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Foreword

Sexuality (and the reproduction to which it leads) are not only crucial functions for the survival of our species, but, for many people, an important component of a fulfilled life. Despite the great importance of sexuality, however, discussion about sexual disorders remains extremely difficult for both patients and physicians. When one of us (DFS) was in medical school, his professor did not accept the abbreviation NA, which stood for “no abnormalities,” in the paragraph on the reproductive tract in the patient’s file; he claimed, rightly, that NA really meant that possible issues had not been discussed with the patient in a professional way. “NA means ‘no attention’,” he would shout. The same reluctant attitude crops up when lower urinary tract dysfunctions are concerned, in spite of the fact that, like sexuality, they are so vital for quality of life. Disorders of these functions are common in patients with peripheral, somatic, autonomic, or central nervous system disorders. Doctors and patients alike feel inhibited when it comes to talking about such dysfunctions, with some interesting exceptions, which are discussed briefly in the history part of the first chapter in this volume.

This volume of the Handbook of Clinical Neurology pays specific attention to the best way to approach patients with sexual or urinary tract dysfunction. The volume starts with chapters on the anatomy and physiology of the genital organs and urinary tract, including data obtained with functional imaging. Disorders due to lesions at all levels of the nervous system and in relation to the major neurologic disorders are systematically described. Finally, detailed attention is paid to the management and rehabilitation of neurologic patients with sexual and bladder dysfunction.

We have been fortunate to have as volume editors Professors David B. Vodúšek and François Boller, who have assembled a truly international group of authors with acknowledged expertise in this particular area to contribute to an excellent synthesis of the literature. We are grateful to them and to all the contributors.

We have read and commented on each of the chapters in our capacity as series editors and believe that both clinicians and basic scientists will find much to appeal to them in this volume. Not only is there plenty of room for clinical improvement in this field, but the more fundamental aspects of the subject require increased attention from basic scientists. The electronic availability of this volume on Elsevier’s Science Direct site should ensure its ready accessibility and facilitate searches for specific information.

As always, it is a pleasure to thank Elsevier, our publishers – and in particular Mica Haley, Michael Parkinson, and Kristi Anderson – for their assistance in the development and production of this volume.

Michael J. Aminoff
Dick F. Swaab
Preface

Sexual and lower urinary tract (LUT) dysfunction are not uncommon in the general population, but they are much more common in patients with neurologic disorders. Both may occur as the presenting symptom in an otherwise "neurologically normal" subject with a developing and as yet unrevealed neurologic disease, as an isolated phenomenon after local nerve injury, or as a consequence of the complex issues accompanying a chronic neurologic disorder. Whereas the link between nervous system involvement and the ensuing dysfunction is, at least in principle, rather straightforward in the case of a peripheral nerve lesion, the correlation gets increasingly complex when ascending the central nervous system. Indeed, even the normal neural control of both organs, which include the somatic and the autonomic nervous system as significant players, is not completely clear. But researchers in neuroscience have become increasingly interested in these issues, and we are proud to present in this volume the reviews of some of the most pre-eminent workers in the field.

In the realm of clinical work, research in neurogenic LUT and sexual dysfunction has not kept pace with the mainstream of modern evidence-based medicine, and this has hampered progress and is frustrating in practice. Yet, knowledge of sexual and LUT dysfunction is clinically pertinent for several reasons, not least because sexuality and bladder control are major determinants of quality of life in patients with neurologic disease. Both sexual and LUT dysfunction are common in neurologic disorders, but patients often fail to mention them spontaneously – at least, to the neurologist. Among other reasons, there is the belief of patients that the neurologist would “not be the right specialist” to address such problems, and is “not interested.” More often than not, this conviction of patients may, unfortunately, still be correct. It is the aim of this volume of the Handbook to try to reverse this attitude and convince neurologists that sexual and LUT function should be addressed in their patients, for reasons of correct diagnosis, possible therapeutic consequences and gaining their trust. More research in sexual and LUT dysfunction in neurologic patients is needed, but will only become possible if neurologists fully embrace the need to address these issues in their patients. We have managed to convince the comparatively few practitioners in the field to share their expertise in this Handbook, and we hope to provide in the respective clinical chapters not only an overview of the epidemiology, pathophysiology, and clinical presentations, but also some guidance for patient management.

It should be mentioned that for this volume in the Handbook series, we may not have – in the opinion of some – included everything that comes to mind, or indeed is relevant to the topic; for example, we have intentionally omitted the neurology of the bowel, although it is highly relevant in many populations of neurologic patients. We nevertheless feel that a comprehensive Handbook on neurogenic bowel disorders is much needed and that, eventually, an integrated work on neuropsychiatric and neurologic issues related to sexuality, fertility, and pregnancy; the urinary tract; bowel disorders; and pelvic and perineal chronic pain syndromes should be attempted, to provide a comprehensive overview of the normal somato-autonomic integrated neural control of these interlaced functions, and the neurogenic derangements thereof.

We express our gratitude to the authors who valiantly collaborated in our endeavor. We thank Dr. Ellen Frank for her suggestions during the preparatory phases of this volume. We also thank the editorial staff of Elsevier, particularly Michael Parkinson, for his help in the production of this book.

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Chapter 1

Introduction

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This volume deals with neurologic disorders of sex and bladder. Sexuality is for the large majority of humans a component of a fulfilled life, and most would agree with the World Health Organization (WHO) that sexuality is, indeed, a central aspect of life and a fundamental right of the individual (WHO, 2006). While sexual dysfunction (SD) is not “vital” in the usual sense of the word, i.e., is not strictly indispensable for individual survival, dysfunctions of the lower urinary tract (LUT) are, as they may lead to chronic infection, dilation of the upper urinary tract, renal insufficiency, and death. Thanks to appropriate management of neurogenic LUT dysfunction (LUTD), mortality after spinal cord injury has dropped dramatically. Treatment of complications such as renal failure and/or urosepsis has reduced from a mortality of up to 75% in 1969 (Whiteneck et al., 1992) to only 2.3% in 1992 (Devivo et al., 1993).

HISTORY OF SEX AND LUT DYSFUNCTION

An early specific mention of a “sexual” disorder is found in the work of François de la Peyronie (1668–1747). He was surgeon to King Louis XV of France, when he described the condition that bears his name, also known as induratio penis plastica, a sclerosis of the corpora cavernosa which deforms the penis, usually in erection, and may prevent sexual intercourse, mainly because it is often accompanied by pain.

In Europe and around the world, in the 19th century, sexual subjects were considered taboo and repression was the main position toward them (Schultheiss and Glina, 2010). Contrary to that trend, Paolo Mantegazza (1831–1910) can be considered the founder of modern sexual medicine. Borne in Monza near Milan, Italy, he graduated in Pavia in 1854. He then embarked on a world tour and came back to Italy in 1858 after having practiced medicine in various countries, including India, Argentina, and Uruguay. He was given the position of Professor of General Pathology at the University of Pavia and in 1870 he became Professor of Anthropology at the University of Florence.

Mantegazza pioneered the development of experimental work and formulated new sexual theories, founding a new science which he called “science of embrace.” As pointed out by Schultheiss and Glina (2010):

Curiously, Mantegazza referred to love [amore] when he was talking of sexual relation. He never used the term sexual. Besides his interest on physiology of “nervous” states (the beginning of neurophysiology) and the action of drugs

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Mantegazza wrote about female sexuality, sexuality in children, masturbation, erectile dysfunction, vaginism, and male and female infertility. He had tried gonad transplantations in frogs and he had measured the blood flow and temperature increase during penile erection (p. 2033).

But again, Mantegazza was an exception. Nineteenth-century clinicians had no qualms about publishing pictures of or even filming their patients, men and women, without any clothes on. Yet one does not find a clear mention of disorders of bladder control or impaired sexual function in Charcot’s description of multiple sclerosis or Parkinson disease. That does not mean that Charcot and his contemporaries ignored problems related, or thought to be related, to SD. Charcot, for instance, had “a special reputation for ailments related to sexuality” (Goetz et al., 1995, p. 255). This, however, for the most part involved the role of “la chose génitale” in neuroses or even in the “treatment” of homosexuality.

Richard Freiherr von Krafft-Ebing (1840–1902) was an Austrian–German psychiatrist. His main work was *Psychopathia Sexualis* (1886), one of the first monographs to study sexual topics such as clitoral orgasm and female sexual pleasure, consideration of the mental states of sexual offenders, and homosexuality. As pointed out by Schultheiss and Glina (2010), in contrast to popular and scientific belief at that time, Krafft-Ebing was one of the first authors to point out that homosexuals did not suffer from mental illness or perversion.

It may have been the influence of Charcot which led to the “sexualization of hysteria,” Freud’s belief in the sexual origin of all hysterical symptoms (Bogousslavsky and Dieuguez, 2014). Apart from these psychopathologies, one finds at least one mention of a potentially organic problem. Impotency was one of the ailments which was “treated” by Charcot and his acolytes with the use of suspension. This approach consisted of having these unfortunate patients hang for several minutes from a contraption fitted under their armpits and around their neck. This had been introduced by a Ukrainian physician for a patient with tabes dorsalis and it is rightly included among the cruelest treatment of neurologic diseases in the 19th century (Walusinski, 2013).

Another noticeable 19th-century attempt to deal with SD took place not far from the Salpêtrière, at the Collège de France in 1889. That is when Edouard Brown-Séquard, then aged 72, made his most famous presentation about a series of rejuvenation experiments. He claimed that daily injections of testicular blood, seminal fluid, and testicular extract from guinea pigs and dogs made him feel 30 years younger. Following that presentation, Brown-Séquard received a considerable amount of publicity, not all of it favorable. He was attacked as a quack and a charlatan. The antivivisection movement, very strong, especially in the UK, also threw its anger at him. We are not aware of double-blind experimental research aimed at proving or disproving Brown-Séquard’s theory. Yet he is considered by many as the father of modern neuroendocrinology for having pioneered the idea that parenterally administered substances could have an action on the hormonal system (Aminoff, 2010; Boller et al., 2015). Actual testicular implants were proposed in subsequent years, particularly in France by the Russian-born Serge Voronoff (1856–1951) and in the USA, where a certain John Brinkley (known as Dr. Goat Gland Brinkley, 1885–1942) is said to have given “new joy” to many thousands of people, men and women, before he was tried for fraudulent practice of medicine, convicted, and forbidden from practicing.

Perhaps because of its more prominent impact on everyday life, diagnosis and even some treatments of LUT, particularly of urinary incontinence, are dealt with in the literature. In his *History of Urinary Incontinence and its Treatment*, Schultheiss (2000) shows that ancient Egyptian sources mentioned devices to collect urine and pessaries for women and even provided advice on how to deal with overflow incontinence (“remove the urine which runs too often”). In subsequent years, reports mainly address cases of extraurethral incontinence, for instance fistulas acquired after childbirth or, in males, overflow incontinence following spinal cord injury. Ambroise Paré (1510–1590), the famous surgeon of the Renaissance, was very interested in the urinary tract and proposed a device that could be used as a urinal by incontinent men.

One had to wait until the 19th century to see the appearance of work aimed at understanding and treating LUT. Here again we have a pioneer: Ludwig Robert Müller (1870–1962), from Augsburg, Bavaria. He performed essential research on the autonomic nervous system which included work elucidating the mechanism of the neurogenic bladder (Müller, 1901; Neundoerfer and Hilz, 1998). An early treatment attempt proposed to use electrotherapy (alternating current applied to the bladder or rectum). This was introduced by Robert Ulzmann (1842–1889) for the treatment of various conditions, including enuresis in children.

Almost all the diagnostic and therapeutic measures for LUT as described in Chapter 9 and 26 only appeared well into the 20th century.

**CLINICAL ASPECTS OF SEX DYSFUNCTION**

What is the cause of SD in the population at large? As for other functions, there may be some decline with aging, but in essence, age is not a valid response to the question
of causation. We know about statistical correlations of SD in the population and several so-called “risk factors,” among them neurologic disease, and neurologic diseases are, indeed, more common with advanced age.

There is great variability in sexual functioning in the population, and particularly so in the elderly. Overall, the frequency of intercourse in the healthy elderly decreases. Men need more time and stimuli to achieve erection and orgasm, and have a decreased sensation of impending ejaculation and a decreased ejaculatory volume. Their refractory period after orgasm is prolonged (Rowland et al., 1993). Hormonal changes in women after menopause lead to decreased desire, decreased sexual thoughts, decreased frequency of intercourse, and thinning of the vaginal wall with decreased elasticity and lubrication (Gracia et al., 2007). Despite this, 26% of the 75–85-year-old age group reports sexual activity during the past 12 months (Lindau et al., 2007).

The neurologist’s clinical interest is necessarily focused more on the physiologic aspects of sexuality. To the neurologist, sexual function involves a series of neurally controlled phenomena occurring in a hormonally defined milieu. Therefore, to the neurologist a cauda equina lesion is a clear-cut “cause” of neurologic deficits (among which SD is prominent), not a risk factor, as it is categorized in an epidemiologic study. But, indeed, not every patient with cauda equina complains of SD (Podnar et al., 2002); thus, cauda equina lesion in the terminology of risk factors is defined as a “high-risk factor”! Sexuality depends not only on intact nervous system function but on many other physiologic systems, and also on psychosocial factors. Both somatic and psychosocial factors may be compromised by neurologic disease. The perspective of partnership and social issues should never be forgotten.

In a neurologic practice, SD may be reported in a patient (referred from a urologist) as an early or even presenting symptom of a developing and as yet undiagnosed neurologic disease (e.g., erectile dysfunction in multisystem atrophy), as an isolated phenomenon after local nerve injury (e.g., erectile dysfunction after prostate surgery), or as a consequence of the complex issues accompanying a chronic neurologic disorder. It is helpful to conceptualize SD in neurologic disease as Foley and Iverson (1992) did for multiple sclerosis: there are primary effects stemming from physiologic or pharmacologic factors; secondary problems related to sensorimotor, bladder, and bowel disturbances and higher brain dysfunction; and tertiary issues related to psychosocial and cultural changes resulting from the disease.

The focus of this volume of the Handbook of Clinical Neurology is not only on the “physiologic/neurologic” but also on the “sexologic” dimensions of sexuality, and therefore eminent sexologists have been invited to contribute. The common denominator of almost all contributions is that research in neurogenic SD is only in its early stage and particularly so in the domain of female sexuality.

The relationship of the neural lesion (as far as it can be precisely determined) and sexual (dys)function is not straightforward and becomes more and more elusive as we “ascend” the nervous system from the periphery to the frontal lobes. Also, how sexual function is defined in the first place will influence both the way we think about brain–function interaction and the research that is done in the field. Prior to 2013, the Diagnostic and Statistical Manual, fourth edition (DSM-IV: American Psychiatric Association, 1994) described SD as disturbances in sexual desire and/or in the sexual response cycle, occurring in any of the four phases of the human sexual response cycle, including libido (desire), arousal, orgasm/climax, and resolution (Gregorian et al., 2002). In accordance with this conceptualization, among other issues, questionnaires about sexual function have been constructed and used. The new DSM-5, released in 2013 (American Psychiatric Association, 2013), creates a paradigm shift, suggesting that sexuality may be experienced differently according to gender and as such should be classified and managed differently (Sungur and Gunduz, 2014; see Chapter 2). We are thus in a period where we are still trying to understand the physiology of sexuality, and still far from completely integrating the information of the neural (particularly brain) control of sexual function (see Chapter 6).

**CLINICAL ASPECTS OF LUT DYSFUNCTION**

SD and LUTD are common occurrences in neurologic patients. (Note that the term LUT is used by specialists who are primarily interested in this organ system; it is the preferred term, although neurologists tend to use “bladder” or, possibly even worse, “sphincter” as a jargon term to denote LUTD.)

Similarly to SD, LUTD is not uncommon in the general population, and a large proportion of those dysfunctions are thought of as “idiopathic.” Indeed, the comorbidity of SD and LUTD is not uncommon, as discussed in Chapter 10. Thus, urologists, urogynecologists, and sexologists are dealing with a large population of non-neurologic patients who suffer from LUTD or SD, or both. These patients with uncertain etiology often demonstrate clinically similar manifestations of SD and LUTD to those encountered in neurologic patients. This also needs to be appreciated by neurologists, who might suppose that all LUTDs and SDs without obvious other cause are neurogenic.
LUTD may also occur as the presenting symptom in a “neurologically normal” subject with a developing and as yet unrevealed neurologic disease (e.g., urinary incontinence in multisystem atrophy), as an isolated phenomenon after local nerve injury (e.g., urinary retention after a cauda equina lesion), or as a consequence of the complex issues accompanying a chronic neurologic disorder (wetting due to difficulties in gait, and not being able to get to the toilet in time; wetting due to cognitive deficits). Again, research into neurogenic LUTD has not kept pace with the mainstream of modern evidence-based medicine, and this has hampered progress and is frustrating in practice. However, in comparison to our understanding of brain control of sexual function, we have a much better-defined model of neural control of LUT (see Chapters 5 and 7).

While sexual dysfunction and LUTD are common in neurologic disorders, they are most often not spontaneously mentioned by the patient – at least not to the neurologist. Among other reasons there is the conviction of patients that the neurologist would “not be the right specialist” to address such problems, and “not interested.” Most often than not this conviction may, unfortunately, still be correct at the present time. It is the aim of this volume of the Handbook to try to reverse this attitude and convince neurologists that sexual and LUT function in fact need to be addressed in their patients, for reasons of correct diagnosis, possible therapeutic consequences, and gaining overall trust from the patient. The approach to the patient is not too sophisticated as it is primarily clinical (see Chapters 8 and 9); it only needs understanding, motivation, and time. The need for further assessment is logical in the patient with LUTD, and minimal in the patient with SD. The first line of management is also straightforward (see Chapters 24–26): the necessary and potential therapies need at least to be understood by the neurologist, even though the patient may be referred to a urologist, gynecologist, rehabilitation specialist, or sexologist. Indeed, the need to tend to the overall needs of the patient in neurology departments taking care of large populations of patients with multiple sclerosis, movement disorders, or stroke should lead to the organization of multidisciplinary teams akin to spinal cord injury centers, where it is established that evaluation and treatment of LUT and SD are carried out by dedicated personnel.

As is often the case, it is the patients’ organizations which have taken the lead in disseminating information on SD and LUTD in particular patient groups, and producing clinical guides (documented information), websites, and internet videos, providing useful information for patients and caregivers.

In conclusion, it should be no surprise that sexuality and LUT function are major determinants of quality of life, and therefore of major importance to the well-being of all of us, and possibly even more to those who have lost other abilities. More research into sexual and LUTD in neurologic patients is very much needed, but will only become possible if neurologists fully embrace the need to address these issues in their patients.

References


CURRENT CONCEPTUALIZATION OF HUMAN SEXUAL RESPONSE

Introduction

Human sexual response is conceptualized as a motivation/incentive-based cycle comprising phases of physiologic response and subjective experience (Basson, 2000, 2001a; Janssen et al., 2000; Balercia et al., 2007; Basson and Weijmar Schultz, 2007; Laan et al., 2008). The phases of the circle overlap and their order is variable (El-Sakka, 2007; Porst et al., 2007). As depicted in Figure 2.1, sexual “desire”/“urge”/“hunger” may or may not be sensed initially; desire can be triggered by the sexual excitement, i.e., the subjective sexual arousal in response to sexual stimuli (Basson, 2001a; Basson and Weijmar Schultz, 2007; Vannier and O’Sullivan, 2010; Goldhammer and McCabe, 2011; Hayes, 2011). Some researchers perceive all arousal and desire to be responses to sexually relevant stimuli: any internal thoughts or fantasies also stem from something external (Both et al., 2007). This overlap of phases is in keeping with neuroimaging data of sexual arousal which have led to the concept that motivation is one facet of sexual arousal and desire is one component of motivation (Stoleru et al., 2012).

Many factors, psychologic and biologic, influence the brain’s appraisal and processing of the sexual stimuli to allow or disallow subsequent arousal. The sexual and non-sexual outcomes influence future sexual motivation. The cycle may be partially or completely repeated a number of times during any given sexual encounter. Variability is marked both between individuals and within a person’s own sexual life, influenced by multiple factors, including stage of life cycle, age, and relationship duration, and robustly linked to mental health and relationship happiness (Mitchell et al., 2013).

A former understanding of sexual physiology emanated from the work of Masters, Johnson, and Kaplan in the 1960s and 1970s. Sexual desire, as in a sexual “drive,” was considered to be the initiator of any sexual response. Similar to the physiologic urge to breathe, to eat, and to sleep, it was implied that to become sexually aroused and experience orgasm was necessary to avoid some kind of discomfort or non-physiologic state. However this conceptualization is not evidence-based. So, rather than a built-in mechanism to maintain homeostasis, human sexual response is understood to be linked to the rewards associated with sex, these being both sexual and non-sexual in nature.

Thematic analysis of the interview transcripts in a recent qualitative study investigating the meaning and experience of sexual desire in partnered women indicated that the experience of desire was primarily responsive rather than an autonomous experience (Goldhammer and McCabe, 2011). This is in keeping with similar research in men and women confirming that an awareness of desire may not be present at the outset of sexual activity (Vannier and O’Sullivan, 2010). Both men and women find it difficult to distinguish desire from arousal, reporting that sexual stimuli trigger both desire and arousal simultaneously (Janssen et al., 2008; Sidi et al., 2008; Brotto et al., 2009). Researchers using functional brain imaging of sexual arousal from erotic visual stimuli speak of psychologic manifestations of sexual arousal, including sexual desire, and physiologic manifestations, including genital responses (Stoleru et al., 2012). Women’s sexual dysfunction typically involves lessened arousal and desire and infrequency of orgasm, as is now reflected in the recently named sexual interest arousal disorder in the American Psychiatric Association (2013) Diagnostic and Statistical Manual, fifth edition (DSM-5). Although
Human sexual response is depicted as a motivation/incentive-based cycle of overlapping phases of variable order. A sense of desire may or may not be present initially: it can be triggered alongside the sexual arousal resulting from attending to sexual stimuli. Sexual arousal comprises subjective (pleasure/excitement/wanting more of the same) and physical (genital and non-genital responses). Psychologic and biologic factors influence the brain’s appraisal of the sexual stimuli. The sexual and non-sexual outcomes influence present and future sexual motivation. ANS, autonomic nervous system. (Adapted from Basson, 2001b.)

the focus in men has typically been on erectile dysfunction (ED) or premature ejaculation, they too may experience a more generalized “sexual distress disorder,” affecting desire, erectile function, and ease of orgasm (Carvalho et al., 2011).

**Sexual motivation**

Recent empiric research indicates that motivation for partnered sexual activity may be distinct from “solitary sexual desire,” as evidenced by sexual thoughts and fantasies, and that motivation for partnered sex is far more relevant to sexual well-being. Of 65 men and 65 women complaining of markedly reduced or absent interest in partnered sexual activity, some 75% continued to report sexual thoughts, on average multiple times per week for men and three-plus times per month for women (McCabe and Goldhammer, 2013). This and other research has identified marked discrepancy between the person’s own self-diagnosis and clinicians’ diagnosis of low desire, the latter focusing on traditional markers of sexual thoughts and fantasies (King et al., 2007).

The majority of factors underlying and influencing sexual motivation reflect pleasure and emotional intimacy. Some 1500 (mostly young) men and women identified 237 distinct reasons why they engaged in sex: factor analysis produced four overall factors – emotional, physical, goal attainment, and insecurity (Meston and Buss, 2007). Emotional factors included love and commitment and the expression of the same. Physical reasons included pleasure and experience seeking, as well as reduction of stress. Goal attainment reasons included social status, resources, and even revenge. The insecurity factors included a wish to boost self-esteem, to fulfill a sense of duty, and to “mate guard.”

This research supported the clinical observation that men and women have multiple sexual and non-sexual reasons for initiating or agreeing to partnered sex: a sense of sexual desire/urge/drive is just one potential underlying reason instead of being the prime mover of sexual initiation, as in the former model of human sexual response. The chief initiating reasons for men were physical: for women, emotional reasons predominated.

Further study focusing on 327 women aged 18–66 years found that, for all women, 72% of their top 25 reasons pertained to either sexual pleasure or love and commitment to the partner (Meston et al., 2009). Consistent with their first study, emotional factors slightly predominated over physical pleasure; reasons to do with insecurity and goal attainment were infrequent. It is readily apparent that neurologic disease interfering with sexual pleasure and/or causing partnership difficulties will severely compromise sexual motivation in both men and women.

Studies point to depression as a major cause of reduced sexual motivation in otherwise healthy persons. This appears to be true also for patients with neurologic disease: increased sexual dysfunction was noted in women with multiple sclerosis compared to controls only when there was comorbid depression (Zivadinov et al., 1999). Even when clinical depression is excluded, low or absent sexual interest is associated with having more depressed and more anxious thoughts, and lower sexual self-image than controls (Hartmann et al., 2004). Neurologic illness can markedly lessen sexual self-image from the associated altered appearances, mobility and cognition changes, ability to provide self-care and be continent, and ability to be gainfully employed. Research confirms individual differences in the effect of mood on sexuality: heterosexual men sometimes sense increased desire for solitary sex, i.e., masturbation, when depressed, but this is rarely reported by women or homosexual men (Janssen et al., 2013).

Empiric data on inhibitory and excitatory factors modulating the brain’s appraisal of sexual stimuli has suggested a “dual-control model” which posits that sexual arousal is influenced by both excitatory and inhibitory mechanisms. These determine a person’s tendency to experience sexual excitation/inhibition (trait), and operate during any given sexual situation (state). Factor analysis of questionnaires developed to explore how men and women would respond to sexual situations with and
without problematic aspects indicated some differences between genders, notably the importance of “arousal contingency factors” for women. Such factors reflect the potential for emerging sexual arousal to fade or fail “unless things are just right.” In general, women show higher inhibition, and men higher excitation (Bancroft et al., 2009). Exploring “dual control,” in men, two inhibition factors emerged: fear of performance failure and threat of performance consequences. A separate questionnaire was developed for women. For them, inhibitory factors included concerns about relationship importance, sexual function, and arousal contingency.

Investigating factors inhibiting sexual arousal is clearly relevant for neurologic patients, for whom there are yet further arousal contingency factors, e.g., for neurologic symptoms to be optimally controlled, and specific factors affecting the relationship, such as when the partner is the caregiver as well as the sexual delegate. Impaired erection or delayed orgasm from autonomic damage typically leads to fears about performance. Feared untoward outcomes include worsening of neurologic symptoms after orgasm, e.g., the rigidity of Parkinson’s disease or neuropathic pain involving genital areas.

Sexual arousal can be heightened to problematic levels in persons with neurologic disease, such as those receiving dopaminergic agonist treatment for Parkinson’s disease (see Chapter 17), or patients suffering severe injury to prefrontal lobes or to both amygdalae, as in the Klüver–Bucy syndrome (see Chapter 6).

Sexual stimuli and sexual context

Adequate sexual stimulation and an appropriate sexual context are essential components of human sexual response. The sexual stimuli may include erotic talking, sexual memories, as well as visual and physical stimulation. The latter includes non-genital as well as genital, and non-penetrative as well as penetrative genital modalities. Choices of stimulation may be curtailed by neurologic disease: touches may not be felt or may cause dysesthesiae; excessive salivation may hinder kissing; and immobility limit the giving of pleasure to the partner. Clinical experience confirms the importance of contextual factors, including the need for privacy from children and from caregivers; of pain relief; and of freedom from undue fatigue. The interpersonal context is critical for many: a longitudinal 8-year study of women transitioning through menopause suggested that feelings for the partner along with mood were the two most important factors determining sexual motivation (Dennerstein et al., 2002).

Relationship difficulties were a major factor associated with low sexual function in the recently published third National Survey of Sexual Attitudes and Lifestyles (Natsal-3), involving 4913 men and 6777 women, the adjusted odds ratio for relationship difficulties being 2.89 and 4.10 respectively (Mitchell et al., 2013). Adjustment between couples is strongly linked to sexual desire in a detailed questionnaire completed by 205 men and 237 women from the general population (Carvalho and Nobre, 2010). Emphasized in qualitative study is, especially for women, the importance of partner characteristics (Bancroft et al., 2009). There is preliminary evidence that, in monozygotic twin women, relationship factors play a key role in the development of sexual dysfunction (Burri et al., 2013). Stress originating within the couple, e.g., worry about the partner’s well-being, rather than external stressors, has been shown to have an incremental effect upon sexual problems after adjusting for relationship quality and psychologic factors (Bodenmann et al., 2006). Whereas neurologic illness can greatly intrude into the interpersonal relationship, sometimes the illness can bring partners closer together emotionally.

Appraisal of sexual stimuli: “information processing”

Even with sufficient sexual motivation and the presence of adequate stimuli in a context satisfactory to the person, arousal and pleasure may not occur if attention is not focused on the present moment, on the sexual stimuli, and on the intimacy of the situation. Review of the literature on sexual arousal in 2009 confirmed a central role for attentional processes in facilitating the subjective but also the physiologic components of sexual arousal (DeJong, 2009). Sexual information is processed in the mind both automatically and consciously. The sexual nature of the stimuli is processed by the limbic system, allowing genital congestion (observed to be quick and “automatic” in women and slower but still involuntary in men). Interestingly, the objective measurement of automatic genital response in sexually healthy women is comparable to the response in women complaining of lack of sexual arousal (Laan and Both, 2008). Conscious appraisal of the sexual stimuli and the contextual cues can lead to subjective arousal. The latter may be further increased by awareness of the genital congestion of arousal, which is more accurately registered and more relevant to men’s experience than to women’s (Basson, 2001a). The subjective arousal will also be cognitively appraised – for instance, is this pleasurable and safe or is this shameful or likely to have a negative consequence? Cognitions such as these continually modify both physiologic and subjective responses (Nobre and Pinto-Gouveia, 2008).

Focusing on non-erotic thoughts during sexual stimulation, generated possibly by anxiety as first suggested...
by Barlow (1986), is associated with having sexual problems. A recent study of 253 men and women in long-term relationships found that women tended to report non-erotic thoughts about their body image and the external consequences of sexual activity whereas men were more likely to report non-erotic thoughts about problematic sexual performance (Nelson and Purdon, 2011). Both men and women had some non-erotic thoughts about the emotional consequences of the sexual activity. Regardless of content, the more frequent the non-erotic thoughts, the more sexual dysfunction. Importantly, the more difficult it was to refocus back on an erotic thought uniquely predicted the intensity of sexual problems. This research is clearly relevant to patients with neurologic disease which frequently has a negative impact upon sexual self-image and/or sexual functioning.

Previous research studying 490 men and women with and without sexual problems highlighted a number of significant correlations between automatic biased thoughts, emotions, and sexual arousal. For both men and women, sadness and disillusion were positively related to negative cognitions and negatively associated with sexual arousal (Nobre and Pinto-Gouveia, 2008). Neurologic disease adds further sources of maladaptive thinking as well as sadness and disillusion.

**Divergence of subjective and genital responses**

Investigators have found that, in sexually healthy women, a highly variable correlation exists between objective measurement of genital congestion (as measured with the vaginal plethysmograph), subjective arousal (Laan et al., 2008; Chivers et al., 2010; Graham, 2010), and brain activation patterns, as recorded from functional magnetic imaging (Arnow et al., 2009). To examine arousal, women viewed a neutral film followed by an erotic film, and the percentage of increase in vaginal pulse amplitude was noted along with their ratings of subjective arousal. Women with sexual arousal disorder typically showed increases in vaginal pulse amplitude in response to visual erotica similar to those of sexually healthy women (Laan et al., 2008; Graham, 2010), but reported minimal or absent sexual arousal during the erotic films, and they may report negative emotions. Similarly, their awareness of genital sensations was minimal, correlating poorly with objective measurement of congestion in response to erotic stimuli.

In addition, the degree of congestion of clitoral structures and vaginal circulation is not accurately perceived by women in general; it is clear that women’s arousal (physical/genital or subjective) cannot be measured by their estimation of genital swelling and vaginal lubrication. DSM-5 criteria for sexual disorder merge components of arousal (subjective and genital) with sexual interest/motivation into one diagnosis — sexual interest arousal disorder. This contrasts with the previous DSM-IV (American Psychiatric Association, 1994) focus on a desire disorder due to lack of fantasies and desire, and an arousal disorder due to women’s report of lack of lubrication and swelling.

In contrast to women, men without neurologic (or vascular) disease generally have high correlations between penile erection and subjective sexual arousal (Chivers et al., 2010); however, there are many exceptions. For instance, sleep-related erections are mostly dissociated from erotic dreams or from subjective sexual arousal. Psychophysiological studies have found that men can get erections in response to films of assault or rape while experiencing no subjective arousal (Janssen et al., 2002). In contrast, a psychophysiological study identified some 25% of men in a community sample with minimal penile response to an erotic video while their subjective arousal was similar to the remaining 75% of men with recorded penile congestion (Janssen et al., 2009).

So, in both men and women it is suggested that unconscious processes underlie the automaticity of the genital response while subjective feelings of sexual arousal are modulated by higher-level conscious cognitive processes. Support for this theory includes experiments where subliminal presentations of sexual stimuli trigger sexual responses in both men and women. However subliminal stimuli, in contrast to supraliminal ones, do not trigger subjective sexual arousal (Janssen et al., 2000; Ponseti and Bosinski, 2010). In women but not in men the automatic genital response can be elicited in response to a stimulus that is deemed simply sexual in a biologic sense and not erotic or potentially arousing, e.g., viewing a video of primates engaged in mating (Chivers et al., 2010).

This complex physiology of variable linkage between genital congestion and subjective arousal (itself hardly distinguishable from desire) must be kept in mind during the assessment and management of autonomic neuropathy disrupting erections and clitoral engorgement and vaginal lubrication. For example, disruption of the sacral segments of the spinal cord from multiple sclerosis may be irrelevant to a woman’s lack of sexual arousal. Attention to sexual stimuli due to lowered self-image, fears of incontinence, and fatigue may prevent her subjective arousal: augmenting genital congestion pharmacologically would not be of benefit. In contrast, a man with similar pathology will likely be distressed by both his ED and his lack of subjective arousal from sensing genital engorgement: phosphodiesterase type 5 inhibitors may restore objective engorgement and subjective arousal.
Sexual outcome

A rewarding experience and outcome, emotionally and physically, will enhance present and subsequent sexual motivation. Sexual satisfaction has received less study than sexual function/dysfunction, but would appear to be a more relevant entity. New questionnaires, notably Natsal-SF (Mitchell et al., 2012), now reflect the importance of sexual satisfaction, in contrast to many previous instruments modeled on DSM-IV (American Psychiatric Association, 1994), in turn modeled on a linear sexual response depicting desire/urge which triggered erection/lubrication, leading to orgasm/ejaculation and then “resolution” of genital effects.

There can be satisfaction despite dysfunction. Dissatisfaction may occur in the context of a functional response. Nevertheless, particularly in men, concerns about sexual outcome in terms of sexual performance and consequences of sexual activity are common (Bancroft et al., 2009). Women’s satisfaction may or may not include orgasm(s) (Graham, 2010) but usually requires freedom from any pain and freedom from partner dysfunction (Heiman et al., 2008), and a positive emotional conclusion. Men’s satisfaction is thought to more frequently require orgasm and ejaculation. Recent study confirms strong links between sexual satisfaction and sexual motives (Stephenson et al., 2011). When the motivation is focused on a specific sexual outcome, e.g., erection or orgasm or the act of intercourse, and this is precluded by the neurologic condition, dissatisfaction may be so profound as to quickly limit further activity.

Figure 2.2 illustrates how all points of the circular sexual response cycle are vulnerable to neurologic disease and its consequences to patients and their sexual relationship.

Functional brain imaging

Functional neuroimaging techniques have become one of the key approaches to understanding the neural correlates of sexual response. A detailed review of some 73 published studies, mostly on healthy male heterosexual volunteers, has led to a model that includes multiple facets of sexual arousal (Stoléru et al., 2012). Brain regions related to the different components of sexual arousal are being delineated. This research also identifies inhibitory processes. Brain imaging during mostly visual sexual stimulation (a minority of studies employed tactile stimulation) engages complex circuitry, with lessening of inhibition combined with sexual excitation.

In keeping with the current circular model of sexual response (depicting sexual incentives or motivations, information processing, overlap of arousal and desire, emphasis on subjective as well as physiologic arousal, plus importance of reward), the model of sexual arousal emanating from the neuroimaging data comprises cognitive, motivational, emotional, and autonomic components (Fig. 2.3). The cognitive component includes appraisal of potentially sexual stimuli, focused attention...
on those deemed erotic, and motor imagery in relation to sexual behavior. The activations of the right lateral orbitofrontal cortex, of the right and the left inferior temporal cortices, of the superior parietal lobules, and of areas belonging to the neural network mediating motor imagery (inferior parietal lobules, left ventral premotor area, right and left supplementary motor areas, cerebellum) are considered to be the neural correlates of the cognitive component. The motivational component comprises the processes that direct behavior to a sexual goal, including the perceived urge to express overt sexual behavior. Thus, the motivational component is conceptualized as including the experience of sexual desire. Neural correlates are thought to be the anterior cingulate cortex, claustrum, posterior parietal cortex, hypothalamus, substantia nigra, and ventral striatum. The emotional component is the brain activity underlying the pleasure from the mental excitement and the perceiving of bodily changes, especially those of the genital response. This pleasure comprises “liking” and “wanting” (Berridge, 1996). The left primary and secondary somatosensory cortices, the amygdalae, and the right posterior insula are conceived as neural correlates of this emotional component. The autonomic and neuroendocrine component includes various responses (e.g., genital, cardiovascular, respiratory, changes in hormonal plasma levels), leading subjects to a state of physiologic readiness for sexual behavior: activations in the anterior cingulate cortex, anterior insulae, putamens and hypothalamus contribute to this component.

From studying the deactivations with sexual arousal, three components of inhibition are envisioned:

1. inhibition mediated by regions in the temporal lobes and the gyrus rectus of the orbitofrontal cortex in the resting state. Patients with lesions in the gyrus rectus are noted to have excessive appetite for sexual and other pleasurable activities (Miller et al., 1986). Temporal-lobe involvement is consistent with the marked hypersexuality of Klüver–Bucy syndrome (Devinsky et al., 2010). The deactivated temporal regions are distinct from those activated in response to visual sexual stimuli
2. inhibition of arousal once it has begun, e.g., to limit its expression, is mediated in the caudate nucleus and putamen. This is consistent with reports of hypersexuality associated with lesions in the head of the caudate nuclei (Richfield et al., 1987)
3. cognitions related to undermining of sexual stimuli, mediated by failure of the left orbitofrontal cortex to deactivate.

It is of interest that those regions thought to mediate inhibition of sexual arousal have been found to be activated during tasks that require moral judgments and those that involve guilt and embarrassment (Takahashi et al., 2004).

**SEXUAL DYSFUNCTIONS**

A circular sexual response cycle of overlapping phases of variable order reflects the well-documented typical comorbidity of dysfunctions in women (Lewis et al., 2010). Recent study suggests similar comorbidity is also frequent in men. Low desire in 1350 men, unassociated with psychopathology, hypogonadism, or hyperprolactinemia, was comorbid with ED, premature ejaculation, and delayed ejaculation in 38%, 28%, and 50% respectively (Corona et al., 2013). Using structural equation modeling, in a different study of 406 men with sexual problems, a model emerged linking low desire, ED, and orgasm delay (Carvalho et al., 2011). This is in keeping with clinical experience of a global sexual disorder in men, especially men with chronic disease. Unfortunately, many physicians view ED as synonymous with male sexual dysfunction (Carvalho et al., 2011). Similarly, ED has been the major focus of research and clinical attention. The most frequently used validated questionnaires are the International Index of Erectile Function and Female Sexual Function Index. However, these questionnaires reflect a non-evidence-based conceptualization of sexual response simplified as a linear entity of discrete sequential phases, beginning with desire at the outset of sexual activity, arousal that is focused on genital events rather than subjective excitement, followed by orgasm and resolution: dysfunctions are considered phase-specific. Thus there is uncertainty as to the true prevalence of sexual disorders, as currently understood in both health and in neurologic disease (Althof et al., 2005).

**CONCLUSION**

This current conceptualization of human sexual response guides the assessment and management of sexual dysfunction associated with neurologic illness. Assessment of the various stages of the circular incentives or motivations-based response cycle allows the clinician to create the patient’s own cycle (Fig. 2.2). The various areas of vulnerability or weakness are clarified: patients sees the logic to their situation. This in itself is therapeutic. The role of the neurologic condition and its treatment is explained: interruption of sexual neurophysiology may have reduced genital sensation and caused orgasmic, erectile, or lubrication dysfunction, or sexual pain. Thus the outcome is no longer rewarding and motivation fades. One aspect of sexual rehabilitation will be the treatment of these dysfunctions. The consequences of living with the condition also disrupts the sex response cycle and can be addressed:
attention can be directed at changes within the relationship and the need for more potent sexual stimuli and optimal sexual environment. Impairment of the brain’s appraisal of sexual stimuli from distractions, depression, and lowered self-image is explained and further guides treatment.

**References**


