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ORGASM

Brain Activity Unique to Orgasm in Women: An fMRI Analysis

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ABSTRACT

Background: Although the literature on imaging of regional brain activity during sexual arousal in women and men is extensive and largely consistent, that on orgasm is relatively limited and variable, owing in part to the methodologic challenges posed by variability in latency to orgasm in participants and head movement.

Aim: To compare brain activity at orgasm (self- and partner-induced) with that at the onset of genital stimulation, immediately before the onset of orgasm, and immediately after the cessation of orgasm and to upgrade the methodology for obtaining and analyzing functional magnetic resonance imaging (fMRI) findings.

Methods: Using fMRI, we sampled equivalent time points across female participants' variable durations of stimulation and orgasm in response to self- and partner-induced clitoral stimulation. The first 20-second epoch of orgasm was contrasted with the 20-second epochs at the beginning of stimulation and immediately before and after orgasm. Separate analyses were conducted for whole-brain and brainstem regions of interest. For a finer-grained analysis of the peri-orgasm phase, we conducted a time-course analysis on regions of interest. Head movement was minimized to a mean less than 1.3 mm using a custom-fitted thermoplastic whole-head and neck brace stabilizer.

Outcomes: Ten women experienced orgasm elicited by self- and partner-induced genital stimulation in a Siemens 3-T Trio fMRI scanner.

Results: Brain activity gradually increased leading up to orgasm, peaked at orgasm, and then decreased. We found no evidence of deactivation of brain regions leading up to or during orgasm. The activated brain regions included sensory, motor, reward, frontal cortical, and brainstem regions (eg, nucleus accumbens, insula, anterior cingulate cortex, orbitofrontal cortex, operculum, right angular gyrus, paracentral lobule, cerebellum, hippocampus, amygdala, hypothalamus, ventral tegmental area, and dorsal raphe).

Clinical Translation: Insight gained from the present findings could provide guidance toward a rational basis for treatment of orgasmic disorders, including anorgasmia.

Strengths and Limitations: This is evidently the first fMRI study of orgasm elicited by self- and partner-induced genital stimulation in women. Methodologic solutions to the technical issues posed by excessive head movement and variable latencies to orgasm were successfully applied in the present study, enabling identification of brain regions involved in orgasm. Limitations include the small sample (N = 10), which combined self- and partner-induced stimulation datasets for analysis and which qualify the generalization of our conclusions.

Conclusion: Extensive cortical, subcortical, and brainstem regions reach peak levels of activity at orgasm. **Wise NJ, Frangos E, Komisaruk BR. Brain Activity Unique to Orgasm in Women: An fMRI Analysis. J Sex Med 2017;14:1380–1391**.

Key Words: Human Female; Orgasm; Functional Magnetic Resonance Imaging; Sexual Behavior; Sexual Arousal

INTRODUCTION

Although the literature on imaging of regional brain activity during sexual arousal in women and men is extensive and generally consistent, the literature on orgasm is relatively limited and variable. During sexual arousal, multiple subcortical and cortical regions become activated. Amygdala activation at visual stimulation-induced sexual arousal was reported in women[1–3] and men,[1–5] and this activation was reportedly greater in men.[6] Hippocampal activity was reported to increase during sexual arousal in men.[7] In women and men during sexual arousal, activation was reported in the medial prefrontal cortex,[3] orbitofrontal cortex,[8] and dorsolateral prefrontal cortex,[9]

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although Huynh et al[10] reported that primary and secondary visual cortices became deactivated in women watching an erotic film. Other brain regions that were reported activated during sexual arousal in response to visual erotic stimulation include the hypothalamus,[1,3,5,11] anterior cingulate cortex,[3,5,7,11,12] and insula.[3,7,11] Ortigue et al[13] reported a correlation between the degree of activation of women's left anterior insular cortex in response to subliminal presentation of their partner's name and the "quality" of orgasm that the women self-rated.

The relatively less extensive literature on orgasm is more variable, perhaps owing to several factors, including the technical issues of head movement and variable latencies to orgasm, the latter of which present a greater difficulty for positron-emission tomography (PET), which requires minutes for preparing the radioactive tracer immediately before orgasm, than for functional magnetic resonance imaging (fMRI), which scans continuously. During orgasm in men and women, activation was reported in the cerebellum,[4,14–16] anterior cingulate,[4,14–16] and dopaminergic pathway from the ventral tegmentum[4] to the nucleus accumbens.[14–16] In women during orgasm, activation was reported in the hippocampus[1,2,14,15] and frontal cortex.[14,15,17] Amygdala activity was reported to increase at orgasm in women[1,2,14,15] but decrease during ejaculation in men.[4] Temporal lobe activity was reported to decrease at ejaculation in men,[18] although middle temporal gyrus activity increased.[4] Activation was reported during ejaculation in the orbitofrontal cortex.[4] Frontal cortical activation also was reported in women during orgasm,[14,15,17,19] whereas deactivations of frontal cortical regions were reported based on PET studies[20,21] and perfusion fMRI[22] in men.

We considered that the difference (activation or deactivation) could be due to the methods used (blood oxygen-level dependent fMRI or PET, respectively) or whether the orgasm was induced in women by self-applied[15–17,19] or partner-applied[20,21] stimulation, respectively.

In the present study, we focused on brain activity during orgasm in relation to that before and after orgasm. We also addressed two methodologic issues raised by our previous reports: possible artifact generated by excessive head movement during orgasm and lack of correction for multiple statistical comparisons. Thus, for the present study, we developed an assembly using a custom-fitted thermoplastic whole-head mask that was molded to a neck brace and rigidly clamped to the scanner head cage; this limited head movement during orgasm to less than 1.3 mm. In addition, the fMRI data were corrected for multiple comparisons.

AIMS

The aims of the present study were (i) to compare brain activity at orgasm (self- and partner-induced) with that at the onset of genital stimulation, at an intermediate phase during the course of stimulation, immediately before the onset of orgasm, and immediately after the cessation of orgasm and (ii) to upgrade the methodology for obtaining and analyzing fMRI findings.

METHODS

Participants

Fourteen healthy women were recruited for this study by word of mouth. Data from two of the participants were excluded because they did not experience orgasm during the scanning session. Two additional datasets were discarded because of technical problems with the scans. Data from 10 participants were used (age range = 29–74 years, mean = 43.6, SD = 14.9). Each participant gave informed consent in accordance with approval by the institutional review board of Rutgers University (Newark, NJ, USA). The scanning session took place at the Rutgers University Brain Imaging Center (RUBIC) in compliance with all RUBIC MRI common practices. The participants were prescreened for MRI safety and completed screening forms in accord with RUBIC requirements. Participants were compensated $50.

Each woman was interviewed before the scanning procedure to collect information about her sexual and relational histories for purposes beyond the scope of this study. Seven participants identified themselves as exclusively heterosexual, and three reported having had "some" bisexual experience. Three participants reported being single at the time of the study, and seven described themselves as "currently in a relationship," ranging from 2 to 20 years in duration. Four women were married to their current partners. Five women reported having had children. Only one participant reported being "postmenopausal." All 10 participants described themselves as being "highly" orgasmic.

Each of the 10 women was accompanied by a male partner to provide the clitoral stimulation for the partner-stimulation–induced orgasm component. Each male partner was prescreened to determine suitability for study participation and gave informed consent in accordance with the Rutgers University institutional review board. In compliance with all RUBIC MRI common practices, the male participants were prescreened for MRI safety and completed screening forms in accord with RUBIC requirements. Male participants also were compensated $50.

Procedure

Each woman participated in one experimental scan consisting of clitoral stimulation-induced orgasm under two sequentially counterbalanced conditions: self-stimulation and partner stimulation.

Protocol for Self-Induced Orgasm

Cues for the self-stimulation condition were presented visually on an fMRI-compatible computer projection screen. The participant saw the instruction "rest" for the duration of 60 seconds. Then, the instruction "press when start stimulation" appeared, which cued her to press the button once she began clitoral self-stimulation. After the participant pressed the button to indicate she was self-stimulating, the instruction "press when