THE EFFECTS OF C-TACTILE AFFERENT STIMULATION ON MALE ORGASM AND EJACULATION

By

Yacoub Ayed Innabi

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Committee Membership

Dr. Amanda Hahn, Committee Chair

Dr. Ethan Gahtan, Committee Member

Dr. Amber Gaffney, Committee Member

Dr. Amber Gaffney, Program Graduate Coordinator

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Abstract

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Yacoub Ayed Innabi

Orgasms and ejaculation are important for relationships and contribute significantly to life satisfaction. There is, however, a lack of research in the current literature regarding orgasm perception. This study tested the effects of endogenous oxytocin on subjective orgasm intensity, ejaculation latency, and ejaculate volume in men. At two separate test sessions, the participants were either stroked on the forearm (to release endogenous oxytocin) or tapped on the hand (to act as a control) with a cosmetic brush. The forearm contains C-tactile afferents that are believed to release oxytocin centrally and peripherally in response to slow, soft stroking stimulation. Then a clinical male vibrator was utilized to induce ejaculation in the absence of any 'cerebral stimulation' and without the need for audiovisual stimuli. Given the role of oxytocin in hedonic and sexual responses, C-tactile induced increase in endogenous oxytocin was expected to significantly increase subjective orgasm intensity, ejaculate weight, and erection hardness and decrease ejaculation latency. The results were inconclusive: There was no significant difference of subjective orgasm intensity, ejaculate volume, erection hardness, and ejaculation latency between the brushing and tapping condition, however this may be due to the low sample size (n = 7). Overall the data showed a change in favor of a greater sexual response

following C-tactile afferent specific stimulation. This novel experimental paradigm is suitable for other male sexual response studies because it was well tolerated and simple enough for participants to follow. Future research should focus on improving recruitment strategies and eliminating the need for a partner.

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The Effects of C-Tactile Afferent Stimulation on Male Orgasm and Ejaculation

The male orgasm is the physiological and psychological consequence of further sexual stimulation during the excitement phase of the human sexual response cycle (Masters & Johnson, 1966). It commonly occurs in conjunction with ejaculation and intense pleasure. Orgasms are an important component to one's quality of life, yet they are seldom studied in humans, especially in the USA. The inability to orgasm, known as anorgasmia, impacts a wide array of people (Rowland & Kolba, 2017) suffering from various afflictions such as multiple sclerosis (Schairer et al., 2013), post-SSRI disorder (Bala, Nguyen, & Hellstrom, 2017), and bipolar disorder treated with antipsychotics (Montejo, Montejo, & Navarro-Cremades, 2015). Anorgasmia may be treated by supplementing one of the many neurotransmitters that coordinate the sexual response. One possible target of such interventions may be oxytocin (OT), produced endogenously by the paraventricular nucleus (PVN), which mediates the sexual response both centrally and peripherally (Melis & Argiolas, 2011). Although exogenous interventions have been shown to increase oxytocin both peripherally and centrally (Striepens et al., 2013), it is also possible to trigger increases in endogenous OT in humans via affectionate touch (Walker, Trotter, Swaney, Marshall, & Mcglone, 2017). The aim of the current study is to determine if these potential natural increases in endogenous OT via affectionate touch has a positive impact on the male sexual response.

OT and the Neural Reward Pathway

Animals achieve pleasure from stimuli, such as sex and sugar, using appetitive and consummatory behaviors. Appetitive behaviors, such as courting and locomotion, are actions that increase the likelihood of acquiring a rewarding stimulus. Consummatory behaviors, such as pelvic thrusting or chewing, are actions that achieve the satisfaction from the acquired stimulus. Appetitive and consummatory behaviors are coordinated by the neurological phases 'wanting' and 'liking', respectively (Berridge & Kringelbach, 2015). The 'wanting' phase is mediated by the dopaminergic system, specifically the mesocorticolimbic pathway (Berridge, 2006). For example, stimulation of this pathway in rats causes an increase in mounting and sucrose consumption. This pathway begins in the dopaminergic neurons of the ventral tegmental area and projects to both the nucleus accumbens (NAc) and the orbitofrontal cortex (OFC). When a pleasurable stimulus is acquired, the 'liking' phase is initiated and hedonic hotspots, or pleasure centers, such as the rostrodorsal qaudrant of the medial shell of the nucleus accumbens (RDMSNAc; Castro & Berridge, 2014; Reynolds & Berridge, 2001), ventral pallidum (VP; Ho & Berridge, 2013, Smith & Berridge, 2005), and OFC (Castro & Berridge, 2017) are activated via opioid and orexin neurotransmitters. The 'wanting' and 'liking' phases are likely connected via NAc projections to these areas (Haber, Kunishio, Mizobuchi & Lynd-Balta, 1995; Za´borsky & Cullinan, 1992). This reward circuitry is critically involved in the human sexual response.

The neurobiological mechanisms of the male sexual response have primarily been studied using the rodent model (see Figure 1 for a visual summary of this literature). As shown in Figure 1, stimulation of the glans penis activates the PVN, which then releases OT into the VTA. Dopaminergic neurons from the VTA activate the NAc core, which is responsible for the 'wanting' phase of pleasurable stimuli. The NAc core then activates the pleasure centers RDMSNAc, VP, and OFC, which is considered the 'liking' phase of pleasurable stimuli. The addition of more OT may stimulate the mesolimbic pathway in humans and increase the 'want' phase during sexual stimulation. Activation of the mesolimbic pathway may increase pleasurable experiences by increasing endogenous opioids in the RDMSNAc, similar to amphetamines (Mick et al., 2014), which might increase orgasm intensity.

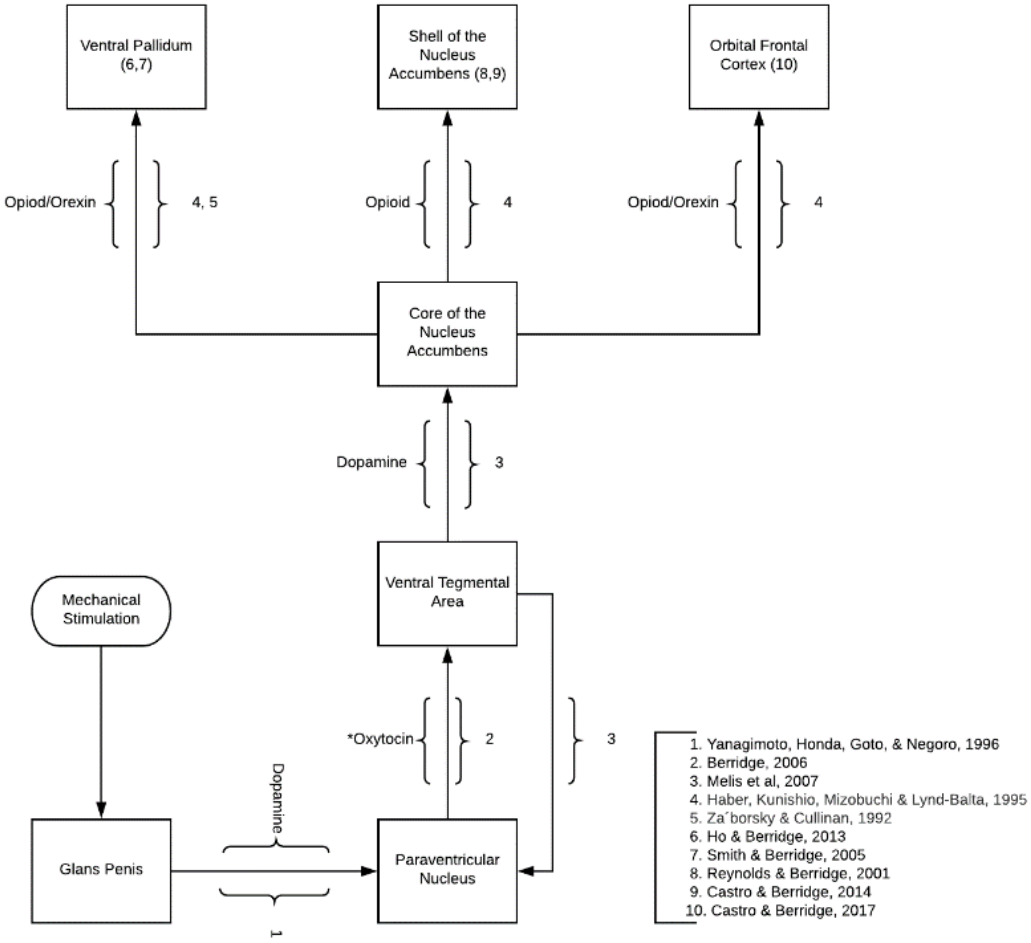

Figure 1. The theoretical neural pathways of the sexual response. The pathway begins with mechanical stimulation of the glans penis, this activates the PVN in the hypothalamus, which activates the mesolimbic pathway, and ends with the activation of the three hedonic hotspots. The neurotransmitters released at each step are labeled next to each arrow. Oxytocin is the neurotransmitter of focus in this study. The numbers indicate references for neurophysiological evidence of the neural pathway or hedonic hotspot.

OT is strongly implicated in the 'liking' component of the reward response, and plays a significant role in the sexual response. This hormone and neurotransmitter is most famous for facilitating behaviors of social bonding in humans and most other vertebrates (Caldwell, 2017). For example, OT administration in prairie voles, a monogamous rodent, increases partner preference and social contact, and OT receptor antagonist decreases these parameters (Cho, Devries, Williams & Carter, 1999). OT is produced by and targets many regions of the brain as well as the body. Specifically, OT receptors are prevalent throughout the reproductive organs and brain of all genders (Gimpl & Fahrenholtz, 2001). In fact, physicians use intravenous injections of OT to induce uterine contractions during labor. OT's potential influence on orgasms is intuitive because orgasms are considered a social bonding behavior. For example, orgasms are associated with partner preference (Coria-Avila, 2016) and increased perceived relationship quality (Costa & Brody, 2007).

OT and the Sexual Response

The neurobiological correlate of the OT enhancing sexual neurological response is supported by nonhuman models. As described previously, the NAc is the reward center of the brain. This brain region is stimulated by dopamine which is a key neurotransmitter in the sexual response (Giuliano & Allard, 2001). There is an interaction between dopamine and OT during orgasm. When the glans penis of rats are tactilely stimulated, half of the oxytocinergic neurons in the paraventricular nucleus (PVN) are activated via the penile dorsal nerve (Yanagimoto, Honda, Goto, & Negoro, 1996). OT injected in the

caudal ventral tegmental area (cVTA) of the rat induces erection and an increase of dopamine in the NAc and the PVN (Melis et al., 2007). Interestingly, the PVN is responsible for releasing OT from the brain into the bloodstream via the posterior pituitary gland. The erection induced by OT injection into the cVTA was unable to form when a dopamine antagonist was injected into the NAc or the PVN. This confirms the oxytocin-induced erection is mediated via these dopaminergic centers. When the researchers injected fluorogold into the NAc, the particles traveled retrograde to the cVTA, which are met by neurons in the PVN (Melis et al., 2007). This attests these brain regions are directly connected to make up a circuit.

Research regarding the role of oxytocin in the sexual response using humans is more limited. Several studies suggest that OT may play an important role in the pleasure component of sexual behavior, from simple touching to actual orgasm. Neuroimaging studies of humans administered intranasal OT have shown increased activity of the NAc in participants in response to being touched by their partner versus an experimenter (touch on shin; Kreuder, 2017). OT is also released significantly in orgasmic women, but not anorgasmic women, after orgasm from intercourse (Caruso, Mauro, Scalia, Palermo, Rapisarda, & Cianci, 2017). This finding is especially interesting because the anorgasmic women are only able to achieve orgasm from self-stimulation without a partner, possibly in absence of the oxytocinergic system. Furthermore, multiorgasmic women have OT levels positively correlated to subjective orgasm intensity during masturbation (Carmichael, Warburton, Dixon, & Davidson, 1994). This may be explained by a more active oxtocinergic system in the sexual response of multiorgasmic women. However, a

possible confound is multiorgasmic women might be more capable to compare subjective orgasm intensity than mono-orgasmic women and men. This is because having more than one orgasm in one trial may be advantageous for comparing orgasms.

Additional experimental work using Nalaxone, an opioid antagonist, has further implicated oxytocin in the human sexual response. Murphy, Checkley, Seckl and Lightman (1987) administered Nalaxone to male participants prior to having them engage in self-stimulation (i.e., masturbation) while viewing sexually explicit material. The administration of Nalaxone was found to inhibit the release of oxytocin (measured via blood) during orgasm in these participants. Importantly, these participants reported lower subjective sexual arousal and orgasm intensity, suggesting that the reduced OT release may have detrimental effects on subjective perceptions of the sexual experience.

In addition to orgasm intensity, OT may also affect human seminal emission. There are two stages of ejaculation: seminal emission and expulsion. The former is the movement of seminal fluid into the urethra, and the latter is the movement of seminal fluid out of the penis. These processes are coordinated by the ejaculation reflex in the lumbosacral spine, which is initiated through central and peripheral signals. Disruption of the oxytocinergic system at the cerebral, spinal, and peripheral level of the ejaculation mechanism produces deficits to both stages of ejaculation in rats (Ackerman, Lange, & Clemens, 1997; Clément et al., 2013). Moreover, stimulation of the oxytocinergic system improves ejaculation. For example, rabbits and humans have OT receptors throughout the epididymis, which promotes contraction of the smooth muscle and consequently transports more sperm out of the penis (Filippi et al., 2002). The modulation of OT

receptor activity decreases ejaculation physiology. In fact, the novel OT antagonist drug Cligosiban is currently undergoing clinical trials as a treatment for premature ejaculation (Muirhead, Osterloh, Whaley, & van den Berg, 2019). Although there is clearly a role of the oxytocinergic system in ejaculation, more research is needed to illuminate these effects in humans.

Human neuroendocrine studies have mixed results for supporting the role of OT in orgasms. All of these studies use a similar paradigm that involve participants watching an edited film. This film consists of 20 minutes of a documentary to establish baseline hormone levels, 20 minutes of heterosexual pornography, and back to 20 minutes of the documentary. Hormone levels measured during the viewing of the edited film is compared to hormone levels during the viewing of a 60-minute documentary to serve as a control. Some of these studies have shown that oxytocin levels spike significantly in the brain and body during orgasm (Carmichael, Warburton, Dixon, & Davidson, 1994; Murphy, Checkley, Seckl, & Lightman, 1987) and others showed no change (Kruger et al., 2003; Kruger et al., 2006).

There are three limitations that can explain the mixed results of these studies. The first limitation common in most of these studies is the use of radioimmunoassay for measuring OT. This method is not sensitive enough to measure OT in the blood plasma of about half of people (McCullough, Churchland, & Mendez, 2013; Leng & Sabatier, 2016, Szeto et al., 2011), which may underestimate significant changes of the amount of peptide. The second limitation present in these experiments is the use of plasma and cerebrospinal fluid samples to assess OT levels in the brain. Cerebrospinal fluid samples

are more accurate than plasma samples for testing changes in central OT levels because OT does not cross the blood-brain barrier. However, cerebrospinal fluid samples still do not represent the localized and restricted OT release in the sexual response neural pathway, as found in microcannula studies in rats (Melis et al., 2007). Therefore, manipulating cerebral OT levels is better suited than measuring them to study the effects of OT on the sexual response.

Finally, the third limitation in these studies is the use of manual self-stimulation to induce orgasm without any sexual-social interaction. It is possible that OT, because it is a bonding neuropeptide, only contributes to orgasms during sexual activity with a partner, whereas dopamine contributes as the primary orgasm inducer during any sexual activity, such as masturbation. In fact, intranasal OT has an effect on the sexual experience of couples during intercourse (Behnia et al., 2014), but not the sexual experience of male participants during solo masturbation (Walch, Eder, Schindler, & Feichtinger, 2001; Burri, Heinrichs, Schedlowski, Kruger, 2008).

There are three studies that tested the effects of intranasal OT administration on the human sexual response and experience. One study administered OT to heterosexual couples before intercourse in their home and reported a significant increase in orgasm intensity and post-intercourse contentment, but no significant change in sexual function, e.g. penile erection (Behnia et al., 2014). The two other studies administered OT to males before solo masturbation in the laboratory and reported no effect on sexual function or sexual experience (Walch, Eder, Schindler, & Feichtinger, 2001; Burri, Heinrichs, Schedlowski, Kruger, 2008). The different results between the intercourse study and the

solo masturbation study implies the possibility that oxytocin only has significant effects on orgasms in a social setting. However, there is a possibility that using a home environment introduced a systematic error that produced a significant result in the intercourse study. To date, there is no experiment that tests the effects of OT (endogenous or exogenous) on the sexual response of participants with a partner in a controlled laboratory setting.

Affectionate Touch Releases OT

Various forms of affectionate touch (e.g. massage, stroking, tickling, and cuddling) increases OT levels in human saliva (Holt-Lunstad, Birmingham, & Light, 2008; Lebowitz et al., 2017; Riem et al., 2017), urine (Bick and Dozier, 2010; Wismer Fries et al., 2005), and plasma (Morhenn, Beavin, Zak, 2012; Turner et al., 1999). Gentle stroking of the body also releases urinary OT in dogs (Mitsui et al., 2011) and plasma OT in anesthetized rats (Stock & Uvnas-Moberg, 1988). In fact, many forms of skin-to-skin contact of mothers and rat pups increases OT levels in the pups' PVN of the hypothalamus (Kojima, Stewart, Demas, & Alberts, 2012), a brain region involved in hedonic responses (as discussed later in this paper). The release of OT from gentle stroking is believed to be mediated by C-tactile afferents (for review see Walker 2017). C-tactile afferents are a class of C afferents (slow conducting, small diameter, unmyelinated nerves) located in hairy skin that respond to low force stroking velocities between 1 and 10 cm/s. Stroking rats (Okabe, Yoshida, Takayanagi, & Onaka, 2015) and neonatal voles (Wei et al., 2013) with this optimal range of velocity increases the number

of OT-containing neurons in the PVN. The rats and neonatal voles were also reported to exhibit features associated with higher OT levels such as higher bodyweight, less anxiety-like behaviors, and vocal frequencies of pleasure.

Unlike in rats, there is currently no direct, causal research in humans that tests OT release from C-tactile afferent stimulation (stroking hairy skin between 1 and 10 cm/s). However, there is convincing indirect evidence that C-tactile afferents are a major contributor to soft touch mediated OT release in humans. OT is released in humans after affectionate touch (e.g. massage, stroking, tickling, and cuddling) (Bick and Dozier, 2010; Holt-Lunstad, Birmingham, & Light, 2008; Lebowitz et al., 2017; Morhenn, Beavin, Zak, 2012; Riem et al., 2017; Turner et al., 1999; Wismer Fries et al., 2005), which is likely to stimulate C-tactile afferents within their optimal stroking velocity range. C-tactile afferent stimulation also modulates pain (Liljencrantz et al., 2017) and lowers heart rate in humans (Fairhust, Löken, & Grossman, 2014), which are other known properties of OT (Boll, Almeida de Minas, Raftogianni, Herpertz, & Grinevich, 2018; Shao & Zhou, 2014). Lastly, C-afferent stimulation is perceived as erotic (Bendas et al., 2017; Jönsson et al., 2015; Panagiotopoulou et al., 2018) and pleasurable (Lloyd, McGlone, & Yosipovitch, 2015), which is consistent with OT's role as a mediator of sexual hedonic responses. Together, these findings suggest that using C-tactile stimulation should cause an increase in endogenous OT levels, eliminating the need for exogenous administration.

Current Study

This study aimed to test the effects of endogenous oxytocin, released by C-tactile afferent specific stimulation, on the sexual response. A novel experimental paradigm for testing ejaculation and orgasm in the laboratory was developed and used for this purpose. In the current study, the participants were either softly brushed on the forearm (to release endogenous oxytocin) or lightly tapped on the hand (to act as a control), at two separate test sessions. Immediately after brushing or tapping, the participant utilized a clinical male vibration device, Viberect-X3, to induce ejaculation while their partner recorded the ejaculation latency. This FDA-approved medical device sandwiches the penis between two high-amplitude vibration pads, stimulating both the dorsal and ventral surfaces of the penis, to induce ejaculation without the need for audiovisual sexual stimulation. The participant then rated their orgasm intensity and erection hardness after the penile stimulation. The ejaculate weight was recorded once the participant and partner left the laboratory. The parameters orgasm Intensity, erection hardness, ejaculate weight, and ejaculation latency are intended to measure central and peripheral aspects of the sexual response.

Hypothesis. Orgasm intensity, erection hardness, and ejaculate weight will be significantly greater and ejaculation latency will be significantly less after the brushing condition (experimental) than the tapping condition (control).

Rationale. Brushing the forearm at speeds specific to optimally stimulate C-tactile afferents should produce an increase in central and peripheral OT levels. The

elevated levels of this neuropeptide should activate the associated OT receptors shown to activate brain regions and reproductive organs that govern the sexual response.

Methods

Participants

Recruitment consisted of dispersing flyers and setting up information booths on the Humboldt State University (HSU) campus and several local, sex positive venues/events (e.g. burlesque shows). The fliers contained information that vaguely describes the study's purpose (see Appendix A) and an email address to contact if interested. The flier also contained optional instructions on how to setup an email address via Protonmail, a free, anonymous, end-to-end encrypted, emailing system created by scientists at MIT and CERN. We included this email option to provide a higher level of anonymity to those who wanted it.

After the participants contacted the laboratory showing interest in the project, they received a numerical ID and survey that assessed their eligibility for the study. The ID was used to keep track of participants without using names. The survey (see Appendix B) they received asked for their assigned ID, their age, biological sex, current partner status, and certain medical conditions that are unsafe for the experiment (e.g. latex allergy). Only biological males of 21 to 35 years were included to avoid age-related hormone changes and associated sexual dysfunctions (Araujo & Wittert, 2011). Also, all participants were required to bring a partner with them to the lab for assisting with the timer and tactile stimulation. If social interaction is a mediator to the effect of oxytocin on sexual response as it does with conformity (Luo et al., 2017), then including a partner

in the experiment will ensure the full effects of endogenous OT are present. Participants were asked to ejaculate at least once in 24 to 48 hours prior to their visit to the lab in order to control for sexual abstinence effects and then to refrain from any sexual activity for the 24 hours prior to attending the lab session (see Figure 2).

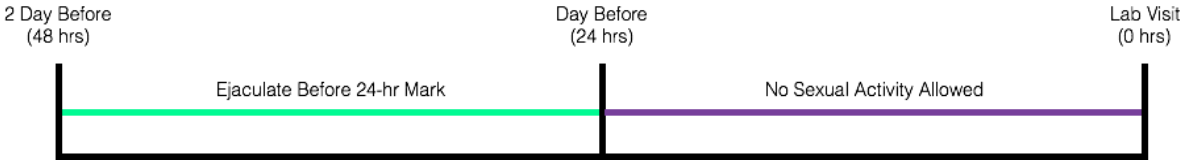

Figure 2. Sexual activity timeline of participant before each trial.

Procedure

This experiment was approved by the Institutional Review Board at HSU (IRB number: 18-122). Participants attend two separate test sessions, at least one day apart. During one of these sessions, the participant was brushed on the forearm to trigger the release of endogenous oxytocin, at the other they were tapped on the hand as a control. The order of these conditions was counterbalanced across participants to control for potential order effects. Although the participants were told the study was investigating the role of hormones on the male sexual response, they were not informed which condition (tapping or brushing) was expected to trigger the release oxytocin.

For each lab visit, the participant and their partner reported to the Behavioral and Social Sciences building, where the student researcher met them in the foyer (see Appendix C for map). They were taken to the private testing room for the duration of the study. Participants were first asked to rinse their mouth with water, to prepare for the first saliva collection. The participant and partner were then briefed on all aspects of the experimental protocol, with the opportunity to ask questions before signing the consent form (see Appendix D for detailed researcher instructions). After the consent form was signed, the researcher asked the participant to passively drool (Papacosta & Nassis, 2011) into a 2 mL collection container until 1 mL of saliva was collected. A second saliva collection was done after the penile stimulation. The saliva was never analyzed for OT levels because the target sample size of 34 was not achieved.

The researcher then led the participant in the touch procedure. The researcher used the brush to demonstrate how to stroke the forearm or tap the hand depending on which condition is assigned that day. The researcher also thoroughly explained the penile stimulation procedure. The participants were then given privacy to start the two minutes of forearm stroking or hand tapping. The penile stimulation procedure started immediately after the stroking or tapping because endogenous oxytocin is released soon after affectionate touch (Turner et al., 1999). Briefly, the experimental procedure is as follows (see Appendix E for details on participant instructions):

1. The researcher verbally goes over all instructions, then leaves the participant and their partner in the private room.
2. All materials (Viberect-X3, condoms, personal lubrication, paper towels, and ziplock bags) are laid out on the table for the participant.
3. The participant and partner complete the brushing or tapping manipulation.
4. The participant follows the stimulation instructions provided by the manufacturer of the Viberect-X3 (note that participants are instructed to apply condom before beginning stimulation to (a) preserve a hygienic environment and (b) collect the ejaculate for measurement).
5. After the orgasm is finished (or 10 minutes of stimulation has passed), the partner discontinues stimulation.
6. The participant removes the condom and places in a bag for weighing.
7. The participant washes hands and notifies the researcher.
8. The participant passively drools into container until 1 mL of saliva is collected.

9. The participant completes the exit interview (see Appendix F).

Parameter Measures

Orgasm intensity, erection hardness, and ejaculation latency. Participants self-reported the orgasm intensity, erection hardness, and ejaculation latency in the exit interview questionnaire. Orgasm intensity was rated using the Orgasmometer, a validated, color-coded visual measure adapted from a widely-used pain perception scale (Limoncin et al., 2016; Zhang, Tang, Li, & Peng, 2017). Erection hardness was rated using the Erection Hardness Score, a validated, widely-used measure of penile tumescence (Mulhall, Goldstein, Bushmakin, Cappelleri, & Hvidsten, 2007). Finally, the participant reported their ejaculation latency on the questionnaire and confirmed if they felt their recoding was accurate.

Ejaculate volume. After the participant and partner exited the laboratory, the researcher weighed the ejaculate. To accomplish this, each bag and condom were weighed together before each trial and recorded on the bag. The initial weight of the bag and condom was subtracted from the final weight to calculate the ejaculate weight.

Data Analysis

34 participants were needed to achieve a paired t-test with a statistical power of 0.8, given the effect size is 0.5 with a significance of 0.05. Participants that did not complete both trials were not included in the analysis. A paired-sample t-test was used to compare the mean difference in each parameter: Orgasm intensity, erection hardness

score, ejaculate weight, and ejaculation latency. A Bonferroni correction is necessary in this analysis to account for the increase in type I error for every parameter tested. This correction results in testing each parameter at a standard of $p < .0125$.

Results

During the study, 19 people filled out the pretrial survey and two were rejected for stating to not have a partner available for the experiment. 10 participants completed at least one trial but only 7 participants completed both trials. As shown in Table 1, participants achieved an erection hard enough for penetration in 11 out of 14 trials. The erection hardness had a high order effect; every second trial was either greater than or equal to the first trial, with five out of seven participants having improved erection hardness regardless of their first trial condition. Participants ejaculated (ejaculate weight greater than 1 g) with achieved orgasm (orgasm intensity greater than 0) in 8 out of 14 trials.

Table 1

Raw Data (tap condition, brush condition).

Subject	EW (*g*)	OI	EH	EL (*s*)
1	.29, 0.31	0, 6	3, 4	600, 503
2	0.21, 0.26	0, 0	3, 3	600, 600
3	0.03, 0.09	0, 0	1, 3	600, 600
4	0.50, 5.17	3, 4	4, 3	N/A, N/A
5	2.22, 2.77	6, 7	2, 3	345, 433
6	6.57, 2.13	9, 8	3, 2	215, 248
7	0.08, 5.37	0, 7	4, 4	600, 519

Note. Ejaculate Weight (EW), Orgasm Intensity (OI), Erection Hardness (EH), Ejaculation Latency (EL). Every subject with an odd number completed the tap trial first.

The observed orgasm intensity, erection hardness, ejaculate weight, and ejaculation latency for the experimental and control conditions were compared using paired-sample t-tests. This analysis was used to determine if these parameters of the male sexual response were affected by endogenous oxytocin release. According to the paired t-test analysis (see Table 2), there was no significant difference in ejaculate volume, orgasm intensity, erection hardness, or ejaculation latency between the hand tapping and forearm brushing conditions. However, finding a significant difference was unlikely given the small sample size ($\beta = 0.80$, $\alpha = 0.05$, $ES = 0.5$, $n = 7$) (Faul, Erdfelder, Buchner, & Lang, 2009). Looking at the descriptive statistics in Table 3, the means of each parameter change in the direction that may indicate a greater sexual response in the brush condition; The mean orgasm intensity, erection hardness, and ejaculate weight was greater and ejaculation latency was less in the brushing condition than the tapping condition. Albeit, the effects of C-tactile afferent stimulation on the male sexual response remains inconclusive.

Table 2

Analysis Values for Paired t-test.

Variable	*t*	*df*	*p-value*
Ejaculate Weight (*g*)	-1.02	6	0.34
Orgasm Intensity	-1.67	6	0.15
Erection Hardness	-0.68	6	0.52
Ejaculation latency (*s*)	0.33	5	0.75

Table 3

Descriptive Statistics (tap condition, brush condition).

Variable	$\bar{x}$	*SD*	*Med*
Ejaculate Weight (*g*)	1.41, 2.69	2.40, 2.10	0.29, 2.77
Orgasm Intensity	2.57, 4.57	3.64, 3.36	0.00, 6.00
Erection Hardness	2.86, 3.14	1.07, .69	3.00, 3.00
Ejaculation Latency (*s*)	493, 483	170, 132	600, 511

Discussion

This within group, counterbalanced designed study aimed to test the effects of C-tactile afferent stimulation on the male sexual response. C-tactile afferent stimulation is theorized to centrally and peripherally increase endogenous levels of OT, a nonapeptide involved in many aspects of the sexual response. This was done using a novel experimental paradigm, which involved self-stimulation of the penis using a male clinical vibrator without the need for audiovisual input. The parameters used all showed a change for a stronger sexual response in the C-tactile afferents stimulation condition: The mean orgasm intensity, erection hardness, and ejaculate weight was greater and ejaculation latency was less in the brushing condition than the tapping condition. However, there was no significant difference in any of the parameters when a paired t-test analysis was applied.

Although all measured variables indicated a minor change in the predicted direction, suggesting a potentially greater sexual response in the brush condition, we failed to find significant changes in these variables. While it is possible that no such changes exist, it is also possible that the small sample size in this study produced insufficient power to illuminate an effect. A large sample was not achieved despite the extensive promotion of the experiment, which included tabling six times at sex-positive events, tabling four times on the quad of the HSU campus, and giving promotional speeches four times at poetry open mics. Flyers were also maintained throughout HSU,

College of the Redwoods, and local sex shops. Future studies should try giving promotional talks in college classrooms to boost recruitment.

Generally, participant recruitment for sex research can be challenging because, although attitudes toward sex became more relaxed since Masters' and Johnson's research in the 1960s, sex is still somewhat taboo, and the idea of ejaculating in a laboratory setting can be intimidating. This may partly explain why there were 39 people that emailed, and several more that visited our recruiting booths, showing interest in participating, but only nine actually visited the laboratory for at least one trial. Another recruiting obstacle was scheduling the participant and partner a visit to the laboratory. This was a known issue for four potential participants who consequently withdrew before completing both trials.

It is possible a larger sample size could have been acquired if a greater incentive was offered, but doing so may be unethical for a sex experiment. For example, using monetary incentive might be coercive to people low on funds, which is the case for many college students. For this reason, only a customized pin button, printed with the picture of the Viberect-X3 and the text "I came for science", was used to encourage participants to complete both trials.

Many published sex studies that involve masturbation in a laboratory setting resulted in a small sample size ($n < 20$) (Burri et al., 2008; Carmichael et al., 1994; Kruger et al., 2003; Murphy et al., 1987; Segal, Tajkarimi, & Burnett, 2013). In fact, only one study that tested the effects of OT on the sexual response acquired a sample size larger than 20 ($n = 49$) (Walch et al., 2001), but it was a between groups design and did

not produce significant results. These research groups likely encountered similar recruiting issues as the current study, with the exception of not having to coordinate scheduling with couples. Due to the lack of quality research, further studies must be done to clarify the role of endogenous oxytocin in the male sexual response, and its potential as a therapeutic intervention for those suffering from anorgasmia. Prior to achieving this, novel recruitment methods must be explored to ensure the success of studies on the sexual response.

Strengths of the current design.

Most sex research currently uses sexually explicit videos or sexual intercourse to achieve ejaculation in the laboratory. Although effective, these methods introduce unnecessary statistical noise due to the unstandardized nature of the stimulation. This study demonstrates that orgasm/ejaculation can be induced in a laboratory setting without the need for such sexual audiovisual stimulation. The use of the Viberect-X3 device is simple to use and only requires one hand to operate. This preset machine reduces the variation of penile stimulation from masturbation and may help the participant feel less pressure to perform sexually. It also eliminates the need for 'cognitive arousal'. The Viberect was well tolerated and painless for all participants, highlighting its suitability for sex research on non-clinical populations.

The printed detailed instruction allowed every participant to successfully follow the detailed protocol with the exception of one participant/partner unable to accurately record their ejaculation latency. Having the participants ejaculate 24-48 hours before each

trial may help reduce the effect of abstinence, such as variation in prolactin levels (Egli, Leeners, & Kruger, 2010).

Limitations of the current design.

Although saliva samples were collected, they were not analyzed for quantifying OT levels because no significant effects were found. Therefore, there is no direct evidence that the manipulation successfully elevated OT levels. Even if salivary OT levels were analyzed on a high powered sample, there is still no evidence that OT levels were increased in the target brain region (cVTA). The difficulty of scheduling visits to the laboratory between the participant and partner was likely a large factor of the low recruitment and high attrition rate. The partner was crucial to brush the participant's arm and record the ejaculation latency because, considering the sexual nature of the experiment, designating these tasks to a researcher would be inappropriate. This issue may be remedied by mechanically automating the tasks if the research group is capable of doing so. In addition to the challenges of scheduling participants with their partners, recruitment was further hindered by the lack of ethical incentive. For example, given the participants were being asked to perform sexual acts, using course credit or cash as incentive would be inappropriate for this type of research. The current study only used a pin button (printed with a picture of the Viberect-X3 and the words "I came for Science") to incentivize participants to complete both trials.

Another limitation is the varying level of descending sexual inhibition that caused a high order effect. For example, the erection hardness in every second trial was either

greater than or equal to the first trial with five out of seven participants having improved erection hardness regardless of their first trial condition. There was also the possible ceiling effect from the participants' orgasm intensity rating. For example, if the participant rates 10 on the scale, they would not be able to rate any higher for the next trial if needed.

Recommendations for future work.

Minor modifications to the experiment could eliminate the necessity for a partner, given the research group has the adequate equipment and technological expertise. For instance, a rotary tactile stimulator could automate the brushing task and provide tactile stimulation at a more precise speed than a human, as accomplished in other C-tactile afferent studies (Pawling, Trotter, Mcglone, & Walker, 2017). Also, installing a sensor on the Viberect-X3 to detect its activity could automate recording the ejaculation latency. Although eliminating the partner from the experiment could reduce the effect of endogenous OT in this study, mechanically automating the experiment could be beneficial for other male sexual response studies.

For reducing the statistical noise produced by the order effects of this experimental paradigm, a practice trial may be beneficial. The participants may be less anxious to perform if they experience the laboratory and procedure prior to their first trial. However, the cost of increasing attrition rates may outweigh the benefit of adding the practice trial if the achieved sample size is small.

Most importantly, the issue of small sample size in studies on the sexual response needs to be addressed before perfecting the experimental paradigm. Novel recruitment strategies must be explored for this type of sex research to produce high-powered results. One possible solution is respondent driven sampling (Forrest et al., 2016). This is a type of snowball sampling that rewards participants for each person they recruit for the project.

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APPENDIX A

Instructions to Create a ProtonMail Email Account

Thank you for your interest in our project! Your privacy is our utmost priority which is why we use a double-encrypted, anonymous emailing system to communicate with our participants. ProtonMail™ is completely free and easy to use. Below are the instructions on how to set up an account if that is how you wish to reach us.

1. Download the ProtonMail-Encrypted Email app on your phone (recommended) or visit https://protonmail.com/ on computer.
2. Select CREATE A NEW ACCOUNT on phone app or SIGN UP on computer (there is a free option but you are welcome to purchase an account).
3. Create a unique username and password and write them down for your reference. Do **not** use your name or any other personal information.
4. Select your preferred level of security (both are free but the "extreme security takes a little longer to set up).
5. Verify you are not a robot.
6. Create display username. Again, do **not** use your name or any other personal information.
7. Please email yai1@protonmail.com stating that you are interested in participating in the experiment with the subject line Gaudens.

APPENDIX B

Participant Survey

Thank you for your interest in participating in this study. Before we are able to enroll you in the study, we have a few quick questions. You are free to omit answering any questions you do not feel comfortable answering.

Please fill out form to best of your knowledge. This form is completely anonymous and confidential. Honesty is essential for the safety and accuracy of this study.

* Required

1. **Please enter ID provided via email** *

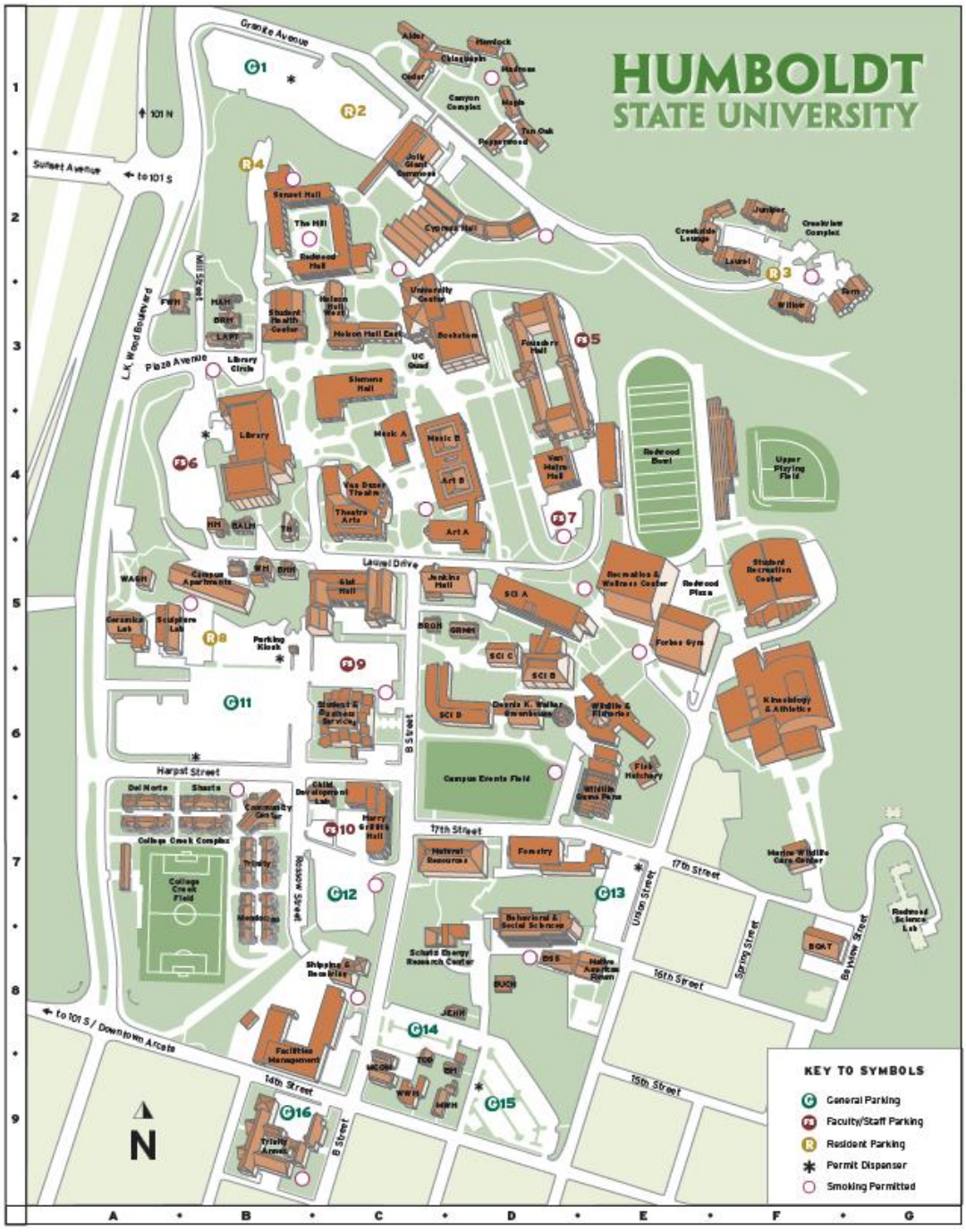
2. **Please enter your age (e.g. 26)** *

3. **What is your biological sex?** *
   Mark only one oval.
   - ◯ Male
   - ◯ Female
   - ◯ Intersex

4. **Do you have a current romantic/sexual partner who would be able to come with you to the lab?** *
   Mark only one oval.
   - ◯ Yes, I do have a partner who is willing to come with me
   - ◯ No, I do not have a partner or my partner is unable to come with me

5. **Do you have any of the following medical conditions? Please check all that apply. If none of these apply to you, please check the "none" option at the bottom.** *
   Check all that apply.
   - ☐ Spinal cord injury
   - ☐ Heart irregularity or other heart condition
   - ☐ Hypertension (high blood pressure)
   - ☐ Cuts or sores on penis
   - ☐ Latex allergy
   - ☐ Sexual dysfunction
   - ☐ None of these apply to me

APPENDIX C



The Behavioral and Social Sciences Building is located at D8 on the map.

APPENDIX D

Laboratory Protocol for Researcher

Consent Protocol

1. When participant and partner arrive, place “sensitive research in progress” note on the door.
2. Have participant **rinse their mouth out with water** to prepare for saliva samples (note: you must wait at least 10 minutes after mouth rinse before collecting the sample).
3. Then participant show their ID number (both visits) and present ID to confirm age 18+ (only need to check age at first visit). When presenting ID to confirm age, the participants should cover their name to remain anonymous - you only need to check birthday to confirm they are 18+. Only participant has ID number, partner does not need an ID number.
4. Give participant and partner a copy of the Participant Instructions (**check participant notes for determining which condition is first**) and verbally go over what they will do during the study. Ask if they have any questions or would like clarification on any aspect of the study before proceeding with consent process.
5. Have participant and partner complete the consent form. Verbally remind them that if they are uncomfortable at any point during the study, they are free to withdraw participation without penalty. Double check that they have both ticked all required boxes before proceeding.

Baseline Saliva Sample Collection

1. Give participant the saliva collection tube and straw.
2. Ask them to allow the saliva to pool in their mouth for a few seconds (thinking of sour candies or yummy food can help get the saliva flowing) until **1 mL mark**.
3. They should lean forward and allow the saliva to drip into the tube using the straw
4. Ask them to avoid making any kind of sucking motion to get the sample as this can cause contamination (cheek cells, blood).
5. Once sample is collected, **straw goes in trash**, ensure the cap is tightened, the tube is properly labeled, such as participant id code, brush (B) or tap (T) condition, and trial 1 or trial 2 (could be T1, T2, B1, B2). Place the sample in the freezer immediately. When put in freeze box, place horizontally (**2 participants for every row**).

Hand/Arm Stimulation Demonstration Protocol

1. Take the participant and partner to the private room (**ensure they leave phones and bags behind** to protect privacy). Check the required materials are present and ready for use: The Viberect and stopwatch should be checked for power and settings. The dorsal and ventral lights should be on and the intensity should be set to 95 Hz (**6 bars of light**).
2. Read either the Forearm Brush-Stroking Instructions or the Hand-Tapping Instructions (whichever is assigned) to the participant and partner and answer any questions if needed.
3. Show the participants on the ruler how fast to brush-stroke the forearm or tap the hand. Remember to demonstrate on the ruler that the brushing alternates each side of the same forearm between strokes.

4. **Take the brush** and stroke the ruler 15 cm in 5 seconds (3 cm/s). Time with the stopwatch for demonstration. If they are assigned the hand tapping, use the end of the bruch to tap the ruler lightly once every two seconds.
5. Now have the partner practice stroking or tapping the ruler until achieving the correct speed.
6. Now have them start the actual brushing or tapping protocol and observe them to verify it is done correctly.

Viberect Stimulation Protocol

1. After 2 minutes of the brushing or tapping (in silence), instruct the participant to stand while partner sits on provided chair. Ensure they have the assigned Participant Instructions sheet and are clear on what they are meant to do.
2. When they are ready, leave them in the privacy of the lab space for the duration of the study, but let them know you'll be in the adjacent room if they have any questions or issues.

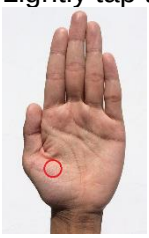
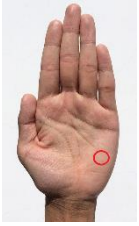
Post-Stimulation Saliva Sample Collection

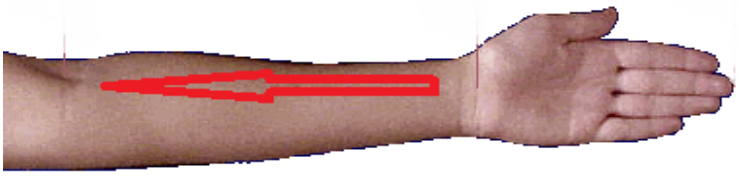
1. When finished, the participant and partner should wash hands and will notify you, the researcher.
2. Give participant the second saliva collection tube and straw.
3. Repeat the baseline collection procedure.
4. Once sample is collected, throw **straw in trash**, ensure the cap is tightened, the tube is properly labeled, and place the sample in the freezer immediately. When put in freeze box, place horizontally (2 participants for each row).

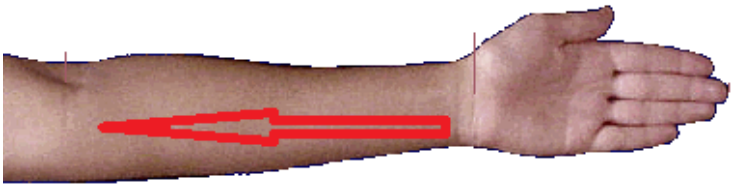
Post-Stimulation Protocol

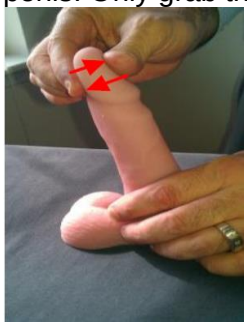
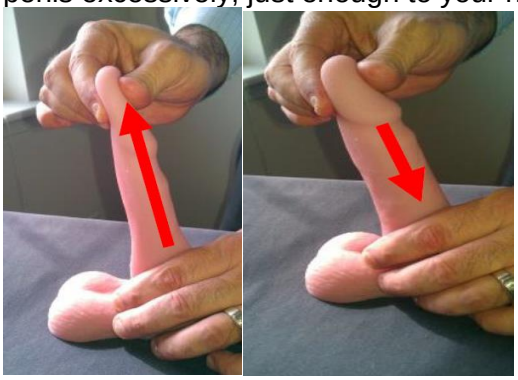
1. Immediately have the participant complete the post-trial survey (hard copy).
2. When they're finished, debrief the participant and partner. After the first visit, debriefing involves **confirming their scheduled visit next week** and making sure they don't have any questions or concerns following this visit. After the second visit, give both participant and partner a debriefing form (they can keep these) and again ask if they have questions or concerns. ***If you are unsure how to answer a question, please call Dr Hahn x3679
3. Weigh the semen. Place the styrofoam cup on the scale, close the scale door, and tare the weight. Place the bag of semen in the cup and close the scale door. Record the weight on the post-trial survey hard copy. Remember to **subtract the bag and condom weight** written on each bag.
4. Clean up & sanitize the lab space for the next participant.
    a. Detach the Viberect pads and washers to clean with alcohol
    b. Return pads and washers to ziplock bag and place in goodie bag
    c. Wipe Laminated Instructions, Stopwatch, and Viberect with Caviwipe
    d. Plug Viberect into charger (don't leave on charger longer than 8 hrs)
    e. Wipe down table, chair, sink (and floor if needed)
    f. Weigh the bag containing the condom & record weight using ID number
    g. Dispose of bag in biohazard container

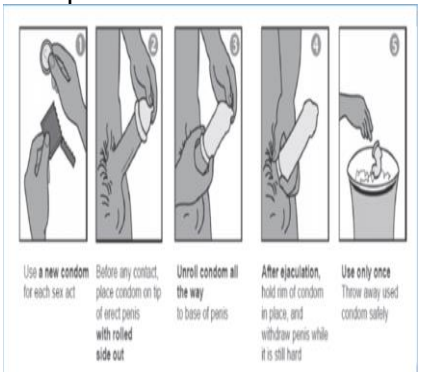
APPENDIX E

Hand Tapping Instructions	
1	Here you will be lightly tapping the palm of the hand with the handle of the brush once every 5 seconds. The hand tapping will proceed for 2 minutes. Start the stopwatch to keep track of the time.
2	Lightly tap the left side of the left palm. 
3	5 seconds later tap the right side of the left palm. 
4	Alternate sides of the palm for 2 minutes.
5	Immediately begin Viberect Instructions.

Forearm Brushing Instructions	
1	The brush stroking of the forearm will proceed for 2 minutes. Start the stopwatch to keep track of the time.
2	The first stroke with the brush begins on the left side of the left forearm near the wrist. The brush will move up the forearm until you reach about an inch from the elbow. This motion should be slow and take about 6 to 10 seconds (as demonstrated by the researcher). 

3	The second stroke will begin at the right side of the left forearm at the same speed. 
4	Alternate steps #2 and #3 for 2 minutes.

Viberect Instructions	
1	The participant is standing with penis exposed and the partner is sitting with viberect in hand. The participant pulls back foreskin (if uncircumcised)
2	Using one or both of your hands, gently grab the head of your penis using your thumbs and index fingers. Only grab the head and not the ring (corona) of your penis. Only grab the head and nowhere else. 
3	Gently stretch your penis in the air until it reaches its normal limit as shown in image. Do **NOT** pull hard enough to cause pain or discomfort. Stretch and release 10 times without letting go of the head of the penis with a couple seconds between pulls. You may feel your penis and pelvic muscles contracting very quickly and resisting your gentle pull for a tiny half a second after each pull. Never stretch your penis excessively, just enough to your normal length when you are erect. 

4	Apply the lubrication to the penis and wipe off your hands on the provided paper towel before applying condom.
5	Now roll on the condom of penis whether it is erect or flaccid. It may help to initially hold penis behind the corona to get condom over glans penis first. 
6	Once the condom is applied, the participant will hold penis parallel to the floor. The participant will place the pads over the glans penis without starting the stimulation. This can be done by holding the large end of the Viberect only. 
7	The participant will clamp the viberect on the penis (touching but not squeezing) and the partner will start timer at the same time. The Viberect with begin vibrating automatically. The participant will gently stretch the penis with the Viberect until full erection. The participant may guide the partner's wrist to ensure optimal placement.   

8	After 5 minutes of stimulation, the participant will remove the Viberect from penis and wait exactly 1 minute before continuing stimulation. The penis will be stimulated for a maximum of 5 additional minutes (10 minutes total of stimulation) or until end of orgasm. The trial is over if the orgasm does not occur within the second 5 minute stimulation. 
9	Once the participant indicates they have started orgasm, the partner will **stop the timer**.
10	Once the participant has finished orgasm, they will **discontinue the stimulation**.

Clean Up	
11	After orgasm or 10 min total of stimulation, the participant will gently place the Viberect on the counter.
12	Before removing the condom, the participant will squeeze the penis (with index finger pressing against the bottom of penis) from the base to the frenulum to expel remaining semen out of the penis. This should be repeated 3 times.
13	The participant will slide condom off the penis with an effort to keep semen contained in the condom. To achieve this, pull the tip of condom while pushing the condom off at the base. Make sure to pinch the base of the condom as it slides off the tip to catch any ejaculate remaining on the glans penis. The condom will be placed in the plastic bag for weighing. The participant will use the provided hygienic wipes to clean the penis. Hands will be washed and the participant will notify the researcher.

APPENDIX F

Exit Interview

Please complete this form after you complete of the procedure.

* Required

1. **What is your assigned 3 digit ID?** *

_____

2. **Were you brushed or tapped today?** *
Mark only one oval.

- ◯ Brushed
- ◯ Tapped

3. **Considering a Likert scale ranging from 0 to 10, where 0 corresponds to the absence of orgasmic perception and 10 to maximum perceived orgasmic intensity, how do you evaluate your orgasmic intensity during the experiment?**

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
No intensity	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Most intesity

4. **Please rate your erection hardness using the scale below.**

0	Penis does not enlarge
1	Penis is larger, but not hard
2	Penis is hard but not hard enough for penetration
3	Penis is hard enough for penetration but not completely hard
4	Penis is completely hard and fully rigid

Mark only one oval.

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4

5. **Recorded time of start of stimulation to start of orgasm. Use format Minutes:Seconds (For example 12:36).** *

_____

6. **Do you feel you accurately recorded the time between the start of stimulation and start of orgasm? Please use the other option if you were not accurate in your timing, and can give us any details about the inaccuracy (e.g., I stopped the timer 5 seconds late)**

Mark only one oval.

- ◯ Yes, I was accurate
- ◯ No, I was not accurate
- ◯ Other: _____

7. **Did you experience any physical or psychological discomfort during study? (Please use the other option if you would like to give us details about the type of discomfort you experienced)**

Mark only one oval.

- ◯ No
- ◯ Yes
- ◯ Other: _____