

Home / News & Opinion

Hermunculus Situates Female Genital Sensation in the Cortex

Researchers also find that the thickness of the brain region representing clitoral stimulation is associated with intercourse frequency.



Sophie Fessl Dec 23, 2021

The iconic homunculus map, showing how the human body is represented in the brain, is clearly male: The drawing, published in 1950, depicts a penis deep within the medial wall of the cortex.

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Female anatomy, including the breasts, vagina, and clitoris, is omitted. Exactly where in the brain sensations felt i female genitalia are processed is still debated, but a study published this week (December 20) in *The Journal of Neuroscience* puts forward the lateral wall of the somatosensory cortex as a likely location. The study also finds tha the size of the brain region that activates in response to clitoral stimulation correlates with self-reported frequence of sexual intercourse.

The paper is a step "toward understanding something unique about the female brain," says cognitive neuroscienti Gillian Einstein of the University of Toronto who was not involved in the study.

The 1950 somatosensory homunculus was based on experiments by neurosurgeon Wilder Penfield and his team, including Theodore Rasmussen, who operated on locally-anesthetized but fully awake patients to treat epilepsy c remove tumors and asked them to describe their sensations as the researchers stimulated different areas of the cortex—the outermost layer of the brain—with electrodes. The map showed that adjacent areas in the body are fc the most part represented in adjacent areas in the brain—that is, somatotopically. The genitals were an exception they were found below the brain region representing sensation in the foot, in the medial cortex, along the deep groove that marks the division between the brain's two hemisphere.

Several studies have investigated where the genitalia map within the cortex, using self- or partner-delivered stimulation or electrical stimulation to try to validate the non-somatotopic location of male genitalia next to the f and to see if female genitalia map to the same location. So far, the questions haven't been answered conclusively, part because how a body area is stimulated affects how the brain responds: some studies agree with the authors of the original homunculus in placing the genital field for females, males, or both in the medial cortex, while others have situated the field adjacent to the hip and knee area in the dorsolateral region, where it would fit somatotopically.

2/7/22, 8:48 PM

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In the present study, Christine Heim and colleagues at Charité Universitätsmedizin Berlin in Germany devised a technique to stimulate the clitoris without eliciting sexual arousal. "We developed a technique to deliver an airburvia a membrane that allows for a precise stimulation while at the same time avoiding any discomfort," writes Heir lead author of the study, in an email to *The Scientist*.

Using fMRI imaging, the researchers mapped 20 participants' responses to those puffs of air to regions along the and side of the cortex, known as its dorsolateral areas. Female genitalia, the authors conclude, are represented in cortex next to the representation of hips and upper legs—where one might expect it if genitalia followed the somatotopic arrangement. Importantly, "the precise location within this region varied from woman to woman," Heim points out. But across all the women, "there were no activations in other areas of the somatosensory cortex beyond the region by the hips and upper legs. This observation is in line with a previous study in males using a n arousing stimulus, which similarly placed the penis' representation field at a somatotopic location between the leg and the trunk.

However, Rutgers University psychologist Barry Komisaruk, whose previous work mapped female genitalia to the medial cortex, questions the techniques Heim's team used. Specifically, he "was surprised to see the crude form o mechanical stimulation that the present authors used in the study," he writes in an email to *The Scientist*. As no siz specified for the membrane used to deliver stimulation, and the disc was attached above underwear, Komisaruk questions how the researchers could avoid stimulating not only the clitoris's pudendal nerve, but also other nerve the groin region. As a result, he postulates that the "cortical near-surface activation is most likely due to stimulatic of the groin region in addition to that specifically of the genitals."

In an email to *The Scientist*, the authors counter that a surface area of no more than two centimetres was stimulate and argue that "using a smaller diameter would have made no difference given the resolution of the fMRI signal." addition, the authors point to ethical reasons for not using a more invasive stimulator, as they devised this type of stimulation to also be used in follow-up studies that will address the long-term effects of sexual abuse. They write "we made considerable extra effort to develop a technique that is very precise and at the same time as minimally intrusive as possible."

Komisaruk also questions why the authors didn't analyze activation of deeper cortical regions. "The problem with their claim is that they report only cortical surface activity in their study, ignoring deeper cortical regions," he wr while his study and others report "a deep cortical representation, especially of the genitals" in addition to nearsurface representation. The authors counter that as the cortical sheet is two dimensional and the cortex is folded, "locations that can be close together in 3D might not be close together in 2D on the cortical surface." Instead of mapping the cortex in 3D, therefore, they write that they "assessed the entire cortical surface, including the deep regions buried in the sulci. No area was left out in the 2D plane," including regions highlighted in previous studie: Komisaruk and others.

For Einstein, the precise location of the genital field matters less than the observation that "the genital representation varies person to person." As far as she's aware, this paper is the first to look at "individual variation the somatotopic maps," she tells *The Scientist*. She also credits the study authors for using a stimulus that did not le to arousal, as "sexual excitation may recruit more areas" than those that would otherwise register sensation.

In a second component of the study, Heim and colleagues measured the thickness of each participant's genital fie by gauging the individual region that was activated the most by clitoral stimulation. They then correlated thickne of these genital fields with the subjects' reports of how frequently they had intercourse, both in the past year and

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since the start of sexual activity. "Very interestingly," says Einstein, the results show a link between the two. Heim points out that future studies are needed to establish whether this relationship between the genital field and frequency of sex is causal, but adds that she and her colleagues "provide a proof of principle for structural variatiof this field related to its use," something which had not been demonstrated in humans before, Heim writes.

In previous work, Heim and colleagues associated experiences of sexual abuse with reduced cortical thickness. "These studies are very important for understanding not just sexual dysfunction as it might be described in biomedical literature, but also how people respond to sexual abuse," says Einstein.

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