CORTICAL ORGANISATION OF TACTILE STIMULATION IN HETEROSEXUAL MALES: WHY BODY AREAS DIFFER IN THEIR FACILITATION OF SEXUAL AROUSAL

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DECLARATION

I, Jackie Chaldecott, hereby acknowledge that this research report is my own unaided work. It is submitted for the degree of Masters of Arts in Research Psychology by Coursework and Research Report at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

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ABSTRACT

Tactile stimulation, an important physiological component of the sexual experience, has the ability to influence the body's representation in the brain. The sensory homunculus proposed by Penfield and Rasmussen illustrates the way in which the body is represented within the somatosensory cortex. Due to neuroplasticity, this map has the ability to adapt to differing levels of tactile input. How sexual arousal affects, or is represented by, the sensory homunculus is unknown. The study sought to identify: which body areas, rated by participants, are high in their ability to facilitate sexual arousal; to measure the intensity of the different body areas; and to identify whether the areas of greatest intensity lie adjacent cortically to the genital area thus supporting the hypothesised neuroplasticity of brain functioning. The current study was conducted through an online survey which was completed by volunteers with access to university portal sites, social networking sites and referrals. Sampling was convenient and comprised 208 heterosexual males. Data were treated quantitatively through descriptive (frequencies) and inferential (correlations, rotated factor analysis) statistics. The research findings provide support for the sensory homunculus mapping and suggest that there are three areas (genital, facial and trunk) that facilitate sexual arousal. The ability to facilitate sexual arousal is proposed to lie in the close proximity that these areas have within the three erogenous centres (cortically) as well as co-activation of body areas through perceived erogeneity and physiological proximity. This has important implications for sex therapy for individuals in which feeling in the genital area is lacking.

Keywords: tactile stimulation, sexual arousal, erogenous zones, cortical organisation, sensory homunculus, neuroplasticity

ABBREVIATIONS

MEG	-	Magnetoencephalography
PET	-	Positron Emission Tomography
APTS	-	Associative Pairing of Tactile Stimulation
CIMT	-	Constraint-Induced Movement Therapy
UK	-	United Kingdom
PHP	-	Hyper Text Pre-processor which is a server-side Hyper Text Mark-up Language (HTML) embedded scripting language
VUMA	-	South African University Student Portal
SONA	-	Student experiment participant website

TABLE OF CONTENTS

Page

CHAPTER 3: METHODOLOGY

LIST OF FIGURES

Page

LIST OF TABLES

CHAPTER ONE
INTRODUCTION TO THE STUDY

1.1. Introduction

The body is represented within the brain in different ways and in different locations. In the cortex the body is represented based on the type of input it receives, either through motor input or sensory input (Penfield & Boldrey, 1937). The brain map for motor input, in the motor cortex, is referred to as the motor homunculus. Similarly, the brain map for sensory input, in the somatosensory cortex, is termed the sensory homunculus. Despite the consistency found within the motor and sensory mapping in the brain, these two areas are distinctly separate in terms of anatomical patterns (Penfield & Boldrey, 1937). The motor homunculus has been the subject of much research and has been more clearly defined than the sensory homunculus. However the sensory homunculus should not be overlooked.

Importantly, the representation of the body within the brain, through the sensory homunculus, is not static in nature. While being dependent on afferent input from different body areas, the sensory homunculus has the ability to adapt to a change in the level of input which subsequently results in a change in homuncular organisation revealing its neuroplastic nature (Candia, Wienbruch, Elbert, Rockstroh, & Ray, 2003; Elbert, Pantev, Wienbruch, Rockstroh, & Taub, 1995; Jones, Manager, & Woods, 1997). If input is decreased it can result in the blending of the homuncular organisation. This illustrates the ability of adjacent areas within the cortical map to "spill over" into each other thereby resulting in one body area being stimulated through its neighbouring body area (Candia et al., 2003; Elbert et al., 1995). Afferent input, through tactile stimulation, travels from touch sensitive receptors in the skin to neurons in the corresponding area of the somatosensory cortex (Gross, 2006) for evaluation and organisation.

Tactile stimulation, as a key physiological component to the sexual experience, is thus transported from different body areas to the brain where the sensation is then interpreted as sexual or pleasurable (Abramson & Pinkerton, 1995). Body areas that result in a pleasurable interpretation within the brain when stimulated through touch are known as erogenous zones. The aim of the current study is to investigate whether areas of highest sexual arousal (erogenous zones, as indicated by participants) cluster around the primary sexual areas within the cortical map thereby supporting the homuncular organisation of the body within the somatosensory cortex as well as the neuroplasticity of the brain with its ability to “spill over” into neighbouring areas.

1.2. Rationale

Human coitus has always been ascribed a reproductive function. However, human beings engage in sexual intercourse not only for reproductive means but also for pleasure (Levin, 2002; Schmitt et al., 2002; Vasey, 1998). It therefore becomes important to study the effects that different body areas have in facilitating sexual arousal as a means to increase the pleasurable aspects thereof. In relation to the above mentioned neuroplasticity of the brain and the homuncular organisation of the body within the brain, it is of interest to determine firstly whether body areas differ in their intensity to facilitate sexual arousal. Secondly, due to the process of homuncular blending, it is anticipated that body areas found adjacent to one another and/or the primary sexual organs should be higher in their ability to facilitate sexual arousal (i.e. are rated as more erogenous) than body areas that are found further away from the primary sexual organs.

The ability of different body areas to facilitate sexual arousal may have important implications for sex therapy with individuals who have been paralysed resulting in a reduced ability of the primary sexual organs to facilitate sexual arousal. Sexuality is a key element in re-establishing a positive view of ‘the self’ after injury (see Farrow, 1990). Farrow (1990) states that sexual experimentation and the de-emphasising of the primary sexual areas (genitals), as the only means through which arousal is facilitated, form essential elements in re-establishing a healthy life-style after injury. The current study thus has the potential to provide alternate ways through which the sexual experience can be enjoyed. Furthermore, it could speak to sex therapy for individuals who have been subjected to genital mutilation and may provide insight into psychological triggers (potentially based on physiological associations and by extension cortical placement within the sensory homunculus), and new techniques for desensitisation, for individuals who have been victims of sexual abuse.

CHAPTER TWO
LITERATURE REVIEW

2.1. Introduction

This chapter will examine the main components on which the research aims are based. These areas will include: sexual stimulation (arousal), tactile stimulation, as well as cortical organisation and neuroplasticity. The sections below will discuss each of these areas and link them to the idea of cortical organisation of tactile stimulation and how body areas differ in their ability to facilitate sexual arousal.

2.2. Sexual Stimulation (Arousal)

When examining sexuality from an evolutionary (adaptionist) perspective, patterns of sexual desire are viewed as functional and are linked to increased reproductive ability through an increase in sexual desire and sensitivity, as well as a decrease in pain sensitivity during ovulation (Levin, 2002; Schmitt et al., 2002). However, many theorists argue that evolutionary explanations are not always adequate in their explanation of sexual behaviour (Schmitt et al., 2002; Vasey, 1998) as human beings do not only engage in sexual intercourse for reproductive reasons (Levin, 2002), but also for pleasure and relaxation. This is supported through methods of self-pleasure such as masturbation, different sexual orientations and the emergence and use of sexual aids and toys (Farrow, 1990).

Several models identifying the core components of the sexual experience have been put forward. The first Sex Response Cycle Model was proposed by Masters and Johnson (1966) who proposed that the core components to the sexual experience included: excitation, plateau, orgasm and resolution. However, in her seminal work, Kaplan (1979) found that in comparison to men, women experienced a lack of spontaneous sexual desire/arousal. This posed a problem for the Masters and Johnson model due to the absence of a sexual arousal phase which Kaplan went on to place prior to excitation. The revised model contained the following sequential phases: desire, excitation, plateau, orgasm and resolution (Kaplan, 1979; Levin, 2002). Abramson and Pinkerton (1995) highlighted the need for a sexual pleasure element in the understanding of sexuality. Their core components include a physiological experience and a psychological aspect.

Sexual pleasure is thus elicited when the erogenous zones of the body are stimulated (tactile stimulation) and this in return sends a signal to the brain which then interprets the stimulus as either pleasurable or sexual.

A further development was proposed by Levin (2000) in which he suggested two desire phases for understanding sexuality and the sex response cycle. The first phase is based on Kaplan's model in which the desire phase is spontaneous in nature and acts as a precursor to sexual excitation. In the second phase, however, it is proposed that sexual desire (pleasure) is activated through the excitation phase (Levin, 2000). The second phase of sexual desire is relevant for the current study, since physical excitation (tactile stimulation) plays a key role in sexual arousal/pleasure in relation to different body areas and how these areas are mapped within the somatosensory cortex.

2.3. Tactile Stimulation

Tactile stimulation is a form of sensory stimulation which is composed of the consistent and non-invasive touching of the skin (as adapted from studies involving touch in infancy, see for example Ottenbacher, Muller, Brandt, Heintzelman, Hojem, & Sharpe, 1987). As discussed above, tactile stimulation facilitates sexual arousal through the physical excitation of different body areas and thus acts as the route for stimulation passing from peripheral body areas to the brain (Arezzo, Schaumburg, & Spencer, 1982). Tactile sensation and the body are strongly linked through the skin as the receptor for touch while forming the physical body, and is represented in several different ways within the brain (Longo, Azañón, & Haggard, 2010; Serino & Haggard, 2010).

2.4. Cortical Organisation as a Theoretical Framework

Many of the sensory modalities have been mapped within the brain and can be found as follows: visual neurons are said to be concentrated in V1 and V2 areas (Brodmann's area 17, 18a and 18b) of the occipital lobe, whilst auditory neurons are found in A1 of the temporal lobe as well as belt cortices (Brodmann's area 39 and 41). Despite speculation that little or no topographical organisation exists for olfactory sensation, research suggests that a stereotyped map might exist (Savic, 2001; Zou, Horowitz, Montmayeur, Snapper, & Buck, 2001). Zou, Li and Buck (2005) suggest that mappings of structurally related odours are logical and complex within the olfactory cortex. However, the authors conclude that in contrast to the olfactory bulb, there are no distinct odour maps in the cortex, with different odours being represented by ‘subsets of neurons in extensively overlapping spatial arrays’ (Zou et al., 2001; Zou et al., 2005, p. 7727). In a study on the mapping of taste in the cortex of the monkey, Scott and Plata-Salamán (1999) did not find a clear topographic organisation of taste. The difficulties inherent in mapping taste lie in the dual function of the tongue both in motor and sensory processing as well as its role in language (Pardo, Wood, Costello, Pardo, & Lee, 1997). Iyengar, Qi, Jain, and Kaas (2007) suggest that Brodmann’s area 3a, 3b and 1 are implicated in processing tactile information from the tongue and teeth as well as the possibility of taste.

Somatosensory neurons are found concentrated in S1 and S2 areas (Brodmann’s area 1, 2, 3, and 7) (Arezzo et al., 1982; Wallace, Ramachandran, & Stein, 2004). Tactile stimulation is proposed to primarily activate Brodmann’s area 3b (Hari et al., 1993; Iwamura, Tanaka, Sakamoto, & Hikosaka, 1983). Similar to touch, proprioception conveys information regarding the body in relation to space. In contrast, information regarding the body areas (eye and ear) and the self, involved in vision and hearing are of secondary importance when compared to importance of information conveyed from external objects (Azañón & Haggard, 2009; Longo et al., 2010). However, of all the sensory modalities, somatosensory perception has received the least attention (Blankenburg, Ruff, Deichmann, Rees, & Driver, 2006; Friedman, Chen, Roe, & Kaas, 2004) and thus leaves much room for further research.

Tactile sensation is conveyed to the primary somatosensory cortex of the contralateral hemisphere via the dorsal column-medial lemniscus pathway as well as the thalamus (Serino & Haggard, 2010). Afferent projections from the body to the primary somatosensory cortex maintain the spatial organisation of the sensory input, thereby producing a topographically, spatially organised representation of the contralateral side of the body (Serino & Haggard, 2010). Due to the strong connections between the physical body and its representation within the somatosensory cortex the term touch is often synonymous with somatosensation. Furthermore, the relationship between tactile stimulation and the representation of the body within the somatosensory cortex is bidirectional with tactile sensory input defining the neural maps which in turn influence how tactile stimulation is experienced throughout the body (Serino & Haggard, 2010). This is further illustrated by the fact that damage to the somatosensory cortex can result in an impaired capacity to localise tactile stimulation or hemianaesthesia (an inability to perceive touch) (Medina & Coslett, 2010; Serino & Haggard, 2010).

2.5. Mapping Sensation

Approximately 70 years ago, a general map of the cortical representation of tactile stimulation was produced by Marshall, Woolsey and Bard (1937). In their study of monkeys, discrete tactile stimulation was applied to anaesthetised areas of the monkey's brain. Results showed surface positive waves that were well localised and regular over time and thus were used to develop a cortical representational map of tactile stimulation (Marshall et al., 1937). Research into cortical mapping was continued by Woolsey's (1958 cited in Chapin & Lin, 1984, p. 200) classic studies which resulted in the first detailed exploration of the patterns of representation from sensory receptors to the somatosensory cortex in mammals. Details on adaptations made to the map produced by Marshall and colleagues (1937) is lacking and it is unclear from the available literature how this map differs to that reported in Chapin and Lin (1984). It is suggested that perhaps the differences lie in the mammals that formed the basis of study.

Seminal work on the mapping of the body within the somatosensory cortex by Penfield and Boldrey (1937) reveals the following map of the body (represented graphically from top to bottom): toes, foot, leg (foot to hip), hip, trunk, shoulder, arm, elbow, forearm, wrist, hand, small finger, ring finger, middle finger, index finger, thumb, eye, nose, face, lips, tongue, taste, jaw and teeth, and throat (Penfield & Boldrey, 1937, p. 431). Sensation in the genital region and that of the rectum were found above and posterior to the toes, thus the genital region was found to be below the toes in the somatotopic map (Penfield & Boldrey, 1937). In their initial mapping, the neck was considered a functional part of the trunk and as such was not mapped separately. A second neck area with the throat was represented adjacent to the face but not above it, thus it did not join onto the trunk area but was presented below the face (Penfield & Boldrey, 1937). Movements associated with the neck (excluding head turning) were included in their map. Neck movements were further shown to be located in close proximity to that of facial movements. However, the authors proceeded to mention that due to the small number of responses they could not be certain of the position of the neck in the body map (Penfield & Boldrey, 1937). Mention is made of Foerster who placed the neck between the thumb and upper face area in both his motor and sensory mappings (1936 cited in Penfield & Boldrey, 1937, p. 433).

Revisions were made to the initial mapping by Penfield and Boldrey and a single map of the human body surface was suggested by Penfield and Rasmussen (1950 cited in Kell, von Kriegstein, Rösler, Kleinschmidt, & Laufs, 2005, p. 5984–5987) for the primary somatosensory cortex of mammals, with the hind limbs medially oriented and the head oriented laterally. This is in contrast to the earlier map by Penfield and Boldrey (1937) where the body was represented more linearly from the toes (at the top) to the throat (at the bottom). They found that the individual size of different body areas varied in their representation in the somatosensory cortex. This map is known as the sensory homunculus, a graphical representation of what humans would look like if their bodies were sized to the same proportions that exist within the brain area that is responsible for processing its corresponding stimuli (Arezzo et al., 1982; Gross, 2006; see Figure 1). Similarly to the revisions made on the Marshall and colleagues (1937) map, little detail is given on the adaptations that were made to the map proposed by Penfield and Boldrey (1937) and the map proposed by Penfield and Rasmussen (1950 cited in Kell et al., 2005).

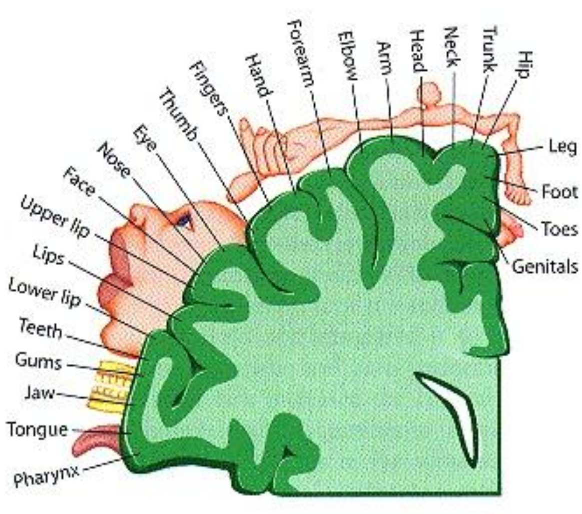

Figure 1. Sensory Homunculus (obtained from Scholarpedia, 2010, Figure 3)

The accepted norm for cortical mapping of sensory input appears to be the sensory homunculus with most studies involving the mapping of somatosensory input relying on the placement of body areas within the homunculus (see for example, Aglioti, Bonazzi, & Cortese, 1994; Buonomano & Merzenich, 1998; Fox, Burton, & Raichle, 1987; Mogilner et al., 1993; Nakamura et al., 1998; Pons et al., 1991; Serino & Haggard, 2010) without any emphasis or explanation as to why this map is accepted as the norm.

Studies on the localisation of different body areas (lips, fingers, toes), that have confirmed the mapping of the body as presented in the sensory homunculus, have used positron emission tomography images of cerebral blood flow after applying cutaneous vibration[1]. Results indicated that the location within the primary somatosensory cortex differed with each body area that was stimulated, thereby revealing a consistent homunculus (Fox et al., 1987; Serino & Haggard, 2010). For example when the lip was stimulated, the parietal operculum was activated; the finger activated areas posterior, medial and superior to that mentioned for the lip; and toe stimulation led to activation medial, posterior and superior to the finger activation site (Fox et al., 1987).

Nakamura and colleagues (1998) studied the somatosensory representation map in the human primary somatosensory cortex by using tactile stimulation of the 'whole body' and recording magnetic fields via magnetoencephalography (MEG). Similarly, it was found that the equivalent current dipoles of multiple body areas were located in the postcentral gyrus and were arranged consistent with the sensory homunculus along the central sulcus. The body areas were found to be mapped inferior to superior, lateral to medial, and anterior to posterior in the following manner: the tongue, lips, fingers, palm, forearm, elbow, upper arm and toes. The trunk and leg areas were not clearly distinguished and the authors hypothesised that this was due to the relatively small cortical representation of these areas.

The studies mentioned above thus support the use of the sensory homunculus in mapping tactile stimulation of the body within the brain. The way in which the sensory homunculus is organised is dependent on the relationship between (1) the size of the receptive field; (2) the extent of primary somatosensory cortex representation; and (3) tactile acuity (Medina & Coslett, 2010; Serino & Haggard, 2010, p. 225). Receptive fields differ in size both on the skin and within the primary somatosensory cortex. As depicted in the sensory homunculus, the size of the representation of body areas differ within the sensory homunculus and certain body areas occupy larger somatotopic regions than others (Marshall et al., 1937; Medina & Coslett, 2010; Serino & Haggard, 2010). For example, body regions that occupy larger areas of cortical space include the face (especially the lips) and the hand (especially the thumb) whilst areas such as the torso/trunk occupies a relatively small cortical space. Body areas differ in the degree of tactile information that they convey (tactile acuity). Tactile acuity in certain body areas are greater than in others, for example, the lip and finger have greater acuity to tactile stimulation than the trunk. The higher the degree of tactile acuity, the larger the representational area occupied within the sensory homunculus (Medina & Coslett, 2010; Serino & Haggard, 2010).

2.6. Neuroplasticity of the Brain

Cortical organisation and the homuncular representation of the body within the somatosensory cortex is not rigid in nature but can be changed. The brain has the ability to form new neural connections, reorganise itself (pre-existing networks), create new networks and produce axonal sprouting (Buonomano & Merzenich, 1998; Jones et al., 1997; Taupin, 2006). Neuroplasticity, the ability of the brain to undergo modification on both a structural and functional level, has received much attention due to its ability to compensate for injury and disease, as well as for its role in training (Donoghue, 1995; Draganski, Gaser, Busch, Schuierer, Bogdahn, & May, 2004). However, the way in which this is done is not fully understood (Taupin, 2006).

While the nervous system and subcortical structures can undergo change, it appears that the primary site for neuroplasticity is within the cortex as this reorganisation is not always observed within the thalamus and other subcortical structures. Indeed, large portions of the finger representation can be removed from its thalamic representation without causing a change/shrinkage in its representation within the somatosensory map. The unmasking of neural connections, through disinhibition, that were previously silent could result in a hypersensitivity of these neural connections to input from neighbouring areas that would not normally be processed in this area. Similarly, sprouting and the strengthening of thalamocortical axons and intracortical horizontal projections could result in neuroplastic changes evidenced in the cortex (Buonomano & Merzenich, 1998; Jones et al., 1997; Serino & Haggard, 2010; Weiss, Miltner, Liepert, Meissner, & Taub, 2004).

There are two proposed theories for explaining the significance of cortical plasticity on a functional level – functional respecification and functional conservation. Functional respecification refers to changes in the sensory cortical maps and the subsequently linked changes in perceptual functioning. Thus, sensory input provided to the new receptive fields of the deafferented neurons in the primary somatosensory cortex is proposed to produce sensation either to the new area of activation or concurrently to both the new and original areas (Doetsch, 1998). This theory has received support from studies with amputees and referred sensations (discussed below). Functional conservation refers to the theory that deafferented neurons maintain their perceptual meaning without a change in peripheral reference. Thus the damaged area still projects and mediates sensory input to the original area (Doetsch, 1998).

A large body of literature on the effects of cortical plasticity on the somatosensory map is based on studies of sensory deprivation (mostly animal models and amputation patients) (Aglioti et al., 1994a; Buonomano & Merzenich, 1998; Gandevia & Phegan, 1999; Kew et al., 1997; Pons et al., 1991); simultaneous co-activation (Braun, Schweizer, Elbert, Birbaumer, & Taub, 2000; Buonomano, & Merzenich, 1998; Chen, Friedman, & Roe, 2003; Mogilner et al., 1993; Ragert, Schmidt, Altenmüller, & Dinse, 2004); or an increase in stimulation and learning based changes (Elbert et al., 1995; Medina & Coslett, 2010; Nudo, Wise, SiFuentes, & Milliken, 1996; Pascual-Leone, & Torres, 1993; Ragert et al., 2004). When areas of normal input are removed or damaged, neighbouring intact areas exhibit the ability to expand into the non-functional area by means of blending the boundaries between these adjacent areas. This is in line with the theory of functional respecification. Areas represented in specific cortical zones thus expand to be represented 'over a far larger territory, in finer topographic grain and detail' (Buonomano & Merzenich, 1998, p. 168).

Deprivation. The relationship between sensory input and the corresponding representation within the somatosensory cortex is clearly outlined by deprivation studies. Deafferentation results in plastic reorganisation within the sensory homunculus in such a manner that adjacent body areas begin to respond to sensory input from the deafferentated areas (Buonomano & Merzenich, 1998; Serino & Haggard, 2010). Pons and colleagues (1991) investigated cortical plasticity of the somatosensory cortex in four cynomolgus monkeys who had undergone deafferentation of the arm and hand more than 12 years prior to testing. The normal cortical representation of the body areas of monkeys reveals that the upper limb is bordered by the trunk medially and the face laterally. They deprived the fingers, palm, upper limb, neck and occiput of sensory input and found that the entire area now responded to stimulation of the face (Pons et al., 1991, p. 1859). This highlights the way in which cortical maps can reorganise resulting in areas deprived of sensory input responding to neighbouring areas either in terms of body space (shoulder) or space within somatosensory cortex (face) (Aglioti et al., 1994a; Serino & Haggard, 2010).

Changes in perceived size of body areas are also evident in studies of anaesthetisation. For example, Gandevia and Phegan (1999) found that when anaesthetising the thumb of one hand, participants drew their thumb larger than prior to anaesthetisation and reported feeling that their thumb had grown in size. Furthermore, this effect did not carry over to the index finger on the ipsilateral hand nor did it affect the perceived size of the thumb and index finger on the contralateral hand. Interestingly, when participants drew an outline of their lips, the perceived size of the lips also increased. Similarly, their complementary study on partially anaesthetised lips resulted in both the left and right thumbs being perceived as larger. When stimulating the same body areas by providing increased afferent input (electrical stimulation or activation by painful cooling) the results obtained were smaller than those seen in anaesthetisation. The authors suggest that this phenomenon could be attributed to the unmasking of inputs to the corresponding primary somatosensory cortical cells after the sensory input has been removed.

In addition to deprivation studies where neighbouring body areas stimulate areas that have undergone deafferentation, in amputees a phenomenon known as referred sensation is evidenced. This is when a neighbouring body area to the amputated region is stimulated and the individual reports experiencing the sensation in a phantom part of the body. If amputation occurs in the upper limb, referred sensations are reported when the lower face is stimulated on the same side of the body and tactile sensation in this area results in reported sensation for both the face and the phantom hand (Aglioti et al., 1994a; Ramachandran, Stewart, & Rogers-Ramachandran, 1992; Ramachandran, 1998; Serino & Haggard, 2010). Furthermore, when neighbouring areas are stimulated on the face, corresponding neighbouring sensations are reported for areas adjacent to the phantom limb. Phantom sensation and its associated referred sensations are said to provide evidence for cortical reorganisation following amputation (Doetsch, 1998; Medina & Coslett, 2010; Ramachandran, 1993; Ramachandran, 1998; Ramachandran & McGeoch, 2007; Serino & Haggard, 2010). A further study by Pons and colleagues (1991) found that when body areas (e.g. the arm) did not receive sensory input for prolonged periods of time it could result in this area being taken over by sensory input from a neighbouring area (e.g. the face) (Ramachandran, 1993).

Kew and colleagues (1997) studied the effects of deafferentation on one upper limb in patients who had undergone elective amputation. When vibrotactile stimulation was applied to the pectoral region ipsilateral to the amputation referred sensations were present on the trunk and in the phantom limb. However, when vibrotactile simulation was applied to the contralateral side no referred sensations were reported. Using positron emission tomography (PET) they discovered that stimulation on the contralateral side activated the trunk area of the primary somatosensory cortex whilst stimulation on the ipsilateral side activated an area extending from the original trunk representation to the area traditionally demarcated for the hand and arms. Evidence provided by studies conducted with amputees provides support for body representations to remain in the primary somatosensory areas and higher order areas resulting in referred sensations to be felt within phantom limbs and other body areas (Medina & Coslett, 2010).

Phantom sensations were studied in lower limb amputees by Aglioti and colleagues (1994a). They found that the foot and toes were perceived more clearly when compared to the leg in one of their patients reporting his phantom foot to be close to the stump. This is due to a process called telescoping in which the phantom leg progressively shortens so that the foot becomes located more closely to the stump. When different areas of the stump were stimulated, patients reported sensation at both the stump and the corresponding point on the phantom limb.

When afferent input to cortical regions is removed, it results in an ‘invasion’ or blending of intact neighbouring areas and consequently a blending in homuncular organisation (Candia et al., 2003; Elbert, Flor, Birbaumer, Knecht, Hampson, Larbig, & Taub, 1994; Elbert et al., 1995; Jones, 2000). This blending within the homuncular organisation of the body shows the plasticity of the brain and the ability of adjacent areas within the cortical map to ‘spill over’ into each other thereby resulting in the sensory input from intact body areas stimulating neighbouring body areas (Weiss et al., 2004). However, as illustrated by Chen and colleagues (2003), these body representations are not only influenced by absolute touch but also the perception of touch. Thus the ability of a body area to facilitate sexual arousal could be linked to the perceptions that individuals have regarding their arousability.

Simultaneity. The Hebbian principle states that simultaneity (synchronous, co-activation) plays a role in mediating changes in plasticity at a synaptic level. When synaptic efficacy is altered it leads to cortical reorganisation and can influence the way in which sensory stimuli are processed within the somatosensory cortex (Buonomano & Merzenich, 1998; Ragert et al., 2004). Core to Hebbian plasticity is the notion of temporal correlations of sensory input. Thus, areas in close proximity of one another should receive sensory information in a synchronous manner and as such it is expected that neighbouring areas would be more correlated with one another than areas that are found further apart and that this would inform the cortical mapping of the body (Buonomano & Merzenich, 1998).

Mogilner and colleagues (1993) tested whether altering the correlations between body areas would result in a corresponding alteration of the cortical map. They did this by using magnetoencephalography (MEG) to map the changes evidenced in human subjects pre- and post-surgical separation of congenital digital syndactyly. Prior to surgery, they found that neighbouring digits overlapped with one another and different digits were not clearly defined. However, post-surgery the representations of the digits within the cortex moved further apart as a result of the changing structure of sensory input allowing for the representation of separate fingers.

In a study conducted by Goode, Spengler and Dinse (1996) in which they tested the impact of an analogous associative pairing of tactile stimulation (APTS), they found that plastic changes were evidenced in the expansion of the cortical skin representations when stimulated simultaneously.

They also observed the emergence of new skin fields in previously non-somatic responsive cortical zones which led to a relocation of the somatosensory cortical boundary. Enlarged receptive fields were found not only close to the site of stimulation but directed towards the stimulation sites, thereby causing a distance-dependent and directed enlargement with the tendency to include these receptive fields. Interestingly, these changes were reversible and were not dependent on motivation or attention but instead suggest an automatic plastic reorganisation based on Hebbian co-activation (Serino & Haggard, 2010).

Despite co-activation resulting in increased spatial discrimination, prolonged task relevant, co-active, repetitive stimulation leads to a disarranged (passive stimuli) or fused (discrimination training) topographic representation of the areas involved. This results in a decrease in tactile acuity between body areas in localisation tasks and an increase in spatial discrimination within a body area. For example, when simultaneous stimulation is provided to the thumb and little finger for one hour a day, it will result in increased spatial discrimination of the fingers but a diffused ability to differentiate between stimuli provided to either the thumb or the little finger due to their prior simultaneous activation (Braun et al., 2000; Serino & Haggard, 2010). Furthermore, Chen and colleagues (2003) found that areas that do not lie adjacent to one another (second and fourth digit) co-activated through simultaneous stimulation revealed two separate activation areas as would be expected if either digit were stimulated separately. In contrast, areas close in proximity (i.e. adjacent digits) revealed one area of activation in the centre of the two separate activation points. The authors further illustrated that the representation of the body within the primary somatosensory cortex is not based only on the location of stimulation but also on the perception of tactile stimulation (Chen et al., 2003; Serino & Haggard, 2010).

Learning. A further case for neuroplasticity in humans is the recovery of the cortical representation of a paretic limb through the use of Constraint-Induced Movement Therapy (CIMT) as well as the recruitment of adjacent cortical areas (Sunderland & Tuke, 2005). In contrast a study by Nudo and colleagues (1996) with adult squirrel monkeys found that reorganisation of damaged areas did not appear in adjacent areas. The representations of the body area (hand movement) next to the lesion site, though not damaged directly, still underwent a loss of cortical territory. After providing rehabilitative training to the monkeys they found an initial period of improvement followed by a relapse which is suggestive of degenerative changes in adjacent, undamaged areas. Cortical maps in the motor cortex revealed that areas surrounding the lesion had undergone rearrangement of representation. Indeed the non-damaged hand appeared to encroach upon the adjacent representation areas so that it now blended with the area of elbow and shoulder representation. They concluded that compensatory learning and perhaps functional reorganisation are important factors in the cortical changes witnessed (Nudo et al., 1996).

Continuous prolonged practice of sensorimotor skills, such as those displayed by musicians, results in the expansion of cortical representational areas. This highlights use-dependent cortical plasticity and the ability of the cortex to dynamically allocate area based on use (Buonomano & Merzenich, 1998; Jones, 2000; Ragert et al., 2004). Ragert and colleagues (2004) studied the effects of piano playing on neuroplasticity within the somatosensory cortex by applying co-activation stimuli through a solenoid attached to the right index finger of participants for three hours. Their results indicate a rapid reorganisation of the somatosensory areas for the right index finger and a corresponding increase in spatial discrimination performance when compared to non-musicians. Years of playing piano were correlated to the gains in performance witnessed. Similarly, in their study Elbert and his colleagues (1995) found that the digits of musicians' left hands occupied a larger cortical space when compared to their right hands and to control individuals. Furthermore, their left hand representations were shifted towards the region for palm representation. These cortical changes provide evidence of plasticity within the brain based on use and experience, as the degree to which cortical organisation was present was correlated to the length of time that the musician had spent playing his/her instrument.

Braille readers present with larger cortical areas for the right index finger used for reading when compared to either their left index finger or controls. Interestingly, the representation of areas of the hand, not used in Braille reading, were found to be smaller than those of control individuals (Pascual-Leone & Torres, 1993). Furthermore, anatomical changes as a result of brain neuroplasticity can be seen in the relationship between regions of transient structural grey-matter and juggling performance in normal individuals after training is provided. Training is shown to induce anatomic changes in the brain indicating cortical plasticity at a structural level (Draganski et al., 2004).

The sensory homunculus is based on areas that are high receivers of tactile stimulation (Medina & Coslett, 2010) and as sensory input is altered, so too is the sensory homunculus. Plasticity within the somatosensory cortex of the body map (somatotopy) reveals the ability of the brain to adapt by expanding or contracting various body areas based on increased or decreased input from sensory receptors in the different body areas (Jones et al., 1997; Serino & Haggard, 2010), as illustrated by the deprivation, co-activation and learning studies mentioned above. The present study is concerned with the relationship between different body areas, high in their ability to facilitate sexual arousal (erogenous zones), and cortical mapping to the somatosensory cortex. A discussion of erogenous zones follows.

2.7. Erogenous Zones

Freud was the first person to mention different body areas as erogenous zones. He stated that different body areas have the ability to facilitate sexual arousal. Freud proposed three main body areas – the mouth, the anus and the genital organs – as erogenous and capable of facilitating sexual arousal. These are seen as the classic erogenous zones in humans. He further suggested that different body areas such as the skin and vision were erogenous in similar ways to the initial three zones proposed and that sexual lust and activity are derived from these zones (cited in Triebel, 2005, p. 193).

As identified by Freud, and confirmed through physiological studies, the primary area for sexual arousal is the genital region for both females and males. Male sexuality is focused on the penis as the number one erogenous zone (Levin, 2002) with little research identifying other non-genital regions as being erogenous. The ability of erogenous zones to facilitate sexual arousal is dependent upon its capacity and sensitivity in conveying tactile stimulation to the brain as a pleasurable stimulus. This is illustrated through the fact that men experiencing erectile problems have been shown to have a decrease in tactile penile sensitivity (Edwards & Husted, 1976; Rowland, Leentvaar, Blom, & Slob, 1991). This highlights the need to establish different, non-primary areas with the ability to facilitate sexual arousal so as to provide new avenues for these individuals to enjoy the sexual experience.

Female sexuality has been studied in more detail and is identified as being facilitated through primary and secondary body areas, with the primary body areas including the vagina and clitoris and secondary body areas including the breasts and nipples (Goettsch, 1989; Levin, 2006). Sexual arousal, facilitated through tactile sensitivity, may be affected by estrogen levels (Frohlich & Meston, 2005). However, sexual desire as a result of excitation through tactile stimulation (Levin's second desire phase) might suggest an evolving feature of women in their move away from the control of hormones to a more active role in the sexual experience by deciding both the initiator and source of tactile stimulation (Levin, 2002). This is further strengthened by the clitoris, labia, nipples, pelvic musculature and the periurethral glans which all respond to tactile stimulation despite being maintained by androgens and their dependency on hormonal support (Chivers, Seto, Lalumiére, Laan, & Grimbos, 2010; Levin, 2002). Thus the ability of erogenous zones to facilitate sexual arousal may lie in the mapping of these body areas within the brain while not being fully dependent on hormonal influences.

2.7.1. Cortical Representation of the Primary Sexual Area

In their study, Georgiadis, Reinders, Paans, Renken, and Kortekaas (2009) found that there were significant differences between male and female cerebral blood flow levels during tactile genital stimulation with these differences becoming less pronounced during the orgasm phase. The following brain areas are shown to be activated during sexual stimulation of the erect penis: the right posterior claustrum, insula, the secondary ***somatosensory cortex***, and the right ventral occipitotemporal region which differed from those areas that were activated in females during clitoral stimulation (i.e. left primary and secondary ***somatosensory areas***) (Georgiadis & Holstege, 2005; Georgiadis et al., 2009). The representation for painful stimulation in both the hand and foot have been found to be represented in the posterior secondary somatosensory cortex whilst non-painful stimulation activates the separate regions demarcated for the hand and foot in the anterior secondary somatosensory cortex. Thus painful sensation or sexually arousing stimuli have the ability to activate the posterior secondary somatosensory cortex (Ferretti et al., 2004 cited in Georgiadis & Holstege, 2005, p. 36).

Research on the cortical representation of the penis has yielded mixed results (Bradley, Farrell, & Ojemann, 1998; Michels, Mehnert, Boy, Schurch, & Kollias, 2010). Some studies have found that the external genitalia are represented on the mesial wall of the paracentral lobule and the interhemispheric surface of the postcentral gyrus in the primary somatosensory cortex (Georgiadis & Holstege, 2005; Michels et al., 2010). During penile tactile stimulation, the secondary somatosensory cortex and the insula are activated. Various studies have confirmed this location (see Georgiadis & Holstege, 2005, for a review).

In terms of the sensory homunculus, the genitals seem to be discontinuous with the rest of the body, being represented below the toes (see Figure 1 on the previous page). In their study, Kell and colleagues (2005) found that the representation of the penis in the primary sensory areas of the brain overlaps with the representation of the lower abdominal wall and that stimulation of the penis borders Brodmann area 3b and 1. Thus they argue for the penis to be located between the upper leg and the lower trunk which is in contrast to its widely accepted placement within the sensory homunculus (see Kell et al., 2005, p. 5987, for their modified version of the sensory homunculus). Similarly, in their article, Bradley and colleagues (1998) propose a sensory homunculus with the penis overlapping the lower abdomen and extending to the under the knee (with "the abdomen and leg as being immediately anterior to the genitalia" cited in Bradley et al., 1998, p. 125). Indeed pop culture might ascribe such a large area of somatosensory mapping to the penis as the primary erogenous zone for males.

Proposed reasons for the conflicting results found in mapping the penis include arguments that the genital region is difficult to map due to issues inherent in self-report measures utilised in the initial mapping techniques such as shame and embarrassment which leads to false reports of sensation or lack thereof. This then influences the way in which the genitals are mapped (specificity) and their purported accuracy (stability) (Kell et al., 2005; Michels et al., 2010; Penfield & Boldrey, 1937). Another potential reason for the conflicting results is that many studies have utilised artificial electrical stimuli when mapping the way in which the body is represented instead of using physiological stimulation which results in the activation of larger cortical areas (Kell et al., 2005; Michels et al., 2010).

Literature on the presence of phantom penises exists, however, few of the articles that formed part of the literature review looked at what body areas, when stimulated, produced these phantom experiences in the absent penis. Spontaneous reports by lower limb amputees stated that defecation and sexual intercourse resulted in a referred sensation, either traveling along the lateral surface of the leg from the stump to the phantom limb (as in one of the patients) or in the phantom foot (by a second patient). However, light touch on the scrotum and groin did not result in referred phantom sensations. The ability for defecation and sexual intercourse to produce referred sensations provides evidence for a medial-to-lateral reorganisation within the somatosensory cortex after amputation as the genital region, rectum and anus are found medially to the lower limb within the sensory homunculus (Aglioti et al., 1994a).

Input from nerves. The sensory pathway of the penile dorsal nerve to the sensory cortex is not well established (Bradley et al., 1998). The genital region including the scrotum, the perineum and the anus all derive somatic fibers (sensory innervations) from the second, third, and fourth sacral routes through the pudendal nerve (Kern, Arndorfer, Hyde, & Shaker, 2004; Moore & Dalley, 1999; Netter, 2003). Furthermore, the pudendal nerve provides motor innervations to the bulbospongiosus and ischiocavernosus muscles as well as the external sphincter of the urethra and anus (Michels et al., 2010, p. 181; Moore & Dalley, 1999; Netter, 2003). Anatomically, the perineum refers to the anal canal, the intermediate and spongy parts of the urethra and the root of the penis and scrotum. The perineum is diamond-shaped and can be split into two triangles, namely the urogenital area and the anal area. The urogenital area is comprised of the root of the scrotum and the penis, whilst the anal area contains the anus (Moore & Dalley, 1999; Netter, 2003). However the term perineum is also used in a more restricted manner, as was used in the current study to clarify the perineum, referring to the area between the genitals and the anus (Moore & Dalley, 1999).

Research identifying which non-primary body areas respond to tactile stimulation and facilitate sexual arousal draw from studies involving individuals with spinal cord injuries in which feeling in the genital area is lacking (Farrow, 1990), sexual dysfunction literature (Edwards & Husted, 1976; Goldstein & Davis, 2006; Rowland et al., 1991) and sexual arousal literature (Levin, 2002).

2.7.2. Cortical Representation of Secondary Sexual Body Areas

The primary genital regions (reproductive organs) are not the only body areas that facilitate sexual arousal. Other secondary sexual body areas (non-reproductive organs) have also been reported to have the capacity to evoke sexual excitation in primary sexual areas through tactile stimulation (Aglioti et al., 1994a; Goettsch, 1989; Levin, 2006; Levin & Meston, 2006).

Studies investigating the representation of the trunk in the primary somatosensory cortex in animals reveal a lateral representation of the thigh and leg. It is important to note that research on the representation of the human trunk area and its components is sparse (Rothemund et al., 2005). The representation of the oral areas of humans was found to be concordant with the sensory homunculus of Penfield and Rasmussen with the teeth being represented superior to the tongue and inferior to the lip region, i.e. the tongue, teeth and lips were found to be mapped in a ventral-dorsal direction (Miyamoto et al., 2005).

Research on secondary body areas and their ability to facilitate sexual arousal is more detailed in terms of female anatomy than male anatomy. Non-primary erogenous zones in females and potentially by extension in males, that may facilitate sexual arousal may include: earlobes, mouth/lips, abdomen, inner thighs, anus, perineum and the back of the knees (Farrow, 1990; Goettsch, 1989; Goldstein & Davis, 2006; Levin, 2002; Rhodes, 1975). One secondary body area that has been studied is the human female breast. In terms of cortical mapping of the breast, in a study conducted by Rothemund and colleagues (2005) it was found that the breast was situated between the first digit and the groin.

The female breast is completely developed by puberty, after which it increases in its level of sensitivity to tactile stimulation (Levin, 2006). In women, changes in the size of the nipple and sex flush in the breast which can extend to cover the whole breast, in the late excitement phase are also evidenced during sexual arousal (Levin, 2006). Thus the nipple and indeed, the entire breast are found to be sexually arousing in women. Furthermore, women who underwent a mastectomy were found to experience phantom breast sensations when the pinnae of their ear lobes, shoulder or doso-thoracic regions were stimulated ipsilateral to their mastectomy, especially focused on the nipple, suggesting some form of neural sharing within the brain (Aglioti, Cortese, & Franchini, 1994b; Halligan, Zeman, & Berger, 1999).

Despite developing from the same foetal tissue and having the same connections to the brain, the male breast/nipple is largely ignored and is seen as a non-functional area for sexual facilitation (Levin, 2006). In a survey conducted by Kinsey and colleagues (1953 cited in Levin, 2006, p. 244) they found that it is rare for females to try stimulating the breasts of their male counterparts. However, this behaviour was seen more frequently for male homosexuals. Levin (2006) concludes that males do not report sexual arousal when their nipples are stimulated. The way in which different secondary sexual areas activate sexual arousal in the brain of both males and females through tactile stimulation is not known, nor have there been any studies on their stimulation with reference to brain mapping (Levin, 2006). In a further study by Levin and Meston (2006) they found that 81.5% of the women who participated in their study reported that stimulation of the nipple/breast initiated or increased sexual arousal. Similarly, it was found that 51.7% of the male participants expressed increased sexual arousal through stimulation of the nipple. Importantly, no information is given on the sexual orientation of the participants involved.

Other non-primary areas of the body can be arousing and stimulated through touch as evidenced through an internet search on erogenous zones[2]. These websites illustrate the potential for the entire body to function as an erogenous zone in both males and females. However, little empirical research has been done to establish which body areas are the most arousing, especially in males, and how these areas are mapped within the brain. Indeed, most studies involving functional organisation of body areas within the somatosensory cortex focus on the hand, face, and foot (see Rothemund, Schaefer, Grüsser, & Flor, 2005, for a review). This might be due to the fact that these body areas are more easily accessible and are not as sensitive (or invasive) a topic for study as well as the larger cortical areas that these areas occupy within the somatosensory cortex, making localisation in these body areas easier to detect.

2.7.3. Anticipated Areas for Facilitating Sexual Arousal

- Based on the sensory homunculus it is anticipated that the body areas that participants will identify as highly sexually arousing will include, but not be limited to:
    - The genital region, and
    - Areas clustering around the genitals such as the toes, inner thighs (hip to foot) and buttocks.
- Based on the Hebbian rule:
    - Areas found to be correlated with one another will be found to be highly arousing.
    - For example, the mouth/lip area.
- Based on neuroplasticity of the brain and the ability of neighbouring body areas to blend with one another,
    - Cortical areas mapped closer to the genitals should have the ability to be more arousing than areas further away in the cortical map of the body.
    - Similarly, areas mapped further away from the primary sexual areas will not be identified as sexually arousing such as the elbow, shoulder and nose.

The current study will investigate whether body areas, including the genitals, are found to be sexually arousing based on their placement within the cortical map, as illustrated in the following example:

> I felt asexual for a long time because a man's sex was supposed to be in his penis, and I couldn't feel my penis. It didn't occur to me that it felt good to have my arms stroked… I learnt… I don't have to do anything with my genitals to have sex
>
> (Bullard & Knight, 1981 cited in Goodwach, 2005, p. 162).

2.8. Significance of the Current Study

As can be seen from the literature reviewed, very little literature exists on the ability of different body areas to facilitate sexual arousal. Furthermore, there is little empirical evidence on which areas, other than the genitals, facilitate sexual arousal, their intensity and the mechanisms through which sexual arousal is facilitated. The current study will thus seek to move into this unknown territory by looking at different erogenous zones (primary and secondary sexual body areas) to determine which body areas are the most arousing (as identified by participants) and the way in which they are mapped in the somatosensory cortex as a possible explanation for their ability to facilitate sexual arousal. To my knowledge this study will be the first to explore erogenous zones and their ability to facilitate sexual arousal in light of the way in which they are mapped in the somatosensory cortex.

2.9. Research Aims

The aims of the current study are:

1. To identify which body areas (primary and secondary sexual body areas) are identified by participants as the most sexually stimulating to touch (tactile stimulation).
2. To measure the intensity of sexual stimulation of these identified areas.
3. To identify (in terms of organisation of the primary somatosensory cortices) whether the areas of greatest intensity lie adjacent to the genital areas thus supporting the hypothesised neuroplasticity of brain functioning.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. Introduction

In conducting research, an important aspect of the process is the design of the study. This is particularly important as it relates to the overarching aims and purpose of the study. It is also necessary to consider the sample to be used, the way in which the sample is obtained and the procedures to be followed as this will impact on the type of data analysis conducted. The research methodology used in the current study is outlined below.

3.2. Research Design

The study was preliminary and exploratory, investigating the degree to which different body areas facilitate sexual arousal and how these areas are mapped within the brain. In a broad sense, it was a non-experimental, differential research design (comparing pre-existing groups, delineated by characteristics such as marital status, race and sexual orientation, with an unequal number of participants in each group) with a descriptive research strategy (summarising single variables for specific groups) (Gravetter & Forzano, 2006). An online survey format was followed for the collection of data (Langston, 2005). The internet has gained in popularity with regards to research on sexuality as it provides easy access, anonymity and availability of participants. Thus it is able to facilitate the collection of information about individuals' perceptions of different body areas and their ability to facilitate sexual arousal while providing participants with psychological distance and anonymity – which are important elements for sensitive natured topics like that which the current study sought to explore (Gravetter & Forzano, 2006).

The sampling technique was convenient in nature because it relied on volunteers who completed the online survey. In line with the *central limit theorem* which states that the closer the number of participants (*n*) is to infinity, the more the sample will resemble a normal distribution (Gravetter & Wallnau, 2004), the current study thus sought to reach as many individuals as possible. Similarly, the *law of large numbers* states that 'the larger the sample size (*n*), the more probable it is that the sample mean will be close to the population mean' (Gravetter & Wallnau, 2004, p. 208). The internet has the ability to facilitate this aim due to its capacity to reach a large number of individuals from various backgrounds that are not easily reached through traditional forms of data collection (Mustanski, 2001). It can be argued that a more diverse sample can be reached with the same level of convenience through the internet when compared to pen and paper versions (especially with regards to samples in different geographic locations) (Bailey, Foote, & Throckmorton, 2000; Mustanski, 2001).

The use of an internet based measure was useful in that participants are able to complete the survey in their own time without the presence of a researcher thereby reducing any bias that may have resulted from a researcher being present (Elkonin, Foxcroft, Roodt, & Astbury, 2006). The internet survey thus provided maximum privacy while being minimally invasive to the participants. An advantage of the self-report method of data collection used was that it assumed that the participant knew the most about his/her feelings, beliefs and self (Gravetter & Forzano, 2006). However, a disadvantage is that participants may still have answered in a socially desirable way, which would have impacted on the validity of the results obtained (Gravetter & Forzano, 2006). Despite acknowledging the potential for social desirability, it was felt that the participants would be more honest and display less socially desirable responses due to the psychological distance that the internet provided between the participant and the researcher (Mustanski, 2001). Research indicates that there are non-significant differences in the results obtained through internet surveys and its pen and paper counterparts (Langston, 2005; Mustanski, 2001).

There was no manipulation of the independent variables. The independent variables included demographic variables such as marital status and race as well as the capacity of body areas to be arousing, measured on a nominal scale. The dependent variable was the results obtained from the 'Hotness Scale', measured on an interval scale. These results were in the form of 'hotness' ratings on a scale from one to 10 where 10 represented the maximum value for the given body area to facilitate sexual arousal. The intent of the study was to determine the degree to which body areas facilitate sexual arousal in relation to neuroplasticity and cortical mapping. Importantly, a pilot study was conducted so as to determine the user friendliness of the survey.

3.3. The Sample

Participants comprised individuals who completed an online survey and were invited through a form of non-probability, opportunistic sampling (Gravetter & Forzano, 2006). The sampling technique was opportunistic in that it assumed a level of representation of the population. The study was global in nature, and not specifically a South African study, as no restrictions were placed on geographical location, see Appendix C for a list of all countries included in the survey.

Two versions of the survey were presented to meet the ethics criteria in South Africa and the United Kingdom (UK). Participants either completed the South African survey at www.sexandthebrain.net or the UK survey at www.sexandthebrain.co.uk. The UK survey site had additional questions which related to the quality (the degree to which participants were satisfied with their sexual encounters) of the sexual experiences that the participants had engaged in and their frequency. However, this information was not used in the analyses and was beyond the scope of the current study.

Individuals were invited to participate regardless of their gender, age (minimum age of 19 years, an upper age limit was not instituted and indicated by a 50+ category), race and sexual orientation. The racial categories were labelled as follows: White, Black, Asian, Coloured, Indian and Other for the South African based website. For the UK based website the racial categories were labelled as follows: White, Black, Asian, Chinese, Mixed and Other. Males and females from any sexual orientation (heterosexual, homosexual and bisexual) were invited to participate and disclosing their sexual orientation was not a compulsory field. However, for the purposes of this report, only heterosexual males were used in the analyses, with the potential for further research and analyses to be conducted on the full data set.

3.4. Measurement and Materials

The primary instrument used in the study was an online questionnaire. The questionnaire was designed by a PHP[4] developer with four sections, which participants completed. The questionnaire was forced choice in design and as such individuals who did not complete the form and/or decided to leave the webpage prior to completion were excluded from the analyses due to missing information.

The first section of the online survey was an ***Explanatory Statement*** (Appendix D) of the study which was the first point of contact for volunteers. This section consisted of a warning statement regarding the nature of the study, ethical considerations and a check box in which participants gave consent to participate in the study and acknowledged that they were within the prescribed age range. There were also two links, one to navigate away from the page should the individual not want to participate in the study and a second one navigating to a page summary on the nature of the study.

In the ***Study Information*** (Appendix E) section, a page summary was provided on the nature and aims of the study, the researcher was introduced, and what participation would entail was outlined. Once again there was a link for those who did not wish to participate so that they could navigate away from the study. After consenting, the second section of the questionnaire was presented, which was a ***Biographical Questionnaire*** (Appendix F). This questionnaire was forced choice in nature and participants selected the response from drop down lists.

After completing the Biographical Questionnaire, participants were taken to the third section, ***the Hotness Scale***[5] (Appendix G). The Hotness Scale consists of 41 body parts. These 41 body parts were listed under the following headings: Front of Body and Back of Body. The Front of Body included: forehead, eye and temple, nose, cheeks, mouth/lips, ears, front of neck, shoulders, elbows, wrists, hands, fingers, chest, nipples, stomach, sides, bellybutton, pubic hairline, hips, penis, scrotum, perineum (area between genitals and anus), inner thighs, outer thighs, knee caps, ankles, foot, and toes. The Back of Body included: head and hair, back of neck, shoulder blades, upper back, lower back, buttocks, back of thighs, behind the knees, and calves/back of shins. The term ‘buttocks’ was chosen over the term ‘anus’ due to the negative connotation that is associated with this term in relation to sexual orientation. It was felt that participants might feel uncomfortable with this term and as a result thereof under report the ability of this area to facilitate sexual arousal. Each body part was rated firstly, either as arousing or not (yes/no). If the participant answered that the body area was arousing, a 10-point thermometer scale was presented on which to indicate the degree of arousal/hotness. For internet surveys, closed questions in the form of multiple choice options has been indicated to work best (Langston, 2005). Within the form, an image was included as a visual cue and served as an aesthetic for participants to make the site more appealing.

Lastly, there was a ***Thank You*** section (Appendix H) which thanked volunteers for their participation. A generic email address (info@URL[6]) was provided for questions and queries. A short statement regarding the availability of the results was also provided. The email address was given so that those who were interested in receiving results could request feedback. Importantly, the submitting of email addresses for feedback was **not** linked to the participant's questionnaire information thereby retaining confidentiality and anonymity of responses.

It is important to note that the current study did not measuring current levels of arousal but sought rather to tap into participants' memory and whether or not they had experienced different body areas as sexually arousing. Graham, Janssen and Sanders (2000) found that physiological measures for genital arousal and self report measures of sexual arousal were similar. It can thus be said that self report measures of sexual arousal would not differ significantly from physiological measures thus providing a valid way in which to investigate sexual arousal.

3.5. Data Collection Procedure

The study was conducted once ethics clearance was obtained from the University of the Witwatersrand. The data collection procedure was preceded by a pilot study which was conducted at the University of the Witwatersrand. Convenience sampling was used and participation comprised 20 males who consented to and completed a pen and paper version of the online survey. Changes were made to clarify body areas that participants felt were confusing or which they did not know. Thus, 'calves' was adapted in the online survey to read 'calves/back of shin' as clarification was requested. Similarly, body areas were placed in a more sequential manner so as to aid in the understanding and logic of the survey with subheadings of 'Front of Body' and 'Back of Body' and progressing from the head to the feet. Clarification was also added stating that participants were rating these body areas based on ***their*** own body and not based on what they find arousing in a partner: 'These are areas on ***your*** body'.

After making the necessary adjustments highlighted by the pilot study, the main study went live via the South African website: www.sexandthebrain.net. Additional ethics clearance was sought and obtained from Bangor University (UK)[7] allowing for the UK website to go live, www.sexandthebrain.co.uk

Invitations for participation were distributed in the following manner:
In South Africa, a brief invitation directing students at the University of the Witwatersrand to the website was placed on the student portal site[8]. Invitations (in hardcopy) were handed out to students during lectures. Invitations were also posted onto Facebook, LinkedIn and the VUMA portal through the researcher's profile on each network. A Facebook group was also established so that more people could be reached through snowballing and could subsequently be invited to participate. Similarly, in Wales, a brief invitation was placed on SONA (student experiment participant website) which invited students to participate and provided the accompanying link. Further permission was granted by Monash South Africa and students were invited to participate through hardcopy invitations that were handed out during lecture times and email invitations sent out. All participants from countries other than South Africa and Wales were invited to participate via Facebook and through referral recruitment. All individuals who completed the study and indicated that they would be interested in the results were encouraged to spread the word to anyone who would be willing to participate. The rationale behind actively recruiting in the countries mentioned was based purely on practical and convenient grounds. Similarly, the reason for actively recruiting university students was due to the convenient nature and accessibility of this group. However, participation was not confined to university students. The justification for keeping all 250 countries in the questionnaire is due to social mobility and the changing composition of university settings, it was felt that individuals responding through the South African or the United Kingdom websites would not necessarily be from that origin.

3.6. Data Analyses

All data from the online survey was automatically stored in a database. Any anomalous cases were deleted and the dataset checked for errors. Importantly, the data was coded prior to the commencement of the study through the development of the website. The scored data from the Biographical Questionnaire and the 'Hotness Scale' were entered into a statistical software programme (PASW Statistics Student Version 18) so that descriptive and inferential statistical analysis could be conducted.

The descriptive statistics conducted for the Biographical Questionnaire included: the mean, variance, standard deviation, the range (minimum and maximum) as well as kurtosis and skewness when necessary and relevant for the demographic variables. Frequency distributions were conducted for body areas on the 'Hotness Scale' so as to determine which body areas were most frequently chosen as being erogenous (popularity scores) and overall mean scores for each body area (intensity scores). Correlations were run between the top 12 body areas to determine the degree to which these body areas would facilitate sexual arousal.

A common factor analysis was run with an oblique rotation to determine how the areas of highest sexual arousal (as indicated by participants) clustered around the primary sexual area within the cortical map. Cronbach's alpha was calculated to give an indication of the reliability of the scale. These concepts will be discussed in more detail in Chapter 4.

3.7. Ethical Considerations

The first principle under consideration was that of ***Confidentiality and Privacy*** (as outlined by the American Psychological Association (APA), 2010). In meeting this requirement, it was stated that the information gathered from the online website would not be used for purposes beyond those outlined in the aims and objectives/ research questions. Linking to this principle was the notion of ***Anonymity***. The internet provided a powerful backdrop for anonymity (Binik, Mah, & Kiesler, 1999). The questionnaire in both the pilot study and main study did not use any personal identifiers such as name or identity number so as to ensure that participants' information remained anonymous. When deciding whether or not to track IP addresses in light of the risk of repeated completions versus anonymity for participants[3], it was decided that anonymity took priority and thus IP addresses were not tracked but participants were asked to complete the survey only once. In situations where the identity of an individual could be recognisable (for example, if an individual was the only one from a certain country to respond) the researcher aimed to minimise identifying elements by not linking the responses obtained on the 'Hotness Scale' with the demographic portion thus maintaining confidentiality.

Informed Consent (as outlined in the Nuremberg Code, reproduced in Gravetter & Forzano, 2006, p. 92), was addressed through the *Explanatory Statement*. Thus participants who chose to complete the survey and selected the informed consent box were informed from the outset about the study. Similarly, participants are asked to check a box acknowledging that they are over the age of 18 years so as to comply with the lower age limit of 19 years.

There was no voluntary withdrawal and participants were notified that upon entering the website, all information gathered would become the property of the researcher and as such may be used in the subsequent study analyses and possible journal article publications. There were no direct benefits or advantages for individuals who chose to participate when compared to those who decided not to participate.

Record Keeping (as outlined by the APA, 2010), all data collected will be kept on an external 1TB Verbatim storage device for 7 years and will only be used for research purposes. Thereafter, the data will be deleted. To further ensure that the study was conducted in an ethical manner and to ensure minimal risk to participants, ***Institutional Approval*** (as outlined by the APA, 2010) was sought from all universities involved. Ethical clearance was obtained from the University of the Witwatersrand, as the primary institution involved in the study. Further ethical clearance was sought and obtained from Bangor University for the UK URL link to be placed on their student experiment participant website (SONA). Lastly, permission was obtained by Monash South Africa for the distribution of invitations to students. The websites are self-funded and thus there were no competing institutional interests.

3.8. Conclusion

This chapter has outlined the approach the current study has taken in answering the research questions posed. The research design, sampling technique, procedure used, data collection methods, and the statistical analyses have been explained.

CHAPTER FOUR
RESEARCH RESULTS

4.1. Introduction

The study took a quantitative approach. This was achieved by looking at the demographic questionnaire descriptively and the 'Hotness Scale' inferentially.

4.2. Descriptive Statistical Analyses

The total sample size used in the present study consisted of 208 heterosexual male participants. Due to the forced choice nature of the questionnaire missing data was minimal. However, due to a technical problem two of the participants did not have their nationality accurately captured but were included as all other fields of data were not affected. The mean age for the overall sample was 26.57 years with a standard deviation of 6.76 years, ranging from 19 years to 50+ with 90% of participants younger than 36 years. Nationalities included: South Africa (60.7%), United Kingdom (19.9%), Australia (3.9%), Zimbabwe (3.9%), United States (1.9%), Great Britain (1.5%), Canada (1%), Germany (1%), Nigeria (1%), Portugal (1%), Singapore (1%), Botswana (0.5%), Bulgaria (0.5%), Chile (0.5%), Ireland (0.5%), Malawi (0.5%), Netherlands (0.5%), and Slovakia (Slovak Republic, 0.5%).

The largest racial category was White with 80.3% of the participants, followed by Black with 13%, Indian with 3.8%, Asian with 1.4%, Mixed/Coloured with 0.5% and Other with 1%. It is noted that the sample was largely westernized as internet penetration rates may not be as high in some parts of the world, i.e. developing countries. Furthermore, the current study tried to investigate whether or not there were any differences in the patterns of erogenous zones endorsed between racial groups, specifically the White and Black racial groups (as the two groups with the largest sample sizes). However, due to large discrepancies in sample size and the number of tied scores within each racial category no statistical analyses beyond descriptive statistics (see Appendix A) could be conducted confidently or accurately.

Participants' marital status comprised approximately 40% single (n=83), 42% in a relationship (n=88), 14% married (n=30), 2.4% divorced (n=5) and only 1% separated (n=2). Similarly, the current study sought to investigate whether there were any significant differences in the responses to body areas and their ability to facilitate sexual arousal between the different groups based on marital status. Due to the small sample sizes in the divorced and separated group, no strong conclusions could be drawn, as any differences noted could have been attributed to chance and not true differences between the groups. Furthermore, the large number of tied scores and values of '0' limited the statistical tests that could be performed on the current data. Descriptive statistics are presented in Appendix B.

4.2.1. Frequencies

The body areas were analysed both in terms of the popularity of the area (based on only those individuals who found the body area to be arousing) as indicated in Figure 2 and the intensity of the area (based on the overall mean score of the area when divided by the full sample regardless of the popularity of the area) as indicated by Figure 3 below.

The top 12 body areas were chosen for further analysis as there is a marked drop in the ratings by popularity and intensity after the 12th body area. The top 12 areas by popularity were: the penis (92.8%), mouth/lips (92.3%), scrotum (77.9%), inner thighs (76.4%), front of neck (75.5%), back of neck (72.6%), nipples (69.7%), pubic hairline (66.3%), ears (68.3%), chest (63%), perineum (63%), and buttocks (62.5%). Thereafter there was a decrease in the number of individuals endorsing the remaining body areas with only the head and hair (57.7%) and hand (50.5%) areas being endorsed above the 50% mark. In the diagram below, those areas endorsed by less than 20% of the participants were not included in order to simplify the graphic. However, the five least popular body areas, with less than 10% of the sample endorsing this body area, were: the shin (4.8%), elbows (5.8%), nose (6.2%), knee caps (7.7%), and the forehead (9.1%).

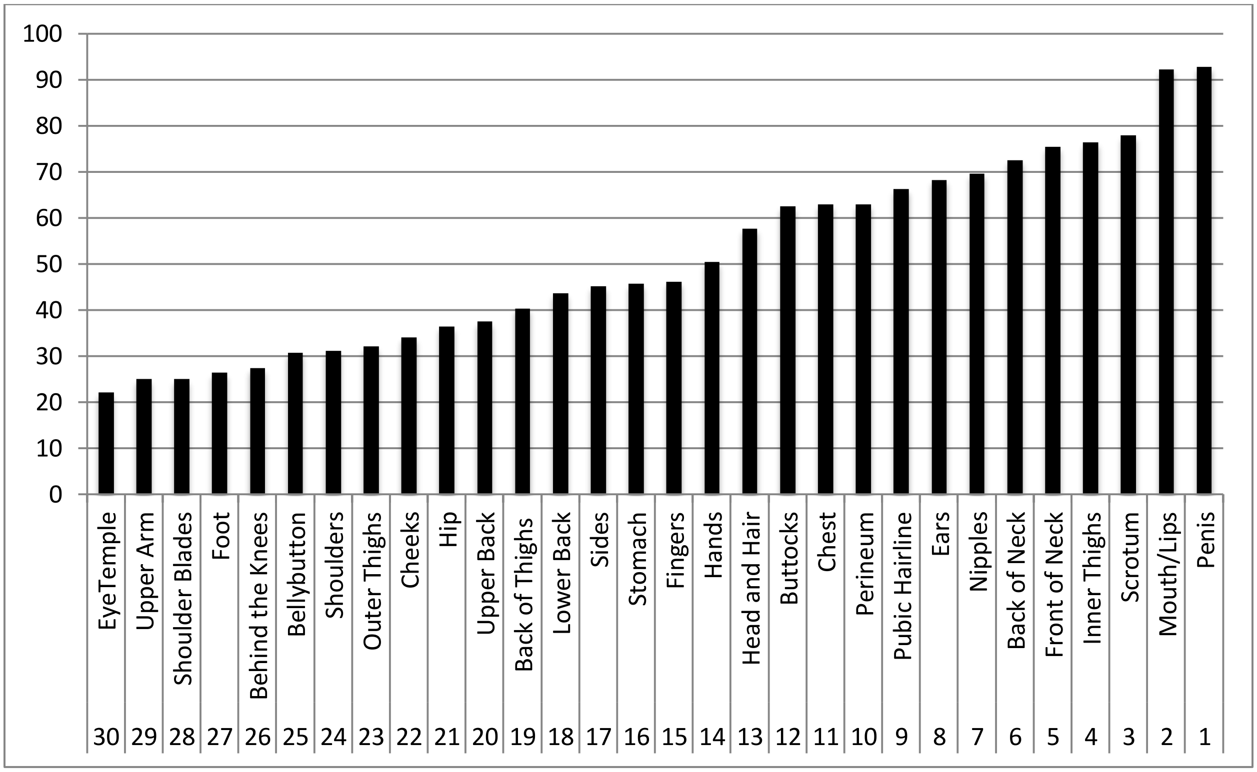

Figure 2. Graphical representation of frequencies of body areas based on percentage popularity scores.

The top 12 areas by mean intensity are: the penis (8.97), mouth/lips (7.04), scrotum (6.58), inner thighs (5.66), front of neck (5.48), perineum (5.01), pubic hairline (4.96), nipples (4.96), back of neck (4.57), ears (4.50), chest (4.08), and buttocks (4.04). In the diagram below, those areas with a mean of less than 1.00 was not included in order to simplify the graphic. However, the body areas with the lowest intensity scores were (i.e. those below 1 point on the 'Hotness Scale'): the shin (0.15), elbows (0.21), nose (0.24), knee caps (0.31), forehead (0.43), ankles (0.48), chin (0.56), calves/back of shins (0.61), forearms (0.80), and wrists (0.82).

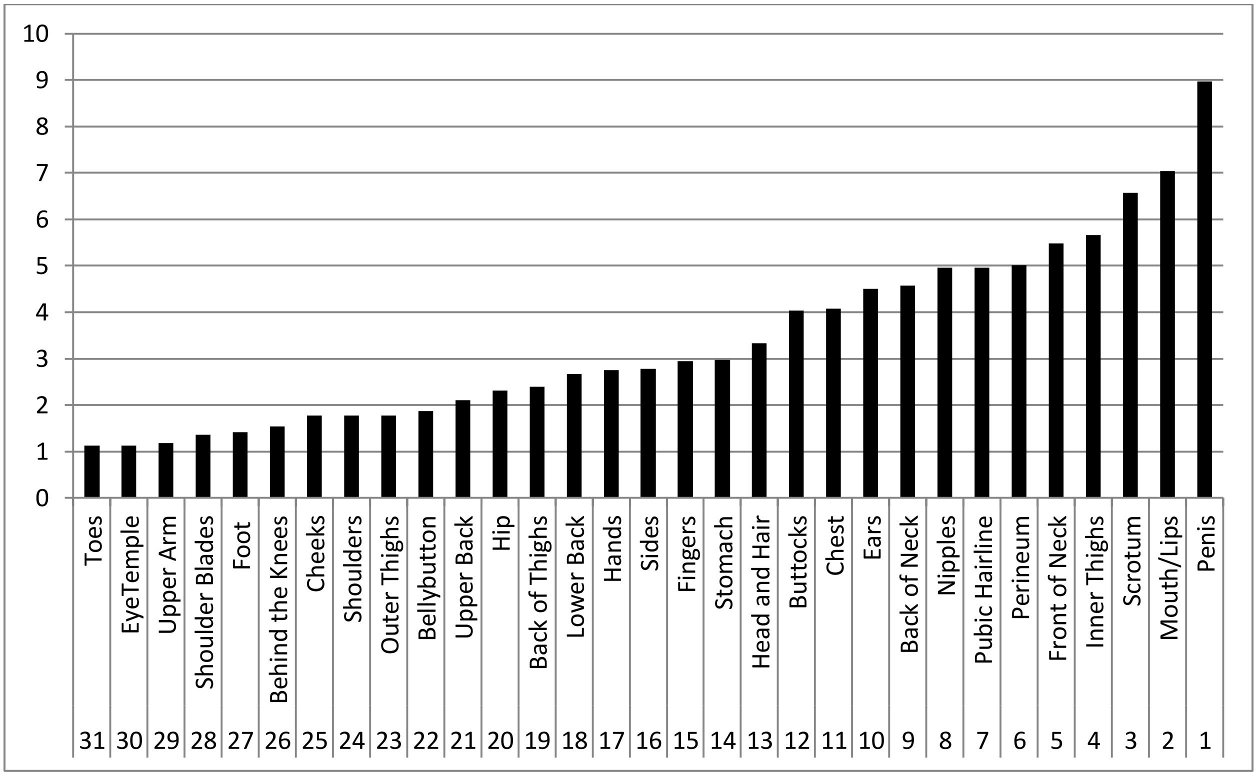

Figure 3. Graphical representation of frequencies of body areas based on overall intensity scores.

Overall the top 12 areas based on popularity and intensity consisted of the same body areas. The back of the neck, nipples and ears were rated more highly in terms of popularity than intensity. In contrast the perineum was rated higher in terms of intensity than popularity. It was decided to focus on the top 12 body areas as more than 60% of the participants found these areas to be arousing.

Nine individuals entered in additional body areas in the text boxes provided at the bottom of each section on the survey form. These extra body areas were: the anus (n=5), armpit/under the arms (n=2), palm of the hand (n=1) and spine (n=1).

4.3. Inferential Statistical Analyses

Since the top 12 body areas included the same areas based on intensity and popularity these areas were collapsed for the inferential statistics that follow.

4.3.1. Correlations

In line with the Hebbian principle of synchronous, co-activation and its influence in neuroplasticity (Buonomano & Merzenich, 1998; Ragert et al., 2004) as well as the ability of neighbouring body areas on the somatosensory homunculus to blend boundaries (Candia et al., 2003; Elbert et al., 1994; Elbert et al., 1995; Jones, 2000), the top 12 body areas were correlated, using Spearman's Rho (as normality cannot be assumed), with the remaining top 12 body areas. This was done so as to determine the degree to which stimulation of one body area would influence the ability of other body areas to facilitate sexual arousal, see Table 1.

Table 1

Spearman's Rho Correlation Coefficients for the Top 12 Body Areas

		Ears	Mouth/ Lips	Front of Neck	Chest	Nipples	Pubic Hairline	Penis	Scrotum	Perineum	Inner Thighs	Back of Neck	Buttocks
Ears	Cor. Coeff	1.000	.399**	.511**	.277**	.341**	.329**	.207**	.294**	.282**	.428**	.504**	.254**
	Sig.	.	.000	.000	.000	.000	.000	.003	.000	.000	.000	.000	.000
Mouth/ Lips	Cor. Coeff	.399**	1.000	.440**	.350**	.329**	.301**	.292**	.210**	.118	.410**	.428**	.254**
	Sig.	.000	.	.000	.000	.000	.000	.000	.002	.090	.000	.000	.000
Front of Neck	Cor. Coeff	.511**	.440**	1.000	.359**	.352**	.353**	.153*	.271**	.292**	.485**	.570**	.240**
	Sig.	.000	.000	.	.000	.000	.000	.028	.000	.000	.000	.000	.000
Chest	Cor. Coeff	.277**	.350**	.359**	1.000	.534**	.389**	.126	.236**	.226**	.476**	.470**	.407**
	Sig.	.000	.000	.000	.	.000	.000	.070	.001	.001	.000	.000	.000
Nipples	Cor. Coeff	.341**	.329**	.352**	.534**	1.000	.441**	.207**	.281**	.326**	.502**	.452**	.385**
	Sig.	.000	.000	.000	.000	.	.000	.003	.000	.000	.000	.000	.000
Pubic Hairline	Cor. Coeff	.329**	.301**	.353**	.389**	.441**	1.000	.259**	.370**	.442**	.603**	.334**	.436**
	Sig.	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000
Penis	Cor. Coeff	.207**	.292**	.153*	.126	.207**	.259**	1.000	.477**	.291**	.323**	.198**	.249**
	Sig.	.003	.000	.028	.070	.003	.000	.	.000	.000	.000	.004	.000
Scrotum	Cor. Coeff	.294**	.210**	.271**	.236**	.281**	.370**	.477**	1.000	.605**	.422**	.230**	.303**
	Sig.	.000	.002	.000	.001	.000	.000	.000	.	.000	.000	.001	.000
Perineum	Cor. Coeff	.282**	.118	.292**	.226**	.326**	.442**	.291**	.605**	1.000	.507**	.243**	.354**
	Sig.	.000	.090	.000	.001	.000	.000	.000	.000	.	.000	.000	.000
Inner Thighs	Cor. Coeff	.428**	.410**	.485**	.476**	.502**	.603**	.323**	.422**	.507**	1.000	.516**	.497**
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000
Back of Neck	Cor. Coeff	.504**	.428**	.570**	.470**	.452**	.334**	.198**	.230**	.243**	.516**	1.000	.385**
	Sig.	.000	.000	.000	.000	.000	.000	.004	.001	.000	.000	.	.000
Buttocks	Cor. Coeff	.254**	.265**	.240**	.407**	.385**	.436**	.249**	.303**	.354**	.497**	.385**	1.000
	Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.

All significance values are 2-tailed.

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

N = 208 for all correlations

The highest correlation for the ears is with the front of the neck, r = .511, p = .001 and with the back of the neck, r = .504, p = .001. The mouth/lip area was most highly correlated with the front of the neck, r = .440, p = .001 and the back of the neck, r = .428, p = 0.001. The highest correlation for the front of the neck is the back of the neck, r = .570, p = .001. The chest and nipples were most highly correlated with one another, r = .534, p = .001. The chest was also highly correlated with the inner thighs, r = .476, p = .001 and the back of the neck, r = .470, p = .001. The nipples were also correlated highly with the inner thighs, r = .502, p = .001. The highest correlation for the pubic hairline was with the inner thighs, r = .603, p = .001 with a large drop in correlation coefficient value for the remainder of the body areas. The penis was most highly correlated with the scrotum, r = .477, p = .001 and this is the only correlation higher than a .4 in value. The scrotum was most highly correlated with the perineum, r = .605, p = .001 with a marked decrease in the correlation strength for the rest of the body areas. The highest correlation with the perineum was the scrotum, r = .605, p = .001 and the inner thighs, r = .507, p = .001. The highest correlation with the buttocks is the inner thighs, r = .497, p = .001 and the pubic hairline, r = .436, p = .001.

Despite obtaining many significant correlations, it was decided to run a rotated factor analysis so that the way in which the body areas cluster together could be explored in line with the way in which the body is represented within the somatosensory cortex.

4.3.2. Factor Analysis

Factor analysis refers to a set of mathematical procedures used for data reduction by identifying clusters of variables which account for the common variance seen by using the least number of exploratory models (Field, 2005). Exploratory factor analysis consists of 'estimating, or extracting factors; deciding how many factors to retain; and rotating factors to an interpretable orientation' (Floyd & Widaman, 1995 cited in Cohen & Swerdlik, 2005, p. 180). The study utilised an exploratory factor analysis with the full 208 participants.

A Direct Oblimin, a form of Oblique Rotation suited for correlated variables (Field, 2005), was utilised. According to Stevens (1996, cited in Field, 2005, p.637) a loading of >.364 is needed for a sample of 200 to determine significant loadings. As such, small coefficients below this value were suppressed to make the output clearer. The results of this factor analysis, was also specified to 3 factors based on the scree plot below.

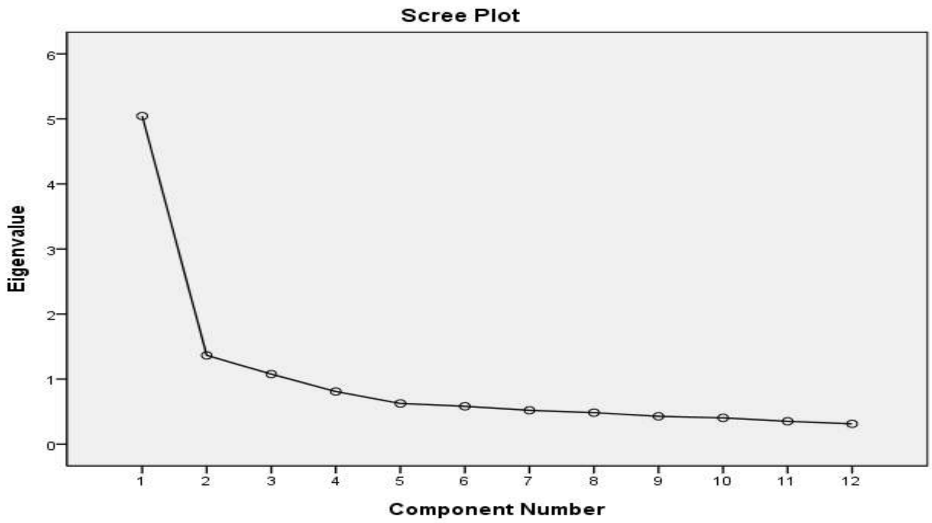

Figure 4. Scree plot identifying the different factors based on the top 12 body areas.

Table 2

Pattern Matrix for the 12 Top Body Areas

	Component		
	1	2	3
Buttocks	.739		
Pubic Hairline	.694		
Chest	.679		
Nipples	.631		
Inner Thighs	.584		
Perineum	**.548**	.532	
Penis		.785	
Scrotum		.766	
Mouth/Lips			.797
Front of Neck			.731
Ears			.696
Back of Neck			.629

Extraction Method: Principal Component Analysis

Rotation Method: Oblimin with Kaiser Normalization

a. Rotation converged in 15 iterations

The three factors produced by the factor analysis seem to represent a trunk area (factor 1), a genital area (factor 2) and a head area (factor 3). The communalities table reflected that all variables had extraction values of >.536 which indicates that each of the variables included in the factor analysis explain more than 28.7% of the original data. MacCallum, Widaman, Zhang and Hong (1999, cited in Field, 2005, p.640) state that with communalities in the .5 range, sample sizes of 100 to 200 can be sufficient. Similarly, Guadagnoli and Velicer (1988 cited in Field, 2005, p.640) state that if a factor has four or more loadings of .6 and above then the factor analysis is reliable regardless of sample size. Only two of the body areas had loadings less than .6, the inner thighs and the perineum. The perineum is the only body area to load with values above .5 on two of the factors (factor 1 and factor 2).

The results of the factor analysis represent the variation in the ability of different body areas to facilitate sexual arousal through tactile stimulation. Factor 1 accounted for 42% of the variance obtained. This suggests that the buttocks, pubic hairline, chest, nipples inner thighs, and the perineum account for the majority of variation in the body's ability to facilitate sexual arousal. Factor 2, which represents the genital region, accounted for an additional 11.37% of the variance. Factor 3, the head factor, accounted for 8.97% of the variance.

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was sufficient for the factor analysis run, with a value of .881 which is termed 'great' value and met the criteria for sampling adequacy of at least .5 (Field, 2005, p.640). Furthermore, the Bartlett's Test of Sphericity was significant at 0.000 indicating that the correlation matrix is not an identity matrix and thus appropriate for factor analysis (Field, 2005). There were 37 (56%) non-redundant residuals with absolute values greater than .05 which raises caution as the value is greater than the 50% criteria for suitability for the factor analysis. Despite the variables correlating with one another, the Determinant value reveals that multi-collinearity is not a problem as the values are greater than .00001 (Field, 2005, p.641).

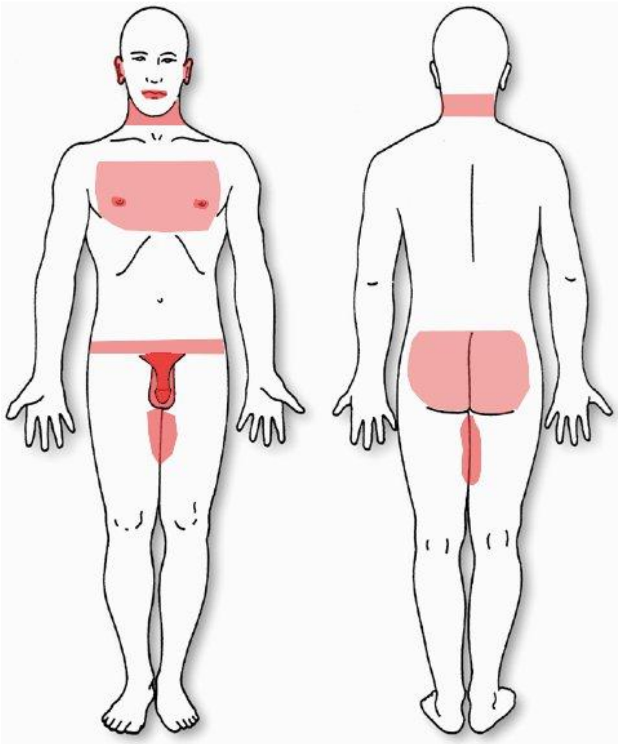

Figure 5. Graphical representation of the top 11 body areas based on their intensity to facilitate sexual arousal (the perineum could not be indicated on the image above).

4.3.3. Reliability

Reliability refers to the stability and consistency of a measurement instrument (Cohen & Swerdlik, 2005). The measure of reliability used is Cronbach's alpha which provides a reliability coefficient for items answered on a Likert scale (i.e. the 'Hotness Scale'). The alpha value ranges from 0 to 1.00, with higher values indicative of a highly reliable measure (Gravetter & Forzano, 2006). The tables below provide the Cronbach's alpha value for the 'Hotness Scale'.

Table 3

Cronbach's Alpha for the 'Hotness Scale'

Cronbach's Alpha	N of Items
0.934	41

4.4. Conclusion

Overall, the 'Hotness Scale' had a reliability value of 0.943 for the 41 body areas. The correlated data was found to be suitable in size for an oblique factor analysis. The Direct Oblimin factor analysis resulted in clustering around three specified factors. These seem to present a head (ears, mouth/lips, front of neck and back of neck), trunk (chest, nipples, pubic hairline, inner thighs and buttocks), and genital region (penis and scrotum).

CHAPTER FIVE
DISCUSSION AND CONCLUSION

5.1. Introduction

The aim of this chapter is to discuss possible reasons for the results obtained by the current study. The results will be discussed in reference to the literature presented and the aims of the study. Limitations to the study will be discussed. Recommendations and future directions will then be presented.

5.2. Discussion of Descriptive Statistics

Two areas within the demographics section of the survey will be discussed below as they relate to the ability of different body areas to facilitate sexual arousal. These two areas are marital status and race.

Marital Status. Descriptive statistics indicating the mean value for each body area by marital status group (see Appendix B) reveals slightly different patterns when rank ordered. The single, in a relationship and married groups reveal very similar patterns in terms of the body areas that were selected as high facilitators of sexual arousal, with the top three areas being the same – penis, mouth/lips and scrotum. From the top 12 body areas all 12 are found to be rank ordered in the top 12 by these three groups except for the buttocks in the single group who ranked the head and hair area as slightly more erogenous than the buttocks (mean of 3.410 compared to 3.325). Individuals indicating that they were in a relationship reveal a tendency to rate body areas as more arousing. The divorced and separated groups had 11 of the top 12 areas represented. The divorced group had a steep drop in mean rating values (from a mean of 7.6 to 4.8) beyond the top three areas (penis, scrotum and mouth/lips). Due to the small number of participants in the separated group many of the mean values are the same with 14 body areas having a mean value greater than ‘8’.

The overall pattern obtained hints at the potential mediating effect of novelty on the reported ability of different body areas to facilitate sexual arousal and the level of intensity at which their capacity are rated. This is illustrated by the relationship group ranking body areas more highly on average than single and married individuals as well as by the high values obtained for the separated sample. However, these suggestions are speculative and require further investigation with larger sample sizes.

Racial Differences. Due to the large discrepancies between the numbers of individuals in the various racial groups meaningful comparisons were not possible between these groups. As such any interpretation of the descriptive statistics presented in Appendix A remains speculative and could be attributed to chance or the sample characteristics and is thus not generalisable. In light of this the fact that Black and White individuals made up more than 95% of the sample, only the means pertaining to these two groups were presented. When ranking the top 12 body areas for the two racial groups (White and Black) slight differences in placement are observed with the Black sample ranking the stomach within the top 12 body areas and the not the chest (ranked 13th). The general trend of the scores indicated that Black individuals may, on average, rank body areas as more arousing than White individuals. Black individuals had 10 of the 12 top body areas with a mean larger than five compared to only five body areas with a mean greater than five for the White sample. Only the top two areas were identical: the penis and the mouth/lips. Reasons for the differences found are highly speculative.

5.3. Discussion of Research Aims

The current study was exploratory in nature and sought to identify which body areas, as indicated by participants, were perceived to be high facilitators of sexual arousal and how these areas are mapped within the somatosensory cortex as a possible explanation for their erogeneity. The first aim of the study was to identify which body areas were identified by participants as sexually stimulating to touch. All body areas were rated by participants in varying degrees of erogeneity, each body area received at least some support (the least endorsed area was the elbows with 94.2% of participants rating the elbows as ‘0’ on the ‘Hotness Scale’). However, only those body areas that were endorsed by more than 60% of the sample (which subsequently formed the top 12 body areas) were used in order to investigate the relationship between erogenous zones and the way in which they are represented cortically. The top 12 areas, including the genitals, identified by participants as erogenous, from most intense, were as follows: the penis, mouth/lips, scrotum, inner thighs, front of neck, perineum, pubic hairline, nipples, back of neck, ears, chest and buttocks. The study then sought to explore whether these secondary body areas were sexually appealing based on their placement on the sensory homunculus, in close proximity to the primary sexual areas. The concept of neuroplasticity was also taken into account as a possible explanation for capacity of certain body areas to facilitate sexual arousal more intensely than others.

5.3.1. Erogenous Zones

In terms of identifying whether the areas of greatest intensity support the somatotopic representation of the body within the brain, it was found that the body areas formed three clusters. These three clusters could be said to represent: a genital, trunk and facial factor and would appear to provide three separate centres of erogeneity and not a single primary region represented by the genitals.

This is in line with the three classic erogenous zones proposed by Freud – the mouth, anus and the genital organs (cited in Triebel, 2005). The penis, as the primary erogenous zone, was rated the most erogenous body area by participants. Direct support is also provided for the mouth, as this area was rated the second highest in its ability to facilitate sexual arousal and formed the facial factor. Despite not including the anus as a separate body area, it would appear that the buttocks (as the larger anal region) receive some support through the third factor, representing the trunk of the body. Further support is provided through the additional text box located at the end of each section on the survey for participants to include any other body area that they feel is sexually arousing. The anus was entered by five individuals and was the only body area to be entered in with more than two entries. Thus the current study shows areas of overlap with the classic erogenous zones proposed by Freud (Triebel, 2005) i.e. genitals (genital factor), mouth (facial factor) and anus (trunk factor). The three factors will be discussed in more detail below.

5.3.1.1. Genital factor

The genital factor is composed of the penis and the scrotum, which are shown to lie adjacent to one another below the toes on the sensory homunculus. These areas loaded with values greater than .532 and as such explain between 28.3% and 61.6% of the original data.

Penis. In line with previous research (Edwards & Husted, 1976; Levin, 2002; Rowland et al., 1991), the current study provides support for the penis being the primary area for sexual arousal. The penis was rated as the highest body area in terms of both intensity and popularity rating scores.

Scrotum. The scrotum was viewed as highly erogenous by 77.9% of the sample with 73% rating the scrotum higher than a '6' on the 'Hotness Scale'. The penis and the scrotum were significantly correlated with one another, $r = .477$, $p < 0.01$. Thus the ability of the scrotum to facilitate sexual arousal based on its mapping within the somatosensory cortex as part of the genital region (situated below the toes) is supported. Furthermore, since the scrotum lies adjacent to the penis both physiologically and on the sensory homunculus, sexual arousal can be facilitated through the simultaneous co-activation of these body areas. The scrotum was also found to significantly correlate with the perineum, $r = .605$, $p < 0.01$, and the inner thighs, $r = .422$, $p < 0.01$. This reveals the interconnected nature of the relationship between the genital region and those areas that are found in close proximity with the genitals anatomically.

The way in which the genitals are mapped within the somatosensory cortex is subject to conflicting opinions (Bradley et al., 1998; Georgiadis & Holstege, 2005; Kell et al., 2005; Michels et al., 2010). The current study provides support for the cortical mapping of the genital region as depicted on the sensory homunculus as the penis and scrotum load onto an independent factor, the genital factor (see Figure 1; Gross, 2006; Penfield & Rasmussen, 1950 cited in Kell et al., 2005, p. 5984–5987). This further supports the discontinuous mapping of the genitals as an area which participants found highly erogenous.

5.3.1.2. Facial factor

Four body areas were found to load strongly on the facial factor: the ears, mouth/lips, the front of the neck and the back of the neck. All loadings were found to be above 0.629 which indicates that these body areas explain more than 39.6% of the original data.

Mouth/Lips. The mouth/lip area formed the second highest erogenous zone based on both popularity and intensity scores. A total of 92.3% of the sample found this area to be highly arousing. Approximately 70% of the participants rated the mouth/lips higher than a '7'on the 'Hotness Scale'. The reason for the high ranking of the mouth/lips could be related to Hebbian plasticity in that the mouth/lip area is often stimulated prior to and in combination with the genital areas during the sexual experience. As such their perceived connectedness increases the synaptic strength of these neuronal areas causing them to fire together or in close proximity to one another (Buonomano & Merzenich, 1998). Furthermore, this relationship between the mouth/lips and the sexual experience provides the foundation for these two physically and cortically separate body areas to facilitate sexual arousal.

Ears. Since the ears are not represented on the sensory homunculus it is suggested that they would be mapped by the facial area and thus will be in close proximity to the mouth/lip area. The ears were a popular body area amongst 68.3% of the sample who indicated that they found the ears to be arousing. The ability of the ear to facilitate arousal may be linked to the perceptions that individuals have regarding the sensual nature of tactile stimulation to this body area. As indicated by Chen and colleagues (2003), it is not only tactile stimulation that affects the representation of the body in the brain but also the perception of these body areas that impacts on the way in which they are mapped within the brain. It is suggested that individuals may have found the ears to evoke a perceived connection to the sexual experience and as such these areas become linked via co-activation. The ears were found to significantly correlate with the penis, $r = .207$, $p < 0.01$. Despite the correlation value being weak, it does provide evidence for the capacity of the ears to facilitate sexual arousal. Furthermore, the ears were found to significantly and moderately correlate with the mouth/lips, $r = .399$, $p < 0.01$. It could therefore be suggested that the ability of the ears to facilitate sexual arousal may lie in its placement on the somatosensory cortex, in close proximity to the mouth/lips, and thus be subject to the blurring of cortical boundaries and a spread in the activation and facilitation of sexual arousal.

The Neck. Research on the mapping of neck is sparse and literature regarding the separate mapping of the front and the back of the neck did not form part of the literature reviewed. It is unclear from the sensory homunculus whether the front of the neck and the back of the neck are represented in the same area between the trunk and the head (not the facial area) as one region or whether they represent two separate regions but in close proximity. In their earlier mapping of the body, Penfield and Boldrey (1937) were uncertain of the position of the neck as represented in the body map. Furthermore, they ascribed two separate regions for the neck. The first region was as a functional part of the trunk and not as a separate entity which was revised by Penfield and Rasmussen (1950 cited in Kell et al., 2005) and is depicted on the sensory homunculus in a slightly elevated manner between the trunk and head. The second neck area was presented adjacent to the face (Penfield & Boldrey, 1937). However, the reasoning and boundaries of the neck area are not clear.

More than 70% of the sample found both the front of the neck (75.5%) and the back of the neck (72.6%) to be arousing. As would be expected, the front of the neck and the back of the neck are highly correlated with one another, $r = .570, p < 0.01$. The reason for the front of the neck and the back of the neck to load onto the same factor as the ears and mouth/lip area remains speculative. An interesting pattern that emerged from the factor loadings within the facial factor is that the highest intercorrelation found for the ears, mouth/lips and the back of the neck is with the front of the neck. The front of the neck is not found to be significantly correlated with the penis, $r = .153, p > 0.01$. It is therefore suggested, that it is the co-activation of the neck with the mouth/lips that would result in this factor loading. The front of the neck was found to be significantly correlated with the ears, $r = .511, p < 0.01$ and with the mouth/lips, $r = .440, p < 0.01$. This could suggest that the erogeneity of the front of the neck is more closely linked to its association with the mouth/lips and the ears through perceived linkages with the sexual experience. When examining the back of the neck, a similar pattern is seen. The back of the neck is found to be significantly correlated with the ears, $r = .504, p < 0.01$ and the mouth/lips, $r = .428, p < 0.01$. In contrast however, the back of the neck is found to be significantly correlated with the penis despite the correlation value being very weak, $r = .198, p < 0.01$.

The findings of the current study could be interpreted in two different ways. Firstly, the findings could suggest that the both the front and the back of the neck would lie adjacent to the facial area as supported through these two areas loading onto the facial factor and not the trunk factor. As such the front and back of the neck would be in close cortical and physiological proximity to the facial region and thus their ability to facilitate sexual arousal could be linked to their placement within the sensory homunculus, highlighting a second centre of erogeneity. Secondly, it could be suggested that the front of the neck is mapped closer to the facial region (based on the significant correlations between the front of the neck with the mouth/lips and ears but not the penis) whilst the back of the neck is situated adjacent to the trunk within the somatosensory cortex (based on the significant correlation the back of the neck has with the penis). Furthermore, it is suggested that the ability of the front of the neck to facilitate sexual arousal would be linked to its positioning close to the mouth/lips. Activation of the front of the neck through its cortical positioning near the mouth/lips and ears (as erogenous zones) could cause the spread of sexual activation to the back of the neck due to its close proximity to the front of the neck anatomically and thus through the process of co-activation. However, these suggestions remain speculative.

5.3.1.3. Trunk factor

The trunk factor consisted of the following six body areas: nipples, chest, pubic hairline, buttocks, perineum and the inner thighs. These areas loaded with values greater than .548 and as such explain between 30% and 54.6% of the original data. Within these body areas, there appears to be an upper trunk area (chest and nipples) and a lower trunk area (pubic hairline, buttocks, perineum and the inner thighs). When looking at the sensory homunculus, these body areas are not demarcated and it is assumed that the placement of these body areas will be on the area labelled ‘trunk’ and lie between the neck representation and extend to the area just beyond the hip but not reaching the knee. As such the mapping of the nipples, chest, pubic hairline, buttocks, perineum and the inner thighs are consistent with the sensory homunculus.

Chest. The chest was the 11th most popular and intensely rated body area with 63% of the sample endorsing its ability to facilitate sexual arousal. The chest is not however, significantly correlated with the penis, $r = .126$, $p > 0.05$ and as such it is suggested that the chest has the ability to facilitate sexual arousal through the co-activation with body areas neighbouring the chest and that are significantly correlated with the penis. The chest is most strongly correlated with the nipples, $r = .534$, $p < 0.01$ which in turn is significantly correlated with the penis, $r = .207$, $p < 0.01$. It is therefore suggested that the capacity for the chest to be arousing is due to the close proximity it has within the sensory homunculus to the nipples resulting in a blurring of boundaries between the chest and nipples and an increased ability to facilitate sexual arousal.

Nipples. The nipples are found to be significantly correlated with the penis, $r = .207$, $p < 0.01$ and endorsed by approximately 70% of the sample. The nipple is also found to be more strongly erogenous than the chest mentioned above and is ranked seventh in terms of popularity ratings and eighth in the intensity ratings. In contrast to theory on the male nipple, as a largely non-functional area for sexual stimulation (Levin, 2006) the current study found the nipple to be rated highly by heterosexual male participants. In fact, 69.7% of the participants found the nipple to be high in its ability to facilitate sexual arousal and 60.5% of these respondents rated at as greater than a ‘5’ on the ‘Hotness Scale’. This is also in contrast to the survey results obtained by Kinsey and colleagues (1953 cited in Levin, 2006, p. 244) whereby the stimulation of nipples in males for sexual pleasure was reported to be a more frequent occurrence for homosexual males. No comparison can be made as to whether or not homosexual males would rate this body area as even higher in intensity as that is beyond the scope of the current study. The current study does provide some support in line with the study conducted by Levin and Meston (2006) implicating the nipple as an erogenous zone amongst male participants.

Pubic Hairline. This area is hypothesised to lie near the hip area of the sensory homunculus and as such lies adjacent to the trunk area within the sensory homunculus. The ability of the pubic hairline to facilitate sexual arousal could be linked to its proximity to the trunk area. The pubic hairline is significantly correlated with the penis, $r = .259$, $p < 0.01$ and was popular amongst 66.3% of the sample. It is suggested that the location and perceived erogeneity of the pubic hairline plays a role in its ability to facilitate sexual arousal. The highest intercorrelation for the pubic hairline was found with the inner thighs, $r = .603$, $p < 0.01$. Due to its physiological proximity to the genitals, the pubic hairline might be erogenous due to the principle of co-activation. Connection between this area, the inner thighs and the perineum will be discussed under the perineum.

Buttocks. The buttocks are the 12th highest body area by intensity and popularity and it is assumed to be presented below the hip area on the sensory homunculus. This area is significantly correlated with the penis, $r = .249$, $p < 0.01$ and was selected by 62.5% of the sample as erogenous. The location of the buttocks on the somatosensory cortex supports the hypothesis that areas closer to the genitals will be more arousing than areas further away.

Perineum. The perineum was endorsed by 63% of the sample as arousing. It is acknowledged that the boundaries of the perineum depend on the way in which the definition is applied. As mentioned, the current study defined the perineum in the more restrictive manner as the 'area between the genitals and the anus'. The perineum although not mapped on the sensory homunculus is proposed to be situated on the trunk area, near the pubic hairline and the buttocks. As such the perineum supports the hypothesis that areas close to the primary sexual organs are more arousing than areas further away.

The perineum was the only body area to load substantially on two of the three factors (trunk factor and the genital factor). This may be reflective of the nature of the perineum and the dual definition that exists for this body area. The somatic fibres of the scrotum, anus and the perineum all converge in the pudendal nerve (Kern et al., 2004; Moore & Dalley, 1999;

Netter, 2003). As such it would not be surprising if these areas had loaded together onto one factor. One of the reasons for the perineum to load apart from the penis and scrotum and to load more strongly with the buttocks (anus) is evident when looking at the two triangles that make up the diamond-shaped perineum. The first triangle is the urogenital triangle which contains the root of the penis and scrotum. This then provides an explanation for the genitals to be found loading on their own factor. The second triangle is the anal triangle which contains the anal canal (Moore & Dalley, 1999; Netter, 2003). Thus the perineum, based on the definition adopted for the current study, is more suited to load in conjunction with the buttocks and as such to form part of the trunk factor.

The perineum was found to be significantly correlated with the penis, $r = .291$, $p < 0.01$. However, the correlation is weak. The perineum is most highly correlated with the scrotum, $r = .605$, $p < 0.01$, the inner thighs, $r = .507$, $p < 0.01$, the pubic hairline, $r = .442$, $p < 0.01$ and the buttocks, $r = .354$, $p < 0.01$. The current study thus supports the placement of the perineum on the trunk of the body and as such would facilitate sexual arousal based on its physiological proximity to the genitals as well as through co-activation of surrounding areas (inner thighs, pubic hairline and the buttocks) which are found to correlate more highly with the penis.

Inner Thighs. The inner thighs were found to facilitate sexual arousal by 76.4% of the participants with 65.9% rating its intensity as greater than ‘6’on the ‘Hotness Scale’. This body area was significantly correlated with the penis, $r = .323$, $p < 0.01$. This supports the cortical map as the inner thighs are found to be closely mapped to the genital region and as such supports the hypothesis that areas close to the genitals will be reported as more arousing than areas further away. The inner thighs had the highest correlation was the pubic hairline, $r = .603$, $p < 0.01$ which supports the notion that areas closer to one another have the ability to blend boundaries and thus the ability to facilitate sexual arousal.

The implications of the trunk factor suggest a third centre capable of facilitating sexual arousal. Research on the mapping of the trunk area is sparse (Rothemund et al., 2005) and has yielded unsatisfactory results. Much of the difficulty in accurately mapping the trunk area lies in the fact that such a large anatomical body area is allocated a small area of cortical space which has resulted in an inability to accurately identify the components of the trunk (Nakamura et al., 1998). In the study by Nakamura and colleagues (1998) the distinction between the trunk and the leg was not clear. This has important implications for the current study as a relatively large number of body areas were found to load onto this factor in a seemingly haphazard manner. However, in light of the small cortical area available for the mapping of the trunk, the body areas found to load onto this factor seems appropriate. Furthermore, as proposed by Freud, the current study provides support for the idea that multiple body areas have the ability to be erogenous.

5.3.2. Cortical Organisation

The current study used the sensory homunculus as would appear to be the norm in studies involving the cortical mapping of sensation (see for example, Aglioti et al., 1994a; Buonomano & Merzenich, 1998; Fox et al., 1987; Mogilner et al., 1993; Nakamura et al., 1998; Pons et al., 1991; Serino & Haggard, 2010). Despite finding three separate factors, the results obtained in the current study provide some evidence for the mapping of the body within the somatosensory cortex as represented by the sensory homunculus. Thus it can be said that the ability of body areas to facilitate sexual arousal is in part related to their neighbouring locations on the sensory homunculus.

When examining the genital factor, it is evident that the penis and scrotum are found to cluster independently from the trunk and as such this provides support for their separate mapping on the sensory homunculus. Despite participants not rating the toes and foot as arousing, with 73.6% of the sample scoring these areas as zero on the 'Hotness Scale', areas of the upper leg and trunk area were reported to be arousing.

Since many of the body areas selected by participants as high in their capacity for sexual arousal were not explicitly mapped on the sensory homunculus, their location had to be inferred. This is especially true for the trunk factor where participants indicated that the pubic hairline, perineum, inner thighs and the buttocks were high in their ability to facilitate sexual arousal. These areas are assumed to lie in close proximity of one another. However, Kell and colleagues (2005) argue that areas that occupy small representational space within the sensory homunculus, such as the trunk, could result in an incorrect description of sensations being reported. The current study would seem to disagree with this statement as many specific areas on the trunk were found to be distinguished in their ability to facilitate sexual arousal. The mapping of the trunk area is thus supported by the current study with this area covering the trunk and hip area demarcated on the sensory homunculus. As such the current study also provides support for the hypothesis that areas mapped closer to the genitals should be more arousing than areas further away.

The facial factor provides mixed results for cortical organisation due to the ambiguity of the neck area. The placement of the front of the neck and the back of the neck are not indicated on the sensory homunculus and as such were assumed to lie on either side of the head area near the trunk. However, the ears and the mouth/lips would be presented further away from the trunk area on the second head area representing the face. As such the neck is mapped quite far from the ears and mouth/lip. This does not support the hypothesis that areas lying in close proximity to the genitals will be higher in their ability to facilitate sexual arousal. A possible explanation for this seemingly contradictory finding is discussed under the neuroplasticity section.

5.3.3. Neuroplasticity

Neuroplasticity highlights the ability of neighbouring body areas to respond to sensory input (Buonomano & Merzenich, 1998; Serino & Haggard, 2010). It was thus hypothesised that areas neighbouring the genitals as the primary erogenous zone would be higher in their ability to respond to tactile stimulation and thus be found to facilitate sexual arousal more than areas further away. In light of the three factors found, it is suggested that the areas neighbouring these centers would be higher in their facilitation of sexual arousal. The results obtained support this notion with inter-correlations between the areas forming each of the factors being higher than those with other factors. It is noted that the correlation values obtained are not very strong and most lie within the weak to moderate range (Field, 2005; Gravetter & Wallnau, 2004). However, they do provide valuable insight into the interconnected nature of these body areas in their ability to facilitate sexual arousal.

Furthermore, the data obtained provides evidence for Hebbian plasticity in influencing the ability of body areas to facilitate sexual arousal. Areas in close proximity such as the chest and nipples; and the pubic hairline, perineum, inner thighs and the buttocks have been shown to be significantly correlated with one another but not always with the penis. This shows the ability of neighbouring body areas to be activated simultaneously (and for this activation to spread to adjacent body areas) and thus facilitate sexual arousal despite not being significantly correlated with the genital region. Indeed, the perineum had the strongest correlation with the scrotum and not the penis and it is suggested that the spread of sexual arousal activation might move from the perineum via the scrotum. In addition, areas further away from one another or the primary genital area such as the mouth/lips have also been shown to facilitate sexual arousal through co-activation. The role of perceived erogeneity of different body areas was not the focus of the study but could provide possible explanations for the simultaneous activation of body areas that are located further away from one another both physiologically and within the sensory homunculus (Chen et al., 2003; Serino & Haggard, 2010).

Some research suggests that prolonged, repetitive stimulation can result in disarranged or fused representations of the areas involved (Braun et al., 2000; Serino & Haggard, 2010). This might play a role in terms of the factors found and the body areas that were found to load onto each factor. For example, the close proximity of the scrotum and the penis, and hence the high degree to which they co-activate might result in them appearing to be a separate factor. However, this seems unlikely due to the high degree to which participants were able to differentiate between different body areas and their ability to facilitate sexual arousal including areas like those found on the trunk that are closely mapped in relation to one another while occupying relatively little cortical space.

5.4. Limitations and Future Research

The current study acknowledges that due to poor internet penetration rates within the African continent the sample obtained may be subject to bias in that individuals from specific socio-economic strata would have had access, or be denied access, to the survey. However, in an attempt to limit this impact, url links were placed on university websites which provides internet access for those who might not have access to the internet at home. Due to practical and convenient reasons, the survey was only presented in the English language and as such would show a bias towards English speaking individuals. However, individuals who log onto university portals and social networking sites do so largely in English. Since the survey format was largely forced choice it should aid in providing less ambiguity.

It is noted that the sample was subject to truncation of range and was composed predominantly of white individuals (80.3%). Future research should aim to utilise a more representative racially distributed sample. A larger, more evenly distributed sample would provide for stronger conclusions to be drawn and as such it is recommended for future research. A sample of at least 410 is preferable (10 participants per item) (Field, 2005). The sample size obtained for the current study was lower than anticipated which could be the result of an underlying reserved nature when it comes to an individual's own sexuality. This could explain why 24.4% of heterosexual males who visited the survey site did not complete the full form. It is unknown whether these individuals differ from those who volunteered and completed the study (Field, 2005; Gravetter & Forzano, 2006). It would be interesting to know if more people would have completed the survey had the 'Hotness Scale' been based on what an individual would find arousing on his/her partner. Furthermore, as cellular phones become increasingly popular for accessing the internet, it is suggested that future online surveys be made compatible for completion via cellular phones.

Future research should aim to increase the sample size so that patterns of erogenous zones can be compared more fully between different racial groups to determine whether the sensory homunculus is stable across different racial groups and if not, to investigate the possible effects of culture on notions of erogeneity of different body areas. However, as participants are rating the ability of different body areas to facilitate sexual arousal in relation to their own bodies, it is suggested that cultural values and norms would not impact largely on the ability of different body areas to facilitate sexual arousal. More research in this area would however be essential in understanding the degree to which sexual arousal, facilitated through different body areas, is encapsulated by the mapping of the body within the somatosensory cortex.

Another limitation of the current study is the use of the term 'buttocks' over 'anus'. What participants understood by the term buttocks is unknown (buttock cheeks versus anus) and was seen as qualitatively different to the 'anus' and as such were viewed differently with two individuals entering 'anus' into the additional text box provided. This leaves room for speculation as to why the buttocks were found to be high in their ability to facilitate sexual arousal. It is thus suggested that future studies include the anus as a body area so that a more accurate description can be formed. In retrospect, perhaps it would have been better to include all the body areas mentioned on the sensory homunculus or to limit the body areas to those represented by the somatotopic map so as to reduce the ambiguity encountered when deciding on the location of certain body areas (such as the neck) on the sensory homunculus.

Furthermore, future research would also benefit from more detailed studies investigating the way in which the body is represented within the somatosensory cortex so that all body areas are adequately mapped. Despite the penis being a controversially mapped body area, it is not the only body area to provide ambiguity on the sensory homunculus. In a study by Iannetti, Porro, Pantano, Romanelli, Galeotti and Cruccu (2003) it was found that the representation of the face within the primary somatosensory cortex is both more complex and different to that proposed in the classical homunculus. However, no further information is given as to the differences and complexities involved. A clearer, more detailed mapping of the body within the brain would provide clarity on the mechanisms at work in the facilitation of sexual arousal by different body areas.

Another area for future research is in the field of anatomy. In mapping the way in which different body areas are represented within the brain, it would be beneficial to draw on literature which traces the way in which tactile stimulation travels from touch sensitive receptors in the skin until it reaches the somatosensory cortex.

Research into erogenous zones would benefit from studies which look at the effects of novelty on the ability of body areas to facilitate sexual arousal. It is hypothesised that individuals who have just entered new relationships or who have ended long term commitments would find more body areas to be arousing and potentially at a higher intensity. The current study hints at this notion through an increase in popularity and intensity ratings between individuals who are in relationships or separated. However, no strong conclusions could be drawn due to the small sample sizes involved.

The current study thus provides a rich field for future research in clarifying the role of cortical mapping in sexual arousal. It was found that despite being controversial, the sensory homunculus is still widely used and reproduced without further information on its applicability and/or whether there have been any revisions made to it since the famous mapping provided by Penfield and Rasmussen.

5.5. Research Implications

The current research study was exploratory in nature and as such sought to open up the field of erogenous zones and their ability to facilitate sexual arousal in light of the representation of the body within the brain. The sensory homunculus was used as the theoretical framework through which to explore this phenomenon. The results of the study provide evidence for the body to be mapped within the somatosensory cortex as depicted by the sensory homunculus. Furthermore, the current study would suggest three areas that are high in their ability to facilitate sexual arousal and not solely the genital region, as all three of these factors have an overall loading in the .600 - .700+ range. The ability of body areas to facilitate sexual arousal is suggested to lie both in the close proximity that these areas have within the three erogenous centres as well as co-activation of body areas through perceived erogeneity and physiological proximity.

The research findings provide important implications for sex therapy for individuals experiencing problems relating to a decrease in tactile acuity and sensitivity in the genital region (Farrow, 1990). Based on the sensory homunculus sex therapists should encourage individuals to explore the three erogenous centers as part of the therapeutic process while placing less emphasis on the genital region as the primary means through which the sexual experience can be enjoyed. Furthermore, through Hebbian co-activation and neuroplasticity, other areas (such as the mouth/lips, chest and nipples, pubic hairline, perineum, inner thighs and the buttocks) should be emphasised as key areas to explore so as to optimise the sexual experience.

5.6. Conclusion

The study of erogenous zones in heterosexual males highlighted three factors identified as facilitating sexual arousal. Interestingly, the pattern of arousal is somewhat dispersed across the body. The implication of the current findings is that body areas other than the primary genital area do have the ability to facilitate tactile sexual arousal. As previously mentioned, benefits of knowing which areas are sensitive to tactile sexual stimulation could play an important role in therapy for individuals who do not have full functional use of their primary genital region by providing alternate avenues for enjoying the sexual experience.

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Footnotes

[1] The reason for using vibration as a form of tactile stimulation was due to the fact that it results in increases in neuronal activity in the primary somatosensory cortex.

[2] Internet sites such as: www.askmen.com for articles on male and female pleasure spots/erogenous zones; www.health24.com for erogenous zones on women; www.womanknows.com for erogenous zones on women; and Martin, C. (2009). Sexpert's A-Z guide to G-spots. *The Sun,* Retrieved February 2, 2011, from http://www.thesun.co.uk/sol/homepage/features/article2227806.ece

[3] Indeed by tracking IP addresses the risk of repeated submissions is not eliminated as each time an individual logs onto the internet a new, dynamic IP address is assigned.

[4] Which is a server side scripting language.

[5] Note: Participants are required to rate body areas on the ***same*** form as their own gender in terms of its ability to elicit sexual arousal but is not limited to current levels of sexual arousal.

[6] Where URL is the Website's name: sexandthebrain.net/sexandthebrain.co.uk

[7] Proposal number 1627.

[8] Only the link and a brief invitation to the external hosting website will be placed on the various portals and social networking sites from which individuals may access the survey.

[9] Referencing and the Reference List are compiled according to the APA format.

Appendices

Appendix A: Descriptive Statistics by Race

Descriptive Statistics for White and Black Individuals

		N	Mean	Std. Deviation
Forehead	White	167	.4850	1.60142
	Black	27	.2963	1.20304
Eye/	White	167	1.0479	2.23016
Temple	Black	27	1.7778	3.16633
Ears	White	167	4.4192	3.41211
	Black	27	5.1481	3.41607
Nose	White	167	.2934	1.14761
	Black	27	.0370	.19245
Cheeks	White	167	1.8204	2.80556
	Black	27	1.9630	2.78017
Mouth/	White	167	6.9880	2.75940
Lips	Black	27	7.4074	2.67839
Chin	White	167	.5389	1.69957
	Black	27	.7037	2.10886
Front of	White	167	5.4311	3.56941
Neck	Black	27	5.5185	3.75572
Shoulders	White	167	1.8982	2.98517
	Black	27	1.6667	2.73158
Upper	White	167	1.2814	2.38693
Arm	Black	27	.8889	1.76141
Elbows	White	167	.2275	1.09036
	Black	27	.2222	.69798
Forearm	White	167	.7365	1.80763
	Black	27	1.4074	2.09870
Wrists	White	167	.8683	2.01665
	Black	27	.9259	2.07412
Hands	White	167	2.8743	3.13968

	Black	27	2.4074	2.72113
Fingers	White	167	3.0958	3.55378
	Black	27	2.5556	3.33205
Chest	White	167	4.2275	3.55791
	Black	27	3.8148	2.98763
Nipples	White	167	4.9820	3.74724
	Black	27	5.1852	3.99073
Stomach	White	167	2.9341	3.55869
	Black	27	4.1852	3.75230
Sides	White	167	2.7365	3.27128
	Black	27	3.4074	3.78519
Belly-	White	167	1.7964	2.99907
button	Black	27	2.8148	3.57380
Pubic	White	167	4.8802	3.79093
Hairline	Black	27	6.7407	3.41482
Hip	White	167	2.3892	3.36146
	Black	27	2.8519	3.55943
Penis	White	167	9.0419	2.42068
	Black	27	8.3704	3.57500
Scrotum	White	167	6.4850	3.81161
	Black	27	6.3704	4.06815
Perineum	White	167	4.9222	4.10259
	Black	27	5.9630	4.21062
Inner	White	167	5.5090	3.44818
Thighs	Black	27	6.6667	3.26991
Outer	White	167	1.6886	2.76794
Thighs	Black	27	2.2593	2.76785
Knee	White	167	.3054	1.26925
Caps	Black	27	.5185	1.60217
Shin	White	167	.1557	.80642
	Black	27	.1852	.96225
Ankles	White	167	.4850	1.55949
	Black	27	.6667	1.81871
Foot	White	167	1.4731	2.65669

	Black	27	1.4074	2.56094
Toes	White	167	1.1677	2.48526
	Black	27	.8519	2.16091
Head &	White	167	3.4192	3.36590
Hair	Black	27	3.3333	3.25813
Back of	White	167	4.6707	3.36968
Neck	Black	27	4.2593	3.42606
Shoulder	White	167	1.4611	2.69258
Blades	Black	27	1.3704	2.42024
Upper	White	167	2.0539	2.96822
Back	Black	27	2.3704	3.43229
Lower	White	167	2.6228	3.32319
Back	Black	27	3.1481	3.39347
Buttocks	White	167	4.1078	3.57372
	Black	27	4.0000	3.47519
Back of	White	167	2.4251	3.21781
Thighs	Black	27	2.4074	3.39977
Behind	White	167	1.4970	2.73063
Knees	Black	27	2.6296	3.11508
Calves	White	167	.6946	1.98704
	Black	27	.4074	1.47438

Appendix B: Descriptive Statistics by Marital Status

Descriptive Statistics by Marital Status

		N	Mean	Std. Deviation
Forehead	Single	83	.3976	1.45619
	Relationship	88	.5000	1.66091
	Married	30	.2000	.80516
	Divorced	5	.0000	.00000
	Separated	2	3.0000	4.24264
Eye/ Temple	Single	83	1.1205	2.38592
	Relationship	88	1.1591	2.38716
	Married	30	1.0667	2.25806
	Divorced	5	.0000	.00000
	Separated	2	3.5000	4.94975
Ears	Single	83	4.0482	3.66228
	Relationship	88	5.0795	3.24204
	Married	30	4.3000	3.30256
	Divorced	5	1.6000	2.19089
	Separated	2	8.0000	.00000
Nose	Single	83	.2530	1.04582
	Relationship	88	.2614	1.13961
	Married	30	.2000	.80516
	Divorced	5	.0000	.00000
	Separated	2	.0000	.00000
Cheeks	Single	83	1.6024	2.54683
	Relationship	88	2.1023	3.03254
	Married	30	1.0333	2.18905
	Divorced	5	2.6000	2.96648
	Separated	2	3.5000	4.94975
Mouth/ Lips	Single	83	6.8434	2.88174
	Relationship	88	7.3295	2.65105
	Married	30	6.5667	2.59553
	Divorced	5	7.6000	1.67332

	Separated	2	8.5000	2.12132
Chin	Single	83	.4217	1.66836
	Relationship	88	.7159	1.81278
	Married	30	.2667	1.01483
	Divorced	5	.0000	.00000
	Separated	2	5.0000	7.07107
Front of Neck	Single	83	5.3012	3.70476
	Relationship	88	5.6364	3.59815
	Married	30	5.3333	3.29402
	Divorced	5	4.8000	3.03315
	Separated	2	10.000	.00000
Shoulders	Single	83	1.7590	2.78756
	Relationship	88	1.6705	2.88365
	Married	30	1.8000	2.92905
	Divorced	5	.8000	1.78885
	Separated	2	9.0000	.00000
Upper Arm	Single	83	1.1928	2.22216
	Relationship	88	1.2614	2.36106
	Married	30	.8667	2.09652
	Divorced	5	.6000	1.34164
	Separated	2	3.0000	4.24264
Elbows	Single	83	.1928	.91675
	Relationship	88	.2386	1.16456
	Married	30	.1333	.73030
	Divorced	5	.0000	.00000
	Separated	2	1.5000	2.12132
Forearm	Single	83	1.0602	2.07981
	Relationship	88	.6477	1.68864
	Married	30	.5000	1.45626
	Divorced	5	.6000	1.34164
	Separated	2	2.0000	2.82843
Wrists	Single	83	.8916	2.06606
	Relationship	88	.8182	1.98005
	Married	30	.7667	1.85106

	Divorced	5	.4000	.89443
	Separated	2	.0000	.00000
Hands	Single	83	2.5060	2.92747
	Relationship	88	3.0000	3.26950
	Married	30	2.6000	2.95483
	Divorced	5	2.2000	2.28035
	Separated	2	6.5000	4.94975
Fingers	Single	83	2.7108	3.44125
	Relationship	88	3.2727	3.62218
	Married	30	2.6667	3.29402
	Divorced	5	.4000	.89443
	Separated	2	8.0000	2.82843
Chest	Single	83	3.6988	3.46317
	Relationship	88	4.6932	3.51142
	Married	30	3.2333	3.44096
	Divorced	5	3.4000	3.28634
	Separated	2	7.0000	2.82843
Nipples	Single	83	4.3012	3.91288
	Relationship	88	5.3409	3.79621
	Married	30	5.6000	3.11393
	Divorced	5	3.8000	2.58844
	Separated	2	8.5000	.70711
Stomach	Single	83	2.6627	3.47913
	Relationship	88	3.4091	3.70658
	Married	30	2.8333	3.58236
	Divorced	5	.8000	1.78885
	Separated	2	4.5000	6.36396
Sides	Single	83	2.6747	3.30228
	Relationship	88	3.0795	3.49128
	Married	30	2.1667	3.21723
	Divorced	5	1.8000	2.48998
	Separated	2	5.5000	2.12132
Belly-button	Single	83	1.6024	3.06013
	Relationship	88	1.9432	2.92574

	Married	30	2.3000	3.33374
	Divorced	5	.0000	.00000
	Separated	2	7.5000	.70711
Pubic	Single	83	4.2289	3.85824
hairline	Relationship	88	5.6023	3.89087
	Married	30	5.0000	3.58156
	Divorced	5	3.8000	3.56371
	Separated	2	9.5000	.70711
Hip	Single	83	1.9398	3.15591
	Relationship	88	2.7955	3.64253
	Married	30	2.0000	2.71649
	Divorced	5	1.0000	2.23607
	Separated	2	4.0000	5.65685
Penis	Single	83	8.6386	3.12963
	Relationship	88	9.1705	2.34016
	Married	30	9.1333	1.96053
	Divorced	5	9.6000	.54772
	Separated	2	9.5000	.70711
Scrotum	Single	83	6.3855	3.97808
	Relationship	88	6.7500	3.82145
	Married	30	6.2000	3.52723
	Divorced	5	8.0000	1.41421
	Separated	2	9.0000	1.41421
Perineum	Single	83	4.7229	4.24354
	Relationship	88	5.2955	4.17480
	Married	30	4.8333	3.93116
	Divorced	5	4.4000	4.03733
	Separated	2	9.0000	1.41421
Inner	Single	83	5.2169	3.60909
Thighs	Relationship	88	6.4886	3.07752
	Married	30	4.6000	3.66343
	Divorced	5	3.4000	3.78153
	Separated	2	9.0000	.00000
Outer	Single	83	1.3494	2.47639

Thighs	Relationship	88	2.1477	3.07208
	Married	30	1.4667	2.40306
	Divorced	5	2.4000	3.57771
	Separated	2	6.5000	2.12132
Knee	Single	83	.1687	.79356
Caps	Relationship	88	.3977	1.49743
	Married	30	.1000	.54772
	Divorced	5	1.2000	2.68328
	Separated	2	3.5000	4.94975
Shin	Single	83	.0843	.58861
	Relationship	88	.1023	.45586
	Married	30	.5000	1.67641
	Divorced	5	.0000	.00000
	Separated	2	.0000	.00000
Ankles	Single	83	.4940	1.76257
	Relationship	88	.5000	1.39786
	Married	30	.4667	1.52527
	Divorced	5	.0000	.00000
	Separated	2	.0000	.00000
Foot	Single	83	1.1807	2.47004
	Relationship	88	1.7273	2.87169
	Married	30	1.4333	2.50080
	Divorced	5	.0000	.00000
	Separated	2	.0000	.00000
Toes	Single	83	.9398	2.29713
	Relationship	88	1.3182	2.63725
	Married	30	1.2667	2.54522
	Divorced	5	.0000	.00000
	Separated	2	.0000	.00000
Head &	Single	83	3.4096	3.32410
Hair	Relationship	88	3.3864	3.35087
	Married	30	2.8667	3.37060
	Divorced	5	3.4000	2.70185
	Separated	2	4.0000	5.65685

Back of	Single	83	4.3976	3.34204
Neck	Relationship	88	4.7841	3.38845
	Married	30	4.4333	3.42086
	Divorced	5	2.8000	3.03315
	Separated	2	8.5000	.70711
Shoulder	Single	83	1.2410	2.44246
Blades	Relationship	88	1.3409	2.65177
	Married	30	1.3333	2.49597
	Divorced	5	1.2000	2.16795
	Separated	2	7.5000	2.12132
Upper	Single	83	2.0361	2.86461
Back	Relationship	88	2.0909	3.15003
	Married	30	2.0667	2.98194
	Divorced	5	1.0000	1.73205
	Separated	2	8.0000	1.41421
Lower	Single	83	2.4578	3.12855
Back	Relationship	88	2.7727	3.49623
	Married	30	3.1000	3.43762
	Divorced	5	1.2000	1.78885
	Separated	2	4.5000	6.36396
Buttocks	Single	83	3.3253	3.45037
	Relationship	88	4.4659	3.63871
	Married	30	4.5667	3.42086
	Divorced	5	3.6000	3.78153
	Separated	2	8.5000	.70711
Back of	Single	83	2.2530	3.13456
Thighs	Relationship	88	2.5682	3.38284
	Married	30	2.4000	3.21205
	Divorced	5	1.2000	2.16795
	Separated	2	4.5000	6.36396
Behind	Single	83	1.2892	2.54965
Knees	Relationship	88	1.9318	2.97033
	Married	30	.9667	2.22033
	Divorced	5	.0000	.00000

	Separated	2	7.5000	.70711
Calves	Single	83	.3373	1.35500
	Relationship	88	.8864	2.16254
	Married	30	.4000	1.61031
	Divorced	5	.0000	.00000
	Separated	2	4.5000	6.36396

Appendix C: List of Countries

1 Afghanistan
2 Albania
3 Algeria
4 American Samoa
5 Andorra
6 Angola
7 Anguilla
8 Antarctica
9 Antigua and Barbuda
10 Argentina
11 Armenia
12 Aruba
13 Ascension Island
14 Australia
15 Austria
16 Azerbaijan
17 Bahamas
18 Bahrain
19 Bangladesh
20 Barbados
21 Belarus
22 Belgium
23 Belize
24 Benin
25 Bermuda
26 Bhutan
27 Bolivia
28 Bosnia and Herzegovina
29 Botswana
30 Bouvet Island
31 Brazil
32 British Indian Ocean Territory
33 Brunei Darussalam
34 Bulgaria
35 Burkina Faso
36 Burundi
37 Cambodia
38 Cameroon
39 Canada
40 Cape Verde
41 Cayman Islands
42 Central African Republic
43 Chad
44 Chile
45 China
46 Christmas Island
47 Cocos (Keeling) Islands
48 Colombia
49 Comoros
50 Democratic Republic of the Congo (Kinshasa)
51 Congo, Republic of (Brazzaville)
52 Cook Islands
53 Costa Rica
54 Ivory Coast
55 Croatia
56 Cuba
57 Cyprus
58 Czech Republic
59 Denmark
60 Djibouti
61 Dominica
62 Dominican Republic
63 East Timor Timor-Leste

64 Ecuador
65 Egypt
66 El Salvador
67 Equatorial Guinea
68 Eritrea
69 Estonia
70 Ethiopia
71 Falkland Islands
72 Faroe Islands
73 Fiji
74 Finland
75 France
76 French Guiana
77 French Metropolitan
78 French Polynesia
79 French Southern Territories
80 Gabon
81 Gambia
82 Georgia
83 Germany
84 Ghana
85 Gibraltar
86 Great Britain
87 Greece
88 Greenland
89 Grenada
90 Guadeloupe
91 Guam
92 Guatemala
93 Guernsey
94 Guinea
95 Guinea-Bissau
96 Guyana
97 Haiti
98 Heard and Mc Donald Islands
99 Holy See
100 Honduras
101 Hong Kong
102 Hungary
103 Iceland
104 India
105 Indonesia
106 Iran (Islamic Republic of)
107 Iraq
108 Ireland
109 Isle of Man
110 Israel
111 Italy
112 Jamaica
113 Japan
114 Jersey
115 Jordan
116 Kazakhstan
117 Kenya
118 Kiribati
119 Korea, Democratic People's Rep. (North Korea)
120 Korea, Republic of (South Korea)
121 Kuwait
122 Kyrgyzstan
123 Lao, People's Democratic Republic
124 Latvia
125 Lebanon
126 Lesotho
127 Liberia
128 Libya
129 Liechtenstein
130 Lithuania

131 Luxembourg
132 Macau
133 Macedonia, Rep. of
134 Madagascar
135 Malawi
136 Malaysia
137 Maldives
138 Mali
139 Malta
140 Marshall Islands
141 Martinique
142 Mauritania
143 Mauritius
144 Mayotte
145 Mexico
146 Micronesia, Federal States of
147 Moldova, Republic of
148 Monaco
149 Mongolia
150 Montenegro
151 Montserrat
152 Morocco
153 Mozambique
154 Myanmar, Burma
155 Namibia
156 Nauru
157 Nepal
158 Netherlands
159 Netherlands Antilles
160 New Caledonia
161 New Zealand
162 Nicaragua
163 Niger
164 Nigeria
165 Niue
166 Norfolk Island
167 Northern Mariana Islands
168 Norway
169 Oman
170 Pakistan
171 Palau
172 Palestinian National Authority
173 Panama
174 Papua New Guinea
175 Paraguay
176 Peru
177 Philippines
178 Pitcairn Island
179 Poland
180 Portugal
181 Puerto Rico
182 Qatar
183 Reunion Island
184 Romania
185 Russian Federation
186 Rwanda
187 Saint Kitts and Nevis
188 Saint Lucia
189 Saint Vincent and the Grenadines
190 Samoa
191 San Marino
192 Sao Tome and Príncipe
193 Saudi Arabia
194 Senegal
195 Serbia
196 Seychelles
197 Sierra Leone
198 Singapore

199 Slovakia (Slovak Republic)
200 Slovenia
201 Solomon Islands
202 Somalia
203 South Africa
204 South Georgia and South Sandwich Islands
205 Spain
206 Sri Lanka
207 Saint Helena
208 St. Pierre and Miquelon
209 Sudan
210 Suriname
211 Svalbard and Jan Mayen Islands
212 Swaziland
213 Sweden
214 Switzerland
215 Syria, Syrian Arab Republic
216 Taiwan (Republic of China)
217 Tajikistan
218 Tanzania
219 Thailand
220 Tibet
221 Timor-Leste (East Timor)
222 Togo
223 Tokelau
224 Tonga
225 Trinidad and Tobago
226 Tunisia
227 Turkey
228 Turkmenistan
229 Turks and Caicos Islands
230 Tuvalu
231 Uganda
232 Ukraine
233 United Arab Emirates
234 United Kingdom
235 United States
236 U.S. Minor Outlying Islands
237 Uruguay
238 Uzbekistan
239 Vanuatu
240 Vatican City State (Holy See)
241 Venezuela
242 Vietnam
243 Virgin Islands (British)
244 Virgin Islands (U.S.)
245 Wallis and Futuna Islands
246 Western Sahara
247 Yemen
248 Zaire (see Congo, Democratic People's Republic)
249 Zambia
250 Zimbabwe

Appendix D: Explanatory Statement

Explanatory Statement

The following study is a clinical study undertaken with ethics approval by the University of the Witwatersrand on the effects of tactile stimulation on sexual arousal. It is commonly known that the genital areas are sexually arousing. However, have you ever wondered why some other areas (e.g. ears, neck) are also sexually arousing? This study seeks to explore different body areas and the level of arousability that they facilitate.

WARNING! This is a clinical study of a sexual nature and may be offensive to some. If you fear that this may be offensive to you please navigate away from this website or Click Here.

All information captured in this survey will remain strictly confidential and will not be used for any purposes beyond the scope of this study.

For more information about this study please Click Here

☐ I have read and understand the nature of the study and acknowledge that I am 19 years of age or older.

☐ I consent to participate in the study.

Proceed

Appendix E: Study Information

Study Information

Dear Reader,

This study aims to examine whether different parts of our bodies are more arousing when touched than others. It will also look at how these areas are represented in the brain. The research is being conducted, with ethics approval from the University of the Witwatersrand, under the supervision of Prof. Marilyn Lucas (University of the Witwatersrand, RSA) and Prof. Oliver Turnbull (Bangor University, UK). Participation in this research study will involve 15 - 20 minutes of your time during which you will complete two forms. The first form is a Biographical Questionnaire in which most fields are compulsory. However, those fields which are not compulsory have been demarcated as such. Once completing the Biographical Questionnaire, you will then be taken to the 'Hotness Scale' which consists of 41 body areas which you are to rate as arousing or not. If you rate the body area as arousing, a thermometer will appear (if it does not appear due to browser differences, please click on the page and it should then appear) on which you are to rate the level of 'arousal' of the body area on a 10 point scale with 1 being slightly hot and 10 being sizzling.

For example: if you find it arousing to have your ear touched/nibbled you will firstly click 'yes' that it is arousing and then you will decide how arousing it is for you to have your ear touched/nibbled based on the thermometer/'Hotness Scale'. If you find it irresistable to have your ear touched/nibbled then you will click on the '10' of the scale. However, if you only find this slightly arousing, you will click on the '1' of the scale.

After completion of the 'Hotness Scale' you will proceed to a contact page where you will be presented with email address for questions and queries as well as for receiving feedback once the study is completed.
*NOTE: Your responses to the Questionnaire will **NOT** be linked to your email address should you wish to receive feedback or send questions and queries. Thus your participation remains anonymous and strictly confidential.*

Participation in the study is completely voluntary and you are kindly requested to complete the survey only once. It is important to note that any information that is entered is automatically stored and thus becomes the property of the researcher. There will be no advantage or disadvantage to you whatsoever should you choose to participate or not. All data will be anonymous (there will be no questions directly related to identifying you as a person) and all information will be kept confidential and only myself and my supervisors will have access to the data.

Should you wish to participate in the study please click here
Should you wish not to participate in the study, you may exit the site by clicking here

Many thanks for considering to participate in my study.
Kind Regards,
Jackie Chaldecott, Marilyn Lucas and Oliver Turnbull

Appendix F: Biographical Questionnaire

Biographical Questionnaire

Age: Please Choose One

Gender:
- Male
- Female

Race:
- White
- Black
- Asian
- Coloured
- Indian
- Other

Nationality: Please Choose One

Relationship Status:
- Single
- In a Relationship
- Married
- Divorced
- Separated

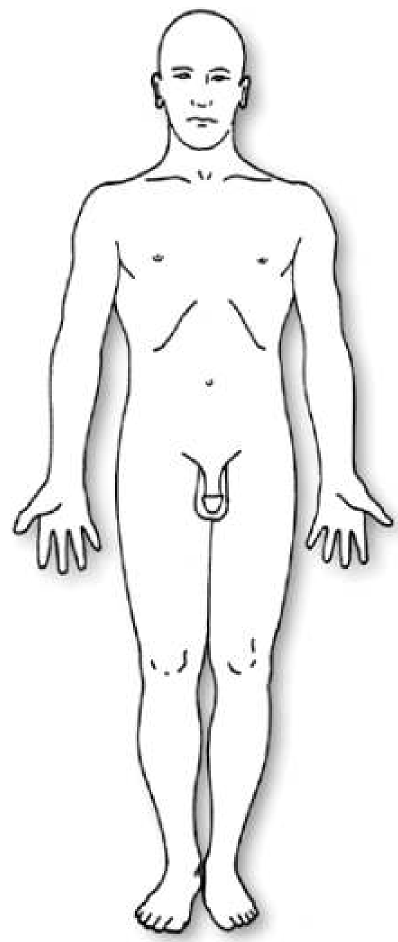
Sexual Orientation (Optional):
- Hetrosexual
- Homosexual
- Bisexual

Proceed

Appendix G: Hotness Scale – Male

Hotness Scale

Please rate the following body areas based on the strength of their tactile (touch) stimulation and facilitation of sexual arousal. (These are areas on *your* body)



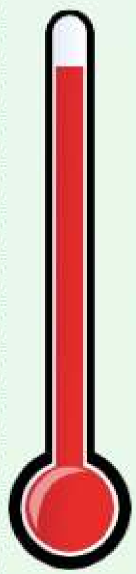
Front of Body

1.1 Forehead	◯ Yes	◯ No
1.2 Eye and Temple	◯ Yes	◯ No
1.3 Ears	◯ Yes	◯ No
1.4 Nose	◯ Yes	◯ No
1.5 Cheeks	◯ Yes	◯ No
1.6 Mouth/Lips	◯ Yes	◯ No
1.7 Chin	◯ Yes	◯ No
1.8 Front of Neck	◯ Yes	◯ No
1.9 Shoulders	◯ Yes	◯ No
1.10 Upper Arm	◯ Yes	◯ No
1.11 Elbows	◯ Yes	◯ No
1.12 Forearm	◯ Yes	◯ No
1.13 Wrists	◯ Yes	◯ No
1.14 Hands	◯ Yes	◯ No
1.15 Fingers	◯ Yes	◯ No
1.16 Chest	◯ Yes	◯ No
1.17 Nipples	◯ Yes	◯ No
1.18 Stomach	◯ Yes	◯ No
1.19 Sides	◯ Yes	◯ No
1.20 Bellybutton	◯ Yes	◯ No
1.21 Pubic hairline	◯ Yes	◯ No
1.22 Hips	◯ Yes	◯ No
1.23 Penis	◯ Yes	◯ No
1.24 Scrotum	◯ Yes	◯ No
1.25 Perineum (Area between genitals and anus)	◯ Yes	◯ No

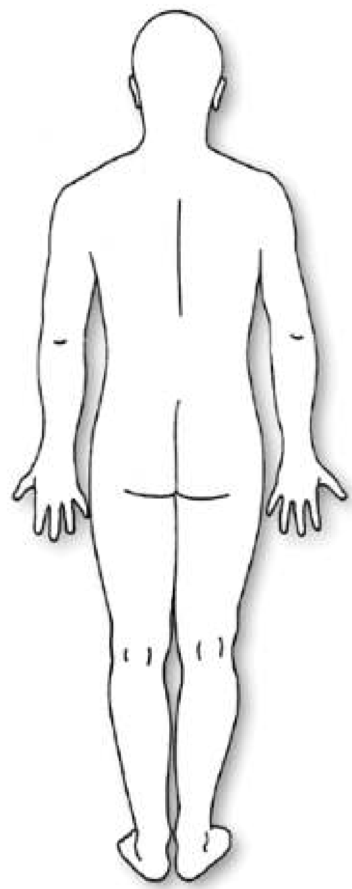
1.26 Inner Thighs	○ Yes	○ No
1.27 Outer Thighs	○ Yes	○ No
1.28 Knee Caps	○ Yes	○ No
1.29 Shin	○ Yes	○ No
1.30 Ankles	○ Yes	○ No
1.31 Foot	○ Yes	○ No
1.32 Toes	○ Yes	○ No
1.33 Other [ ]	○ Yes	○ No

<u>Back of Body</u>

2.1 Head and Hair	○ Yes	○ No
2.2 Back of Neck	○ Yes	○ No
2.3 Shoulder Blades	◉ Yes	○ No



○ 10
○ 9
○ 8
○ 7
○ 6
○ 5
○ 4
○ 3
○ 2
○ 1



2.4 Upper Back	○ Yes	○ No
2.5 Lower Back	○ Yes	○ No
2.6 Buttocks	○ Yes	○ No
2.7 Back of Thighs	○ Yes	○ No
2.8 Behind Knees	○ Yes	○ No
2.9 Calves/Back of Shins	○ Yes	○ No
2.10 Other [ ]	○ Yes	○ No

[Proceed]

Appendix H: Thank-you and Contact Page

Thank You!

Thank you for your participation in this study. If you have any questions or queries please feel free to contact:
info@sexandthebrain.net

Results will be available by March 2011. Should you wish to receive feedback please send your email address to:
info@sexandthebrain.net and a copy will be emailed to you.

Appendix I: Permission Granted From Monash South Africa

MONASH South Africa

A campus of Monash University Australia

OFFICE OF THE DEPUTY PRO VICE CHANCELLOR: RESEARCH

PERMISSION TO INVITE STUDENTS TO PARTICIPATE IN THE COMPLETION OF ELECTRONIC QUESTIONNAIRES FOR A MASTERS DEGREE IN PSYCHOLOGY.

TITLE OF RESEARCH PROJECT: THE CORTICAL ORGANISATION OF TACTILE STIMULATION: WHY BODY AREAS DIFFER IN THEIR FACILITATION OF SEXUAL AROUSAL.

To whom it may concern

Monash SA wishes to confirm that permission has been granted to Ms Jackie Chaldecott to invite students to complete online questionnaires in order to submit her thesis.

We trust that the student will ensure that all ethical guidelines are followed in terms of the responsible conduct of research.

Yours sincerely

D Burger

A/Prof Dina Burger
Deputy Pro Vice Chancellor: Research

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