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Neural Pathways of Sexual Arousal

Ashley Hall

Introduction

The research I conducted for the neuroscience emphasis graduation requirement was a combined topic with my gender studies minor thesis. The thesis title was *Dirty Minds: Comparing the Gender Differences in Neural Sexual Arousal with Theories of Human Sexuality*. The first purpose of the thesis was to explore the neuroscience evidence for gender differences in sexual arousal to better understand what is happening on a physiological level. The second portion of the thesis was designed to investigate if the current psychological theories of human sexuality were in line with the experimental results researched previously. Ruth Hubbard's argument to understanding the relationship between biology and culture as transformational was the framework that I used to consider these two strains of research [1]. This framework allowed me to consider neuroscience, psychology, and culture as interdependent in a way that perpetuated the norms and expectations of our gendered culture. Specifically, the powerful influence of gender roles on the questions that researchers ask, such as targeting only female sexuality as in need of explanation because male sexuality is biologically driven [2]. The influence of gender roles has permeated into the language of the sciences; for example, fertilization is often discussed as sperm actively penetrating the egg, when in fact the egg plays a more active role in fertilization [3]. The following review discusses the neurological evidence for human sexual arousal pathways and known gender differences.

Defining Sexual Desire & Arousal

In a review of the neural pathways of sexual desire, Jim Pfaus [4] produced the following definition of sexual desire: "The behavioral patterns stimulated by those systems [dopamine, hypothalamus, limbic] and the subjective feelings that accompany them" [4]. Because the field of human sexuality does not have a standardized definition of sexual desire, Pfaus's contribution is especially important. By specifying that the behaviors which are associated with sexual desire are the products of the three systems implicated in the excitatory arousal system, Pfaus narrows down a great deal of behaviors. Under this definition, behavioral products of this system are entirely voluntary, and would not be the result of coercion or physical force. For example, his clear definition would negate the potential claim that although a woman did not want to perform a particular sex act, her complicity, or lack of saying *no*, indicated desire. Pfaus [4] went on to also define libido as the aspects of sexual desire in addition to "genital and sympathetic arousal" [4]. By distinguishing the two, he makes clear that desire is a cognitive process, and libido the physical manifestation of the desires.

The larger implications for this definition go beyond the realm of human sexuality, and may clarify vague understandings of arousal or desire in both personal and legal realms. Remaining focused on human sexuality though, this definition clarifies the physiological patterns that can be measured in future research and standardized to allow researchers to compare findings. Because self-reports are not always accurate due to unwillingness or inability to give meaningful data, this definition can increase the

quality of results. Finally, the distinctions between libido and desire will allow for researchers to study both conscious and unconscious manifestations of desire.

Neurological Pathways of Human Sexual Arousal

The availability and distribution of neural imaging software has advanced the understanding of human sexuality within the sciences. The transition away from self-reports and interviews allows the field to distinguish more reliable, replicable, and comparable results. The sciences have not, however, moved beyond the culturally influenced gender roles when conducting this research. As discussed in Hubbard's framework [1], culture continues to have a transformational effect on science. Culture directs the questions asked in science, and science informs the public knowledge and expectations. When the field does not value a topic, it is left untouched. The implications of this can be seen in neuroscience where researchers largely avoid conducting studies on female participants. Margaret McCarthy and colleagues [5] cite excuses of neuroscientists for not conducting research on females, such as the difficulty of controlling for hormonal fluctuations related to menstruation, as easily remedied and unacceptable. Since neuroscience research often informs medical treatments, the differences in manifestation of diseases and disorders between genders is evidence that only utilizing male participants can negatively impact the well being of females. Despite this dangerous undervaluing of females as a group, there has been recent work focused on understanding the different internal pathways that influence sexual behaviors in both men and women.

Excitatory Pathway

As the field of neuroscience continues to advance, researchers are discovering interactions between neural systems that complicate the seemingly simple original picture. Specifically looking at pathways for sexual arousal, Pfaus [4] suggests that three are core to producing sexual excitement: the dopamine system, the hypothalamus, and the limbic system. Dopamine, a hormone that is associated with rewards, is produced and sent to the hypothalamus and limbic areas. In general, dopamine has the effect of teaching, and subsequently reinforcing, learned behaviors associated with sexual behaviors. In humans this can be learning how to flirt, and then repeating effective methods when it scores you a kiss. On a more physiological level, dopamine also stimulates blood flow to areas needed for sexual behaviors such as the heart and genitals.

The research Pfaus [4] cites is both compelling, and based in longstanding theories. The dopamine reward pathway is implicated in a great deal of learned behaviors, and though this fits the sexual arousal concept, it is not particularly specific, nor does it explain original sources of arousal. If someone is sexually active, it is likely that his or her partner is strongly associated with arousal via the learned reward pathway. However, it does not explain arousal to novel stimuli or stimuli which is not subjectively rated as desirable. In short, the learned response aspect of this theory doesn't apply to the findings of Chivers [6], which found heterosexual women to be physiologically aroused by things they indicated they weren't aroused by (female-female pornography). Furthermore, because dopamine is widely produced and has a very extensive influence over the entire body, it may be the product, not necessarily the cause, of sexual arousal.

Inhibitory Pathway

In addition to analyzing the excitatory system, Pfaus [4] provided evidence that the inhibitory system is equally relevant to human sexual arousal. As in the field of human sexuality, he cited both biological and sociocultural factors that he felt were likely to play a role. Specifically, he provided evidence that the pre-frontal cortex (the area under your forehead) that is typically associated with evaluating morals and social cost is an active component of the inhibitory system. Logically, culture and social cues would then influence the decision to accept or reject a sexual advance based on social norms. If sex were seen as unacceptable in a particular circumstance, an individual would likely take this into account via their pre-frontal cortex, and evaluate the potential social consequences as greater than the benefits. Finally, Pfaus cites the inhibitory effects of non-reward experiences [4]. This could be when an individual does not experience orgasm during their first sexual experience, and therefore does not receive the intense chemical and emotional reward that accompanies it, making the individual less likely to repeat the behavior. These three inhibitory sources, however, manifest into chemical effects within the brain and act on various levels of the excitatory system to suppress it.

Neural Differences in Gender

In terms of gender differences, Pfaus [4] notes the production of hormones from the female ovulation cycle creates fluctuations in desire, arousal, and emotional responses. Specifically, in the follicular phase, or the two weeks of the menstrual cycle prior to menstruation, women are producing greater amounts of the hormone estradiol and consistently report greater sexual desire. Specifically during this stage, Pfaus cites studies that found women were aroused by pornographic videos, but were not aroused during the second half of the menstrual cycle when estradiol level is low. Because this hormone is not present in high levels for men, or after menopause in women when sexual desire decreases, estradiol may be a very important gender difference in the neural arousal pathways.

Estradiol, a biological factor of female sexuality, is another piece of evidence that challenges the assumption that biological factors were more dominant in males than females from Baumeister [2]. Though not incompatible with the theory, since Baumeister acknowledges the role of biological and social functions in each gender's sexuality, it does present an interesting foundation for future investigation about the neurological differences between genders. If there are meaningful variations, then the differences may not be as easily attributable to social factors when one brain system is no longer comparable to the other.

The evidence which indicates that women's arousal is contingent upon timing within the menstrual cycle also challenges the results of Chivers [6] and poses questions about implications. If arousal is in fact only hormonally induced, what about the hormones is widening the scope of arousing stimuli? Since these results are found during the period of fertility, might they be the result of evolutionary or reproductive adaptations? If a woman were becoming fertile and not yet pregnant, it would be evolutionarily beneficial to increase the range of potential partners she would be attracted to. It is also interesting to note that the women in the study seemed to report increased desire but not necessarily an increase in libido. In circular logic, the regulatory function of social and personal evaluation may be the inhibiting factor during this time. In sum, the evidence that there are hormonal underpinnings to changes in

female desire indicates that there is a potentially meaningful difference between females and males, which would begin to explain some of the gender differences highlighted in the human sexuality field.

Additional neurological studies found similar differences between genders. While watching porn, heterosexual women spend more time looking at other women and genitals while heterosexual men are more likely to look at women's faces [7]. Although these results suggest stability rather than flexibility in desire, as theorized by Baumeister [2], they highlight that there is a greater range in the types of stimuli females are aroused by. This range in female arousal makes it possible for behaviors to be sampled from a diverse realm of satisfying possibilities that would appear as flexible or as adaptation to situational cues.

In short, modern scientific research continues to demonstrate that females have greater variation in sexual desires and behaviors than males. With this insight, the purpose of my gender studies thesis was not to find the scientific evidence for differences between the genders and their pathways of sexual arousal, but to point out the limitations of the field and suggest new directions. Because both psychology and neuroscience heavily emphasize explaining female sexuality, my alternative hypothesis was to understand male sexuality as culturally influenced, as Baumeister suggested female sexuality is [2]. The limited research on male sexuality leaves this hypothesis in the realm of speculation and a worthy avenue for future research.

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