant relationships were established in healthy controls and weaker non-significant ones in the clinical groups.

**Self-Reported Assessment of ED**

Self-reported ratings of sexual arousal have been used in the previously mentioned studies to assess differences that may occur between genital arousal and subjective sexual arousal ratings in clinical versus healthy populations. As previously mentioned, clinical populations of men showed lower agreement between genital arousal and subjective sexual arousal ratings than healthy controls (Sarin at al., 2014). Additionally, subjective sexual arousal ratings alone can be used to differentiate between two clinical populations. For example, in the same study by Sarin, Amsel & Binik, it was found that men with HSDD/ED showed lower subjective sexual arousal ratings in general than men with ED only and healthy controls (2014). Very little, however, is known regarding differences in subjective sexual arousal ratings between the two types of ED. A study by Sakheim, Barlow, Abrahamson, and Beck (1987) looked at self-reported sexual arousal while using waking erectile assessments (WEA); a technique that uses visual and vibrotactile stimuli to elicit a physiological erectile response which is assessed using measures of penile circumference. Results revealed that the men with psychogenic ED tended to underestimate their level of subjective sexual arousal compared to their genital arousal, whereas men with organic
ED tended to over estimate their level of subjective sexual arousal compared to their genital arousal. In contrast, a study conducted by Janssen, Everaerd, Van Lunsen, and Oerlemans (1994) also used WEA while recording continuous and discrete subjective sexual arousal ratings from the participants. Men with ED (both organic and psychogenic) were compared to each other as well as to a control group. Results revealed that there were clear physiological differences amongst the three groups; however, subjective sexual arousal ratings only differed between clinical (ED patients in general) and healthy controls, and not between the two types of ED. These studies, however, are over 25 years old and newer studies are warranted to verify whether there are differences in subjective sexual arousal ratings between the two types of ED while complying with up to date research protocols. Using self-report ratings as a way to differentiate between the two types of ED could be a way to validate physiological responses that are unique to each type of ED. This could ultimately create a general profile for each ED diagnosis that not only targets what genital arousal patterns look like, but also how that matches subjective sexual arousal ratings.

**The Present Study**

For the present study, secondary data that was collected at the laboratory for the Biopsychosocial Study of Sexuality at McGill University in Montreal was used. The goal of this study was to compare the two methods of physiologically assessing ED (Colour-Doppler ultrasound and thermographic imaging) and to examine whether there were differences in the genital arousal ratings yielded from both methods. The study aimed to discover if results from thermography were highly related to the well-established and validated Colour-Doppler ultrasound. Specifically, to demonstrate good convergent validity, a correlation of .70 and higher (Neuman and Robson, 2012) was required to establish this relationship between the two
instruments. Furthermore, the study aimed to discover whether the use of thermography can be justified in diagnosing ED and differentiating between organic and psychogenic ED.

Establishing that thermography can differentiate between the two types of ED and can be used as a reliable and valid instrument to diagnose ED would be beneficial in a number of ways. First, thermography is a less invasive instrument, as it requires no physical contact with the patient, which contrasts with the need for physical placement of the ultrasound wand on the penis for measurement. Second, the training required to operate the thermography camera is relatively quick as compared to the specialized training required for ultrasonography, making thermography assessments more accessible and cost-effective than ultrasound appointments. Lastly, based on the statistics mentioned previously, approximately half of the ED cases diagnosed are due to psychogenic factors and half are due to organic factors. Only those suffering from organic ED would need to undergo further physiological assessments. Thermography can thus potentially be used as a preliminary screening tool, which could reduce the burden of having to go through long wait times, costly and invasive assessments for many patients who do not need it.

The current study also aimed to use subjective sexual arousal ratings as a way to further examine whether thermography can detect differences between organic and psychogenic ED. As previously mentioned, individuals with organic and psychogenic ED may have unique subjective sexual arousal ratings in response to sexually explicit material in that men dealing with psychogenic ED may have lower subjective sexual arousal compared to their genital arousal and men dealing with organic ED may have higher subjective sexual arousal compared to their genital arousal. To our knowledge, this is the first study to compare thermography with ultrasound in assessing ED. Furthermore, this study may help to provide a unique profile of
physiological and subjective sexual arousal patterns that may differentiate patients with the two types of ED.

**Hypotheses**

Four hypotheses were established in the currently proposed study. First, given that the impairment in organic ED is one of physiological nature, it was hypothesized that men with organic ED are distinguished from men with psychogenic ED by means of lower penile temperature change in response to the sexually explicit film. Second, as a measure of convergent validity, physiological arousal levels yielded from thermography and the ultrasound were expected to be highly significantly related. Third, given that impairment in psychogenic ED is one of psychological nature, it was hypothesized that men classified as having psychogenic ED would show lower continuous and discrete subjective sexual arousal ratings in response to the sexually explicit film when compared to men classified as having organic ED. Fourth, to further support that thermography is a sensitive tool that can be used to differentiate between organic and psychogenic ED, correlations between the subjective and physiological sexual responses were examined. A discrepancy was expected between subjective and physiological rating whereby, men with higher temperature change (suggesting psychogenic ED) in response to the sexually-explicit film would have lower subjective sexual arousal ratings whereas men with lower temperature change in response to the sexually-explicit film (suggesting organic ED) would show higher subjective sexual arousal ratings.

Finally, exploratory data analysis was conducted to examine whether patterns of temperature change could classify participants into unique temperature clusters that correspond to ultrasound assessment of psychogenic and organic ED. Moreover, scores on the International Index of Erectile Functioning (IIEF) were used to examine whether there were group differences
in participant self-report of sexual experiences and erectile functioning. Differences were expected between the two groups; however, directionality could not be hypothesized due to the lack of empirical evidence and previous studies that looked at these variables.

**Methods**

**Ethics**

The study was approved by the IRB at McGill University and the ethics board of the SMBD Jewish General Hospital in Montreal, Quebec, Canada (See Appendix A).

**Procedure**

A total of 95 participants were recruited in the original study. Participants were all cisgender males, and had an initial assessment of erectile dysfunction by a Urologist prior to participation in the study. Participants were referred to the study by their urologist after an initial appointment at either the SMBD Jewish General Hospital in Montreal or the Royal Victoria Hospital in Montreal. The urologist provided initial information and a study pamphlet to patients. Those who expressed interest in participating had their contact information forwarded to the study research assistant (RA), who called participants and provided them with additional information, answered questions and conducted a phone screening for eligibility (Appendix B). Exclusion criteria included participant discomfort with sexually explicit videos or difficulty understanding and communicating in either French or English. Interested participants were scheduled to undergo two testing appointments, the first being the thermography appointment and the second being the ultrasound. Participants were not compensated for their time; however, their ultrasound procedure, including cost of injection, was covered by the study.

For the thermography appointment, participants attended the session at the laboratory for the Biopsychosocial Study of Sexuality at McGill University. Informed consent (Appendix C)
was obtained after which participants underwent a semi-structured interview to obtain demographic, general health and sexual health information (Appendix D). Following this, the experimenter left participants alone in the examination room to complete the Erectile Dysfunction Clinic Patient Questionnaire (Appendix E), which asks further questions about physical and sexual health, the International Index of Erectile Functioning (IIEF) questionnaire (Appendix F) as well as the State-Trait Anxiety Inventory (STAI) via pencil and paper (Appendix G). Upon completion, the interviewer collected the questionnaires and once again left the participants alone in the examination room for the procedure. Participants were instructed to remove their clothes from the waist down and to sit with their legs comfortably apart on the examination table. The thermal imaging camera was set up to record temperature changes throughout the duration of the experiment and was positioned approximately one meter from participants. Temperature regions of interest were focused on the shaft of the penis and the inner thigh of the right leg. Participants watched three, 15-minute videos. The first was a video segment containing still images of nature accompanied by soothing music. This served as a temperature acclimatization period whereby body temperature was given time to stabilize with the room temperature. The temperature stabilization phase was followed by a series of questions targeting the participant’s self-reported arousal level (Appendix H). The second video segment also had a nature theme and served as the baseline in terms of temperature change. Self-reported arousal using the same questionnaire was measured after the video segment. The third video segment was a sexually-explicit film validated by the Kinsey Institute (Janssen, Everaerd, Van Lunsen, & Oerlemans, 1994). The same self-report measure was administered for the last time following this video. Throughout each video, participants also indicated their subjective sexual arousal through the use of a continuous measure device. Following the sexually explicit film and
questions, participants got dressed and indicated when they wanted the experimenter to come in to the room for debriefing. At this point, the participants were then given the opportunity to discuss the study and ask any additional questions. Upon leaving, the participants were given an appointment for their ultrasound testing session with the urologist.

The ultrasound appointment was held in the Urology Department at the SMBD Jewish General Hospital in Montreal. The RA met with participants prior to the procedure to verify if there were any changes in their demographic or health information since the last appointment and to go over the hospital consent form for the ultrasound procedure. Participants once more filled out the same subjective sexual arousal questions (Appendix H) before the Doppler ultrasound as well as the STAI (Appendix G). Participants completed the questionnaires via pencil and paper in the waiting room for the ultrasound. Upon completion of these questionnaires, participants met with the RA and Urologist to go over the ultrasound procedure one more time, after which participants sat on the examination table with their pants and undergarments removed and the urologist obtained baseline measures of penile blood flow with the ultrasound. Following the baseline recording, the urologist injected Prostaglandin E1 into the base of the penis and penile blood flow was once more recorded using ultrasound. To enhance pharmacotesting, participants were asked to briefly self-stimulate after the urologist and RA left the room. This technique is suggested by Donnatucci and Lue (1992) and is said to yield more accurate results as a more rigid erection is achieved when combining both the injection and self-stimulation. Following self-stimulation, the Urologist entered the room and blood flow was measured one more time with the ultrasound. After the ultrasound was over, participants got dressed and went into the waiting room where the RA asked them to fill in the subjective sexual arousal questionnaire for the last time as well as answer a few questions on both procedures
(Appendix I).

**Measures**

**Demographic and health information.** Demographic information was gathered from the participants through a semi-structured interview adapted from previous studies (Kukkonen et al., 2007; Kukkonen et al., 2010) which included information about their age, ethnicity, mental and sexual health. A physical health patient self-report questionnaire was obtained from their hospital file and was used to determine any diagnosed chronic illness, surgeries, medication and recreational drug use.

**Erectile functioning.** The International Index of Erectile Function (IIEF) is a well established and validated questionnaire that was used to assesses the effects of participants’ erectile problems on five domains of sexual functioning; erectile function, orgasmic function, sexual desire, intercourse satisfaction and overall satisfaction (Rosen, Riley, Wagner, Osterloh, Kirkpatrick, & Mishra, 1997). The scale contains questions on a six-point Likert scale that ranged from zero to five. Rosen et al. (1997) investigated the psychometric properties of the IIEF and and found that the questionnaire demonstrates good internal consistency (Chronbach’s alphas range from .73-.99) and test re-test reliability ($r$ range from .64 to .84). Moreover, convergent validity was assessed in the same study by comparing IIEF results with clinicians’ assessments of sexual functioning. Correlations between the five domains of the IIEF and the clinician ratings ranged from .45 to .75. Finally, divergent validity was also established by comparing the IIEF results with the Lock-Wallace marital adjustment scale and the Marlow-Crowne social desirability scale. Low, non-significant correlation coefficients were established across all domains.

**Stait and trait anxiety.** Participant anxiety was assessed using the Spielberger Stait Trait
Anxiety Scale. This scale demonstrates good internal consistency (Chronbach’s alpha between .86 -.95) (Spielberger, 1983). This scale also showed high correlations with the Taylor Manifest Anxiety Scale (r=.73) and Cattell and Scheier’s Anxiety Scale Questionnaire (r=.85), demonstrating good content validity (Spielberger, 1983). The scale was used to measure general trait anxiety as well as state anxiety prior to each procedure. Questions targeting state-anxiety assesses participants’ feelings “at the moment” on a four-point Likert type scale (1=not at all, 2=somewhat, 3=moderately, 4=very much so). Questions targeting trait-anxiety assesses the frequency of certain feelings “in general” on a four-point Likert type scale (1=almost never, 2=sometimes, 3=often, 4=almost always).

**Physiological Sexual Response**

**Thermography.** The same thermal imaging camera was used as Kukkonen et al. (2007; 2010). A TSA ImageIR thermal imaging system was used (Seahorse Biosciences, North Billerica, MA). This camera operated under temperatures that ranged from 15°C to 40°C with a sensitivity of 0.07 °C and sample interval of eight frames per second. The camera was placed 1.0 meters diagonally to the left of the participant and at a height of 1.09 meters and tilted at an angle of approximately 30 degrees. Greater distance of the camera from the participant allowed for more accurate imaging (Kukkonen et al. 2010). The thermal camera measured temperature changes on both the shaft of the penis and the inner thigh.

**Ultrasonography.** Ultrasound assessments were conducted at the SMBD Jewish General Hospital by the urologist (S.Carrier). Ultrasound measurements were obtained at baseline and after an injection of Prostaglandin-E1, administered directly by the Urologist. PSV, EDV and RI were calculated from the procedure as measures of arterial sufficiency and venous leakage.
Self-Reported Sexual Arousal

A continuous subjective measure of arousal was used during the thermographic procedure. A program using windows as previously implemented in the Kukkonen et al., 2010 study was incorporated. Participants were asked to rate their subjective sexual arousal on a scale from zero to ten (0 = no sexual arousal and 10 most sexually aroused) using a computer mouse, clicking right to indicate an increase in arousal and left to indicate a decrease in arousal. Subjects were prompted to indicate their arousal level if 60 seconds have passed with no activity. Discrete subjective sexual arousal questionnaires (Kukkonen et al., 2007; Kukkonen et al., 2010) were also administered prior to and after each procedure which contained statements that the participants had to rate on a scale from 0 (no sexual arousal) to 10 (most sexually aroused).

Statistical Analysis

Based on the ultrasound results, patients were differentiated based on their PSV scores after self-stimulation, and classified as having psychogenic or organic ED. PSV scores after self-stimulation were used as they were suggested to be more accurate representations of a potential problem with vascular functioning (Donatucci, 1992). As previously mentioned, a PSV value under 25 cm/sec is indicative of definite arterial insufficiency and a PSV of over 35 cm/sec is indicative of normal vascular functioning (Aversa & Sarteschi, 2007). PSV values between 25 and 35 cm/sec are considered a grey area in that patients who fall within this range may have normal vascular functioning; however, psychological inhibition may be the underlying factor as to why a full erection was not achieved (Aversa & Sarteschi, 2007; Patel, Amin, Friedman, Vale, Kirby, & Lees, 1993). Thus, identifying the underlying cause can be difficult when patients score in this range, additionally, these cut offs become inaccurate with advancement of age as mentioned before (Caretta, Palego, Roverato, Ferlin & Foresta, 2006). To resolve this problem, a
PSV formula was created by Caretta et al. (2006) that adjusts for age of the participant and forms a new cut off value for arterial insufficiency. The formula is $6.73+\text{age of participant} \times 0.7$. Therefore, participants with PSV values below $6.73+\text{age} \times 0.7$ were classified as having organic ED and participants with PSV values above this cut off were classified as having psychogenic ED. This formula has been successfully used in previous studies (e.g., Ahmed, Ali, Hwary, & Abd el-Kream, 2016; Foresta, Palego, Schipilliti, Selice, Ferlin, & Caretta, 2008).

Preliminary data analysis was conducted to test for group differences on demographic variables and clinical characteristics. Baseline genital temperature was compared for the two groups. Chi-square, independent sample $t$-tests, or non-parametric tests were used depending on the nature of the data. To test the first hypothesis, results from the thermography procedure were used to investigate if there were differences in genital temperature between the two groups. A 2x4 repeated measures factorial ANOVA was used with the independent variable being the type of ED (psychogenic and organic). Average temperature recordings were calculated for the first, middle and the final 5-minutes of experimental testing (sexually explicit film) as well as the last five-minutes of baseline testing and were used as the repeated measures factor. For the second hypothesis, bivariate correlations were conducted to look at whether results from thermography and the ultrasound agree. PSV values after self-stimulation were correlated against genital temperature in the last five minutes of experimental testing. For the third hypothesis, participants in each group were compared on subjective sexual arousal measures (discrete and continuous).

To identify the important discrete subjective sexual arousal measures and classify them in distinct groups, a factor analysis with oblique rotation was conducted on a set of discrete subjective sexual arousal measures. After allocating the variables into the appropriate factors, a multivariate analysis of variance (MANOVA) was conducted to see if the two groups differed on
the extracted factors. Additionally, a 2x3 repeated measures ANOVA was also conducted to look at continuous subjective sexual arousal ratings in the first, middle and final five minutes of experimental testing between the two groups. Finally, for the fourth hypothesis, within group correlations between subjective sexual arousal and genital arousal were examined to look at the nature of the relationship in terms of size and direction of the correlations and whether unique characteristics can be established for the two types of ED. An independent sample t-test was then conducted to examine the difference in correlations between the two groups.

Finally, as part of the exploratory data analysis and to identify whether specific temperatures can be used for diagnosis purposes, a hierarchical cluster analysis was conducted to examine patterns of average genital temperatures in the last five-minutes of experimental testing. A Chi-square test of independence was then conducted to look at the relationship between ED group and where they are classified according to the temperature clusters. Additionally, a MANOVA was conducted using the five domains of the IIEF (erectile function, orgasmic function, sexual desire, intercourse satisfaction and overall satisfaction) as the dependent variables and ED group as the independent variable.

**Results**

**Sample Characteristics**

Initially, 95 participants were recruited for the study. After, data cleaning, 83 participants were included in the final sample. Of the 12 that were eliminated from the sample, 10, did not show up to the ultrasound appointment, and two dropped out during the thermography procedure for reasons such as difficulty in understanding the experiment, language barriers and disliking the videos being viewed during the experiment. Of the 83 participants that were included in the experiment, 45 were classified as having organic ED and 36 were classified as having
psychogenic ED. Two participants were further dropped as classification of ED type was based on post-stimulation PSV values, which were missing two values due to the fact that the urologist forgot to record them. To validate this classification, it was compared to the urologist’s diagnosis of arterial insufficiency. There was a high degree of association between the two methods ($\phi=.61$).

Demographic variables were examined to identify sample characteristics between the two ED groups. An independent sample $t$-test revealed that there was a significant difference in age between the two groups, whereby men with organic ED ($M=55.38$ years, $SD=11.19$) were significantly older than men with psychogenic ED ($M=31.14$ years, $SD=9.76$), $t(79)=10.25$, $p<.001$. Furthermore, there was also a significant difference in the number of years of education whereby men with organic ED ($M=13.32$ years, $SD=3.44$) had fewer years of education than men with psychogenic ED ($M=14.89$ years, $SD=2.28$), $t(74.96)=-2.35$, $p=.021$. Additionally, a significant difference was found in relationship status between the two groups $\chi^2(4)=9.98$, $p=.020$ (see table 1) as well as in the number of health conditions reported by participants in each group $\chi^2(2)=60.93$, $p<.001$ (see table 2 for difference in the types of conditions between the two groups). No significant differences were found in place of birth between the two groups (65.82% North America). Finally, an independent sample t-test was conducted to examine whether there are differences in baseline genital temperature between the two groups. No significant differences were found.
<table>
<thead>
<tr>
<th>Type of ED</th>
<th>Organic (n= 45)</th>
<th>Psychogenic (n=36)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, $M(SD)$</td>
<td>55.38(9.76)</td>
<td>31.14( 9.76)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Years of education, $M(SD)$</td>
<td>13.32 (3.44)</td>
<td>14.89(2.28)</td>
<td>.021</td>
</tr>
<tr>
<td>Relationship Status $n$(%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>10 (12.35)</td>
<td>8(9.88)</td>
<td>.020</td>
</tr>
<tr>
<td>Dating</td>
<td>7 (8.64)</td>
<td>16 (19.75)</td>
<td></td>
</tr>
<tr>
<td>Cohabitating/married</td>
<td>20(24.69)</td>
<td>10 (12.35)</td>
<td></td>
</tr>
<tr>
<td>Separated/divorced/widowed/other</td>
<td>8(1.66)</td>
<td>2(-1.66)</td>
<td></td>
</tr>
<tr>
<td>Number of medical condition $n$(%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>14(17.28)</td>
<td>29(35.80)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>One</td>
<td>31(38.27)</td>
<td>7(8.64)</td>
<td></td>
</tr>
<tr>
<td>Two or more</td>
<td>37(45.68)</td>
<td>14(17.28)</td>
<td></td>
</tr>
<tr>
<td>Place of birth $n$(%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North America</td>
<td>29(36.71)</td>
<td>23(29.11)</td>
<td>.939</td>
</tr>
<tr>
<td>Europe</td>
<td>4(5.06)</td>
<td>5(5.06)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>10(12.66)</td>
<td>(11.39)</td>
<td></td>
</tr>
</tbody>
</table>
Table 2
Frequency of medical conditions in the organic (n=45) and psychogenic (n=36) ED groups as reported by participants.

<table>
<thead>
<tr>
<th>Medical Condition</th>
<th>Organic (n=45)</th>
<th>Psychogenic (n=36)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angina</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Cardiac bypass</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Vascular surgery</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Depression/anxiety/psychosis</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Prostate surgery</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Prostatectomy for Prostate cancer</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Heart attack</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>High blood pressure</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Radiotherapy</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Back/pelvic/hip injury</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>High cholesterol/ lipids</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Diabetes</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Back surgery</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>No medical problems</td>
<td>14</td>
<td>29</td>
</tr>
</tbody>
</table>

Temperature Change Over Time

To investigate the relationship between group (organic vs psychogenic) and temperature over time, a 2x4 repeated measures ANOVA was conducted. Four temperature time-points were included in the analysis (average genital temperature in the last five minutes of baseline testing, average genital temperature in the first five minutes of experimental testing, average genital temperature in the middle five minutes of experimental testing, and average genital temperature in the last five minutes of experimental testing).
The assumption of sphericity was violated; therefore, a Greenhouse-Geisser correction was applied to all within group effects. The assumption of homogeneity of variance was met; therefore, no corrections were applied to between group effects. Results revealed a significant main effect of temperature $F(3, 237)=60.61, p<.001, \eta^2_p=.43$, power=1.00, a significant main effect of group $F(1,79)=5.68, p=.020, \eta^2_p=.07$, power=.65 and non-significant temperature x group interaction ($p=.351$). Follow-up post-hoc tests using a Bonferroni correction were used to analyze the main effects. Average genital temperature was lower in the last five minutes of baseline testing ($M=31.38^\circ C, SD=1.31$) than the first five minutes of experimental testing ($M=31.74^\circ C, SD=1.46, p=.012$), the middle five minutes of experimental testing ($M=32.48^\circ C, SD=1.66, p<.001$) and the last five minutes of experimental testing ($M=32.77^\circ C, SD=1.52, p<.001$). Additionally, average genital temperature in the first five minutes of the experimental testing was lower than the average middle five minutes of the experimental testing ($p<.001$) and the last five minutes of the experimental testing ($p<.001$). Finally, average genital temperature was lower in the middle five minutes than the last five minutes of experimental testing ($p<.001$) (See Figure 3). The significant main effect of group reveals that participants in the psychogenic ED group ($M=31.73^\circ C, SD=1.34$) had overall higher average genital temperatures than those in the organic ED group ($M=32.45^\circ C, SD=1.34$).
Figure 3. Graph showing genital temperature change over the last five minutes of baseline testing (Baseline), the first five minutes of experimental testing (Time 1), the middle five minutes of experimental testing (Time 2), and the last five minutes of experimental testing (Time 3) for the organic and psychogenic ED groups.

Comparing Thermography with Ultrasound Results

To test whether the results of the thermography were related to the results yielded from the ultrasound, a bivariate Pearson correlation was conducted between PSV values after self-stimulation and average genital temperature in the last five-minutes of experimental testing. Results revealed a small but significant positive correlation between PSV after self-stimulation and average genital temperature in the last 5 minutes of experimental testing $r(81)= .23, p=.040$.

Comparison of Subjective Sexual Arousal

Discrete subjective sexual arousal. In order to compare the two groups on discrete subjective sexual arousal measures, exploratory factor analysis was first conducted to categorize the different measures of subjective sexual arousal into appropriate categories. Since all the
questions on the discrete sexual arousal questionnaire were related to subjective feeling of sexual arousal, the latent factors were assumed to be correlated and an oblique (promax) rotation was used for the analysis. To examine model fit, the Kaiser-Maeyer-Olkin (KMO) measure of sampling adequacy and the Bartlett test of sphericity were examined. Results of the factor analysis revealed that the KMO value is .79; this value is over .5, indicating that the sample size is adequate for factor analysis (Field, 2013). Bartlett test of sphericity was significant $\chi^2(105)=541.39, p<.001$, therefore the off diagonal correlations are significantly greater than zero which makes this dataset appropriate for factor analysis (Field, 2013). Variables that yielded communality values below .4 were excluded as suggested by Osborne and Costello (2009) as they could not be related to other items in the questionnaire to a high enough degree. Additionally, variables that had loadings lower than .3, were also excluded from the analysis as they do not contribute enough to fit into a specific factor (Field, 2013). After variable elimination, two factor, mental and physical sexual arousal, were extracted from the analysis, and explained 39.65% of the total variability. Variables included in the mental arousal category were overall sexual arousal, mental sexual arousal, peak sexual arousal rating, desire to have sex with partner and desire to masturbate. Variables included in the physical mental arousal category were physical sexual arousal, amount of genital change, and erections rating (see Table 3 for factor loadings). Internal reliability using Chronbach’s alpha were also calculated. Variables within both the mental and physical factors yielded high internal consistency ($\alpha=.83$ and .86, respectively).

A multivariate analysis of variance (MANOVA) was conducted to see if there are differences between the two groups on mental and physical arousal. Participants in the two groups did not significantly differ on either mental ($p=.453$) or physical arousal ($p=.202$).
Table 3. 
*Final factor loadings of discrete self-reported sexual arousal ratings into the two extracted variables; physical and mental sexual arousal.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor 1 (Mental sexual arousal)</th>
<th>Factor 2 (Physical sexual arousal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall sexual Arousal</td>
<td>.94</td>
<td></td>
</tr>
<tr>
<td>Mental sexual arousal</td>
<td>.78</td>
<td></td>
</tr>
<tr>
<td>Peak Sexual arousal</td>
<td>.75</td>
<td></td>
</tr>
<tr>
<td>Desire to have sex with partner</td>
<td>.67</td>
<td></td>
</tr>
<tr>
<td>Desire to masturbate</td>
<td>.60</td>
<td></td>
</tr>
<tr>
<td>Physical sexual arousal</td>
<td></td>
<td>.45</td>
</tr>
<tr>
<td>Amount of genital change</td>
<td></td>
<td>.99</td>
</tr>
<tr>
<td>Erection rating</td>
<td></td>
<td>.62</td>
</tr>
</tbody>
</table>

Continuous self-reported sexual arousal. To examine whether differences exist between the groups on the continuous subjective sexual arousal measure, a 2x4 repeated measures ANOVA was conducted. Four time-points were included in the analysis (average continuous subjective rating in the last five minutes of baseline testing, average continuous subjective rating in the first five minutes of experimental testing, average continuous subjective rating in the middle five minutes of experimental testing and average continuous subjective rating in the last five minutes of experimental testing). No differences amongst the groups were found, neither was there a significant interaction showing differences in patterns for continuous subjective sexual arousal between the groups. (See Figure 4).
Figure 4. Graph showing differences in continuous subjective sexual arousal ratings (on a scale of 0-10) over the last five minutes of baseline testing (Baseline), the first five minutes of experimental testing (Time 1), the middle five minutes of experimental testing (Time 2) and the last five minutes of experimental testing (Time 3) for the organic and psychogenic ED groups.

**International Index of Erectile Functioning (IIEF).** The two groups of participants were compared on the five domains of erectile dysfunction yielded by the IIEF; erectile function, orgasmic function, sexual desire, intercourse satisfaction and overall satisfaction. A MANOVA was used to examine whether differences occurred between the participant groups on the five domains. Men in the psychogenic ED group had better erectile functioning than men in the organic ED group, $F(1,68)=9.28, p=.003$, $\eta^2_p=.12$, power=.85. Furthermore, men in the psychogenic group had better intercourse satisfaction $F(1,68)=6.07, p=.016$, $\eta^2_p=.08$, power=.69, as well as overall satisfaction $F(1,68)=7.51, p=.008$, $\eta^2_p=.10$, power=.77 (see Table 4 for means and standard deviations). No significant differences between the two groups were found on orgasmic function ($p=.320$) or sexual desire ($p=.147$).
Table 4. Means and standard deviation of the five domains of the IIEF for the organic and psychogenic ED groups

<table>
<thead>
<tr>
<th>Domain</th>
<th>Type of ED</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic</td>
<td>Psychogenic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$M(\text{SD})$</td>
<td>$M(\text{SD})$</td>
<td></td>
</tr>
<tr>
<td>Erectile Function</td>
<td>9.56 (6.58)</td>
<td>14.97 (7.25)</td>
<td></td>
</tr>
<tr>
<td>Orgasmic Function</td>
<td>5.40 (3.13)</td>
<td>6.31 (2.64)</td>
<td></td>
</tr>
<tr>
<td>Sexual Desire</td>
<td>6.37 (2.47)</td>
<td>7.37 (2.20)</td>
<td></td>
</tr>
<tr>
<td>Intercourse Satisfaction</td>
<td>5.88 (3.87)</td>
<td>8.19 (4.01)</td>
<td></td>
</tr>
<tr>
<td>Overall Satisfaction</td>
<td>3.80 (2.02)</td>
<td>5.23 (2.22)</td>
<td></td>
</tr>
</tbody>
</table>

**Relationship Between Genital and Subjective Sexual Arousal**

In order to examine whether there were differences in the magnitude and pattern of the relationship between genital and subjective measures of arousal, within group correlations were conducted for each participant. The correlations were then compared between groups. An independent sample $t$-test was conducted to examined if there were differences in mean correlations between the two-groups. Results have shown that men in the psychogenic ED group ($M=.49$, $SD=.34$) showed a stronger relationship between genital and subjective sexual arousal than men in the organic ED group ($M=.27$, $SD=.42$), $t(79)=2.56$, $p=.012$.

**Cluster Analysis on Genital Temperature**

The purpose of the cluster analysis was to determine if genital temperature change in the last five minutes of watching the sexually explicit material could be classified into distinct temperature clusters. Based on PSV classifications (under 25 cm/second indicating arterial insufficiency, over 35 cm/second indicating normal vascular functioning and between 25 and 35 cm/second indicating a potential mixed etiology), at least three clusters were expected to be yielded from the analysis. As a cluster analysis, however, has never been conducted on genital temperature data, an algorithmic hierarchical cluster analysis that does not predetermine the number of groupings...
was used. Distances between clusters were evaluated with the squared Euclidean distance measure. This method was used based on the fact that the variable of interest is on an interval scale (Page-Gould, 2017). Clusters were combined using the centroid method; this method defines the distance between two groups as the distance between their centroids (vector average) (Page-Gould, 2017). The agglomeration schedule from this analysis was examined to determine the ideal number of clusters, and temperature ranges were assigned to clusters at this stage. A reverse scree plot (Figure 5) was used to determine the number of clusters to be used. As shown in the figure, the distance between combined clusters increased most substantially between steps 80 and 81 (step of inflection). The Agglomeration schedule revealed that the distance between clusters combined in step 81 (D = 3.254) was a substantial increase from the distance between combined clusters from step 80 (D = 2.297). Therefore, in support of the PSV categorization mentioned previously and the results from the reverse scree plot, a 3-cluster solution (N-step of inflection; 83-80=3) was determined to be ideal for this data.

To confirm that in fact there are three clusters, a one-way between group ANOVA was conducted to see if there are significant differences in genital temperature in the last five minutes of experimental testing between the 3 clustered groups. Results of the ANOVA were statistically significant $F(2,80)=216.08, p<.001$, $\eta^2_p=.84$, power=1.00.

To confirm that these clusters are related to the diagnosis of ED that was based on the PSV values controlled for age, after self stimulation, a Chi-square test of independence was conducted between the temperature clusters (1= highest average temperature, 2= medium average temperature, and 3= lowest average temperature) and the two ED groups (organic and psychogenic). Results revealed a significant Chi-square between group and temperature clusters $\chi^2(2)=7.26, p=.026$. Further post-hoc analysis using adjusted residuals was conducted to examine
where the differences were. There were significantly more people in the psychogenic ED group (41.67%) than the organic ED group (15.56%) classified in the highest temperature cluster (Table 5).

**Figure 5.** Graph showing reverse scree plot of the agglomeration step against the distance between combined clusters to determine the appropriate number of clusters to be used in the analysis.

**Table 5**  
*Chi-square test of independence including adjusted residuals for PSV after self-stimulation and temperature clusters*

<table>
<thead>
<tr>
<th>Temperature Cluster</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>( \chi^2 )</th>
<th>( \phi )</th>
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<td></td>
<td>(34.05-35.49°C)</td>
<td>(31.59-33.86°C)</td>
<td>(29.12-31.28°C)</td>
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<tr>
<td>Organic ED</td>
<td>7</td>
<td>26</td>
<td>12</td>
<td>7.26*</td>
<td>.30</td>
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<td></td>
<td>(-2.63)</td>
<td>(1.20)</td>
<td>(1.40)</td>
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<tr>
<td>Psychogenic ED</td>
<td>15</td>
<td>16</td>
<td>5</td>
<td></td>
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<tr>
<td></td>
<td>(2.63)</td>
<td>(-1.20)</td>
<td>(-1.40)</td>
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*Note. *\( \ast = p < .05 \). Adjusted standardized residuals appear in parentheses below group frequencies.*
Discussion

The aim of the current study was to examine the clinical utility of thermography in diagnosing and differentiating between the two types of ED. The overall results support this with potentially important clinical implications. It was hypothesized that genital temperature during sexual arousal, as measured with thermography, would differentiate men with organic and psychogenic ED and that genital temperature recordings would correspond with ultrasound measures, which they did. Although it was also expected to see differences in self-report ratings of sexual arousal between men with organic and psychogenic ED, this was not the case. Both groups of men self-reported similar levels of sexual arousal, although the relationship between physical and subjective sexual arousal was stronger in men with psychogenic ED. Results from the cluster analysis showed that thermography was more accurate at identifying men with psychogenic ED into the high temperature category than other temperature clusters. Moreover, men classified into the psychogenic ED group had better erectile, intercourse, and overall satisfaction as measured by the IIEF.

Sample Characteristics

It was noted that there were some demographic differences between the groups. For example, there was a difference in age, whereby men with organic ED were older than those with psychogenic ED. This difference was expected and accounted for by the classification of the type of ED based on an age-adjusted PSV cut-off formula as explained previously (Caretta et al., 2006). Furthermore, it is well supported in the literature that the prevalence of organic related problems increases with age (Araujo, Durante, Feldman, & McKinlay, 1998; Feldman, Goldstein, Hatzichristou, Krane, & McKinlay, 1994; Laumann, Paik, & Rosen, 1999). Indeed, this is also shown in the current study as the number of medical conditions reported by men in
the organic group was significantly higher than those in the psychogenic group. The other
differences in sample characteristics were likely a result of this initial age difference. For
example, years of education was significantly different between the organic and psychogenic ED
groups. Given that the average age for men in the psychogenic group identifies them largely as
millennials (those born between 1980 and mid 1990s), a group known to spend more time in
school than previous generations (Arnett, 2000), it is not surprising that they are more educated
than those in the older organic ED group. Along the same lines, men in the psychogenic ED
were also found to be less likely to be married and more likely to identify their relationship status
as dating than the older group of men with organic ED.

**Temperature Change over Time**

Regarding the first hypothesis, a 2x4 repeated measures ANOVA revealing a significant
difference in genital temperature across the two groups meant that, regardless of the type of ED,
genital temperature increased in response to the sexually explicit videos. Differences were also
significant amongst all time points, which meant a linear relationship of genital temperature over
time. These results are comparable to what Kukkonen et al. (2007) and Kukkonen et al. (2010),
found in regards to genital temperature increase in response to sexually explicit material; healthy
men and women viewing a sexually-explicit video had significantly higher genital temperature
than those watching a video that was non-sexual in nature. The current results add to those
findings by Kukkonen et al. (2007) and Kukkonen et al. (2010) confirming that, even within
patients who have a sexual dysfunction such as ED, thermography is sensitive enough to detect
temperature changes in regards to being sexually aroused from watching the sexually-explicit
film. These results are also supported by the study conducted by Sarin et al. (2014), whereby
genital temperature increased in response to sexually-explicit material in healthy men, men with
HSDD, men with ED and men with both ED and HSDD. Therefore, it can be concluded that regardless of an underlying sexual problem, thermography is a sensitive tool that detects a range of temperature change in response to sexual arousal. The significance of temperature change over time was also supported by a high effect size ($\eta_p^2 = .430$) which means increases in temperatures were both significant and meaningful.

A group main effect was also found to be significant. Specifically, men classified as having organic ED had significantly lower genital temperature increase than men classified as having psychogenic ED. This is the first study to look at differentiating organic and psychogenic ED using thermography; however, previous research showed that thermography can differentiate between different types of sexual dysfunction. Sarin et al., 2014 found that men with ED (type not specified) and men with both ED and HSDD showed lower genital temperature change than men with HSDD alone and healthy controls. The current results add to the results by Sarin et al. (2014), by emphasizing that thermography can even differentiate between different types of the same sexual dysfunction. These results make sense in terms of why organic ED patients would have lower genital temperature than psychogenic ED patients. As mentioned previously, thermography works by measuring temperature changes based on blood flow to a specific area of the body (Kukkonen et al., 2010; Parada & Germé, 2015). The underlying factors contributing to organic ED are commonly vasculogenic in nature (Lue, 1999; Schellack & Schellack, 2013; Shamloul & Ghanem, 2013); therefore, it would be expected that blood flow to the penis and vasoconstriction to be compromised in men with organic ED. Finally, the main effect of group was also accompanied by a medium effect size ($\eta_p^2 = .07$), which adds further validation to the findings.
Comparing Thermography with Ultrasound Results

It was found that the correlation between the average PSV post self-stimulation from the ultrasound procedure and genital temperature in the last five minutes of experimental testing were significantly correlated; however, the value of the correlation was small. This demonstrates that thermography should not completely replace the ultrasound as a procedure; however, it can be a preliminary tool used to eliminate those who likely do not need to see a urologist for clinical testing and to potentially rule out an organic underlying cause. This was evident from the cluster analysis results. Table 5 showed that men classified in the organic group were less likely to also be classified in the high temperature cluster than expected if there were no group differences. Similarly, men classified in the psychogenic group were more likely to be classified in the high temperature cluster than expected if there were no group differences. Significant differences, however, were not detectable in the medium and low temperatures (Table 5).

These results may be looked at in terms of specificity; the proportion of individuals without organic ED that test negative (Akobeng, 2007). For example, if high temperature is considered to be the criterion for determining that a participant has normal vascular functioning (ED not due to organic cause) and considering that there were 15 participants with psychogenic ED classified in this cluster, the specificity rate would be calculated by dividing this number by the total number of participants who do not have organic ED (15/36 = .42). This gives thermography a specificity value of 42% when using the PSV value cut-offs established through ultrasound. These values, however, do not correspond perfectly with the urologist diagnosis. Interestingly, the urologist classified 49 patients as not having vascular insufficiency (as compared to 36 using the PSV cut offs). When examining the specificity of thermography using the urologist ratings, 18 out of the 49 participants classified by the urologist as not having
vascular insufficiency were grouped in the high temperature cluster, giving thermography a specificity value of 37%. Although both of these values are not high enough to conclude that thermography is a procedure that is high in specificity, it is still valuable to know that the procedure can identify a percentage of patients that likely do not need to be referred to see a specialist for an ultrasound assessment. The difference in diagnosis between PSV values alone and the addition of the urologist’s clinical opinion is an important one and emphasizes clinical judgement and training in assessing a patient’s case. Taking this into consideration, thermography results should be as conservative as possible. It is also important to note the limitations of specificity as these numbers only consider participants that do not have organic ED and test negative (Akobeng, 2007). Specificity values do not take into account those who do have organic ED but test negative; in this case the seven participants in the organic ED group that were classified in the high temperature cluster. Predictive value is a better statistic to be considered for this case as it assesses the proportion of participants testing negative without organic ED out of all participants that tested negative (Akobeng, 2007). When using predictive value, there were 15 participants that were diagnosed with psychogenic ED and tested negative and seven participants with organic ED and tested negative, therefore the predictive value is 15 over 22 which gives thermography a negative predictive value of 68% based on PSV values. When determining the predictive value of thermography based on urologist diagnosis, the value goes up to 82% (18 participants without arterial insufficiency divided by the 22 participants in the high temperature cluster). These results suggest that thermography was accurate at predicting those without organic ED by placing them in the high temperature cluster, particularly when urologist diagnosis is taken into account. Predictive value is more appropriate for use with thermography as it provides an indication of participants with high genital
temperatures that likely do not need further genital assessment. To remain on the side of caution and be more conservative, those with a diagnosis of psychogenic ED who fall into the middle and low temperature clusters are better off with a more detailed ultrasound assessment. Thermography therefore could be an appropriate tool in eliminating those who likely do not have organic ED and do not need further assessment with an ultrasound.

As previously mentioned, the ultrasound is a more appropriate measure for those who are classified in the mid and low temperature clusters. Firstly, although patients in the organic ED group were not significantly more likely to be classified in the low temperature cluster than men with psychogenic ED, the results of the 2x4 factorial ANOVA discussed earlier demonstrated that men with organic ED had significantly lower genital temperatures than men with psychogenic ED. Lower genital temperatures could indicate an organic underlying cause to the ED and these patients should be sent for further screening by a specialist. In terms of the medium temperature cluster, it can be seen from Table 5 that a substantial percentage of the patients (both organic and psychogenic classifications) were placed in this cluster. This shows that the diagnosis of ED is complex and may not be clear cut in terms of fully organic or psychogenic. In fact, previous research has shown that PSV values falling below 25cm/s as substantial evidence for arterial insufficiency and PSV values of over 35 cm/s as indicative of arterial sufficiency and normal vascular functioning (Golijanin, Singer, Davis, Bhatt, Seftel & Dogra, 2007; Halls et al., 2008; Patel et al., 2012). Nevertheless, PSV values between 25-35 cm/sec are highly debatable and are suggested to be indicative of a mixed etiology (Golijanin et al., 2007; Halls, Bydawell et al., 2008; Patel et al., 2012). For example, patients who fall within this range may have normal vascular functioning; however, psychological inhibition may be the underlying factor as to why a
full erection was not achieved (Aversa & Sarteschi, 2007; Patel, Amin, Friedman, Vale, Kirby, & Lees, 1993). Therefore, this group of patients would benefit from additional screening.

To conclude, thermography may be beneficial to identify those patients that likely do not need additional screening by a urologist, as they show healthy genital temperature patterns in response to the thermography procedure. This may eliminate a percentage of patients presenting with erectile difficulties and ultimately put less pressure on the health care system and provide a cost effective initial screening for patients.

**Comparison of Subjective Sexual Arousal**

The hypothesis regarding discrete subjective sexual arousal was that men classified as having psychogenic ED would show lower subjective sexual arousal ratings than men classified as having organic ED. This hypothesis was based on the idea that men with psychogenic ED potentially have a psychological underlying factor contributing to their ED, and so their subjective sexual arousal was assumed to be lower than men who have organic ED. This idea was also supported by Sakheim et al. (1987). In their study, men with psychogenic ED underestimated their subjective sexual arousal compared to their genital arousal, compared to men with organic ED who overestimated their subjective sexual arousal compared to their genital arousal. Although no recent study compared men with organic and psychogenic ED on discrete subjective measures after watching a sexually explicit film, Sarin et al., 2014, compared men with different types of sexual dysfunction as well as healthy controls. Discrete subjective measures were also classified as physical and mental factors. Interestingly, men diagnosed with both ED and HSDD showed lower subjective sexual arousal than men with ED alone; however, the type of ED was not classified. Since HSDD is a disorder that can be triggered by psychological factors (Meuleman & Van Lankveld, 2005) its association with ED was the most
comparable in the literature to subjective sexual arousal in response to sexually-explicit film in psychogenic ED. This hypothesis, however, was not supported by the current results. There were no differences amongst the groups on mental or physical discrete subjective sexual arousal ratings. These results do support the Janssen, Everaerd, Van Lunsen, and Oerlemans (1994) study that concluded that subjective sexual arousal ratings were different between ED patients and healthy controls but not between the two types of ED. The current study results suggest that men with ED are equally subjectively sexually aroused by the sexually explicit film, so differentiating them on this measure may not be appropriate. This further supports the importance of physiological measures in the diagnosis and assessment of ED.

Similarly, when examining continuous subjective sexual arousal ratings between the two groups, no differences were found, suggesting that subjective sexual arousal in response to the film cannot differentiate men in the two ED groups. Therefore, the original hypothesis suggesting men with psychogenic ED to show low subjective sexual arousal was not supported. In contrast, when comparing the two groups on the IIEF scales, there were significant differences between the groups on the erectile function, intercourse satisfaction as well as overall satisfaction subscales whereby men with psychogenic ED reported higher scores (better functioning) on the mentioned scales than men with organic ED. Moreover, when comparing the severity of ED based on the interpretation of the IIEF scores for the erectile functioning subscale, patients in the psychogenic ED group were classified in the “moderate” dysfunction group compared to patients in the organic ED group who were classified in the “severe” dysfunction group as per the IIEF classification (Rosen, 2008). For the other subscales, higher scores are interpreted as less dysfunction (Rosen, 2008). As men in the psychogenic ED group reported significantly higher scores on intercourse and overall satisfactions, this alludes to the fact that men in the
psychogenic ED group may have better intercourse and overall satisfaction compared to men in the organic ED group. It is important to note, however, that even though men in the psychogenic group show better functioning on some domains, their results remain in the “dysfunction” category. These results are supported by a study conducted by Tang, Li, Zhang, Yi, Zhu, Zeng, and Tang, (2014) whereby men with psychogenic ED had a higher score on the simplified IIEF-5, also referred to as the Sexual Health Inventory for men (SHIM). Interestingly, the SHIM focuses on erectile function and intercourse satisfaction (Rosen, Cappelleri, Smith, Lipsky, & Pena, 1999) which are the two main domains that differed between the two groups in the current study. Several studies, however, do not recommend the use of IIEF as a tool to differentiate between the two types of ED. For example, Deveci, O’Brien, Ahmed, Parker, Guhring, and Mulhall (2008), looked only at the erectile functioning subscale to see if they matched the diagnosis produced by the results of the Doppler ultrasound. Seventeen percent of the participants that were categorized as having psychogenic ED were classified in the severe ED category by the IIEF. This led the authors to conclude that the IIEF was not an appropriate tool to be used for differentiating between the two types of ED and that objective measures are necessary. As a limitation, the authors did not look at other domains of the IIEF and their sample size was very small. Similarly, Melman, Fogarty, and Hafron (2006) looked at the relationship between nocturnal penile tumescence rigidity (NPTR) using the Rigiscan and the IIEF scored for erectile functioning and found no significant correlations between the two measures.

The mixed results further support the importance of physiological measures, and that self-report measures should not be used in lieu of objective ones. Nonetheless, it is important to look at subjective measures along with results from an objective measure in a complementary way to strengthen and support decisions made regarding a patient’s diagnosis. As seen by the
results of the current study, subjective sexual arousal in terms of mental and physical measures after viewing a sexually-explicit film do not seem to differ amongst the two types of ED groups. Subjective measures in terms of self-report feelings of one’s own perceptions of sexual functioning as demonstrated by the IIEF results, however, may be detectable amongst the groups. Replication of these results in future studies with bigger sample sizes is nonetheless necessary.

**Relationship Between Genital and Subjective Sexual Arousal**

This study demonstrated that men in the psychogenic group showed higher genital temperature in response to the sexually-explicit material than men with organic ED, but it was also found that there were no differences in subjective sexual arousal between the two groups. Although these findings might suggest a lower agreement between the genital and self-reported sexual arousal in men with psychogenic ED, the within group correlations did not find this. Men in the psychogenic ED group had stronger agreement between subjective and genital sexual arousal than men in the organic ED group. Mean correlations of both groups were positive, in the low range ($M=.27$, $SD=.42$) for men in the organic ED group and the medium range ($M=.49$, $SD=.34$) for men in the psychogenic group. Contrary to the hypothesis initially formulated, this set of results fail to support the idea that men in the psychogenic group will show less agreement between subjective and genital sexual arousal. These results suggest that men with psychogenic ED do in fact have better physiological functioning that corresponds to their subjective self-report. Interestingly, when looking at the mean within group correlations of the psychogenic ED group ($M=.49$), it is comparable to the ED within group correlation in the Sarin et al. (2014) study ($M=.48$), whereas the organic ED average within group correlation in the current study ($M=.27$) was lower than all conditions in Sarin et al. (2014) study. The two studies however, cannot be compared directly in that manner for methodological and statistical reasons and it is
not possible to determine whether the differences were significant or clinically important therefore, the comparisons are made based only on observation. Nonetheless, these two studies have very similar designs and looking at the similarities between them can explain different aspects of the current results. Since the ED participants were not separated into organic and psychogenic groups in the Sarin et al., (2014) study, the within group correlation between physiological and subjective measures for ED patients may have been inflated. It is also interesting to compare the correlations for organic and psychogenic ED groups to the healthy control ($r=.61$) from the Sarin et al. (2014) study. It is evident that healthy controls have a visibly stronger relationship between subjective and physiological measures; however, the difference in within group correlations between the psychogenic ED group and healthy controls was not as dramatic as the difference in the within group correlations between the organic ED group and healthy controls.

**Implications of the Current Research**

The current study posits some important implications in the assessment and diagnoses of erectile dysfunction. Firstly, there is a clear distinction between organic and psychogenic ED in terms of temperature change, whereby organic ED patients show overall lower temperature change in response to the sexually explicit material. This suggests that thermography can potentially be used to differentiate between the two types of ED based on genital temperature. As explained previously, using thermography for the assessment of erectile dysfunction can have several benefits. Firstly, thermography is a more non-invasive and cost-effective procedure. Men might be more likely to seek help for their ED if they knew that the initial diagnostic procedure would be lower in cost and intrusion than the current ultrasound assessment. Additionally, thermography does not require a urologist to perform the procedure, and with the proper training
many technicians and health care providers can carry out the procedure. As previously mentioned, thermography was useful and accurate at identifying those who do not have ED due to an organic underlying factor. In the literature, ED due to psychogenic factors may be as prevalent as 40-50% (Aydin et al., 2001; Caspari et al., 1999; Melman et al., 1988). A proportion of men with psychogenic ED (about 18.5% of the total sample and 42% of all patients diagnosed with psychogenic ED) were accurately identified using thermography. This being a conservative yield is beneficial in order to reduce the potential problem of a false negative diagnosis. Therefore, thermography will only eliminate patients that likely do not have an organic problem contributing to their ED. Moreover, the IIEF along with the thermography procedure may be used as a complementary tool, given that differences were established amongst the two groups on domains such as erectile functioning, intercourse satisfaction and overall satisfaction. Finally, it is possible that the stronger continuous subjective and genital sexual arousal patterns in men with psychogenic ED may be used as an additional confirmation of diagnosis.

**Limitations of the Current Research.**

The current study was associated with a number of drawbacks that need to be taken into account. Firstly, even though the classification of ED was based on age-adjusted PSV values, the classification did not perfectly match that of the urologist’s arterial insufficiency classification. As mentioned previously, the degree of association between the diagnosis based on PSV values and the urologist’s classification was moderate ($\phi=.61$). This shows that the numerical value produced by the ultrasound procedure may not be completely representative of the patient’s condition and that trained professionals may evaluate the patient according to their medical and professional knowledge. This is why it is important for the thermography procedure to be a
conservative tool and for it to only eliminate those who most likely do not need a urological assessment.

Second, the sample size may have been sufficient for appropriate analyses to be conducted and to obtain acceptable power values; however, a bigger sample would be beneficial, especially for replication of results and implementation into the health care system. The current participants were referred to the study by their urologist, who gave them the option to undergo the ultrasound assessment by participating in the study. This may represent bias in the sample because it may be a group of individuals with more severe symptoms to be willing to go through fairly intrusive medical testing. Therefore, this group of participants may not be representative of all ED patients.

Lastly, participants were significantly different on baseline variables such as age, years of education, relationship status and number of medical conditions. Although these were differences that were expected due to the different characteristics associated with each type of ED, it is nonetheless a critical limitation to evaluate since results need to be interpreted with caution when participants are not comparable on baseline and demographic characteristics. It is important to note however that although this is a limitation in terms of result interpretation in research, these distinct group difference will continue to occur in natural settings and that the only way to control for such variability would be by using these baseline characteristics as control variables which will require bigger sample sizes in order to maintain a study that is high in statistical power.
Future Goals and Implications for Research

For thermography to be implemented in the health care system, replication of the above results will be necessary. Replication of these results will need to be conducted with larger sample sizes. Additionally, it would be beneficial to seek men experiencing ED outside of the clinical populations, as professional help seeking behavior may induce self-selection bias (Rosen, Fisher, Eardley, Niederberger, Nadel, & Sand, 2004). Moreover, a qualitative piece with a brief interview and sexual history-taking as suggested by Maurice (1999) may be a useful and easily trainable skill that may shed some light on why someone may be experiencing erectile difficulties and may aid in taking the decision of referring the patient to perform further testing.

Conclusion

Erectile dysfunction is a complicated and multi-faceted condition. It is important to identify whether the nature of the dysfunction is mainly organic or psychogenic in order for a proper course of treatment to be implemented. Currently, there is a burden on the health care system for ED to be diagnosed using sophisticated physiological assessments such as the Doppler ultrasound, which requires a trained urologist. The high cost, long wait times, and invasiveness of the procedure may have a negative impact on men seeking help for ED. Thermography, on the other hand may be used as a preliminary screening tool to assess patients before seeking help from a urologist. Thermography is low in cost, non-invasive, and is accurate in eliminating those who have healthy vascular functioning. This screening process may eliminate a conservative yet clinically important proportion of psychogenic ED patients from having to go through further assessment. This can ultimately free up time and space for those who need to be referred to a specialist for further testing.
References


Impotence Research, 11(4).


Venetikou, M. S., Lampou, T., & Gizani, D. (2012). Percentage of organic versus psychogenic erectile dysfunction in male patients


Appendix A

Ethics Certificate

May 26, 2003

Dr. Irv Binik
Stewart Biological Sciences Building
1205 Dr. Penfield Avenue
Montreal, Quebec H3A 1B1

Dear Dr. Binik,

We have received correspondence in support of the research proposal A000-B15-03B entitled "A Pilot Study to Evaluate Thermographic Imaging as a Measure of Sexual Arousal in Men and Women" which was reviewed by the Institutional Review Board, Faculty of Medicine at its meeting of April 28, 2003.

The responses and revisions were found to be acceptable and we are pleased to inform you that final approval for the protocol (April 2003), revised consent form (May 15, 2003), study instruments (April 2003) and English and French recruitment ads (May 2003) was provided on May 26, 2002 valid until April 2004. The certification of approval (executed) has been enclosed.

It is the responsibility of the investigator to assure that the approved research protocol and consent form is deposited with the Research Ethics Boards of each hospital where patient treatment and data analysis will take place. Failure to do so may result in the invalidity of data collected and possible freezing of research funds.

We ask you to take note that review of all research involving human subjects is required on an annual basis in accord with the date of initial approval. Should any modification to the study (including the consent form) or unanticipated development occur prior to the next review, please advise the IRB promptly.

Sincerely,

Serge Gauthier, M.D.
Co-Chair
Institutional Review Board

cc: Ms. F. Cantini - JGH
Ms. E. Boyle – MUHC/MGH
Ms. L. Fateen – MUHC/RVH
A04-B15-03B
CERTIFICATION OF ETHICAL ACCEPTABILITY FOR RESEARCH INVOLVING HUMAN SUBJECTS

The Faculty of Medicine Institutional Review Board consisting of:

SERGE GAUTHIER, MD
MARK S. GOLDBERG, PhD
MARIGOLD HYDE, BSc
HARVEY SIGMAN, MD

GEORGEY BLAKE, MD
VINCENT GRACCO, PhD
ABBY LIPPMAN, PhD
SALLY TINLEY, BCOM

has examined the research project A04-B15-03B entitled "A Pilot Study to Evaluate Thermographic Imaging as a Measure of Sexual Arousal in Men and Women" as proposed by: Irv Binik to

Applicant

and consider the experimental procedures to be acceptable on ethical grounds for research involving human subjects.

May 26, 2003

Date

Chair, IRB

Dean of Faculty

Institutional Review Board Assurance Number: FWA 00004545
Appendix B

Thermal Imaging Telephone Screening Interview

Date: ____________________  Language: English  French

Interviewer: ____________________________

1. Are you calling in response to a specific study?  YES  NO
   ➢  If YES, which one?
      ☐ Thermal imaging
      ☐ Other

2. How did you hear about this/these studies?
   ☐ Newspaper ad (which one: ____________________________)
   ☐ Word of mouth
   ☐ Other (how: ____________________________)

Let me tell you about the study:

Thermal Imaging

The purpose of this study is to first establish whether thermal imaging can be used to measure sexual arousal in healthy men and women. A second goal of this study is to then compare the physiological response of healthy participants to that of women who suffer from sexual arousal difficulties, pain during intercourse (Vulvar Vestibulitis Syndrome) and men with erectile problems. To date there is no non-intrusive way of measuring genital response during sexual arousal and successful completion of this study will provide promising data concerning the clinical usefulness of this measure.

This study consists of answering questions about general demographic and health information over the phone and a 1.5 hour testing session. Participants will watch three 15 minute film clips on special DVD goggles while their genital temperature is monitored remotely with a thermal imaging camera. This technology picks up heat emitted from the body and requires no physical contact with the participant. Participants will watch one neutral travelogue with no sexual content and are then randomly assigned to view either a sexually explicit, a humorous, an anxiety provoking or another neutral travelogue video.

Do you have any questions about the study? (Answer any questions)

The erotic video you may be viewing in this study (one in four chance) consists of scenes depicting consenting adults engaged in a variety of sexual activities including kissing, masturbation, mutual oral sex and penetration. There is no talking or storyline in the video and the scenes are quite explicit.
3. Are you interested in participating? YES NO*

4. Do you mind answering some questions about your general medical, gynecological(urological), and sexual history to determine if you are eligible for the study? YES* NO

5. May I have your name: __________________________________________________________

6. How old are you: ____________

7. Are you currently taking any medications regularly (including birth control)?

   YES* NO

   ➢ If yes, which one(s)? ____________________________________________________________

8. **FOR WOMEN ONLY (MEN CONTINUE TO QUESTION 9):**

   a) How often do you get your period?* ____________________________________________

   b) Have you noticed any irregularities with your menstrual cycle?

       YES* NO

       If YES: explain and when did you notice a change in your cycles?

       __________________________________________________________

       __________________________________________________________

   d) Are you experiencing any of the following symptoms:

       ➢ Hot flashes? YES* NO
       ➢ Night sweats? YES* NO
       ➢ Urinary incontinence? YES* NO
       ➢ Pain during urination? YES* NO
       ➢ Pain during intercourse? YES* NO

   e) Are you currently taking any hormone replacement medications?

       YES* NO
If yes, which ones? __________________________________________

________________________________________________________

f) Are you currently taking any natural supplements of phytoestrogens? (e.g., soy products, black cohosh, St. John’s wort, wild yam, dong quai, evening primrose, valerian root, ginseng, chasteberry)

YES* NO

If yes, which ones and why? __________________________________________

________________________________________________________

9. Are you suffering from any chronic illnesses? YES* NO (e.g., diabetes, hypertension, etc.) __________________________________________

10. Have you had a gynecological (urological) examination in the past year?

YES* NO*

➤ If YES (Urological), for what reason? __________________________________________

➤ If NO (Gynecological), why not? __________________________________________

11. Do you currently suffer from any sexual difficulties? YES* NO

➤ If YES, What? __________________________________________

12. Have you ever watched a sexually explicit movie or video?

YES NO*

13. Do you feel uncomfortable about or object to the idea of watching a sexually explicit
video or movie?

YES*       NO

14. Do you have any difficulty getting aroused at sexually explicit movies or videos?

YES*       NO       I DON’T KNOW*

15. Do you have difficulty getting sexually aroused by yourself (e.g., masturbation)?

YES*       NO       I DON’T KNOW*

16. Do you have difficulty getting sexually aroused with a partner?

YES*       NO       I DON’T KNOW*

17. Are you concerned about your ability to get sexually aroused?

YES*       NO       I DON’T KNOW*

➢ If yes, would you like us to refer you to someone to discuss this with?

YES       NO

18. Are you primarily heterosexual, homosexual or bisexual? (circle)

➢ Clips are heterosexual in nature
BOOKING SUBJECTS

When are you generally available to participate in this study?

Eligible for the study?

☑ YES
☑ NO
☑ NOT SURE (consult Tuuli before booking)

*FOR WOMEN ONLY:

➤ When was the first day of your last period? ____________________________
➤ BOOK WOMEN ONLY BETWEEN FIRST DAY OF PERIOD TO 10-12 DAYS AFTERWARDS (FOLLICULAR PHASE)
➤ If 12 days has already passed, ask when next period is and book within 12 days of that starting date and then call during her period to make sure she has it.

We will contact you to confirm your appointment, please notify us 24 hours ahead of time if you will be unable to make it.

Phone #

➤ Home: __________________________ Can we leave a message? YES NO
➤ Work: __________________________ Can we leave a message? YES NO
➤ Cell: __________________________ Can we leave a message? YES NO
➤ Pager: __________________________
➤ Email: __________________________

APPOINTMENT DATE AND TIME:

Group Placement:

☑ HW (healthy women)
☑ HM (healthy men)
☑ FSAD (female sexual arousal disorder)
☑ ED (erectile dysfunction)
☑ VVS (vulvar vestibulitis syndrome)

**Conduct demographic questionnaire immediately over phone!**
SOCIO-DEMOGRAPHIC INFORMATION

1. Date of birth: ___/___/______ Age: ______
   day    month    year

2. Place of Birth
   A) Canada        B) United States        C) Western Europe
   D) Eastern Europe E) Africa              F) Asia
   G) Australia     H) Middle East          I) Latin America/South America
   J) Caribbean

3. What is your mother tongue? ________________________________

4. Occupation? ________________________________

5. How many years of schooling do you have? ________________

6. Which of the following best describes your current dating/couple/marital situation?
   - No regular partner at the moment
   - Dating one partner regularly
   - Dating more than one partner
   - Living with a partner
   - Married
   - Separated/divorced
   - Widowed
   - Other ________________________________

7. Have you experienced childbirth? YES NO
   ➢ If YES, please specify # of children ____________
Appendix C

Consent form

SUBJECT CONSENT FORM

A Pilot Study to Examine the Validity of Thermographic Imaging As a Measure of Sexual Arousal

Principal Investigators
Dr. Serge Carrier, Dr. Samir Khalife and Dr. Irv Binik

Introduction
This study is being carried out by a multidisciplinary group of gynecologists, urologists and psychologists. The principal urologist is Dr. Serge Carrier (842-1231 loc. 34356), Dept. of Urology, Royal Victoria Hospital; the principal gynecologist is Dr. Samir Khalife (933-8877), Dept. of Obstetrics and Gynecology, Jewish General Hospital; the principal psychologist is Dr. Irv Binik, Dept. of Psychology, McGill University (398-6095) and Director, Sex and Couple Therapy Service, Royal Victoria Hospital.

Purpose of the Study
This study is being conducted to investigate whether thermal imaging (similar to that used in night vision goggles) can be used to measure temperature change in the genital area. Measuring temperature change in this area is important because it is closely related to blood flow, which is considered to be the physiological basis of both female and male sexual arousal. This project is an initial exploration of whether increases in genital temperature as measured by this technology accurately reflect changes in sexual arousal. In addition, this study will examine the diagnostic potential of thermography for erectile difficulties by comparing it to the current clinical gold standard, penile Doppler ultrasonography. The potential advantage of this technology is that it is not intrusive and does not require touching or manipulation of the genitalia by the experimenter or the person to be tested.

Procedures of the Study
Participation in the study will involve the following procedures: 1) a brief demographic, sexual arousal and medical questionnaire; 2) exposure to three 15 minute video segments; 3) rating of subjective reactions to each video; 4) having one’s genital area monitored with a special camera; 5) feedback to the participant. Finally, at your upcoming ultrasound appointment, we will ask you to rate your subjective reactions prior to and immediately following the ultrasound procedure.

Demographic, Sexual Arousal and Medical Interview This brief interview will inquire about your age, general health, current medications, and sexual arousal difficulties.

Video Viewing and Genital Temperature Measurement A research assistant will help you put on DVD goggles and earphones so that the videos can be viewed. While sitting in a reclining chair with your knees up, you will view three videos while a special camera monitors genital temperature. This first video will be a 15 minute neutral travelogue without sexual content. This time period will also allow genital temperature to stabilize.
and will also allow you to become acclimatized to the setting. The second neutral video will be viewed for 15 minutes. This video will be used for the baseline measurement of genital temperature. Finally, a third video (either sexually explicit or humorous or anxiety provoking or neutral) will be viewed for 15 minutes. During each video you will be asked to continuously monitor your sexual arousal with the use of a mouse. In addition, after each video, you will be asked to rate subjective reactions to the film (relaxation, sexual arousal, etc.).

**Feedback to the Participant** The research assistant will meet with you after the above to discuss the procedures of the experiment. Any questions will be answered.

**Ultrasound Appointment** We will ask you to rate your subjective reaction of relaxation, anxiety, sexual arousal, etc. prior to undergoing the ultrasound appointment and immediately following it.

**Risks and Benefits**
The major risk involved is that some of the above procedures may be embarrassing. The major benefit will be the opportunity to aid in the development of a method which may help in the assessment and treatment of sexual arousal problems.

**Compensation**
The fees associated with your upcoming ultrasound procedure that are not covered by Medicare will be waived.

**Participation Rights**
You are under no obligation to participate in this study. Furthermore, you are free to withdraw from the study at any time or to refuse to answer any questions posed without need of an explanation on your part. Participation or withdrawal from this study will in no way affect your upcoming treatment. Should you wish additional information concerning possible treatment referral, we will attempt to provide this.

**Contacts**
In the event that you have any complaints or dissatisfactions with this research, they can be communicated to one of the principal investigators. Questions regarding your rights as a research subject should be directed to the patient representative either at the Jewish General Hospital (Lianne Brown 340-8222, loc. 5833) or at the Royal Victoria Hospital (Pat O'Rourke 842-1231, loc. 35655).

**Confidentiality**
Subject data will only be identified by a research number and will only be available to members of the research team. A list of number codes linked to names will be kept separate from the data in a locked filing cabinet accessible only to the research team.

**Participant's Signature**
The study has been explained to me and my questions have been answered to my satisfaction. I agree to participate in this study. I will keep one copy of this form.
Appendix D
Structured Interview

Participant #: 

STRUCTURED INTERVIEW

THERMAL IMAGING STUDY

ED PILOT

Subject Number
Group
Referred from
Interviewer
Date of interview
SOCIO-DEMOGRAPHIC INFORMATION

1. Date of birth: __/__/____  Age:_____
   day  month  year

2. Place of Birth
   A) Canada  B) United States  C) Western Europe
   D) Eastern Europe  E) Africa  F) Asia
   G) Australia  H) Middle East  I) Latin America/South America
   J) Caribbean

3. What is your mother tongue?_____________________________________

4. Occupation?________________________________________________

5. How many years of schooling do you have?_____________________

6. Which of the following best describes your current dating/couple/marital situation?
   ☐ No regular partner at the moment
   ☐ Dating one partner regularly
   ☐ Dating more than one partner
   ☐ Living with a partner
   ☐ Married
   ☐ Separated/ divorced
   ☐ Widowed
   ☐ Other____________________________________________________

7. How long have you been (fill in whatever they checked off)?________

UROLOGICAL HEALTH INFORMATION

1. Have you ever been to see a urologist?  YES  NO
   ➢ If YES, why______________________________________________
SEXUAL AROUSAL

1. Do you have any difficulty getting sexually aroused by yourself (e.g. during masturbation)?
   Y  N  Don't Know

   If yes or don't know, please explain______________________________

2. Do you have any difficulty getting sexually aroused with your partner?
   Y  N  Don't Know

   If yes or don't know, please explain______________________________

3. Do you have any difficulty getting aroused at sexually explicit movies or videos?
   Y  N  Don't Know

   If yes or don't know, please explain______________________________

4. On a scale from 0-100%, with 0 being no erection at all and 100 indicating a full erection, how would you rate your erection during:
   ➢ Masturbation by yourself________
   ➢ Masturbation with a partner________
   ➢ Intercourse with a partner________
   ➢ Sexually explicit videos________
   ➢ Reading sexually explicit materials________
   ➢ Ejaculation________
   ➢ Morning erections________
   ➢ Nighttime erections________

5. FOR MEN WITH ED ONLY: How long have you had your current erectile difficulties?______________________________

6. Have you ever received treatment for erectile difficulties?
   YES  NO
   ➢ If Yes, what treatment?_______________________________________
   ➢ When did you receive treatment?______________________________
   ➢ How well did it work?_______________________________________
7. Are you concerned about your ability to get sexually aroused?
   Y    N    Don't Know

If yes or don't know, please explain________________________________________

8. If yes, would you like us to refer you to someone to discuss this with? Y    N

**UROLOGICAL/HEALTH HISTORY**

HAVE THEM FILL OUT THE RVH ED CLINIC QUESTIONNAIRE and IIEF
Appendix E
Erectile Dysfunction Patient Questionnaire

Erectile Dysfunction Clinic
Patient Questionnaire
Participant #: ____________
Date: _________________

1. Do you have any of the following medical conditions?
   - Angina
   - Cardiac Bypass
   - Vascular Surgery
   - Depression/Anxiety/ Psychosis
   - Prostate Surgery
   - Bladder Surgery
   - Prostatectomy for prostate cancer
   - Heart attack
   - High blood pressure
   - Radiotherapy
   - Back/Pelvic/Hip injury
   - High cholesterol/lipids
   - Diabetes
   - Back surgery

2. List all the medication(s) that you are taking (please print).
   - Name: ____________________ Since: ____________
   - Name: ____________________ Since: ____________
   - Name: ____________________ Since: ____________
   - Name: ____________________ Since: ____________
   - Name: ____________________ Since: ____________
   - Name: ____________________ Since: ____________

3. Are you allergic to any medications? □ NO
   □ YES ________________________________

4. Do you smoke?
   □ YES _______ cigarette(s) per day     □ NO  □ Quit smoking since ____________ (date/year)

5. Do you drink alcohol?
   □ Never
   □ 1-2 drinks/week
   □ 5-10 drinks/week  □ 2-5 drinks/week
   □ more than 10 drinks/week
   □ Quit drinking since ____________ (date/year)

6. Do you use recreational drugs?
   □ NO  □ YES, specify name of drugs: ________________________________

7. Have you ever had an operation? (please print)
   □ NO  □ YES, specify:
   - Name: ____________________ Date: ____________
   - Name: ____________________ Date: ____________

8. Which of the following treatments have you had for your sexual problems?
   □ N/A
   □ No previous treatment
   □ Viagra □ 25 mg □ 50 mg □ 100 mg No. of times used ____________
   □ Cialis □ 10 mg □ 20 mg No. of times used ____________
   □ Levitra □ 5 mg □ 10 mg □ 20 mg No. of times used ____________
   □ MUSE □ 500 μg □ 1000 μg No. of times used ____________
   □ Vacuum device
   □ Penile Injection: Name ____________________ since ____________
   □ Andriol since ________________________________
9. Erectile dysfunction/Impotence
☐ N/A
☐ Sudden onset
☐ Progressive since: _______ months _______ years

10. Do you have difficulty:
☐ To get a rigid erection
☐ To maintain the erection
☐ To penetrate your partner
☐ No difficulty

11. You are able to successfully penetrate your partner in ____% of the time.

12. You are able to have successful intercourse in ____% of the time.

13. Your semen ejaculation comes:
☐ Normally
☐ Before loss of erection
☐ After loss of erection

14. Number of sexual partners presently: ____________

15. Number of attempts for sexual intercourse per month: _____, successful in ______ times

16. Current type of relationship with your partner(s):
☐ Stable  ☐ Married
☐ Single  ☐ Other___________

17. Is your partner cooperative with you?
☐ Yes
☐ No
☐ Sometimes

18. Are your morning erections:
☐ Rigid
☐ Rigid, not sustained
☐ Partially rigid
☐ None

19. Your sexual desire is:
☐ Normal
☐ Decreased
☐ Decreased because of your erectile dysfunction

20. Compared to sexual intercourse, what is the quality of your erection when you masturbate:
☐ Better
☐ Same as intercourse
☐ Worse
☐ No masturbation
Appendix F

International Index of Erectile Function Questionnaire (Rosen et al., 1997)

Over the past 3 months:

1. How often were you able to get an erection during sexual activity? _______
   0 = No sexual activity
   1 = Almost never/never
   2 = A few times (much less than half the time)
   3 = Sometimes (about half the time)
   4 = Most times (much more than half the time)
   5 = Almost always/always

2. When you had erections with sexual stimulation, how often were your erections hard enough for penetration? _______
   0 = No sexual activity
   1 = Almost never/never
   2 = A few times (much less than half the time)
   3 = Sometimes (about half the time)
   4 = Most times (much more than half the time)
   5 = Almost always/always

3. When you attempted sexual intercourse, how often were you able to penetrate (enter) your partner? _______
   0 = Did not attempt intercourse
   1 = Almost never/never
   2 = A few times (much less than half the time)
   3 = Sometimes (about half the time)
   4 = Most times (much more than half the time)
   5 = Almost always/always

4. During intercourse, how often were you able to maintain your erection after you had penetrated (entered) your partner? _______
   0 = Did not attempt intercourse
   1 = Almost never/never
   2 = A few times (much less than half the time)
   3 = Sometimes (about half the time)
   4 = Most times (much more than half the time)
   5 = Almost always/always

5. During sexual intercourse, how difficult was it to maintain your erection to completion of intercourse? _______
   0 = Did not attempt intercourse
   1 = Extremely difficult
   2 = Very difficult
   3 = Difficult
   4 = Slightly difficult
   5 = Not difficult

6. How many times have you attempted sexual intercourse? _______
   0 = No attempts
   1 = One to two attempts
   2 = Three to four attempts
7. When you attempted sexual intercourse, how often was it satisfactory for you? _______

0 = Did not attempt intercourse
1 = Almost never/never
2 = A few times (much less than half the time)
3 = Sometimes (about half the time)
4 = Most times (much more than half the time)
5 = Almost always/always

3 = Five to six attempts
4 = Seven to ten attempts
5 = Eleven or more attempts

8. How much have you enjoyed sexual intercourse? _______

0 = No intercourse
1 = No enjoyment
2 = Not very enjoyable
3 = Fairly enjoyable
4 = Highly enjoyable
5 = Very highly enjoyable

9. When you had sexual stimulation or intercourse, how often did you ejaculate? _______

0 = No sexual stimulation/intercourse
1 = Almost never/never
2 = A few times (much less than half the time)
3 = Sometimes (about half the time)
4 = Most times (much more than half the time)
5 = Almost always/always

10. When you had sexual stimulation or intercourse, how often did you have the feeling of orgasm or climax? _______

0 = No sexual stimulation/intercourse
1 = Almost never/never
2 = A few times (much less than half the time)
3 = Sometimes (about half the time)
4 = Most times (much more than half the time)
5 = Almost always/always

11. How often have you felt sexual desire? _______

1 = Almost never/never
2 = A few times (much less than half the time)
3 = Sometimes (about half the time)
4 = Most times (much more than half the time)
5 = Almost always/always

12. How would you rate your sexual desire? _______

1 = Very low/none at all
2 = Low
3 = Moderate
4 = High
5 = Very high
13. How satisfied have you been with your overall sex life? _______
1 = Very dissatisfied
2 = Moderately dissatisfied
3 = About equally satisfied and dissatisfied
4 = Moderately satisfied
5 = Very satisfied

14. How satisfied have you been with your sexual relationship with your partner? _______
1 = Very dissatisfied
2 = Moderately dissatisfied
3 = About equally satisfied and dissatisfied
4 = Moderately satisfied
5 = Very satisfied

15. How would you rate your confidence that you could get and keep an erection? _______
1 = Very low
2 = Low
3 = Moderate
4 = High
5 = Very high
Appendix G

State-Trait Anxiety Inventory (Spielberger, 1983)
STAI Form Y-1

Name…………………………….     Date…………….     Age………   Sex……………………

Directions: A number of statements which people have used to describe themselves are given below. Read each statement and then write the number in the blank at the end of the statement that indicates how you feel right now, that is, at this moment. There is no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Statement</th>
<th>Not at all</th>
<th>Somewhat</th>
<th>Moderately so</th>
<th>Very much so</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I feel calm</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>I feel secure</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>I am tense</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>I feel Strained</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>I feel at ease</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>I feel upset</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>I am presently worrying over possible misfortunes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>I feel satisfied</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>I feel frightened</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>I feel comfortable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>I feel self self confident</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>I feel nervous</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>I am jittery</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>I feel indecisive</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>I am relaxed</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16</td>
<td>I feel content</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17</td>
<td>I am worried</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18</td>
<td>I feel confused</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19</td>
<td>I feel steady</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20</td>
<td>I feel pleasant</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Self-Evaluation Questionnaire
STAI form Y-2

Name …………………………………………………………………………………………….

Directions: A number of statements which people have used to describe themselves are give below. Read each statement and then write the number in the blank at the end of the statement that indicates how you feel in general. There is no right or wrong answer. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Statement</th>
<th>Almost Never</th>
<th>Sometime</th>
<th>Often</th>
<th>Almost always</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>I feel pleasant</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>22</td>
<td>I feel nervous and restless</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>23</td>
<td>I feel satisfied with myself</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>24</td>
<td>I wish I could be as happy as others seem to be</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>25</td>
<td>I feel like a failure</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>26</td>
<td>I feel rested</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>27</td>
<td>I am calm, cool and collected</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>28</td>
<td>I feel that difficulties are piling up so that I cannot overcome them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>29</td>
<td>I worry too much over something that doesn’t really matter</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>30</td>
<td>I am happy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>31</td>
<td>I have disturbing thoughts</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>32</td>
<td>I lack self confidence</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>33</td>
<td>I feel secure</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>34</td>
<td>I make decisions easily</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>35</td>
<td>I feel inadequate</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>36</td>
<td>I am content</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>37</td>
<td>Some unimportant thoughts run through my mind and bother me</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I take disappointments so keenly that I can’t put them out of my mind</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
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<td>---</td>
</tr>
<tr>
<td>38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td></td>
<td>I am steady person</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>I get in a state of tension or turmoil as I think over my recent concerns and interests</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Appendix H

Self-Reported Sexual Arousal Questionnaire

Please indicate the number which best describes your experience:

1. Overall, how relaxed did you feel during this film?
   
<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>not</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>the most relaxed I’ve ever been</td>
</tr>
<tr>
<td>at all</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Overall, how much did you enjoy the film?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>not</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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3. Overall, how funny did you find the film?

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4. Overall, how anxious did you become during this film?

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5. Overall, how frightening was this film?

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<td>most frightening film I’ve ever seen</td>
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6. Overall, how sexually aroused did you become during this film?

0 1 2 3 4 5 6 7 8 9 10
not sexually aroused at all
the most sexually aroused I’ve ever been

7. At what point during the film would you say that you were most sexually aroused?

- Was not at all sexually aroused
- Within the first 5 minutes
- Between 5-10 minutes (middle of film)
- During the last 5 minutes
- Varied throughout (up and down during the film)
- Other; explain

8. How would you rate your peak sexual arousal during the film?

0 1 2 3 4 5 6 7 8 9 10
not at all sexually aroused the most sexually aroused I’ve ever been

Now I am going to ask you to consider your sexual arousal specifically in terms of mental and physical parts:

9. Overall, how sexually aroused were you **mentally** during the film?

0 1 2 3 4 5 6 7 8 9 10
not at all mentally aroused the most mentally aroused I’ve ever been

10. Did watching the video make you feel like having sex with a partner?

0 1 2 3 4 5 6 7 8 9 10
not at all the most I’ve ever felt

11. Did watching the video make you feel like masturbating?
12. Overall, how sexually aroused were you **physically** during the film?

0  1  2  3  4  5  6  7  8  9  10
not at all the most I’ve ever felt

13. How much genital change did you feel during the film?

0  1  2  3  4  5  6  7  8  9  10
no genital change the most genital change I’ve ever felt

14. How would you rate your erection in response to this film?

0  1  2  3  4  5  6  7  8  9  10
no erection at all hardest erection ever

15. How sexually aroused did you feel during the film as compared to how sexually aroused you typically are with a partner?

-5  -4  -3  -2  -1  0  1  2  3  4  5
much less sexually aroused no difference much more sexually aroused

16. Did the process of having your genitals filmed affect you in any way?

   YES  NO

➢ If Yes, describe how:

   ___________________________________________________________________________________

A) To what extent did it □ increase or □ decrease your sexual arousal?

0  1  2  3  4  5  6  7  8  9  10
not at all the most possible
B) To what extent did it □ increase or □ decrease how funny you thought the video was?

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<td>not at all</td>
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C) To what extent did it □ increase or □ decrease how relaxed you were during the video?

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17. Is there anything else you would like to say about this film?
Appendix I
Questions Evaluating Thermographic and Ultrasound Procedures

Please rate the following on a scale of 0-10:

1. Overall, how invasive/intrusive did you find this procedure

   0  1  2  3  4  5  6  7  8  9  10

   No at all  Very much

2. Overall, how painful was this procedure

   0  1  2  3  4  5  6  7  8  9  10

   No at all  Very much

3. Overall, how uncomfortable did you feel during this procedure?

   0  1  2  3  4  5  6  7  8  9  10

   No at all  Very much

4. Which procedure did you prefer, ultrasound or thermography or no preference between the two?

   Thermography
   Ultrasound
   No preference

Why?_______________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

5. Is there anything else that you would like to comment on regarding this procedure?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

6. Would you recommend any changes in the way the procedures are conducted?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________