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Effects of sexual arousal on VDT in aged men with and without erectile dysfunction

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Running title: Somatosensory effects of sexual arousal

Abstract. Background: Erectile dysfunction (ED) is a common problem in ageing men. Abnormalities in sexual arousal may contribute to its development, and to the failure of pharmacological therapies. However, there are few objective ways of assessing arousal. Sexual arousal has been shown to affect vibrotactile detection thresholds (VDT) in young, healthy men. This study assessed the effects of sexual arousal on VDT on middle aged men with and without ED in order to determine whether differences exist between the groups and if such differences may be useful in the evaluation of ED.

Methods: VDTs in the right index finger of 15 heterosexual males (mean age 74.3 ± 6.0 years) who had been formally diagnosed with ED (ED group) and 16 men (mean age 68.0 ± 6.6 years) who reported no sexual dysfunction in the last 6 months (EF group) were measured before and after watching erotic and control videos using a forced-choice, staircase method at frequencies of 30, 60, and 100 Hz. A mechanical stimulator was used to produce the vibratory stimulus. Results were analyzed using repeated measures analysis of variance. **Results:** There was no significant effect of watching the erotic video on VDT in subjects in the ED group. In the EF group, VDT was significantly lower at 60 and 100Hz after watching the erotic video. There was no change in VDT after watching the control video in either group.

Conclusions: In response to sexual arousal, VDT in ageing men with normal erectile function decrease, whereas VDT in ageing men with ED remain unchanged.

Introduction

Erectile dysfunction (ED) is a common problem, defined as the inability to achieve and / or maintain an erection sufficient for satisfactory sexual performance or intercourse.¹ Large-scale epidemiologic studies have identified a consistent age-related loss of erectile function in men from different geographic and ethnic backgrounds.² ED can be broadly classified into organic and psychological, and has multiple aetiologies. ED can be lifelong or acquired, generalized or situational, and caused by medical factors, psychologic factors, or a combination of both.³ The organic and psychological factors can be predispose to, precipitate, or perpetuate ED.⁴ Alterations in perceptual and attentional processes may also contribute, as they have been shown to occur in sexually dysfunctional males.⁵

Disorders of arousal may contribute to ED. However, sexual arousal can be difficult to assess. Arousal is cluster of state alterations that has both general and specific elements which act synergistically. Pfaff and Banaver⁶ have defined arousal as a state that activates responses to stimuli in any sensory modality, generates voluntary motor activity, and produces demonstrations of emotional reactivity. They state that there is growing evidence that “large classes of salient stimuli from several sensory modalities can cause changes in the entire state of the CNS”.

Arousal may influence the processing of sensory information. We have recently shown⁷ that sexual arousal resulted in decreases in vibrotactile detection thresholds (VDTs) at 30, 60 and 100 Hz in young men with normal sexual function, suggesting that changes in VDT may serve as a measure of arousal⁷. Lesion studies have identified possible areas of overlap between

somatosensory and sexual function. The parietal and frontal lobes of the cortex are involved in the sexual response, as they mediate the sexual excitement phase of male sexual arousal.⁸ Lesions of the parietal cortex have an adverse effect on vibrotactile sensation, and sexual seizures may result from lesions in the parietal cortex.^{8,9} Patients with temporal lobe epilepsy have impaired ability to interpret tactile information.¹⁰ The temporal lobe is also activated during sexual arousal.¹¹

The purpose of this study was to determine the effects of sexual arousal on VDT in ageing men with normal erectile function and ED in order to determine whether sexual arousal had the same effects on VDT in ageing men as those previously reported in younger men, and to assess the effects of sexual arousal on VDTs in men with EF.

Methods

Participants

All studies were conducted between August and October 2006. Participants aged between 55 and 85 years were recruited into two groups: erectile dysfunction (ED) and erectile function (EF). Participants in the ED group were invited to participate while using the telephone counseling service provided by Impotence Australia in Sydney. Participants in the EF group were recruited using advertisements placed in local newspapers.

During an interview prior to the experiment, the participants were informed about the details of the study, and gave their consent to participate. During the interview, a sexual and medical history was taken using two questionnaires. Erectile function was assessed using the International Index

of Erectile Function (IIEF), which has been previously validated.¹² The second, unvalidated questionnaire assessed whether the participant had been formally diagnosed with ED, whether the participant had been diagnosed with diseases related to ED and whether the participant had used medications, such as antihypertensives, antidepressants or antiandrogens, in the past 6 months. It also assessed whether participants had used erotic videos in the past and their response to them. All participants in the ED were required to abstain from use of any treatments for erectile dysfunction for 14 days before testing. To be included in the EF group the participants were required to self-report that they had had normal sexual function throughout the preceding 6 months.

Audio-Visual stimuli

Each participant had their VDT measured on two occasions, once after viewing an erotic video intended to generate sexual arousal, and once after watching a control video. Participants watched the videos by themselves in a room on the University of Sydney campus. Both videos were of 20 minutes duration. The erotic video contained scenes of heterosexual intercourse and fellatio. The videos were classified X 18+ on the Australian National Classification Code. This classification applies to films that contain only sexually explicit content. The control videotape contained scenes of built and natural environments. Erotic videos have been previously used to produce sexual arousal in laboratory settings.^{13 - 15} During the initial session, participants were randomly assigned to initially watch either the control or the

erotic video. All the experiments were conducted in the period from midday to late afternoon.

Equipment and protocol

The details of the testing protocol have been previously described.¹³ All participants were tested by the same male experimenter. Each participant completed all testing in a single session. Testing began immediately after the completion of the video, when the experimenter returned to the room. The video was timed to ascertain when the experimenter should return. A mechanical stimulator (TV50018, Tira Maschinenbau, Germany) was used to generate precise and reproducible sinusoidal waves at frequencies of 30, 60 and 100 Hz. These frequencies are commonly used in studies of vibrotactile sensitivity in the fingertips as they result in activation of both the Meissner's and Pacinian corpuscle mechanoreceptors.¹⁴ The stimulator was controlled using the Lab VIEW virtual instrument software (National Instruments Corporation, Texas). The stimuli were delivered to the fingertip using a 5 mm diameter circular probe. The vibrotactile stimulus was applied to the same skin area in each of the testing sessions. A point was marked on the middle of the distal pad of the right index finger and participants were instructed to keep the marked point on the fingertip in soft contact with the tip of the stimulator probe which protruded 2 millimeters through a Perspex plate. All participants were familiarized with the testing procedure before it began. During testing, the participant was seated comfortably with the right upper limb supported. This method has been shown to give reproducible results in humans.¹⁴

The forced – choice, staircase-method was used to assess vibrotactile detection thresholds. Prior to each video session an initial test was conducted to determine VDT. Testing began at a low, undetectable amplitude, which was increased in steps of 0.01 mV until the participant reported that the stimulus could be felt. The amplitude at this point was recorded. The amplitude was then decreased in 0.01 mV steps until the participant reported that the stimulus could no longer be felt, and the amplitude again recorded. Each cycle represented one trial. Six trials were completed at each frequency. The VDT for each frequency was calculated as the mean of the six trials. The order in which the frequencies were tested in each participant was randomized. The change in amplitude produced by each 0.01 mV increment was dependent upon the frequency at which the stimulus was delivered and corresponded to 1.67 microns at 30 Hz, 1.25 microns at 60 Hz and 0.8333 microns at 100 Hz.

After initial testing, participants were randomly assigned to watch either the control or the erotic video. Participants watched the videos in a room by themselves. The experimenter commenced each video, and left the room, returning immediately upon completion of the video as determined by elapsed time. The VDT testing protocol was started immediately upon the experimenter's return. After a 30-min rest period, the VDT measurement protocol was repeated, and participants viewed the second video under identical conditions to those used for the first video. Immediately upon its completion, the VDTs for all frequencies were reassessed..

Statistical analysis

Statistical analysis was performed using SPSS 14 for Windows. An alpha level of $p < 0.01$ was used to determine statistical significance. Because the data were not normally distributed, all data were normalized by log transformation before analysis. The data were analyzed using a 2 (Time: Before and After Stimulus Exposure) x 3 (Frequency: 30, 60, and 120 Hz) repeated measures analysis of variance. A one-way repeated measures analysis of variance was used to identify significant differences between the vibrotactile detection thresholds at each of the frequencies.

Responses to the Likert scale question “enjoyment” were assigned numerical values of 1 (low), 2 (medium) and 3 (high). Responses to the question on erections were assigned the numerical values 1 (0 erections), 2 (1 - 2 erections), 3 (3 - 4 erections), 4 (5 or more erections). Independent t tests were used to compare the responses of the groups.

Ethics Approval

Ethical approval for the study was granted by the University of Sydney Human Ethics Committee.

Results

The ED group contained 15 aged men whose ages ranged from 61-85 years, (mean age 74.3 ± 6.0 years) and who had been formally diagnosed with ED by a medical practitioner. The EF group consisted of 16 aged men whose ages ranged from 57-79 years, (mean age 68 ± 6.6 years). Details of the participants are provided in Table 1.

Preliminary interview

Pooled results for the IIEF domains are presented in Table 2. There was no statistically significant difference between scores recorded for the 5 IIEF domains between the EF and ED groups. However, participants in the ED group recorded significantly different scores for 5 of the 15 IIEF questions compared with participants in the EF group. The results for the five questions are shown in Table 2.

Thirteen participants in the ED group reported that they had watched erotic videos in the past and found them enjoyable without experiencing penile erection. One participant in the ED group had been diagnosed with hypertension.

In the EF group, 14 participants reported that they had watched erotic videos in the past, 13 reported enjoying them, and 12 had experienced penile erections while watching erotic videos. All participants had satisfactory sexual intercourse with their partners during the past six months.

In the group which the erotic video was in the first session there was no significant difference in reported enjoyment between groups (EF = 2.1 ± 0.5 , ED = 1.8 ± 0.6 , $p = 0.35$), nor between the number of erections reported while watching the video (EF = 2.0 ± 0.8 , ED = 1.3 ± 0.6 , $p = 0.70$). The mean and standard deviation values reported here refer to the numeric values assigned to Likert scale responses). Similarly, in the group which the erotic video was in the second session there was no difference in the reported enjoyment between groups (EF = 1.9 ± 0.8 , ED = 1.7 ± 0.7 , $p = 0.9$). However, the mean number of erections reported by members of the EF group while watching the

erotic video in the second session was higher (EF = 1.6 ± 0.5 , ED = 1.2 ± 0.3 , $p = 0.01$). The results are displayed in Table 3.

VDT - Erectile Function Group

VDTs recorded at 30, 60 and 100 Hz before and after watching the control and erotic video for participants in the EF are presented in Table 4. There were no significant differences in VDT recorded before the control and erotic videos in this group. Repeated measures analysis of variance revealed that there were significant differences between VDT measured before and after watching the erotic videos. The VDT at 60 Hz was significantly lower after watching the erotic video compared with pre-video value. For 30 and 100 Hz, although there was a reduction in the VDT after watching the erotic video (0.68 μm and 0.49 μm , respectively), they did not reach significance. On the other hand, no significant differences were found between VDTs recorded before and after watching the control video.

All participants reported enjoying the erotic video although five reported that they did not experience penile erection while viewing it. As a result, the statistical analysis was repeated for the EF group with the data for men who failed to experience an erection while watching the erotic video removed. The results for the second analysis were the same as those for the entire EF group. In each of the five men who failed to achieve an erection, VDT at 60 and 100Hz were decreased after watching the erotic video compared with the pre-video values.

VDT - Erectile Dysfunction group

VDTs recorded at 30, 60 and 100 Hz before and after watching the control and erotic video for participants in the EF are presented in Table 5. There were no significant differences in VDT recorded before the control and erotic videos in this group. The repeated measures analysis of variance revealed that there was no significant difference in VDT at any of the frequencies measured before and after watching the erotic video. Similarly, no statistically significant difference was found in VDT at any frequency measured before and after watching the control videos.

All participants in the ED group reported that they enjoyed watching the erotic video; 12 did not experience penile erection while watching the video; 2 experienced 1 - 3 erections; and 1 person had 4 - 5 erections.

The statistical analysis was repeated for the ED group with the data for men who experienced erection(s) while watching the erotic video removed. The results for the second analysis were the same as those for the entire ED group.

Discussion

Identifying the specific factor/s contributing to ED in a particular patient should improve treatment planning. ED can be caused by medical factors, psychologic factors (including disorders of sexual arousal), or a combination of both.³ Valid measures of sexual arousal are therefore needed in order to determine whether or not arousal is influencing erectile function. Penile tumescence, measured by penile plethysmography, is commonly used clinically to assess arousal.¹⁶ However, physical conditions that prevent penile tumescence may mask disorders of arousal and prevent their diagnosis.

Therefore, methods of assessing arousal that do not rely on the erectile response should be clinically useful.

Sexual arousal has been shown to significantly reduce VDTs in young men with normal sexual function, suggesting that VDTs may be a useful measure of arousal. However, VDTs have been shown to increase with increasing age.¹⁷ This increase has been attributed to changes in the central and peripheral nervous systems, and in the density of receptors in the skin. The age related changes in the central nervous system produce changes in processing, which could alter the effects of sexual arousal on VDT.¹⁸

The first finding of this study was that the effects of sexual arousal resulting from viewing an erotic video on VDT in ageing men with normal erectile function are the same as those reported for young healthy men – that is, VDT decreases, reflecting an increase in sensitivity. This leads us to conclude that aging does not have adverse effects on the central processing of vibrotactile stimuli to the extent that they could not be used as a measure of arousal.

In contrast, sexual arousal did not result in a significant change in VDT in men with ED. This suggests that the processes contributing to arousal, and/or the central effects of arousal, are different in aging men with normal erectile function compared with those with ED. This could be interpreted in several ways. The first is that disorders of arousal are the underlying cause of the ED experienced by men in this study. The second is that sexual dysfunction contributes to disorders of arousal. There is little statistical

evidence of disorders of arousal affecting the members of the ED group. IIEF scores on the arousal scale were similar in both groups, as was the reported enjoyment of both the first and second erotic videos, despite a tendency towards lower enjoyment of both videos for the EF group.

Although the central effects of arousal were not measured in this study, evidence from previous studies suggests that activation of brain areas during sexual arousal is the same in men with normal erectile function and ED. Hagemann et al. used PET scans to assess differences in PET scans to assess brain activation after neutral and sexually stimulating audiovisual presentations in men with ED. They found that the pattern of increased and decreased cerebral activity in response to the visual sexual stimulus was similar to that reported in the literature in healthy men. However, the participants differed from those in the present study in several ways. They were younger (mean age 35), all had experienced erections since the onset of ED, and 50% were smokers. Nicotine has been shown to inhibit erectile function.¹⁹

If the activation of anatomical areas in the brain and arousal is the same in men with normal erectile function and ED, the results of the present study suggest that the higher level processing of afferent information is affected in men experiencing ED – in other words, that the afferent information does not produce the usual responses at the highest levels of the nervous system. Sexual stimuli produce many responses, ranging from emotional to autonomic reactions. Differences in the effects of the complex interplay of these factors may account for the different results observed between the EF

and ED. However, the design of the present study does not allow us to test whether this is the case, or by what mechanism such a change may occur.

There are a number of limitations to this study which must be considered. The first is the small sample size. It was extremely difficult to recruit participants for either group. As well as limiting the power of any statistical analysis performed, the problems in recruitment may mean that the participants were not reflective of the aged EF or ED population as a whole. Insufficient participants with ED due to a specific cause could be recruited to produce a more specific study. Instead, people with ED due to all causes (except the specific exclusion criteria) were grouped together. Therefore, the ED group may have contained people who were suffering the same physical symptom resulting from a number of different, possibly unrelated processes.

A second problem is the fact that in the EF group, a number of men did not achieve erection in response to viewing the video. Visual stimuli have been used to induce sexual arousal and penile erection in men of various ages.²⁰ The failure to elicit an erection in this study may have occurred because the men were insufficiently aroused by the video, may reflect a decrease in libido with ageing, or a slower (or diminished) response to erotic material in the aged. They may also indicate that the physical signs of ED occur along a continuum, and that aged men may be able to achieve erection sufficient for intercourse only after greater and/or longer stimulation or arousal.^{21, 22} Some participants in the ED group did experience erection while watching the erotic video. This may reflect the fact that there are a number of different causes of ED, including psychological factors such as fear of

performance failure which may not be present when people are watching visually arousing material.²³ It is possible that if only participants whose ED was due to a single underlying pathology, the results may have been different. However, this does not explain why the manifestations of arousal in the ED were different from those in the EF group. Decreased libido is a relatively common finding in men experiencing ED.²⁴ Both the decrease in libido and ED have generally been attributed to a common underlying process. Although it was not tested in this study, it is possible that ED may itself have an adverse impact on arousal, and that a vicious cycle may be established whereby pathological changes (for example of a vascular or neurological origin) result in subsequent changes in libido that increase the severity of the ED.

Finally, subtle differences in sexual arousability that could not be detected by the techniques used in this study may have a significant impact on VDT.

In summary, the results of this study have shown that sexual arousal affects somatosensory perception similarly in young and ageing men with normal erectile function, suggesting that there is no specifically age related change in the process of arousal. However, the lack of any change in VDT following sexual arousal in ageing men with ED, suggests that the central effects of sexual arousal are somehow different to those in ageing men with normal erectile function.

Conflicts of interest: none exist

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Table 1. Distribution of subject ages

Age (Years)	ED Group	EF Group
55-60	0	2
61-65	1	4
66-70	2	3
71-75	6	4
76-80	4	3
81-85	2	0

Question	EF Group (mean \pm sd)	ED Group (mean \pm sd)	P
When you attempted sexual intercourse, how often were you able to penetrate (enter) your partner?	3.44 \pm 1.67	1.73 \pm 1.43	0.005
During sexual intercourse, how often were you able to maintain your erection after you had penetrated (entered) your partner?	3.63 \pm 1.50	1.87 \pm 1.55	0.003
During sexual intercourse, how difficult was it to maintain your erection to completion of intercourse?	3.69 \pm 1.66	2.13 \pm 1.68	0.015
How do you rate your confidence that you could get and keep an erection?	2.56 \pm 1.26	1.47 \pm 0.74	0.007

Table 2. IIEF Scores of participants in EF and ED groups

IIEF Domain	EF Group	ED Group	P
	Mean \pm s.d	Mean \pm s.d	
EF	19.8 \pm 8.6	11.7 \pm 6.6	0.45
OF	7.8 \pm 2.9	5.9 \pm 2.8	0.62
SD	7.9 \pm 1.5	7.8 \pm 1.3	0.95
IS	9.4 \pm 4.6	7.5 \pm 3.3	0.27
OS	6.6 \pm 2.4	6.1 \pm 3.0	0.24

EF = erectile function; OF = orgasmic function; SD = sexual desire; IS = intercourse satisfaction; OS = overall satisfaction.

Table 3

		Enjoyment			Number of erections			
		Low	Medium	High	0	1-2	3-4	≥ 5
EF	1 st	1	12	3	4	9	2	0
Group	video							
	2 nd	5	7	4	7	9	0	0
	video							
ED	1 st	4	9	2	12	2	1	0
Group	video							
	2 nd	6	7	2	12	3	0	0
	video							

Table 4. Mean VDT for erectile function group

	Mean (μm)	change	P	Cohen's d
Be30	7.37 \pm 2.19			
Ae30	6.69 \pm 2.06	-0.68	0.09	0.32
Be60	4.50 \pm 1.37			
Ae60	3.27 \pm 1.17	-1.23	0.001*	1.27
Be100	3.07 \pm 1.12			
Ae100	2.59 \pm 1.30	-0.49	0.072	0.94

Be = before erotic video, Ae = after erotic video

* Significantly different from pre video value ($P < 0.01$).

Table 5. Mean VDT for erectile dysfunction group

	Mean (μm)	Change	P values	Cohen's d
Be30	8.83 \pm 3.05		0.04	
Ae30	9.92 \pm 3.77	1.09		0.31
Be60	5.98 \pm 1.93		0.557	
Ae60	6.37 \pm 2.65	0.39		0.16
Be100	4.08 \pm 2.44		0.212	
Ae100	4.58 \pm 3.06	0.5		0.18

Be = before erotic video, Ae = after erotic video