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Review Article

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The Interplay of Sexual Health and Neurosciences

Agostinho Leite D'Almeida

Ast Prof of Psychology, retired, Department of Social and Behavioral Sciences, University of Maia, UNIMAIA, Portugal

***Corresponding author**
Agostinho Leite D'Almeida, Ast Prof of Psychology, retired, Department of Social and Behavioral Sciences, University of Maia, UNIMAIA, Portugal.

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Introduction to Sexual Health

Sexual health is a crucial aspect of human well-being encompassing an individual's physical, psychological, emotional, and social experiences related to sex. Ubiquitous among species, sexual response is valuable for survival, with natural selection favoring successful reproduction. However, sexual function varies between cultures due to moral and legal restrictions, sex education, diverse beliefs, lifestyle changes, technological advancements, and social networking demand. Sexual attitude and behavior are influenced by these settings with adaptation required. The subjective experience of sexuality is complex with inter-individual variations due to diverse stimuli. Sexuality encompasses cognitive, emotional, behavioral, cultural, and biological functions blending multiple systems. The frequent engagement of multiple systems is essential for guaranteed complex function. The biological basis of sexuality relies on anatomical substrates, which include the brain, connectivity, and neurotransmitter configurations. Sexuality is situated in the neurological organism's brain within neural circuits devoted to its function. The emergence of profoundly adaptive sexuality was an evolutionary acquired trait requiring an increase in complexity and metaplastic change of neural structure and connectivity [1].

Neural structures engaged in sexual behavior are located in the nervous system. The peripheral nervous system receives stimuli. Sensory input from various modalities is processed through an upward pathway in the central nervous system. This processing activates the amygdala, hippocampus, cortical structures, and hypothalamus controlling responses at various levels. Interaction with other feelings modifies the reaction complexity. An erection is a multistage event triggered by cognitive, emotional, or sensorial signals. Detection of potential sexual stimuli is reliant on multimodal sensory flow including ocular, olfactory, acoustic, and cutaneous modalities initiating a cortical visual/integrative pathway independently of genital stimulation. Triggers of sexual arousal are represented within the limbic system with the amygdala involved in the recognition and motivation. Disinhibition of exerted control by the limbic system increases sexual motivation and arousal displaying activational sexual behavior.

Overview of Neurosciences

As part of the neuroscience of sexual system and behaviors, anatomofunctional principles of the human behavior towards sex, sexuality, sexual health and sexual dysfunction are reviewed. Advances in understanding of the neuroanatomy underlying human sexual behavior, which represent an interesting interplay between anatomical issues and social values, are therefore useful to enhance both the level of knowledge of health care professionals and the approach towards men and women with sexual health problems. Yet, a profound change in human sexual behaviors and morals has occurred especially in the last decades. On one hand, there are stresses for sexual health such as new hygienic demands, social roles, sexual risk-behaviors, and sexual victimizations. On the other hand, new perspectives on sexual rights, syndromic approaches, and gender issues have emerged. Sexual desire, arousal, orgasm, and resolution are responses generated by them. Inhibitory and excitatory influences from other brain regions are necessary for sexual behavior to occur. Detection of multimodal sexual stimuli initially involves the transmission of information from peripheral sensory structures to the cortex that represents newly acquired knowledge for sexually relevant stimuli. Information regarding the unconditioned valence of sexual stimulus is then transferred to the amygdala for the generation of an emotional response. The detection of sensory experience from sexual stimuli triggers a complex series of autonomic and motor responses that ultimately culminate in sexual behavior, which is subject to cognitive control. Mechanisms underlying sexual desire,

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arousal, and orgasm are common to both sexes, although sexual behaviors differ in various aspects between males and females. This assumption seems to be valid even for monoaminergic and peptidergic systems similar in both sexes but which have distinct anatomical and neurochemical characteristics that confer different functions. Most distinguished aspects relate to the divergent evolution of reproductive organs and the de facto circumscriptions imposed by the social environment.

The Biological Basis of Sexual Health

Sexual response, defined as the overall or local physiological events taking place in responder, is a key condition of all the species without exception. Animals other than man engage in sexual behavior by exploiting the respective neurological-endocrine-genetic characteristics leading to a fixed, species-specific behavioral pattern during sexual excitement. In the case of man, centuries of culture have built an enormous setting around the main ability but with the requirement to adapt behavior to an ever-adjustable, learning set-up which necessitates the deciphering and dynamic reconfiguration of experience pool to match behavioral adaptation. During the last twenty years, numerous advanced studies have contributed to a lasting understanding of human sexual behavior by exploring a number of relevant issues, however, those addressing anatomic/neurophysiological data are seldom outnumbered [1].

Nevertheless, there is some general neuroanatomical background currently available. Evolutionarily, sexual behavior seemed to arise first with low mammals and behaviorally grow fancier in higher species. The structures involved in the mediation of sexual behavior seem to be widely located throughout the central and periphery nervous systems; limbic structures act to modulate sensory data by classifying them under polite, nurturing, aggressive, or sexual. As hypothesized, detection of a multimodal sexual stimulus is first performed by sensory processing at thalamic level and then after extraction of that stimulus modality able to map onto the amygdale the neural representation of which is merged with the prior experiences as compared to set the arousal or inhibition mode for the ensuing neurovegetative and motor responses. Available data support a significant potential of neuroanatomical substrates in the study of sexual response but are hardly manageable in such a synthetic manner.

Sexual desire, desire for coitus, is an intriguing psychological phenomenon: unlike the need for water and food whose satisfaction is automatic and immediate, sexual desire is profoundly influenced by the meaning attributed to it. Aesthetic values (beauty and/or cuteness) are prime enhancers while real, fabricated or fantasized aggressive behavior is a deterrent. Sex and coitus are commonly perceived as the richest source of euphoric or distressing experience. Cultural settings have dramatically influenced sexual behavior amongst homo sapiens and inter-species differences are currently the result of a long process of selective breeding. The neurophysiological basis subservient to sexual-behavior perception is poorly understood, the few available studies indicating utilization of the same neural circuits in both genders. These detect linguistic, bodily, cum foetal attributes reflecting attentional settings engaging similar network of structures, even if some gender differences in EEG potentials have been reported. Accordingly, progressive non-conditional stimulus discriminatory tasks suggest that, independently of the salience of the stimulus modality, the progression of neural engagement spreads from simple analysis at early times towards more integrative processing at later times.

Hormonal Influences

Sexual functioning is the result of complex processes involving multiple factors interacting with each other in a way that is still poorly understood. Sexual health is recognized as an important aspect of individual well-being, and interest in the neuroscientific basis of human behavior has exploded in the last decade. Psychophysical and hormonal influences, neuroanatomy of the CNS structures implicated in human sexual behavior, and a survey of electrophysiological recordings in human brain are reviewed.

There have been several neuroanatomical and functional magnetic resonance studies on the brain areas involved in human sexual behavior. Research directed to the neurobiology of sexual function has been renewed in recent years because of an increasing awareness of the deleterious effects of several pharmacological agents on sexual behavior, together with the high incidence of male sexual problems [1]. In this setting, a wide variety of endogenous, peripheral and central, neurotransmitter and neuromodulator factors is involved in male and female sexual function, although, compared to the neuroanatomy of the genital systems, it has been a neglected area of research. Nevertheless, neuroanatomical and functional studies are an exciting and rapidly evolving area of research, and studies have recently been published that provide new insights on the anatomical substrates and neurological basis of human sexual function.

Neurotransmitters and Sexual Function

Human sexuality is complex and is regulated by a variety of factors. Hormonal variations can have an important impact on sexual interest, activity and performance, and overall, on sexual health. Nevertheless, the main interest concentrates on how the central nervous system regulates sexuality, the part of the body that aims to give a reliable long-term answer to sexual stimuli. Sexual health and functionality, or pleasant orgasm with euphoria, or painful impotence with aversion, vary greatly among individuals. Different brain areas are selectively activated in different sexual arousal situations. People with sexual dysfunctions often have brain activation changes, which are linked to the relevant symptoms. Knowledge on the neuroanatomy and circuits underlying human sexual response is limited, with respect to their scientific and clinical importance, being neglected.

In the past decade, a growing body of work has begun to shed light on ignoring aspects of neuroanatomy and function of human sexuality in building concern of sexual deviations and dysfunctions. Understanding the neural basis of sexual behavior is of importance in understanding the cause of its dysfunction. This is particularly true in sexual desire, an essential component of sexual health recognized by DSM-5. The brain plays a pivotal role in sexual arousal. Neuroimaging studies have identified a number of brain regions that exhibit significant activation in response to sexual stimuli, sexual fantasy and sexual arousal. The role of the neuroanatomists, neurologists, and neuropsychologists in the field of sexual health should be more active.

Sexual activity involves various kinds of behavior in both sexes, such as courting, mating, and pairing, with specious differences. The overall sexual behavior of humans is subject to strong social and cultural influences. Research on human sexual behavior has mainly focused on sexual orientation, sexual motive, and association of sexual behavior with behavioral disorders. There are some recalls of sexological works relevant to sexual preference and arousal, and reports are presented of a case showing sexually provocative criminal behaviors and relevant neuropsychological findings, with special emphasis on brain mapping of a male patient who exhibited violent sexual urges toward an unfamiliar female who sat next to him in the bus [1].

Neuroscience of Sexual Desire

Scientific interest in sexual response dates back to the biblical antiquity and continue today with fresh advancements in knowledge. Sexual response, as defined in this paper, is a physiological condition expressed throughout the species. Thus, in order to understand human sexual behavior, it may be informative to consider first some aspects of sexual behavior in vertebrates [1]. Sexual behavior of vertebrates has been studied in many species including fishes, amphibians, reptiles, birds and mammals. In an effort to understand the anatomical and functional mechanisms underlying these phenomena, considerable advances were made in the fields of neuroanatomy, physiology, ethology and pharmacology. However, in recent years, a great explosion of knowledge on the neuroscience of sexual behavior has occurred in humans, especially in women. In man, more than a century of study in the medical practice has produced a huge amount of knowledge and understanding of the complex interplay of biological, hormonal, neurological and psychological factors which act in sexual function. Nevertheless, even today, there is still an ongoing effort to increase the understanding of man's sexuality. Much of the research carried out in female non-human animals appears to have been guided by the widespread belief among scientists and clinicians that the study of sexuality in women involves more subtle and slower acting nervous, endocrine and genetic factors than in men. During stimulation the detection of multimodal sexual stimuli is the starting point from which a task of sensory processing is exercised in order to trigger the autonomic and motor response of the individual. Descriptive nuclei measure in a specific way the sustainability or aversive component of sexual stimuli. Conciliatory nuclei homeostatically represent the presence and availability of a potential mating partner, as well as the obligation of taking care of the offspring. Rather than conscious motivations, they are responsible for the emergence of subjective feelings of desire. Neural structures engaged in sexual behavior are located down through the length of the nervous system in fish, frogs, turtles, rats, monkeys and man. At three different levels, brain nuclei receive the input from five modalities of sexual stimulation. Awards this involves activation of structures and the release of transmitters in quite different brain regions, pathways activated in learning and consciousness mediate the intricate interplay of sexual function and cognition.

Brain Regions Involved

The versatile nature of Sexual Health (SH) embraces biological, psychological, biomedical, social, education, environmental, and legal dimensions. The WHO emphasizes an integrated and multidisciplinary cultural approach to SH. SH is a complex concept relying on the strict interplay between brain areas that cooperate to guarantee human sexual health and balance with mental well-being. On the contrary, alterations of regional brain function and/or structure can lead to neuropsychiatric disorders altering SH [1]. Brain mapping has been crucial in the last decades in modelling human brain function. A simultaneous exploration of the anatomical, neurophysiological, and functional dynamics of brain areas is still missing in sexual health and neuroscience.

Brain mapping studies exploring the anatomical and functional underpinning of sexual desire, as well as the sexual drive having a relatively distinct neuroanatomical and functional organization, have been conducted. Convergences to this area have been observed with cue-induced brain activity correlating with external conditions associated with a psychosocial function in the sexual desire domain. Studies investigating human sexual orientation, sexual desire, and sexual activity have been conducted, and imaging studies demonstrated that human sexual response involves various brain areas. In the first paradigmatic elegant fMRI studies on the neural basis of sexual response in humans, online studies of brain activity during sexual stimulation were pioneered.

Human sexual response was found to embrace a relatively broad network of cortical and subcortical areas. Planum temporale, hypothalamus, striatum, amygdala, orbitofrontal cortex, and insular were the most relevant areas belonging to a ventral pathway that was suggested to convey sexually salient stimulus from the sensory cortex to the amygdala. The evidence of sexually selective areas with increasing discrete selectivity along the ventral pathway was provided. A multiband imaging study on both appetitive and consummatory sexual behavior contrasting sexual viewing with the resting state. A "sexual wanting" and "sexual liking" pattern is identified. The sexual wanting network mainly involves the right superior parietal lobule, left nucleus accumbens, left orbitofrontal cortex, left anterior cingulate cortex, amygdala, and hippocampus. A "sexual liking" pattern was found to be relatively distinct involving the bilateral inferior parietal lobule, left hypothalamus, left insula, and middle cingulate cortex.

The Role of Dopamine

Dopamine (DA) is the main neurotransmitter of the mammalian reward system. Dopamine neurons project from the ventral tegmental area (VTA) to the striatum and prefrontal cortex. The role of DA in human sexuality is not completely understood yet and most of our knowledge comes from animal models. This makes sense given the difficulties in studying human sexuality. Increases in DA in the striatum disinhibits pathways through which the cortex elicits movements: a) DA is released in the nucleus accumbens during exposure to a receptive female and copulation, however b) DA is released in the VTA and medial prefrontal cortex during exposure to a receptive female but this does not elicit copulatory behavior. The latter is different for males and females and suggests that ventral striatal DA is important for the motoric aspect of copulation, while the VTA-accumbens connection is likely for sexual motivation. Anticipation of a rewarding event also predicts the sight of the receptive female, however and it is unclear what role DA plays in this process. One neuroanatomic basis for action is the medial preoptic area (MPOA), where glutamatergic projections to the

medullary raphe in turn send serotonergic projections to the spinal cord [1]. DA acts in the MPOA in order to promote male sexual behavior. Circumstantial evidence for this hypothesis comes from the following observations: a) all MPOA lesions abolish male sexual behavior, b) all DA-containing lesions in the MPOA abolish male copulatory behavior, c) lesions of the projection from VTA to MPOA decrease socio sexual interaction. Most D1- and D2-like receptor agonists facilitate male sexual behavior. Systemically administered eliaprine acts as a selective D1-receptor agonist and facilitates male sexual behavior in a dose-dependent manner. Issues in the prefrontal cortex include loss of sexual incentive motivation and failure to appear receptive, and lesions may also impair the processing of sexually significant stimuli. Already in the 1940s, dopaminergic drugs were said to facilitate male sexual function clinically. Amantadine, a DA agonist marketed for Parkinson disease, also facilitates erection and copulatory behavior. Screened for compounds to treat impotence, the classic DA agonist apomorphine is effective in treating erectile dysfunction with few side effects. There are three component behaviors in male sexual function: a) intromission; b) erection, c) ejaculation, and they each differ in the degree of autonomic involvement. In castrates, small increases in DA in MPOA disinhibit spinally-mediated genital reflexes; moderate increases facilitate parasympathetically mediated erections and copulatory behavior; and large increases in DA promote sympathetically-mediated ejaculation but inhibit erections. The SNc, on the other hand, is apparently less important for sexual behavior than the VTA. On the other hand, cocaine enhances DA activity by blocking the presynaptic autoreceptors and enhancing DA release. Intravenous cocaine is a common recreational drug and is associated with hyperactivity, insomnia, talkativeness, euphoria, and decreased appetite and is often viewed as an "aphrodisiac" enhancing sexual desire, sexual performance, and pleasure perception. Nonetheless, chronic cocaine abusers often experience sexual disorders such as inhibited sexual arousal, diminished sexual desire, or inhibited or premature ejaculation. Chronic treatment disrupts the dopaminergic system probably after continuous stimulation. The effects of acute and chronic cocaine on sexual function are still not completely clear, possibly due to the diversity of contextual factors surrounding drug use. Cognitive and motivational processes are certainly of importance regarding the effects of acute cocaine on sexual desire and perception of pleasure during sexual excitement.

Impact of Sexual Health on Mental Health

Sexual health is an important aspect of quality of life for gynecologic oncologic patients. Sexual health is an important aspect of quality of life and patients with gynecologic cancer frequently report sexual health concerns. Patients often face psychological concerns including worry, anxiety, and depression. Understanding the relationship between sexual health and mental health needs to be prioritized. Such understanding will aid in developing therapeutic interventions to maximize sexual health and mental health [2].

Sexual satisfaction and quality of life are strongly connected. Neuropsychological consequences of sexual dissatisfaction may result in serious implications in terms of quality of life, psychosocial, and emotional status. In recent years, the mental health sector has stressed the importance of fostering individuals' quality of life. Health professionals make treatment decisions on the basis of objective assessments of disorders that patients present. Yet this focus ignores subjective factors that experience is believed to be central to health. Since quality of life is a broad and subjective manner of conceptualizing impacts on daily living, many aspects of quality of life are studied, with the most frequently used domains pertaining to physical health, psychological well-being, social relationships, and environment.

Sexual health influences quality of life in many ways. Sexual dissatisfaction is higher in patients with depression than in those without depressive or anxiety symptoms. Focusing on partnered individuals, those in a partner relationship tend to report higher sexual satisfaction and sexual activity. Having a partner increases the likelihood of consistent sexual contact. Being married is associated with better mental and physical health. Almost all studies highlight a strong relationship between sexual satisfaction and general well-being including mental health, and individuals deprived of sexual contact report particularly large differences in mental health. Interpersonal variables have differential effects on mental health [3]. In particular, the quality of friendship has a different impact on mental health in partnered and single individuals.

Anxiety and Sexual Dysfunction

Symptoms associated with anxiety are viewed as physiological alterations of the body due to an enhanced sympathetic nervous system (SNS) activity, such as an increase in heart rate, blood pressure, breathing frequency, blood flow to muscles, and perspiration. Anxiety is accompanied by feelings of worry and uneasiness about the current or future events [4]. Anxiety is assumed to be a root of sexual dysfunctions. Sex and anxiety account for opposite extremes. Sex is viewed as a process promoting approaching behavior, whereas anxiety is viewed as a process promoting avoidance behavior. According to this view, the innate conflict between these two urges leads to sexual dysfunctions. Despite the commonsensical notion regarding the interplay between anxiety and sexual function, only few studies have explored the effect of anxiety on sexual function, mainly focusing on the prevalence of sexual dysfunction or on the experience of anxiety during sexual situations. Several researchers have examined the sexual functioning of women with panic disorder, finding that women with panic disorder have significantly higher sexual dysfunctions than healthy women. Moreover, some researchers have found a higher prevalence of sexual dysfunctions in patients with panic disorder, compared to patients with social phobia. Fifty percent of the patients with panic disorder present with sexual aversion, which is the most common sexual dysfunction in this type of patients. The difference in the prevalence of sexual aversion in panic disorder patients compared to other anxiety disorder patients suggests that these patients experience an enhanced inhibition of sexual approach feelings.

The avoidance of sexual intercourse in panic disorder patients may be heightened sensitivity to bodily sensations. Studies have emphasized the idea that heightened levels of sympathetic arousal may interfere with women's subjective sexual arousal and physiological sexual responses, although their results indicate that such situations are not entirely negative for men [5]. Both too much and not enough arousal are used to explain some other sexual difficulties, and it is suggested that an up or

downward shift in arousal may be beneficial in certain contexts. A variety of variables associated with cognitive processing are discussed in the context of explaining performance decrements with anxiety or distraction, in the hope that they may represent concepts that need to be pursued in sexual response research and treatment initiatives.

Depression and Sexual Well-being

Sexual activity and satisfaction are intrinsic to general well-being and health. This often-neglected dimension of quality of life is also a fundamental right. The condition of individuals in a wide array of social contexts is greatly affected by their sexual health, yet this area of health remains underexplored, neglected and poorly understood. Sexual health is considered a positive and multidimensional experience which must be addressed within an integrating theoretical model inspired by the psychosocial paradigm. Public policy must acknowledge both a strong societal and scientific interest in sexual health. Efforts to detect and counter sexual health risks need to be supported by communication and educational campaigns [6].

The relationship between depression and sexual well-being in diverse populations has been examined. Although sexual health is intrinsically linked to mental health, it has been widely overlooked as a relevant aspect of mental wellness in both research and clinical practice. Depression is one of the major causes of health burden. Affecting a wide range of populations across a spectrum of life stages, cultures and socioeconomic backgrounds, depression is a major, treatable public health problem. Nevertheless, more nuanced representations of gendered experiences of mental well-being have yielded evidence to suggest that the prevalence of mental health issues in women differs as a function of shifting sociocultural values and gendered experiences.

In considering the interplay of sexual and mental health, it has been found that a diagnosis of a mental health disorder is associated with lower satisfaction in most dimensions of sexual health. Across numerous studies which include pertinent controls such as sexual health history, sociocultural factors and relationship quality, sexual dysfunction has consistently been reported to be one of the most prevalent issues within the domain of sexual health among individuals presenting with mental health disorders. Some studies have reported an increased suggestibility to the onset of all sexual health problems following the development of mental health disorders. In conclusion, promoting sexual well-being amongst mental health disorder treatment populations may be valuable.

Neuroscience and Sexual Orientation

Individuals do not specify their sexual orientation, attraction, or behavior; rather, they report these characteristics as felt. High-quality studies have shown the presence of same-sex sexual orientation (or attraction and behavior) in virtually all human populations, indicating a largely universal phenomenon. In the great majority of individuals with same-sex sexual orientation, attraction is erotic and sexual, although in some cases, it is romantic or just an affinity with social and physical interaction [7]. These and other phenomena associated with same-sex orientation are observed beyond humans and are argued by ethologists to be normal intraspecies behavioral variation.

The term sexual orientation often refers to a stable pattern of emergent or explicit sexual attraction and chemical odor preference. Sexual orientation should not be confused with sexual behavior. Consider, for instance, abused children, those living in sexually segregated environments, or some hormonally affected individuals who are frequently of the same gender or biological sex as an object of whom sexual behavior is otherwise extremely rare or non-existent. Although all sex differences are probabilistic, in the majority of species, males are typically larger and more aggressive than females (and vice versa for some human minorities), and the same is true for many gender differences [8]. Some human habits almost never cross gender lines.

Sexual orientation is still thought, in some jurisdictions, to be outside the law, and although most individuals are probably tolerant of others' sexual orientation, a sizable minority, still predominantly but not exclusively female, are reported to have 'homophobic' (or more properly heterosexist) attitudes. Like any inherited trait, including language proclivity, a population cannot be conceived of without the behavior of preference per se. It is time to consider the mechanisms of the sexual preference actions carrying with them social consequences, such as societal organization and policies, quality and quantity of marriages, parents, and children.

Biological Factors

The impossibility of de facto sexual health could lead to the refusal to the autonomous ability of the conscious self to be free to express their own sexuality and thereby it becomes a taboo. Those taboo subjects discussed will be initially presented as what sexual health is, what neuroscientific evidence could entail and how might both these concepts be defined. The principles of sexual health being stated, finally, the interplay of neural processes and sexual health will nonetheless be undertaken.

Therefore, it would be imperative to define sexual health before the description of possible neuroscientific evidence. Sexual health was defined in concordance with the definition of health not restricted to the absence of illnesses. Consequently, sexual health comprises feeling well with respect to one's sexual life, and it is important to mention again that the sexual life of each individual is influenced by socio-cultural factors which would not refer only mechanical conditions but would synchronize a psycho-physiological complexity that might be novel per se. Genetic factors might implicitly code, inter alia, the sex itself, any malformations or diseases, basic psychopathologies of thought and behaviour and even possible measures helpful to sexual satisfaction. It could be possible, however, that globally these factors would implicitly dissimulate signals suggesting sexual life.

More specifically to the sexual features of the risk of sexual unhealth, the unique issues of such risks and their incapacity to supplant menaces to general health are being mentioned. As concerns specific factors which might entail sexual health some considerations have to be done. In line with how they realized the definition of sexual health before them, it would be suggested that social pressure and normative sexual behaviours leave a marginal space to personal, individual, inner life.

Social Influences

Each new capacity or risk behavior develops in a social context. Adolescent social life is marked by the increasing importance of peer influence. Adolescents spend progressively more time with peers, who become increasingly central in social activities and communication. Neurobiological changes likely help facilitate this shift toward autonomy from parents and reliance on peer social evaluations, thereby bringing increased social risk. Changes in both predictive neurodevelopment and cognition could serve to internalize cultural models of sexual behavior during early and middle adolescence. Mechanisms of sexual decision-making would correspondingly acquire social and evaluative components, including the need for peer approval of sexual behavior and concern over peer rejection associated with sexual inexperience. As social rewards grow more salient, peer sexual behaviors wield greater influence over decision-making and risk increases [9]. There are many neurodevelopmental mechanisms supporting this shift toward the social context. The adolescent peer hike in social reward seeking coincides with neuroanatomical changes in reward networks. Modeling peer influence on risky reward outcomes helps depict the nonlinear computation of risky social rewards that becomes more prominent with development. Adolescent risky sexual behaviors fall within the broad category of social influence on risky behavior, as peers are a key source of sexual reinforcement and social models of sexual behavior. Neural circuits supporting social comparison to friends' risky sexual behaviors may help explain the marked increase in sexual behavior from early to middle adolescence, when modeling is particularly salient. Exploring the neural and behavioral dynamics of such influences in a richer, more specific social context can help disentangle decision-making mechanisms being away from one-on-one modeling that would provide more ecological relevance.

Sexual Health Across the Lifespan

Human sexuality is an important aspect of health across the life course. Sexual health is recognised by the World Health Organisation as the state of physical, emotional, mental and social well-being in relation to sexuality, not merely the absence of disease or dysfunction. Data is emerging to indicate that sexual activity is associated with many aspects of health, including objectively measured health and longevity. State-specific estimates of sexual activity are provided for all 50 states and the District of Columbia.

The prevalence of sexual activity decreases massively among persons aged 18-85. The prevalence of sexual activity in the past year is 69% for persons aged 57-64, 57% for those aged 65-74, and 28% for persons aged 75-85 [10]. In addition to problems with sexual activity, sexual dysfunction, negatively defined as difficulty with some aspect of the sexual encounter, has been studied in depth. No studies to date have focused on the expected duration of sexually active life among the elderly.

The relationship between general and sexual health among older adults is reviewed with methods, participants, and outcomes of understanding sexual activity and health among those aged 57-85. The first aim is to present population estimates of sexually active life across the lifespan, specifically expected duration of sexual activity at various ages, and geographic variation in activity. The second goal is to present the natural history, or longitudinal patterns, of sexual activity in those aged 57-64 as those individuals grow older. This shorter lifespan projection for sexual activity represents an important gap in research [11]. Recent papers have focused on a single population and examined this issue cross-sectionally. Longitudinal studies over an expanded age range are needed to address the ultimate epidemiological question of what happens to sexual activity among the everaging population of older adults.

Adolescence and Sexual Development

How does the onset of adolescence shape sexual activity? The onset of adolescence is a time of profound changes in motivation, cognition, behavior, and social relationships. During this time, young people also increasingly focus on romantic and sexual interests, both in general and as a personal endeavor. Surprising little is known about how the unique features of adolescence shape sexual activity and romantic relationships. Here is an introduction to some of the biological and social context that is relevant for understanding sexual development, an area of human development for which there is quite limited research.

Adolescents undergo a period of social, emotional, and bodily change that is sometimes compared with that of early childhood. Beginning around 10 years of age, youth become increasingly interested in romantic and sexual relationships, and some begin to act on these interests. Extensive individual and cultural variation can be seen in how these relationships develop along the dimensions of age and duration. Teens typically become involved in romantic relationships 3-5 years earlier than they did even 20 years ago. There has been surprisingly little focus on the importance of adolescence as a sensitive period for romantic and sexual development. As young people enter adolescence, one of their primary tasks is to gain knowledge and experience that will allow them to take on the social roles of adults. This involves a set of biological, social, and cognitive changes that shape not only when dating begins but also the nature of romantic and sexual relationships in this formative time.

The science of adolescent romantic and sexual pairing is in its infancy. Importantly, this does not mean that there is no science of adolescent romance or sex. There are many excellent scientists collecting impressive data that will hopefully be used to continue to bolster our understanding of adolescent romantic pairings. And yet, interest in the role that this early budding romance or sexual behavior plays in the broader developmental course of adolescence is just beginning. Specifically, many developmentally important questions surrounding when and why these explorations begin are known. Just like the initiation of sexual behavior and the development of sexual orientation, great strides have been made almost in the history of amassing data on the timing and context of when early romantic relationships occur [12].

Aging and Sexual Function

Sexuality and sexual function have clear importance for women and men at all ages, including older age. This is apparent in the large amount of previous research into sexual function and health in the aging population, the focus of much public health messaging and the extensive products in the market to address changes in sexual function due to aging. Such changes in sexual function and health can start earlier and are often acutely felt in 40- and 50-year-olds [13]. Nonetheless, for many, sexuality

continues to be an important part of their life for decades longer. For some, sexuality is reframed and expressed differently, while for others interest in and enjoyment of sexual activity declines. While public health messaging may start from a more medical perspective focused on functional disadvantage, continuing sexual activity is seen by some as a crucial aspect of aging well into later life. Sexual expression can be complex and take many forms in later life including flirtation, touching, kissing, fondling and sexual intercourse. And while contact sexual activity is a defining and significant aspect of sexual activity, other forms of intimate expression remain meaningful in their absence.

Sexually-related problems can be prevalent for people of all ages, yet, as for sexual activity, the cause of such problems will be different between younger and older people. For younger people, problems might stem from different contexts including difficulties in forming intimate relationships, anxieties about sexual performance or potentially traumatic encounters, while for older people, such problems may be more likely to arise from physical health difficulties or medication side effects. The increasing focus on sexual health in public health messaging is welcomed, yet this has also taken a somewhat binary approach. On the one hand prevention through public discussion, safe sex messaging and product development, with a shift of focus onto older age in recent decades. On the other hand, the need for treatments and functions discussions related to prostate cancer treatments, vaginal atrophy or erectile dysfunction. Addressing this imbalance in the public health messaging is pressing in the current political context, especially as research continues to demonstrate that sexuality is deeply valued by older people.

The Role of Education in Sexual Health

Health educators play an important role in the sexual health of a population. Health educators are professionals trained to deliver health or health related education to a population. Their trainings varies depending on their intended profession or field of work, most commonly, their trainings are health and research oriented. Another field of study some health educators are specialized in is sexual education. However, there are very few medical doctors who specialize on sexual health education. There is an increasing demand for medical doctor health educators who specialize on sexual health. Medical doctors are trusted more than other health educators to inform the public on sexual health and diseases [14].

An existing blood borne pathogen education policy in a rural high school district was used to test the impact of physician involvement. Investigator observations revealed that the inclusion of a physician in the development and adoption of health education policy created a stronger perception of legitimacy by policy makers. Qualitative interviews with school district employees revealed that physician involvement had made an impact, due to the unique ability of physicians to communicate with many stakeholder groups. Despite the larger health care focus of physicians, their involvement with school health education guidance policies was well-received. Although physicians lack expertise with the educational field, their inclusion in student body health policy development crafted stronger policy outcomes.

Sexuality education policy is a necessity for medically accurate, developmentally appropriate education on healthy sexual development through youth. The personal nature of sexual health makes it more pertinent for community members outside the school system to be involved in this type of legislation.

Comprehensive Sexual Education

Sexual health is an integral part of overall health and well-being and is fundamental to the sustainable development of societies worldwide. Sexual health is not only the absence of disease, dysfunction or infirmity but also requires a positive approach to sexuality and sexual relationships. To identify and address sexual health concerns, an understanding of how sexual health is defined, how sexual function is understood, and common disorders is imperative. The sexual response starts with sexual desire followed by arousal leading to activities such as intercourse and masturbation. The latter is also referred to as sexual activity. Sexual health can be better understood using the sexual response cycle which was defined by Masters and Johnson. There are four phases of the sexual response cycle: desire, arousal, orgasm, and resolution.

Sexual dysfunctions are characterised by a clinically significant disturbance in a person's ability to respond sexually or to experience sexual pleasure. Sexual dysfunctions affect both men and women. Disturbances in desire (male hypoactive sexual desire disorder, female sexual interest/arousal disorder), arousal (male erectile disorder, female sexual interest/arousal disorder), orgasm (male delayed ejaculation, male pre-ejaculation, female orgasmic disorder) and pain disorders (male sexual pain disorder, female vulvovaginal pain disorder) present for a duration of 6 months or more that cause clinically significant distress are matters requiring clinical care [1].

Sexual health is an integral part of overall health and well-being and is fundamental to the sustainable development of societies worldwide. Sexual health is not just the absence of disease, dysfunction, or infirmity, but it also requires a positive approach to sexuality and sexual relationships. Sexual health is not merely the absence of disease, dysfunction, or infirmity; it requires a positive approach to sexuality and sexual relationships [15].

Neuroscience in Sexual Education

Sexual Health Education programs often focus on the prevention of teenage pregnancy and sexually transmitted diseases but are limited in their discussion of other issues related to sexual health. Information on topics such as the neurophysiology of arousal and desire, sexual function, and dysfunction may be valuable to students. Research in neuroanatomy and the physiological bases of sexual behavior in animals has been well documented, but minimal information regarding the neuroanatomy of sexual behavior in humans has been presented to undergraduate students in health-related professions. This too may limit their ability to counsel patients concerning basic human sexual function and dysfunction [1]. The clinical implications of embryological malformations of the spinal cord and peripheral organs have also been largely neglected in the literature. This may deny students an important opportunity to learn about life issues that are unique to younger individuals with such disorders.

Sexual Function and Dysfunction. Students in medicine, physiotherapy, nursing, and allied health curricula are often unaware of the multiple components of human sexual

expression. Many will be the first line of investigation and referral for a consultation concerning male or female sexual function. A thorough understanding of the normal neuroanatomy and physiology of sexual behavior, expression, response and satisfaction is paramount before the clinician can explore the contribution of, and thus treat, peripheral organ, psychological, or central nervous system dysfunction. A knowledge of human sexual function and dysfunction is equally important for allied health professionals. A strong grounding in the neuroanatomy of normal behaviour would allow practitioners to provide advice in regards to healthy options for sharing intimacy with partners with limited peripheral organ function. What students may need are theoretical presentations and discussions with group tutorial work that invites them to unpack the complexity of contemporary human sexuality and share their perceptions and understanding of what are often considered personal matters.

Cultural Perspectives on Sexual Health

Society's attitudes toward and understanding of sex and sexuality have enormous impact on individual lives, community cohesion, and societal well-being. Doctors, in particular, can provide valuable perspective given their training in biomedical, psychological, and social theories of health and disease. Yet, trained medical practitioners are suspiciously absent from these discussions, allowing the formulation of sexual education curricula to devolve to individuals with little formal training in health. For decades, a feud between conservative and progressive factions regarding the role of government, religion, and family in presenting sexual topics has played out mainly in loud and vitriolic debates. Increasingly, this debate has transitioned from legal and legislative channels into the public eye, as groups rally for or against sex education touting slogans such as "sex is sin" or "sex is weapon" [14]. In light of these evolving conversations, inclusion of trained medical professionals is long overdue. By explicating medical facts about sex, clarification of disputes between physicians and other stakeholders may help identify middle ground for common, comprehensive sexual education workable in the communities of those stakeholders. The goals of this proposal are to articulate how medical practitioners are trained to think more critically and deeply about sex than are other stakeholders, to present an overview of the medical facts surrounding sex that form the foundation of educated discussion, and ultimately, to call for consideration of the presentation of these facts to the other stakeholders in the sexual education conversation.

On its merit as a topic, sex is something incredibly personal for individuals and society at large. The immense social importance of sex is evidenced throughout time and history in literature, religion, philosophy, art, politics, law, and social structure. It is one of the most commonly discussed subjects worldwide, ranging from casual, everyday banter amongst friends, to the most sacred, exclusive conversation imaginable. However, despite this universality, the openness or constraint with which it is discussed depends in large part on the society of the speaker.

Cultural Attitudes and Neuroscience

Sexual feelings and behaviors occur in a social and cultural context. In Western society, attitudes toward sex and explicit sexual material are varied, often within the same culture. Attitudes also change over time. Historically, various forces have affected cultural attitudes toward sexuality. Scientific understandings of sexuality are dictated, in part, by cultural and basic belief systems [1]. Each religious belief system and philosophy of morality addresses sexuality differently, with some viewing sexual behavior as potentially harmful, some viewing it as sacred, and some viewing it as primarily neutral or decided by the parties involved. Expectations to behave sexually in a specific manner are thus dictated by culture, and different cultures promulgate different, often conflicting, messages in this regard. Many cultures express two primary hierarchies: sexual privilege (and therefore sexual rights) of heterosexual males, and necessity of sexual restraint for females and, to a lesser extent, males. Such divisions create stigma, danger, and damage for members of many sexual subcultures, which may be sexually marginalized, stigmatized, ostracized, or rendered illegal.

Sex, like other biological issues, has been involved in cultural, social, and power struggles for a very long time. Therefore, it should not be surprising that the field of human sexuality has a long, dark history of attempts to regulate and control sexual knowledge. In many ancient societies, knowledge about sex, reproduction, and sexually-transmitted diseases existed, but it was only under certain circumstances; that is, either for social-political domination of those labels "unclean" or "bad", or for establishment of divinity development control and procreation. Such histories have consequence for the present as societies, knowing the complexity of sex; how the act of sex is influenced by culture, society, context, and personal experience; how is it subject to human problems and suffering; and how investigations into sex are often not innocent pursuit. Connections between sexual health and the social and political organization of sexuality must be taken into account for the development of 21st century approaches if sexual health is to be fulfilled in policy and practice. In the past few decades, there have been numerous national and international agreements reiterating the importance of healthy sexuality for human rights and health.

Global Perspectives on Sexual Health

Sexual health is a major area of relevance to global public health. Although sexual health is a concept that has gained prominence in high-income countries (HICs) over the past 100 years, the latter is better characterised by the notion of sexual health promotion, health services, allied health professional considerations, preventative medicine research and a broader interdisciplinary and critical discourse on, for example, pornography, gender, and sexuality [16]. The imperative of a public health perspective on sexual health in low- and middle-income countries (LMICs) is particularly relevant in the wake of the HIV/AIDS pandemic, with three critiques of this discourse arising: First, the domain of sexual health has largely been restricted to health services, control of STIs and the HIV/AIDS pandemic with little further development or discourse since; second, the dominance of the epidemiological perspectives of sexual health in public health surrounded by a veil of numbers and the discourse largely free of notions of ethics, rights and gender; and, finally, the neglected global north focus on sexually accessible drugs for sexual function/sexuality, the standards of normal sexual function and the associated suffering of sexual anxiety [17]. In 2016, the World Health Organisation published the "Sexual health: Key areas for monitoring" report and noted the myriad risks faced internationally: Sexual and reproductive health systems are generally failing; attention to inequalities is

too limited; and, failing systematically to consider the needs of LGBTI+ communities. There is also growing interest in human rights and LGBTI issues internationally. However, there are few centres of excellence for sexual health in LMICs, where the vast majority of the world's population live. Internationally, a number of issues affecting the validity of sexual health as a major public health challenge also remain.

Sexual Health Interventions

Interventions to enhance sexual health involve approaches across a spectrum of settings, including communities, health and social services, education, and individual and group approaches. Interventions in communities seeking societal change can pursue broad approaches, including influencing public policy and social attitudes affecting sexual health, prevention of violence, traffic injury and other negative sexual health outcomes. Also, community approaches may seek to achieve small-scale social change, as with the early practices of peer education. Community participation in recognition of and action on safety, rights violation or nondiscriminatory issues, to prevent sexual assault, work-place harassment, and other needs can be addressed in partnership with necessary agencies seeking societal change, climate change, and other issues. Health and social approaches seek to enhance access to quality diagnosis and treatment services and social support to promote sexual health, improved working conditions, provision of resources and health information, and enhanced service quality. Approaches seeking to enhance sexual health or factors protecting against poorer sexual health may offer relevant treatments against listed outcomes, including sexually transmitted infections, violence, intimate partner violence, sexual exploitation, problematic mass media, unwanted pregnancies, and unsafe abortions.

Education interventions can seek to improve knowledge and skills to reduce behaviors escalating to a sexual health problem or to enhance factors protecting against the outcome with peer education, sensitive awareness of others, recognizing coercion, risk avoidance, negotiation, and communication skills. Individual and group approaches can intervene to affect beliefs and attitudes associated with improved sexual health, as needed competencies for the above-listed needs. Interventions on behaviors in personal relationships can include couples counseling or expanding habitual sexual practices. Interventions by health professionals to reduce behaviors precipitating sexual health problems typically center on identifying the development of these problems and promoting referral to access treatment or health care. A small number of studies using a structured format were found offering minimal details of the enabling sexual health tasks targeted and the content of outcomes [1].

Therapeutic Approaches

Healthcare providers can improve patient–therapist collaboration regarding sexual issues by addressing the topic of sexual health early in collaboration with patients. Questions and concerns regarding sexual health regarding diagnosis/treatment can arise at any time, and therapy sessions are commonly where patients feel safe raising them. However, many healthcare professionals feel uncomfortable addressing such issues [1] and miss opportunities to assist patients in their sexual health and functioning. Furthermore, many healthcare professionals are unsure how to raise concerns in an appropriate fashion and do not address the socio-emotional context of sexual health. This leads to patients feeling uncomfortable and generates conflict in the therapeutic alliance as patients feel their clinician is neglecting a key part of diagnostic treatment. Sexual health literacy is the fundamental knowledge about sexual health, such as anatomical knowledge and possible sexual problems. Low sexual health literacy is a key contributor to the poor sexual health of many individuals with disabilities. Questions and concerns regarding sexual health regarding diagnosis/treatment can arise at any time, and therapy sessions are commonly where patients feel safe raising them. To address such issues, relationships need to be built, expectations regarding sexual health literacy set, and pathways to raise questions regarding sexual health developed. When sexual health issues are raised, superordinate goals have to be set. There might be a difference in the degree of priority when addressing sexual health, and therefore it must be established that sexual health is addressed. This can facilitate the co-creation of shared understanding of how sexual health will be addressed, helping patients and healthcare providers not miss opportunities to collaborate. Furthermore, the embryonic pathways to raise questions regarding sexual health will have to be tailored to the patient to establish a safe context for raising sexual questions. Questions of how to address this topic, how questions are raised, and how listeners are responded to will have to be discussed.

Neuroscience-Based Treatments

Sexual Health is a neglected aspect of medical care despite its acknowledged importance up to 3rd millennium. The range of sexual behavior varies widely from patient to patient and this makes it impossible to evaluate it appropriately by applying a solely scientific approach. By providing the general non-specialized treatment to patients with one type of sexual dysfunction or poor sexual health, the medical profession subscribes per se to an ideology that standardizes the diverse world of sexual behavior instead of understanding how this world might be disrupted. It translates to viewing sexual behavior as a more or less functioning system. This largely reduced viewpoint on sexual behavior originates from the traditional biological, algorithmic-mind view on behavior [1]. However, a relatively recent development of neurosciences has provided new insights into the functioning of health in relation to the brain. In fact, healthy brains do not initiate or maintain any behavior: they act solely in joint action with other. Yet, brains can also be involved in actions gone wrong; this concern holds a particular topicality for sexual behavior due in part to its acknowledged importance for health and wellbeing.

Currently existing treatments might be grouped as mainstream, complementary and alternative medicine (CAM), neuroscience-based, and social models. Mainstream treatments are widely used in the medical practice but, apart from those targeted at the blood vessels, such as phosphodiesterase inhibitors and others, none have much research done on their efficacy. All CAM treatments need independently evaluated scientific research to support their use. Neuroscience based treatments have been currently investigated as a new way of addressing sexual dysfunction. The simplest way to distinguish the different kinds of treatments is to reflect on how they interpret and address sexual dysfunction in relation to health. In other words, they differ in their epistemological basis: What is sexuality? What is health? What is a dysfunction? What is a brain? What is a treatment? In

this chapter, the currently existing treatments will be reviewed as developments in science, medicine and the society addressed these questions.

Ethical Considerations in Sexual Health Research

Sexuality and sexual health are essential aspects of the human experience and thus, ethical considerations arise. Recently, the relevance of sexual health research was reiterated by Health Canada when presenting the updated Sexual Health Promotion Program. Health Canada recognized the urgent need to address sexual health which has been neglected for too long, an oversight with numerous unintended consequences. Therefore, investments in health research are critically needed to: (a) counter the pervasive negative influences of sexual dysfunction, risky behavior, and unhealthy sexual development across Canadian society, and (b) help people achieve healthy sexual lives.

First, a brief overview of the foundations and advances of sexual health research from psychoanalysis and the behavioral, biological, clinical, and social sciences is given, focusing on its ontological, epistemological, and methodological aspects. Next, this overview is placed within a consumer context to highlight the impact of this research on the sexual health of all Canadians. Lastly, suggestions for improving relevance, rigor, and impact are made, urging fellow researchers to take action to satisfy this urgent national need for health research [18].

To promote effective and ethical sexual health research in Canadian society, it is important to emphasize how sexuality and sexual health matter in the first place. In Canadian society, as in all societies, individuals experience human sexuality from birth in the form of anatomical development, gender identification, falling in love, courtship, entwined lives, and fantasy. As a result, human sexuality is a universal aspect of life for all Canadians [19]. Sexual desire motivates a myriad of caring human experiences, but sexuality can also lead to individual and social tragedies. It can provoke feelings of guilt, shame, fear, and dangers to personal physical and emotional integrity and personal, family, and social respectability; it can lead to suicide, murder, and bloody acts of revenge. Sexual Health is an aspect of health that includes human sexuality, both its normalcy and pathology, natural and artificial health, and sexual health promotion, disease prevention, diagnosis, treatment, and rehabilitation.

Consent and Autonomy

Consent is the consideration of autonomy and the right to exercise the privilege of acting in ways that align with the person's desires without external coercion. In the task of determining consent capabilities, there is an implicit assumption of autonomy across levels of capacity. Nevertheless, there are hurdles to autonomy that may not have made it into this academic framework. Some hurdles come from bullying peoples' sexual rights; that is, some peoples' rights to sexual autonomy are curtailed due to their intelligence, status, or type of disability. As a result, non-consensual sex and sexual abuse may take place and go unreported since those abused may be unable to constitute a legal claim due to their disability. In such situations, a desire is unwanted or invalid, threatening to legal and ethical reputation. In some cultures and sectors, there is a perception that disabled persons cannot autonomously consent to sex or that they are incapable of sexual agency. Neglecting autonomy and competence in a consent abilities framework could lead to not detecting inappropriate sex. Fragile consent is defined as consent with mitigated autonomy. The need to navigate the approval of accepted sex or a safe sexual opportunity is more greatly felt when the partner has increased potential for unwelcome sex, youth, or mild to moderate intellectual disability. Fragile consent is a discourse meant to highlight the delicate nature of consent as a moment understood through time. An otherwise healthy relationship or dialogue about consent can still be abusive by methodically targeting weaknesses, exploring uncertainties, or utilizing emotional leverage [20]. People with cognitive disabilities have been doing gender, and this gendering may not be readily recognizable by parents, guardians, teachers, or doctors. Sex education appears to be one set of lenses people apply to navigate this process. Disapproving organizations and parents must accept complete ignorance and mastery of inability by the youth. There are parents monitoring youths' safe stalls in shopping malls, bathroom use, and prescription use, as learned habits of safety are encouraged. A more robust sense of agency develops with the continued and diverse use of safe sex scripts, sexual rights organizations, exploratory cyberspace, and viewing mainstream media [21].

Implications of Neuroscience Findings

A large body of research has explored the interplay between sexual health (SH) and neurosciences (NS). The significant influence of puberty and adolescence on sexual development has led to speculation about the involvement of sexual maturation processes in the neurological development of higher cognitive functions. A focus on this bi-directional relationship among neurologists, psychologists, and sexologists may enrich each field and foster collaborative research. Huge advances have been made in NS in recent years, including the pathophysiology of sexual dysfunction and dysfunctions originating in the central nervous system, with profound implications for SH in medicine, public health, and education. Sexual relationships also have a strong influence on human well-being and happiness. A normal development of sexual fantasies and life has some protective factors and some morbidity has a major public health impact. Education's failed to keep up with scientific advances in developmental neurosciences. A greater urgency for improvement in both clinical care and education is important to better promote SH and personal efficacy in life. Most neurologists do not deal with sexual health issues, whereas sexologists are poorly trained to consult on neuroanatomy. Management of sexual health issues is insufficient often leading to a huge loss in quality of life. Sexual health (SH) has physiologic, functional, and sociocultural implications [1]. Physiology considers the intactness of anatomy and tissue functionality. Cognitions may impair sexual function and this domain is addressed by sexologists. One common anatomical part is on the topological intersection between the reproductive and urinary tracts: the urogenital sinus (UGS, triangle) which arises dorsally from the cloacae and ventrally from the urigenital sinus. A network of erectile tissues is supplied by a common arterial source guided by common targeting ligaments. The first sophisticated investigations of the spinal control of coital posture are beginning. Out of the pelvic basin, there are brain areas like the medial preoptic hypothalamus that integrate suprapontine influences and project down to regulate synchrony, firmness, and event timing. A life well led has a proper wholeness of sexual life as a success in cooperativeness and empathy with peer beings. It is hypothesized

that common developmental stages and phases have emerged via parallel selection of processes although the evolutionary historical origins of mechanisms may differ greatly [9]. They were theorized and studied independently attracting much research attention: from autism, schizophrenia, depression, anxiety, and personality disorders through addiction, delinquency, and paraphilias.

Future Directions in Sexual Health and Neurosciences

This review highlights the available and future perspectives in the understanding of the neural bases of sexual desire and arousal, which are the main motivations and functions of sexual activity. Sexual function is one of the most important aspects that define one's quality of life. In the last decades, (neuro) anatomical and functional studies have provided consistent advances in the comprehension of how the brain helps to initiate and maintain sexual arousal and desire, ultimately leading to the orgasmic phase. Nevertheless, the question of whether this knowledge is fully addressed in clinical practice is still open. The topics addressed herein could help to overcome the deficit of awareness on the role played by the brain in sexual activity and on the effect of brain disorders on sexual behavior and sexual health. Neural structures, networks, neurotransmitters, hormones, neuromodulators, and neurohormones involved in the initiation and maintenance of sexual desire were highlighted in this review. The different methodologies that helped to acquire this knowledge were also addressed.

Indeed, sexual behavior is the result of the interplay between biological (e.g., genetic, hormonal, and neuroanatomical), psychosocial (e.g., childhood experiences, social behavior), and cultural factors. However, how the sexual signal is properly sensed and how the neuro-signal propagates in the brain in order to elicit an adequate sexual target behavior is still largely unknown [1]. Although a degree of interest can be ascribed to the knowledge of sexual anatomy and physiology, neglecting the very complex neuroanatomy and action of the brain that underlie these behaviors seems serious and puzzling.

Thus far, research has demonstrated a strict interplay between sexuality and neurological diseases. Particularly, the identification of the circuits involved in sexual desire and arousal will foster further investigation on how these circuits are impaired by brain disorders, thereby leading to sexual dysfunctions. Further studies are needed to characterize the sex differences that underlie the neural sex differences that play a role in the social behaviors of both sexes. In this regard, the study of monogamous and altruistic species may yield fruitful results. Neuromodulatory mechanisms, such as the hormonal modulation of kisspeptin and tachykinin, remain largely unexplored in humans.

Emerging Research Areas

The sexuality of concept has been neglected or unknown in neuroanatomy and neurosciences for a long time. Despite its historical roots in religion and mythology, it has recently attracted the attention of scientists, philosophers, and neuroanatomists due to its profound implications for the evolution and survival of species. The human brain areas involved in sexual behavior have been the focus of increasing neuroanatomical attention in the last few decades; they are mainly a network of spatially remote and functionally connected cortex and subcortical areas that track relevant processes [1]. The practical application of this knowledge also appears crucial. Brain injuries, psychopathological disorders, and other conditions affecting anatomical and functional aspects of the areas or networks involved in sexuality can have a remarkable effect on sexual function and reproduction. The comprehension of sexual function and behavior neuroanatomy can thus help clinicians in understanding sexual dysfunction and improving therapy. Knowledge of function and dysfunction of sexual behavior-related brain areas may have repercussions in forensic psychiatry too; indeed, it is worth noting that they are often involved in the neuroanatomy of aggression and violence. Moreover, the knowledge of these areas may have implications for the comprehension of interspecific differences in sexual behavior, a relevant topic in evolutionary biology. Studying sexuality through the "sieve" of contemporary neurosciences such as neuroanatomy and neuroimaging makes it possible to avoid the pitfalls of incommensurable interpretations of phenomenological and environmental data. The brain anatomy and interconnections of both human and animal sexual behavior-related areas are now known, enhancing comprehension of the very basic mechanisms. Available data on their functioning and dysfunctioning are still not exhaustive, but growing and fascinating. It is noteworthy that the sexual response brain systems of humans and other animals turned out to be remarkably similar, although considerable interspecific differences in structure, connectivity, and functions can be found too. In other words, humans are also animals and escape routes, although more complex and articulated, from sexual desire to sexual response and behavior are homologous.

Technological Advances

Before technological advances expanded the scope of sexual behavior in ways impossible in the past, sexually relevant situations were circumscribed to the immediate – as within the limits of eyesight and hearing, for example. Today, individuals may find sexual partners anywhere in the world. By using a digital device and software applications, they can also produce, exchange, view, and store various types of sexual content in the form of images, sound, and text or in live formats, either privately or publicly. The pervasive availability of sexual content through the internet and its interactive forms, 24/7 access to sexual services via smart devices, and the ability to monitor one's own sexual behavior through specialized applications and devices have transformed sexual health issues dramatically [22].

On the one hand, and in view of the technical possibilities mentioned above, there is broader, more diversified access to sexual content, partners, communities, or services throughout one's lifetime. People presently living in culturally restricted societies or social conditions could nevertheless find a partner complying with their specific needs for a sexual relationship. The available varieties of online sexual health information cover a broader range of situations than ever before, including safer-sharing procedures for sexual content that might otherwise result in potential harm. There are numerous possibilities for finding professional or anonymous advice on personal sexual problems. Like access to sexual concerns on the internet, the availability of sexual content forums, organizations, communities, and services also forms an opportunity for tailoring.

On the other hand, technology offers new potential threats regarding sexual health. Non-consensual reproduction and

distribution of nude images or voice recordings is a crucial concern for many people. Anonymity in sex-related online interactions and services can exacerbate unwanted sexual incidents, such as non-consensual images, mass-spreading or -storing, blackmailing, unsolicited contact propositions, aggressive insults, or incitement to act violently. Such framing usually causes substantial distress, worry, and psychotherapeutic access. Unwished and uncontrolled usage of technological devices may exacerbate sexual issues. Today, sexual dissatisfaction, sexual health problems, and addictions linked to technology usage typically arise out of the direct influence of technology.

Final Thoughts and Conclusion

Implementation of educational programs across all levels of clinical and healthcare institutions, with the aim of early formation in sexual well-being issues for physicians and other professionals, is fundamental. In this way, it is anticipated that the current disparity in the knowledge and management of sexual health issues would gradually decrease, without limiting the educational focus to the "reproductive" health of the patient, which often leads to the neglect of "sexual health" [1].

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