

ORIGINAL ARTICLE

Gender difference in brain activation to audio-visual sexual stimulation; do women and men experience the same level of arousal in response to the same video clip?

WS Chung¹, SM Lim², JH Yoo² and H Yoon¹

Factors related to sexual arousal are different in men and women. The conditions for women to become aroused are more complex. However, the conventional audio-visual stimulation (AVS) materials used to evaluate sexual arousal are universal. In the present study, we investigated sexual differences in the response to different types of AVS by studying activated areas of the brain using functional magnetic resonance imaging (fMRI). fMRI was performed during two types of AVS in 20 healthy heterosexual volunteers (aged 20–28 years, 10 men and 10 women). The two AVS types were: (1) mood type, erotic video clips with a concrete story and (2) physical type, directly exposing sexual intercourse and genitalia. fMRI images were analyzed and compared for each stimulation with a Mann–Whitney *U* test, with statistical significance set at $P < 0.05$. Men preferred the physical type of AVS to the mood type (mean arousal score 2.14 vs 1.86 in females) and women preferred the mood type (mean arousal score 2.14 vs 1.86 in males) ($P < 0.05$). Degrees of activation in brain areas differed between genders and types of AVS for each gender. This should be considered when applying the AVS method to evaluate and diagnose female sexual dysfunction.

International Journal of Impotence Research (2013) **25**, 138–142; doi:10.1038/ijir.2012.47; published online 10 January 2013

Keywords: audio-visual stimulation; functional brain MRI; gender; sexual response

INTRODUCTION

Arousal and desire are interwoven and expressed in different ways in men and women. Understanding human sexual responses and their basic mechanisms and abnormalities is essential for diagnosing and managing female sexual dysfunction.

The human sexual response cycle, sexual desire, activities, satisfaction, and physical and mental responses in men and women are different. Men usually feel sexual satisfaction during sexual activity and are more prone to physical attraction, whereas women are more affected by the environment and emotions related to the sexual partner or sexual fantasy in terms of sexual satisfaction.^{1–2} Men generally respond to visual sexual stimuli, such as attractive nude or erotic pictures, or erotic films. Women respond differently to the same sexual stimuli. Some women feel repulsed by muscular, erotic male photos, and some are sexually attracted by emotional or lingual stimulation.³ In other words, men are more sexually aroused by visual stimuli, but women are more sexually aroused by concrete, auditory, olfactory, touch and emotionally relevant sexual stimulation.^{4–6} For example, adolescent boys frequently feel strong genital responses to visual sexual stimuli, which are usually accompanied by a craving for sexual expression or masturbation. In contrast, adolescent girls' sexual feelings often arise from emotional reactions to their partner, or romantic themes in films, novels and magazines. Some experimental studies have shown that men respond more to sexual stimuli than women do.^{1,2}

These may be referred to as 'the gender differences of sexual response and sexual function.' There appears to be a clear gender difference in sexual response and function. For optimal outcome,

we should therefore consider the different preferences of the two genders when studying sexual function and dysfunction.

Functional magnetic resonance imaging (fMRI) is a widely used method to detect individual sexual arousal by measuring and mapping activated areas of the brain. Improvements in MRI methodology and mechanics provide more discrete functional information in addition to anatomical information of the human brain.

Historically, there have been a few studies of MRI-based brain region activation in response to visual sexual stimuli in different genders or sexual preferences.^{6–10} However, only a few previous studies reported gender differences in brain activation response to certain sexual stimuli.^{11,12} Although audio-visual stimulation (AVS) is widely used in the clinical setting to induce sexual arousal to examine male or female sexual dysfunction, personal or gender preference to such stimuli-inducing sexual arousal has not been considered, despite discrete sexual preferences between men and women in general AVS examination settings.

There is a lack of data using different AVS to measure sexual response and preference in both men and women to each stimulation.

Therefore, in this study, we aimed to investigate the differences in sexual arousal between men and women in response to different types of AVS in view of gender specificity.

MATERIALS AND METHODS

All fMRI procedures and data collection were reviewed and approved by the Institutional Review Board of the Clinical Research Center of our hospital.

¹Departments of Urology, Ewha Womans University, Seoul, Republic of Korea and ²Departments of Radiology, Ewha Womans University, Seoul, Republic of Korea. Correspondence: Professor H Yoon, Department of Urology, Ewha Womans University, 911-1 Mokdong, Yangcheon-gu, Seoul 158-710, Republic of Korea.

E-mail: wowhana@ewha.ac.kr

Received 2 February 2012; revised 19 September 2012; accepted 30 November 2012; published online 10 January 2013

Study participants included 20 physically and mentally healthy, right-handed volunteers (10 men and 10 women) ranging in age from 20–29 years. Participants were sexually active without any significant sexual problems. To screen for mental illness, stress and anxiety that can affect sexual response, all subjects filled out questionnaires: Symptom Check List-90-Revised (SCL-90-R), Beck's Depression Inventory (BDI), International Index of Erectile Function (IIEF-5) for men and the Female Sexual Function Index (FSFI) for women. Female subjects who were not in the ovulation or menstruation phases of their cycle were selected to avoid the cyclic hormonal influence on sexual response.

During fMRI examination, subjects viewed erotic videos designed for viewing inside the monitor of the patient's MRI booth. The AVS method consisted of 270 s of a random mixture of color bars, non-erotic (natural environmental view) and erotic stimulation. We prepared two types of erotic stimulation. Type 1 (mood type) was erotic, but had a story line and was focused on mood and relationship development. Type 2 (physical type) was typical of commercial pornography with a focus on physical contact, sexual activity and direct exposure of genitalia.

All subjects viewed these two types of erotic videos in a random order without receiving any prior information about the videos. After viewing each type of video, subjects were instructed to score from 1–5 their degree of sexual arousal, with a higher score indicating greater sexual arousal.

Data from each pixel of the brain fMRI signal was collected and integrated. These data were reconstructed according to areas of activation and deactivation, and the results were compared and analyzed statistically between men and women. Data were considered significantly different by Mann-Whitney *U* testing with a *P*-value <0.05.

RESULTS

The mean ages of male and female patients were 24.7 (20–28) and 23.6 (20–26) years, respectively. All 20 volunteers reported sexual arousal from visual stimulation, but the degree of arousal differed by the type of stimulation and gender. Mean arousal score to mood type (type 1) AVS was 1.86 in men and 2.14 in women ($P < 0.05$), but the mean score to physical type (type 2) AVS was 2.14 in men and 1.86 in women ($P < 0.05$). Men showed a preference and higher self-reported arousal for physical type (type 2) visual stimulation. However, women preferred erotic stimulation with a story line and erotic mood (type 1) (Figure 1).

Activated areas observed by fMRI during viewing of the color bars and non-erotic stimulation were used as control and the associated data were extracted during image analysis. Functional images activated by erotic sexual stimulation and similar areas of the brain cortex in both genders included: the cingulate gyrus, hippocampus, parahippocampus, temporal lobe, frontal lobe, parietal lobe and insula. However, women did not show any significant activation at the amygdala. Type 1 stimulation (mood

type) resulted in higher brain activation on fMRI in women compared with men (Figures 2a and b, $P < 0.001$). The signal difference of activated areas between men and women revealed that women exhibited more activation in the right temporal lobe, right parietal lobe, right occipital lobe, right superior and inferior frontal lobe, right cingulate gyrus and right olfactory groove (Figure 2c, $P < 0.001$).

Type 2 stimulation (physical type) resulted in higher brain activation in men compared with women (Figures 3a and b, $P < 0.001$). The areas activated in men by type 2 stimulation were the right frontal lobe, right parietal lobe, right cingulate gyrus, both temporal lobes, both putamens, right occipital lobe and both olfactory grooves (Figure 3c, $P < 0.001$). When comparing the response as the signal intensity of fMRI between the two genders, men showed a much larger difference between type 1 and type 2 stimuli than women ($P < 0.001$).

DISCUSSION

Sexual arousal in response to sexual stimulation appears simultaneously or separately in the brain and genitalia. As women experience less correlation between genital sexual arousal and feelings of sexual arousal than men do,⁷ it is reasonable to detect brain response or activation to sexual stimuli to evaluate or understand the physiology of sexual function and dysfunction.

The fMRI technique is used to document areas of brain activation using a wide variety of motor, sensory or cognitive tasks, including studies of male and female sexual arousal. The activated brain areas demonstrated by fMRI during sexual visual stimulation are the frontal lobe, cingulate gyrus, insula, corpus callosum, caudate nucleus, globus pallidus, inferior temporal lobes and thalamus.^{6–10,13} Arnov *et al.*¹⁴ used fMRI to confirm the activated brain area during penile erection by visually evoked sexual stimulation, and reported that activation of the right insula and inferior portion of the insula, caudate nucleus, cingulate gyrus, posterior temporal lobe and hypothalamus is associated with penile tumescence. However, data addressing sexually aroused females are relatively limited. Using fMRI, Park *et al.*¹⁵ first described female brain activation during sexual arousal showing activation in the inferior frontal lobe, cingulate gyrus, insula, corpus callosum, thalamus, caudate nucleus, globus pallidus and inferior temporal lobe.

In our study, overall, the activated areas on fMRI during sexual arousal were similar to those reported by previous studies. We did not observe any significant activation of the amygdala, whereas the thalamic and hypothalamic areas showed individual variation. These findings differ from other studies. The majority of other fMRI studies of sexual arousal report activation of the amygdala, thalamus and hypothalamus in both men and women, although to different degrees.^{6–13} Activation of the amygdala and hypothalamus are more prominent in men than in women when presented with the same sexual stimuli, even when women reported greater sexual arousal.^{11,12} The amygdala and thalamus may have a greater role in mediating visual stimuli in male sexual behavior. However, the visual stimuli presented in those studies were universal to both genders and did not consider different preferences between the genders. Therefore, their results may differ from our study.

Conventional AVSs, which are traditionally male-oriented erotic films, have clear limitations when identifying brain activation areas in women. We hypothesized, on the basis of established observations of differing responses to various erotic stimuli and differing conditions to become sexually aroused between men and women, that women would require AVS more suited to their own preference in order to properly study female sexual function. As expected, women responded differently to the widely available male-oriented erotic films. We could confirm that—though women are aroused by stereotypical male-oriented AVS—female

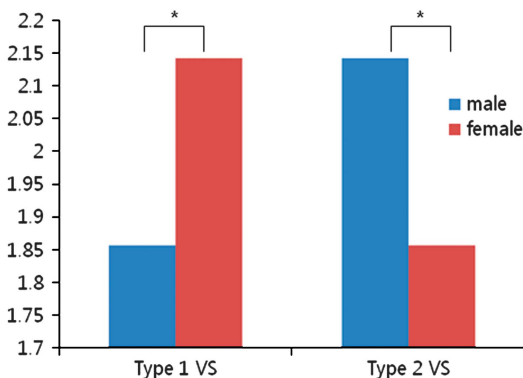


Figure 1. Degree of activation in men and women in response to type 1 (mood preferable) and type 2 (direct physical contact preferable) sexual visual stimuli. The two genders show different preferences for two different types of stimulations ($P < 0.05$ by Mann-Whitney *U* test). A higher score indicates greater sexual arousal.

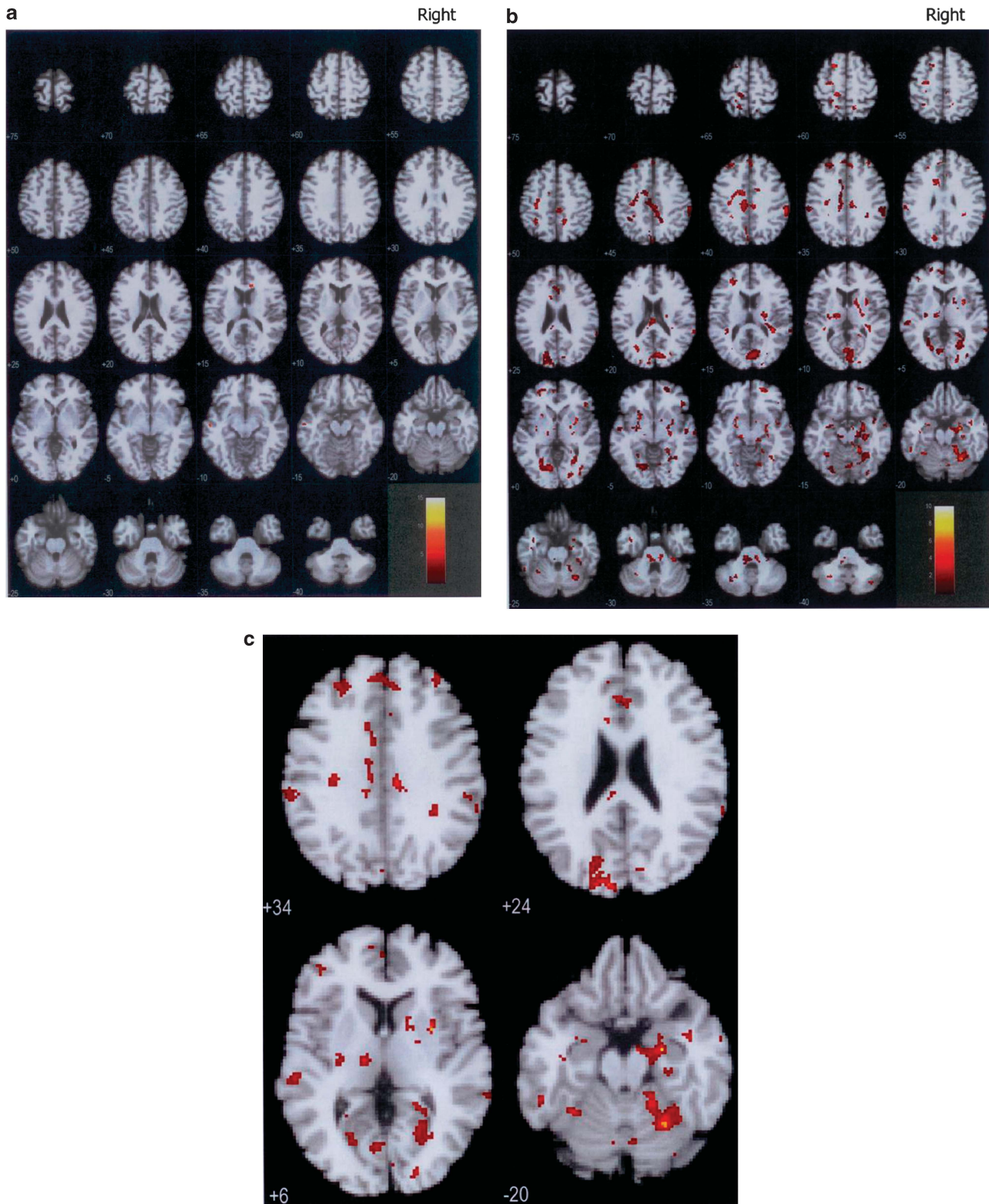


Figure 2. Serial results of fMRI images activated by sexual visual stimulation with mood focused erotic stimuli (type 1) in men (**a**) and women (**b**). The activated areas and their intensities were statistically different between men and women ($P < 0.001$ by Mann–Whitney U test). Women were more activated in the right temporal lobe, both parietal lobes, right occipital lobe, right superior and inferior frontal lobe, right cingulate gyrus, caudate nucleus and right olfactory groove than men (**c**) ($P < 0.001$).

sexual arousal is more powerfully activated by films that better affect sexual emotions and mood (erotic movies with a concrete story and emotional stimulation). In addition, men showed more

activation on fMRI when viewing stereotypical, male-oriented erotic films. Preference for a specific type of visual stimulation affected brain activation more in men than in women. We suggest

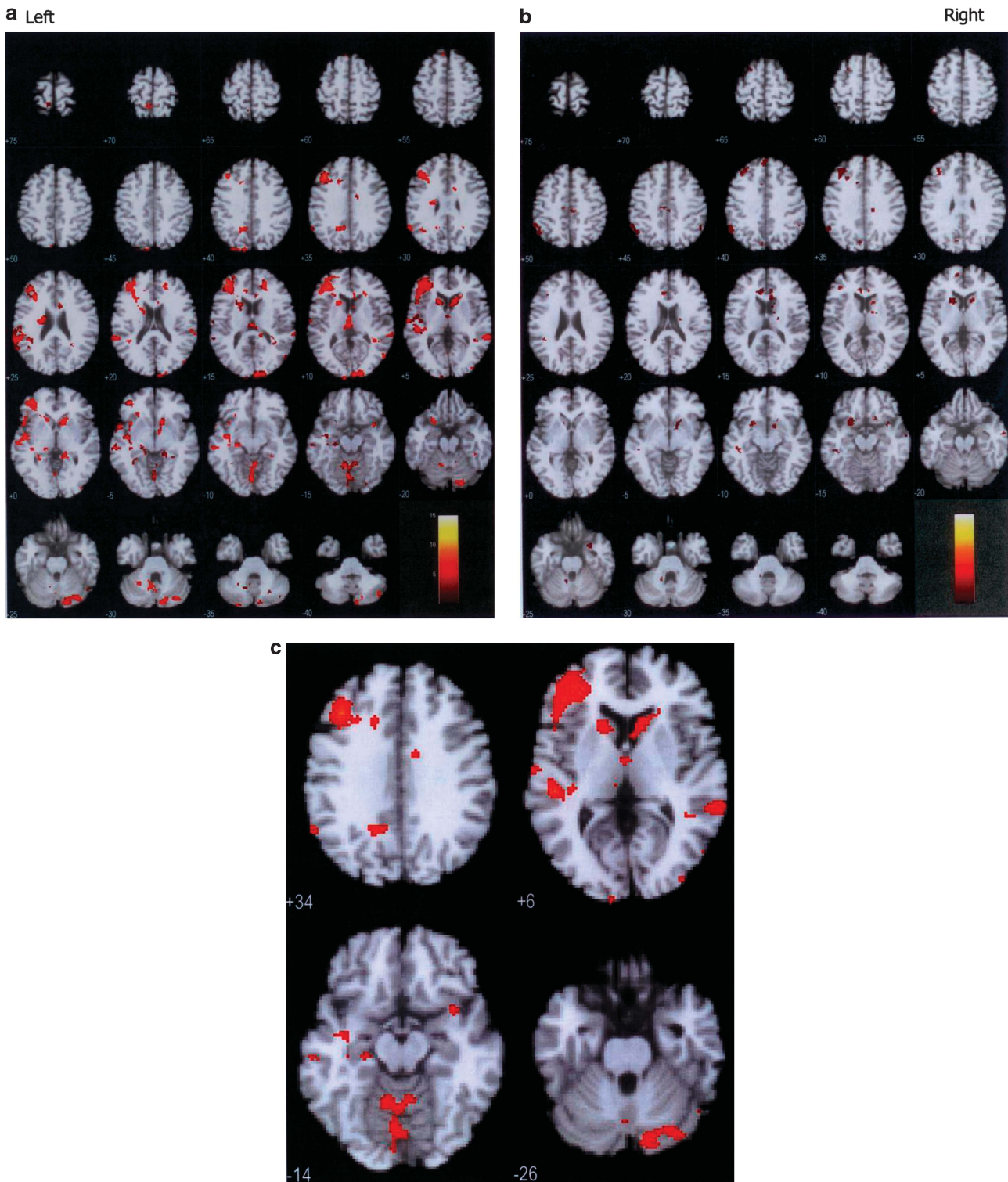


Figure 3. Serial results of fMRI images activated by sexual visual stimulation with physical contact-focused erotic stimuli (type 2) in men (a) and women (b). The activated areas and their intensities were statistically different between men and women ($P < 0.001$). The areas with higher activation in men were the right frontal lobe, right parietal lobe, right cingulate gyrus, both temporal lobes, both putamens, right occipital lobe and both olfactory grooves (c) ($P < 0.001$).

that this is because women are more sensitive to non-visual or emotional stimulation and they easily link current stimuli to recalled memory. According to Jansen *et al.*,⁸ a woman's ability to imagine herself as the woman in the film was the only factor

strongly correlated with her reported arousal. Men also project themselves into the scenario, but may be more likely to objectify the actors.⁹ The presence of this gender difference is interestingly supported by a study of fMRI in male-to-female transsexuals.¹⁶

Male-to-female transsexuals responded more similarly to female control subjects than male control subjects during viewings of erotic stimuli.

Sexual arousal is conditional. Relative to men, more factors contribute to female arousal: personal relationships, family concerns, child issues, emotional status, physical conditions, menstrual cycles, environments and others. Women also have different levels of arousal depending upon menstrual cycles.⁵ In the ovulatory phase, female sexual arousal may be enhanced relative to other menstrual phases.¹⁷ Therefore, gender differences in arousal to sexual stimuli should be considered in the clinical setting. Erotic films for AVS to diagnose sexual dysfunction usually contain male-oriented clips of sexual stimulation. This may not be a suitable method for inducing sexual arousal in women to differentiate and diagnose female sexual dysfunction, because these video clips do not consider women's sexual characteristics and preferences. Results of analyses intended to differentiate female sexual dysfunction by their response to an improper sexual stimulation may not reflect the patient's actual sexual problem.

This study confirmed the different areas of activation between men and women. Gender difference was observed according to the type of visual erotic stimulus and by differential activation on fMRI.

Many contributing factors can affect sexual preference, such as education, social relationships, cultural background, personal sexual preferences, personal history or cognitive processes.^{9,10} It is not yet clear whether differences in preference between the genders are acquired or innate.⁹ The presence of those differences should not be ignored. We suggest that gender differences in sexual arousal on fMRI to different visual sexual stimuli may be the combined product of social and biological influences on cognitive processes that direct the perception and assessment of these stimuli.

This indicates that women need different visual sexual stimulation to be aroused, and clinicians should consider this difference when applying the AVS method to evaluate and diagnose female sexual dysfunction.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

This study was partially supported by a grant from Ewha Womans University Mokdong Hospital Clinical Research Grant 2008. We would like to thank Mr Keun Tack

Ryu and Dr Su Hyun Kim for their technical support and for evaluating and analyzing fMRI data.

REFERENCES

- 1 Laan E, Everaerd W, van Bellen G. Women's sexual and emotional responses to male- and female-produced erotica. *Arch Sex Behav* 1994; **23**: 153–169.
- 2 Muren SK, Stockton M. Gender and self reported arousal in response to sexual stimuli: a meta-analytic review. *Sex Roles* 1997; **37**: 135–153.
- 3 Spiering M, Everaerd W, Laan E. Conscious processing of sexual information: mechanisms of appraisal. *Arch Sex Behav* 2004; **33**: 369–380.
- 4 Joseph R. The limbic system: emotion, laterality, and unconscious mind. *Psychoanal Rev* 1992; **79**: 405–456.
- 5 Dagi TF, Poletti CE. Reformulation of the Papez circuit: absence of hippocampal influence on cingulate cortex unit activity in the primate. *Brain Res* 1983; **259**: 229–236.
- 6 Murnen SK, Stockton M. Gender and self-reported sexual arousal in response to sexual stimuli: a meta-analytic review. *Sex Roles* 1997; **37**: 135–153.
- 7 Suschinsky KD, Lalumière ML. Is sexual concordance related to awareness of physiological states? *Arch Sex Behav* 2012; **41**: 199–208.
- 8 Janssen E, Carpenter D, Graham CA. Selecting films for sex research: gender differences in erotic film preferences. *Arch Sex Behav* 2003; **32**: 243–251.
- 9 Rupp HA, Wallen K. Sex differences in response to visual sexual stimuli: a review. *Arch Sex Behav* 2008; **37**: 206–218.
- 10 Hu SH, Wang QD, Xu Y, Liao ZL, Xu LJ, Liao ZL et al. Haemodynamic brain response to visual sexual stimuli is different between homosexual and heterosexual men. *J Int Med Res* 2011; **39**: 199–211.
- 11 Karama S, Lecours AR, Leroux JM, Bourgouin P, Beaudoin G, Joubert S et al. Areas of brain activation in males and females during viewing of erotic film excerpts. *Hum Brain Mapp* 2002; **16**: 1–13.
- 12 Hamann S, Herman RA, Nolan CL, Wallen K. Men and women differ in amygdala response to visual sexual stimuli. *Nat Neurosci* 2004; **7**: 411–416.
- 13 Park K, Seo JJ, Kang HK, Ryu SB, Kim HJ, Jeong GW. A new potential of blood oxygenation level dependent (BOLD) functional MRI for evaluating cerebral centers of penile erection. *Int J Impot Res* 2001; **13**: 73–81.
- 14 Arnow BA, Desmond JE, Banner LL, Glover GH, Solomon A, Polan ML et al. Brain activation and sexual arousal in healthy, heterosexual males. *Brain* 2002; **125**: 1014–1023.
- 15 Park K, Kang HK, Seo JJ, Kim HJ, Ryu SB, Jeong GW. Blood oxygenation-level-dependent functional magnetic resonance imaging for evaluating cerebral regions of female sexual arousal response. *Urology* 2001; **57**: 1189–1194.
- 16 Gizewski ER, Krause E, Schlamann M, Happich F, Ladd ME, Forsting M et al. Specific cerebral activation due to visual erotic stimuli in male-to-female transsexuals compared with male and female controls: an fMRI study. *J Sex Med* 2009; **6**: 440–448.
- 17 Zhu X, Wang X, Parkinson C, Cai C, Gao S, Hu P. Brain activation evoked by erotic films varies with different menstrual phases: an fMRI study. *Behav Brain Res* 2010; **206**: 279–285.