

The Orgasmic Mind: The Neurological Roots of Sexual Pleasure

Achieving sexual climax requires a complex conspiracy of sensory and psychological signals—and the eventual silencing of critical brain areas

By Martin Portner

She did not often have such strong emotions. But she suddenly felt powerless against her passion and the desire to throw herself into the arms of the cousin whom she saw at a family funeral. “It can only be because of that patch,” said Marianne, a participant in a multinational trial of a testosterone patch designed to treat hypoactive sexual desire disorder, in which a woman is devoid of libido. Testosterone, a hormone ordinarily produced by the ovaries, is linked to female sexual function, and the women in this 2005 study had undergone operations to remove their ovaries.

After 12 weeks of the trial, Marianne had felt her sexual desire return. Touching herself unleashed erotic sensations and vivid sexual fantasies. Eventually she could make love to her husband again and experienced an orgasm for the first time in almost three years. But that improvement was not because of testosterone, it turned out. Marianne was among the half of the women who had received a placebo patch—with no testosterone in it at all.

Marianne’s experience underlines the complexity of sexual arousal. Far from being a simple issue of hormones, sexual desire and orgasm are subject to various influences on the brain and nervous system, which controls the sex glands and genitals. And many of those influences are environmental. Recent research, for example, shows that visual stimuli spur sexual stirrings in women, as they do in men. Marianne’s desire may have been invigorated by conversations or thoughts about sex she had as a result of taking part in the trial. Such stimuli may help relieve inhibitions or simply whet a person’s appetite for sex.

Achieving orgasm, brain-imaging studies show, involves more than heightened arousal. It requires a release of inhibitions and control in which the brain’s center of vigilance shuts down in males; in females, various areas of the brain involved in controlling thoughts and emotions become silent. The brain’s pleasure centers tend to light up brightly in the brain scans of both sexes, especially in those of males. The reward system creates an incentive to seek more sexual encounters, with clear benefits for the survival of the species. When the drive for sex dissipates, as it did with Marianne, people can reignite the spark with tactics that target the mind.

Sex in Circles

Biologists identified sex hormones such as estrogen and testosterone in the 1920s and 1930s, and the first studies of human sexuality appeared in the 1940s. In 1948 biologist Alfred Kinsey of Indiana University introduced his first report on human sexual practices, *Sexual Behavior in the Human Male*, which was followed, in 1953, by *Sexual Behavior in the Human Female*. These highly controversial books opened up a new dialogue about human sexuality. They not only broached topics—such as masturbation, homosexuality and orgasm—that many people considered taboo but also revealed the surprising frequency with which people were coupling and engaging in sexual relations of countless varieties.

Kinsey thus debuted sex as a science, paving the way for others to dig below statistics into the realm of biology. In 1966 gynecologist William Masters and psychologist Virginia Johnson—who originally hailed from Washington University before founding their own research institute in St. Louis—described for the first time the sexual response cycle (how the body responds to sexual stimulation), based on observations of 382 women and 312 men undergoing some 10,000 such cycles. The cycle begins with excitation, as blood rushes to the penis in men, and as the clitoris, vulva and vagina enlarge and grow moist in women. Gradually, people reach a plateau, in which they are fully aroused but not yet at orgasm. After reaching orgasm, they enter the resolution phase, in which the tissues return to the preexcitation stage.

In the 1970s psychiatrist Helen Singer Kaplan of the Human Sexuality Program at Weill Medical College of Cornell University added a critical element to this cycle—desire—based on her experience as a sex therapist. In her three-stage model, desire precedes sexual excitation, which is then followed by orgasm. Because desire is mainly psychological, Kaplan emphasized the importance of the mind in the sexual experience and the destructive forces of anxiety, defensiveness and failure of communication.

In the late 1980s gynecologist Rosemary Basson of the University of British Columbia proposed a more circular sexual cycle, which, despite the term, had been described as a largely linear progression in previous work. Basson suggested that desire might both lead to genital stimulation and be invigorated by it. Countering the idea that orgasm is the pinnacle of the experience, she placed it as a mere spot on the circle, asserting that a person could feel sexually satisfied at any of the stages leading up to an orgasm, which thus does not have to be the ultimate goal of sexual activity.

Dissecting Desire

Given the importance of desire in this cycle, researchers have long wanted to identify its key ingredients. Conventional wisdom casts the male triggers in simplistic sensory terms, with tactile and visual stimuli being particularly enticing. Men are drawn to visual erotica, explaining the lure of magazines such as *Playboy*. Meanwhile female desire is supposedly fueled by a richer cognitive and emotional texture. “Women experience desire as a result of the context in which they are inserted—whether they feel comfortable with themselves and the partner, feel safe and perceive a true bond with the partner,” opines urologist Jennifer Berman of the Female Sexual Medicine Center at the University of California, Los Angeles.

Yet sexual imagery devoid of emotional connections can arouse women just as it can men, a 2007 study shows. Psychologist Meredith Chivers of the Center for Addiction and Mental Health in Toronto and her colleagues gauged the degree of sexual arousal in about 100 women and men, both homosexual and heterosexual, while they watched erotic film clips. The clips depicted same-sex intercourse, solitary masturbation or nude exercise—performed by men and women—as well as male-female intercourse and mating between bonobos (close ape relatives of the chimpanzee).

The researchers found that although nude exercise genitally aroused all the onlookers the least and intercourse excited them the most, the type of actor was more important for the men than for the women. Heterosexual women’s level of arousal increased along with the intensity of the sexual activity largely irrespective of who or what was engaged in it. In fact, these women were genitally excited by male and female actors equally and also responded physically to bonobo copulation. (Gay women, however, were more particular; they did not react sexually to men masturbating or exercising naked.)

The men, by contrast, were physically titillated mainly by their preferred category of sexual partner—that is, females for straight men and males for gay men—and were not excited by bonobo copulation. The results, the researchers say, suggest that women are not only aroused by

a variety of types of sexual imagery but are more flexible than men in their sexual interests and preferences.

When it comes to orgasm, simple sensations as well as higher-level mental processes probably also play a role in both sexes. Although Kinsey characterized orgasm in purely physical terms, psychologist Barry R. Komisaruk of Rutgers University has defined the experience as more multifaceted. In their book *The Science of Orgasm* (Johns Hopkins University Press, 2006), Komisaruk, endocrinologist Carlos Beyer-Flores of the Tlaxcala Laboratory in Mexico and Rutgers sexologist Beverly Whipple describe orgasm as maximal excitation generated by a gradual summing of responses from the body's sensory receptors, combined with complex cognitive and emotional forces. Similarly, psychologist Kent Berridge of the University of Michigan at Ann Arbor has described sexual pleasure as a kind of "gloss" that the brain's emotional hub, the limbic system, applies over the primary sensations.

The relative weights of sensory and emotional influences on orgasm may differ between the sexes, perhaps because of its diverging evolutionary origins. Orgasm in men is directly tied to reproduction through ejaculation, whereas female orgasm has a less obvious evolutionary role. Orgasm in a woman might physically aid in the retention of sperm, or it may play a subtler social function, such as facilitating bonding with her mate. If female orgasm evolved primarily for social reasons, it might elicit more complex thoughts and feelings in women than it does in men.

Forgetting Fear

But does it? Researchers are trying to crack this riddle by probing changes in brain activity during orgasm in both men and women. Neuroscientist Gert Holstege of the University of Groningen in the Netherlands and his colleagues attempted to solve the male side of the equation by asking the female partners of 11 men to stimulate their partner's penis until he ejaculated while they scanned his brain using positron-emission tomography (PET). During ejaculation, the researchers saw extraordinary activation of the ventral tegmental area (VTA), a major hub of the brain's reward circuitry; the intensity of this response is comparable to that induced by heroin. "Because ejaculation introduces sperm into the female reproductive tract, it would be critical for reproduction of the species to favor ejaculation as a most rewarding behavior," the researchers wrote in 2003 in *The Journal of Neuroscience*.

The scientists also saw heightened activity in brain regions involved in memory-related imagery and in vision itself, perhaps because the volunteers used visual imagery to hasten orgasm. The anterior part of the cerebellum also switched into high gear. The cerebellum has long been labeled the coordinator of motor behaviors but has more recently revealed its role in emotional processing. Thus, the cerebellum could be the seat of the emotional components of orgasm in men, perhaps helping to coordinate those emotions with planned behaviors. The amygdala, the brain's center of vigilance and sometimes fear, showed a decline in activity at ejaculation, a probable sign of decreasing vigilance during sexual performance.

To find out whether orgasm looks similar in the female brain, Holstege's team asked the male partners of 12 women to stimulate their partner's clitoris—the site whose excitation most easily leads to orgasm—until she climaxed, again inside a PET scanner. Not surprisingly, the team reported in 2006, clitoral stimulation by itself led to activation in areas of the brain involved in receiving and perceiving sensory signals from that part of the body and in describing a body sensation—for instance, labeling it "sexual."

But when a woman reached orgasm, something unexpected happened: much of her brain went silent. **Some of the most muted neurons sat in the left lateral orbitofrontal cortex, which may govern self-control over basic desires such as sex. Decreased activity there, the researchers suggest, might correspond to a release of tension and inhibition.** The scientists also saw a dip in excitation in the dorsomedial prefrontal cortex, which has an apparent role in

moral reasoning and social judgment—a change that may be tied to a suspension of judgment and reflection.

Brain activity fell in the amygdala, too, suggesting a depression of vigilance similar to that seen in men, who generally showed far less deactivation in their brain during orgasm than their female counterparts did. “Fear and anxiety need to be avoided at all costs if a woman wishes to have an orgasm; we knew that, but now we can see it happening in the depths of the brain,” Holstege says. He went so far as to declare at the 2005 meeting of the European Society for Human Reproduction and Development: “At the moment of orgasm, women do not have any emotional feelings.”

But that lack of emotion may not apply to all orgasms in women. Komisaruk, Whipple and their colleagues studied the patterns of brain activation that occur during orgasm in five women with spinal cord injuries that left them without sensation in their lower extremities. These women were able to achieve a “deep,” or nonclitoral, orgasm through mechanical stimulation (using a laboratory device) of the vagina and cervix. But contrary to Holstege’s results, Komisaruk’s team found that orgasm was accompanied by a general activation of the limbic system, the brain’s seat of emotion.

Among the activated limbic regions were the amygdala and the hypothalamus, which produces oxytocin, the putative love and bonding hormone whose levels jump fourfold at orgasm. The researchers also found heightened activity in the nucleus accumbens, a critical part of the brain’s reward circuitry that may mediate orgasmic pleasure in women. In addition, they saw unusual activity in the anterior cingulate cortex and the insula, two brain areas that Rutgers anthropologist Helen Fisher has found come to life during the later stages of love relationships. Such activity may connect a female’s sexual pleasure with the emotional bond she feels with her partner.

Pleasure Pill?

Disentangling the connections between orgasm, reproduction and love may someday yield better medications and psychotherapies for sexual problems. As Marianne’s case illustrates, the answer is usually not as simple as a hormone boost. Instead her improvement was probably the result of the activation or inactivation of relevant parts of her brain by social triggers she encountered while participating in an experiment whose purpose centered on female sexual arousal. Indeed, many sex therapies revolve around opening the mind to new ways of thinking about sex or about your sexual partner.

Companies are also working on medications that act on the nervous system to stimulate desire. One such experimental compound is a peptide called bremelanotide, which is under development by Palatin Technologies in Cranbury, N.J. It blocks certain receptors in the brain that are involved in regulating basic drives such as eating and sex. In human studies bremelanotide has prompted spontaneous erections in men and boosted sexual arousal and desire in women, but the U.S. Food and Drug Administration has held up its progress out of concern over side effects such as rising blood pressure.

Continued scientific dissection of the experience of orgasm may lead to new pharmaceutical and psychological avenues for enhancing the experience. **Yet overanalyzing this moment of intense pleasure might also put a damper on the fun.** That is what the science tells us anyway.