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A study of sexuality following traumatic brain injury: moving towards the validation of a biopsychosocial model

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Résumé

L'étude de la sexualité dans le contexte des maladies neurologiques est un domaine émergent qui nous permet de mieux comprendre les corrélats cérébraux et neurocomportementaux de divers aspects de la sexualité. Les changements au sujet de la sexualité sont fréquents à la suite de troubles neurologiques tels que les blessures de la moelle épinière, la sclérose en plaques, l'accident vasculaire cérébral, l'épilepsie et les traumatismes craniocérébraux (TCC). Compte tenu de la complexité de la sexualité après un TCC, celle-ci doit être analysée à partir d'une perspective biopsychosociale qui comprend trois facteurs interdépendants : a) les facteurs neuropsychologiques et psychologiques, b) les variables médicales et physiques, et c) les facteurs relationnels.

L'objectif de cette thèse était d'étudier certains éléments de la sexualité auprès de personnes ayant subi un TCC afin de fournir des preuves empiriques pour contribuer à la validation d'une perspective biopsychosociale de la sexualité après un TCC. Trois études quantitatives originales ont été effectuées auprès de personnes ayant subi un TCC léger, modéré ou grave et ayant reçu des services de réadaptation post-TCC, et d'un groupe de témoins en bonne santé, tous vivant dans la communauté. Les groupes étaient comparables en ce qui concerne l'âge, le sexe, le nombre d'années de scolarité, le statut d'emploi et relationnel, et le revenu annuel. Les variables ciblant la sexualité, incluses dans cette thèse, étaient la qualité de vie sexuelle, le comportement sexuel à risque, et la sociosexualité (p. ex., les différences individuelles en ce qui concerne la volonté d'une personne à avoir des relations sexuelles sans engagement). Les variables neuropsychologiques et psychologiques incluaient les fonctions exécutives, la dépression et l'anxiété. Les aspects médicaux et physiques englobaient les

symptômes postcommotionnels. Les facteurs relationnels comprenaient les attitudes envers l'infidélité.

Les résultats démontrent que par rapport aux témoins en santé, les individus avec un TCC ont montré une diminution de la qualité de vie sexuelle, alors que les groupes étaient comparables sur le plan du comportement sexuel à risque, de la sociosexualité et des attitudes envers l'infidélité. Par ailleurs, les résultats ont montré une différence entre les hommes et les femmes sur le plan de la sociosexualité (p. ex., plus restrictive chez la femme). Chez les personnes ayant subi un TCC, une faible qualité de vie sexuelle était significativement associée à un nombre élevé de symptômes postcommotionnels, un comportement sexuel plus à risque corrélait avec une plus grande fréquence de symptômes dysexécutifs, et une plus faible acceptation de l'infidélité était liée à une sociosexualité moins restrictive.

Les résultats de ces trois études soutiennent une perspective biopsychosociale de la sexualité après le TCC. Elles apportent des connaissances nouvelles en ce qui a trait aux domaines de la sexualité qui peuvent être touchés après un TCC, ainsi qu'à certaines variables neuropsychologiques et psychologiques, médicales et physiques, et relationnelles qui sont associées à ces changements. Les implications théoriques, ainsi que pour la pratique clinique et la réadaptation sont discutées. Les limitations des études sont présentées et des recommandations pour la recherche sont proposées. Le modèle biopsychosocial peut être utilisé comme une référence pour guider la recherche future dans ce domaine. D'autres études sur la sexualité et le développement d'interventions multidisciplinaires dans ce domaine pour les personnes TCC sont nécessaires.

Mots-clés : Sexualité, traumatisme craniocérébral, qualité de vie sexuelle, comportement sexuel à risque, sociosexualité, symptômes postcommotionnels, fonctions exécutives, anxiété, dépression, infidélité, intervention, réadaptation.

Abstract

The study of sexuality in the context of neurological disorders is an emerging area leading us to better understand the brain and neurobehavioral correlates of various aspects of sexuality. Changes in sexuality are common following neurological disorders, such as spinal cord injury, multiple sclerosis, stroke, epilepsy, and traumatic brain injury (TBI). Given the complexity of sexuality after TBI, it needs to be analyzed from a biopsychosocial perspective that includes three interrelated factors: a) neuropsychological and psychological factors, b) medical and physical variables, and c) relationship factors.

The objective of this thesis was to study certain aspects of sexuality in individuals with TBI to provide empirical evidence to contribute to the validation of a biopsychosocial perspective of sexuality after TBI. Three original quantitative studies were conducted in individuals with mild, moderate, and severe TBI who received post-TBI rehabilitation services and in a group of healthy controls living in the community. The groups were comparable in age, sex, years of education, work and relationship status, and annual income. The variables targeting sexuality included in this thesis were sexual quality of life, risky sexual behavior, and sociosexuality (e.g., individual differences regarding the willingness to engage in uncommitted sexual relationships). Neuropsychological and psychological variables included executive function, depression and anxiety. Medical and physical aspects encompassed postconcussion symptoms. Relationship factors involved attitudes toward infidelity.

The results demonstrate that compared to healthy controls, individuals with TBI showed lower sexual quality of life, while the groups were comparable in risky sexual behavior,

sociosexuality, and attitudes toward infidelity. Furthermore, the results showed differences between men and women regarding sociosexuality (e.g., more restrictive in women). In individuals with TBI, lower sexual quality of life was significantly associated with the presence of postconcussion symptoms; an increase in risky sexual behavior correlated with greater frequency of dysexecutive symptoms, and lower acceptance of infidelity was linked to a less restricted sociosexuality.

The results of these three studies support a biopsychosocial perspective of sexuality following TBI. They provide new knowledge in the areas of sexuality that may be affected after a TBI, as well as some neuropsychological and psychological, medical and physical, and relational variables associated with these changes. The theoretical implications, as well as those related to clinical practice and rehabilitation are discussed. The limitations of the studies are presented and recommendations for research are proposed. The biopsychosocial model can be used as a reference to guide future research in this area. Other studies about sexuality and the development of multidisciplinary interventions in this area for individuals with TBI are warranted.

Keywords : Sexuality, traumatic brain injury, sexual quality of life, risky sexual behavior, sociosexuality, postconcussion symptoms, executive functions, anxiety, depression, infidelity, intervention, sexual rehabilitation.

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Introduction

Chapter 3

List of abbreviations

AIDS	Acquired immune deficiency syndrome
ANOVA	Analysis of variance
ATIS	Attitudes Toward Infidelity Scale
BADS	Behavioural Assessment of the Dysexecutive Syndrome
BIQS	Brain Injury Questionnaire of Sexuality
CAT	Computer Axial Tomography
CERNEC	Centre de Recherche en Neuropsychologie et Cognition
COG-SEN	Cognitive sensory symptoms subscale of the PCSS scale
CP	Casual partner
CRIR	Center for Interdisciplinary Research in Rehabilitation of Greater Montreal
DEX	Dysexecutive questionnaire
DEXBEH	Behavior subscale of the DEX
DEXCOG	Cognition subscale of the DEX
DEXEMO	Emotion subscale of the DEX
DISF	Derogatis Interview for Sexual Function
DISF-SR	Derogatis Interview for Sexual Functioning-Self-Report
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, 4th Edition
Ex-PLISSIT	Extended-Permission, Limited Information, Specific Suggestions, and Intensive Therapy
fMRI	Functional magnetic resonance imaging
GAD-7	Generalized Anxiety Disorder Scale
GCS	Glasgow Coma Scale
GSSI	Global Sexual Satisfaction Index
HIV	Human immunodeficiency virus infection
HPV	Human papillomavirus
IE-RSB	Intent to engage in risky sexual behaviors
ISA	Impulsive sexual acts
ISB	Inappropriate sexual behavior
LGBTI	Lesbian, gay, bisexual, transgender, and intersex
LOC	Loss of consciousness
MP	Main partner
MRI	Magnetic Resonance Imaging
PCSS	Postconcussion symptoms scale
PHQ-9	Patient Health Questionnaire
PLISSIT	Permission, Limited Information, Specific Suggestions, and Intensive Therapy
POPS	Participation Objective, Participation Subjective questionnaire
PTSD	Post-traumatic stress disorder
PSM	Past six months
PTA	Postraumatic amnesia
QOLI	Quality of Life Interview

RASA	Risky anal sexual acts
REB	Research Ethics Board
RSA	Risky sex acts
SCI	Spinal cord injury
SLEEP-AR	Sleep-arousal symptoms subscale of the PCSS scale
SO	Sociosexual orientation
SOI-ATT	Sociosexual attitudes subscale of the SOI-R
SOI-BEH	Sociosexual behavior subscale of the SOI-R
SOI-DES	Sociosexual desire subscale of the SOI-R
SOI-R	Sociosexual Orientation Inventory - Revised
SPSS	Statistical Package for the Social Sciences
sQoL	Sexual quality of life
SQoL-Q	Sexual Quality of Life Questionnaire
SRS	Sexual Risk Survey
SRT-UP	Sexual risk taking with uncommitted partners
STD	Sexually transmitted disease
STI	Sexually transmitted infection
TBI	Traumatic Brain injury
VEST-SOM	Vestibular-somatic symptoms of the PCSS scale
WHO	World Health Organization

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Introduction

Traumatic brain injury definition and epidemiology

Traumatic brain injury (TBI) has been considered a silent epidemic as it is an important clinical and public health problem that often goes unrecognized (Mustafa & Alshboul, 2013). TBI can be defined as any extracranial mechanical force capable of producing a physiological disruption of the brain with any period of loss or decreased level of consciousness, loss of memory for events immediately before or after the event, or a change in mental status at the time of the event (e.g., confusion, disorientation) (Reeves & Panguluri, 2011). It comprises two injuries: the primary and the secondary injuries. The primary injury occurs concurrently with the impact responsible for the injury, whereas the secondary injury corresponds to an array of pathophysiological responses following the initial trauma which can lead to long-term neuronal and functional dysfunction (Mustafa & Alshboul, 2013). TBI can range in severity from mild concussions to severe injuries leading to a life-threatening state (Frattalone & Ling, 2013). TBI contributes to several negative consequences for the injured individual, the family and the society, including premature death, disability, and adverse medical, social, and financial costs (Leibson et al., 2011). TBI occurs on a broad continuum of severity, ranging from very mild injuries to catastrophic ones leading to death or severe disability that may last for the rest of the person's life. During the first three decades of life, TBI accounts for more productive years of life lost than HIV/AIDS, cancer, and cardiovascular disease combined, being the most common cause of death and disability (Zitnay et al., 2008).

For individuals with TBI, dealing with residual disability, impairment, or handicap is common, especially after catastrophic injuries; as a general rule, as injury severity increases, the

magnitude of impairment increases (Chen, Kang, & Lin, 2011). In Canada, it is estimated that there are 120 000 TBIs each year (Iverson & Lange, 2011b). However, it is almost certainly an underestimation since many people with milder injuries do not seek medical attention after the injury, and thus are not captured in hospital-based data (Iverson & Lange, 2011a). Canadian estimates indicate that most of TBIs are non-intentional (92%) but remain a major cause of death and disability in young adults (Kim & Colantonio, 2008). According to the Public Health Agency of Canada (Government of Canada & Public Health Agency of Canada, 2014), TBI is among the seven most prevalent neurological conditions; it is more prevalent in men regardless of age, with the highest rate of self-reported diagnosed mood disorders (38.3%), and high indirect economic costs ($63 million in 2011, and $32 million in 2031).

TBI must be understood not as a single event, but rather as disease process because it is associated with increased incidences of neurological disorders (e.g., neurodegenerative diseases) and non-neurological effects (e.g., problems with sexuality), as well as with increased long-term mortality compared to non-brain-injured individuals (Masel & DeWitt, 2010). TBI can result in temporary, prolonged or permanent neurological or neuropsychiatric problems such as cranial nerve impairments, motor and locomotor dysfunction, dizziness, visual difficulties, fatigue and sleep problems, headaches, multiple cognitive deficits, anxiety, psychotic disorders, personality changes, lack of awareness, apathy, sexual dysfunction, and other issues associated with sexuality (Iverson, 2005; Iverson & Lange, 2011a, 2011b; Iverson, Lange, Brooks, & Rennison, 2010).

Sexuality after a TBI is particularly important considering that studies on post-TBI marital stability show divorce or separation rates ranging from 15% to 78% (Arango-Lasprilla et al., 2008;

Godwin, Kreutzer, Arango-Lasprilla, & Lehan, 2011; Johnson et al., 2010; Wedcliffe & Ross, 2001). Sexuality is closely tied to one's identity, self-esteem, and need for intimate relationships, all of which can be shaken after a TBI. However, while the many physical, cognitive, and psychosocial sequelae that can result from the injury can have direct impacts on various aspects of sexuality (Moreno, Arango-Lasprilla, Gan, & McKerral, 2013), research literature on the subject remains scarce.

According to the World Health Organization (WHO), people are sexual beings throughout their lives and sexual health care should address not exclusively counseling and care related to procreation or sexually transmitted infections, but also the improvement of life and personal relationships (WHO, 2014). In other words, to promote a satisfying sex life beyond the capability of procreation. When it comes to sexuality and comorbid disability, many health care providers may tend to avoid the topic, act as if it was not important, may assume it is a non-issue, or prioritize other aspects of clinical intervention or rehabilitation (Dyer & das Nair, 2013b).

In the field of clinical neuropsychology, there is an increasing interest in the study of sexuality and disability, and competent clinical neuropsychologists need to increase their knowledge of the integral biopsychosocial aspects of sexuality, sexual function, and disability (DenBoer & Hough, 2010). Enhanced training of health care professionals to increase knowledge, skills, and comfort level in approaching relationship issues and sexuality in individuals with TBI has been put forward as being essential (Gill, Sander, Robins, Mazzei, & Struchen, 2011).

Studies of sexuality after TBI

TBI impacts people's sexuality, with 50 to 60% of persons reporting some level of disruption post-injury (Kreuter, Dahllof, Gudjonsson, Sullivan, & Siosteen, 1998; O'Carroll, Woodrow, & Maroun, 1991; Simpson, 2001). From theoretical and clinical standpoints, medical and psychological perspectives of sexuality problems after TBI try to encompass their multi-causal nature. However, of the research studies available, many have focused on specific sexual problems, in particular sexual function, and large variability in findings is common. Empirical studies on sexuality following TBI can be divided into four perspectives: professional, individual with TBI, individual with TBI/partner, and non-injured. Some of these studies taking into account these four different perspectives are summarized in a critical review of sexuality following TBI (Moreno, Arango-Lasprilla, et al., 2013). For this thesis, part of the content has been reproduced, in a reorganized and updated fashion, from the peer-reviewed journal *NeuroRehabilitation*, Sexuality after traumatic brain injury: a critical review, 32 (1), 69- 85; Moreno, A., Arango-Lasprilla, J., Gan, C., & McKerral, M., Copyright 2013, with permission from IOS Press. The content presented in Table 1 and described in the following paragraphs, concerns studies from the sole perspective of the individual with TBI, which is the most relevant to the purpose of this thesis.

Table 1. Summary of empirical studies on sexuality from the perspective of the individual with TBI

Author	Size of sample	Description of sample	Study focus	Primary findings
(Kosteljanetz et al., 1981)	19 males with TBI	Post-concussional syndrome with loss of consciousness (LOC) less than 15 minutes	To explore endocrinological symptoms and sexual function	Sexual dysfunction (reduced libido and/or erectile dysfunction) occurred in 58% and severe intellectual impairment was more frequent in this group
(Kreutzer & Zasler, 1989)	21 males with TBI	Mild to severe TBI, 16 months post-injury	Assess the sexual behavior of the individual with TBI	Individuals with TBI reported decreased sex drive, erectile function, and frequency of intercourse
(Sandel, Williams, Dellapietra, & Derogatis, 1996)	52 individuals with TBI	63.5% with severe TBI (75% males)	Prevalence of sexual dysfunction and its relationship to demographic and injury variables	Significant reduction in orgasm, desire/drive; frontal lobe and right hemisphere lesions were related to higher sexual satisfaction. Sexual function was not associated with neuropsychological measures
(Kreuter et al., 1998)	92 individuals with TBI	TBI, 9 years post injury (70% males)	To study the impact of TBI on sexual ability, activity, and satisfaction	Individuals with TBI report decreased or absent ability to achieve an erection and decreased frequency of ejaculation, ability to experience an orgasm, sexual desire and intercourse

Author	Size of sample	Description of sample	Study focus	Primary findings
(Crowe & Ponsford, 1999)	14 individuals with TBI and 14 controls	Individuals with TBI with LOC of 3 days or greater, assessed 2 years following injury	To investigate the incidence of disturbances of sexual arousal and the ability to form sexual images	59% of the sample indicated decrease in sexual function overall and the TBI group was less able to form images on sexual themes than controls
(Aloni et al., 1999)	44 individuals with TBI	Individuals with severe TBI during the first 6 weeks post-injury	To determine if sexuality and intimacy dysfunction are already present at the early rehabilitation phase	Only 7.7% reported having sexual dysfunction at that phase of rehabilitation
(Hibbard, Gordon, Flanagan, Haddad, & Labinsky, 2000)	322 individuals with TBI and 264 controls	Mild to severe TBI (60% males)	To determine the relative frequency of sexual difficulties post TBI and its relationships to brain injury characteristics	Individuals with TBI reported more physiological, physical and body image difficulties than controls. Age at onset and severity of injury were negatively related to reports of sexual difficulties in individuals with TBI
(Gaudet, Crethar, Burger, & Pulos, 2001)	50 individuals with TBI and 56 controls	Mild to moderate TBI	To explore differences between individuals with and without TBI concerning behaviors and feelings about cognition, ego adaptability, and sexuality	Individuals without TBI have more positive feelings concerning cognition, ego adaptability, and sexuality than individuals with TBI

Author	Size of sample	Description of sample	Study focus	Primary findings
(Ponsford, 2003)	208 individuals with TBI and 150 healthy controls	Moderate to severe TBI (69% males)	To identify changes in sexual behavior, affect, self-esteem, and relationship quality 1-5 years post-injury	Decreased frequency of engaging in sexual activities, diminished sex drive, lower self-esteem, higher levels of depression and decreased communication levels compared to controls
(Sander et al., 2012)	233 individuals with TBI	Persons with moderate to severe TBI	To investigate the incidence and types of sexual difficulties in individuals with TBI one year post-injury, as well as their comfort level in discussing problems with health care professionals	One year post-injury, women with TBI had difficulties in sexual cognition / fantasy, arousal, sexual behavior / experience, and orgasm. Men showed the same sexual difficulties, except for arousal. A total of 68% of participants indicated that they would mention any sexual concern to their health care professionals if they were experiencing sexual difficulties
(Stolwyk et al., 2013)	865 individuals with TBI	Mild to very severe TBI (70% males)	To validate the Brain Injury Questionnaire of Sexuality-BIQS	Emergence of a three-subscale structure; very good internal consistency, as well as convergent and divergent validity of the subscales
(Downing, Stolwyk, & Ponsford, 2013)	865 individuals with TBI and 142 healthy controls	Participants with predominantly moderate to severe TBI (70.3% males)	To compare sexuality in individuals with TBI with that in healthy controls matched for age and gender	There is a significant difference between individuals with TBI and controls on all the BIQS subscales (sexual functioning, relationship quality, and mood) as well as the total score

Author	Size of sample	Description of sample	Study focus	Primary findings
(Hanks, Sander, Millis, Hammond, & Maestas, 2013)	182 individuals with TBI	Participants with moderate to severe TBI (71% males)	To investigate longitudinal changes in sexual functioning during the first year following TBI (6 and 12 months post injury)	There were no significant differences over this 6-month period in satisfaction with sexual functioning, sexual cognition/fantasy, sexual behavior/experience, and orgasm; there was a minimal improvement in arousal
(Sander et al., 2013)	255 individuals with TBI	Individuals with medically documented moderate to severe TBI (73% males)	To investigate predictors of sexual functioning one year following TBI	Older persons, females, and individuals with more severe injuries appear to be at greater risk of developing sexual dysfunction following TBI
(Ponsford, Downing, & Stolwyk, 2013)	986 individuals with TBI	Individuals with predominantly moderate to severe TBI	To determine the association between sexuality following TBI and demographic, injury-related, and post-injury variables	Being depressed and older in age, at shorter time post-injury, and less independent in activities of daily living significantly predicted poorer sexual functioning
(Simpson, Sabaz, & Daher, 2013)	507 individuals with TBI	Individuals with severe TBI living in the community	To investigate the prevalence and clinical features of inappropriate sexual behaviors in community-dwelling individuals with severe TBI	The point prevalence rate of inappropriate sexual behaviors was 8.9% over the previous 3 months. The most prevalent behaviors were inappropriate sexual talk (57.9%), genital and non-genital touching behaviors (29.8%), and exhibitionism/public masturbation (10.5%)

Author	Size of sample	Description of sample	Study focus	Primary findings
(Goldin, Cantor, Tsaousides, Spielman, & Gordon, 2014)	220 individuals with TBI and 83 healthy controls	Community-dwelling adults with mild to severe TBI (52% males, 62% with moderate to severe TBI)	To examine sexual functioning in relation to fatigue in individuals with and without TBI	Fatigue significantly predicted frequency of sex in individuals with TBI. Individuals without brain injury reported sex to be more important than individuals with TBI

Seventeen studies have investigated sexual difficulties from the perspective of the individual with TBI. A study was conducted with the aim of exploring the link between endocrinological and sexual functioning in 19 males with a post-concussional syndrome, 47 months post-injury (Kosteljanetz et al., 1981). They included computed axial tomography (CAT) scans, electroencephalography, endocrinological examination, neuropsychological testing, and used a questionnaire of 23 items concerning libido, ability to obtain erection, ejaculation, orgasm and sexual intercourse. Findings indicated that sexual dysfunction (reduced libido and/or erectile dysfunction) occurred in 58%, increased plasma concentration of follicle stimulating hormone was observed in 37%, severe intellectual impairment was present in 68%, and cerebral atrophy in 68%. Intellectual impairment was more frequent in participants with sexual difficulties and three participants with sexual dysfunction had electroencephalographic signs of temporal lobe abnormality. The possibility of a hypothalamic disorder causing major hormonal disturbances or sexual difficulties was not sustained.

Kreutzer and Zasler (1989) assessed the changes in sexual behavior, affect, self-esteem, and heterosexual relationship characteristics in a group of 21 mild to severe individuals with TBI, 16 months post-injury, with their Psychosexual Assessment Questionnaire (Kreutzer & Zasler,

1989). Findings suggested that following injury, individuals with TBI reported a decrease in sex drive (57%), diminished ability to maintain an erection (57%), diminished frequency of intercourse (62%), lower self-confidence (67%), declines in sex-appeal (52%), and increased depression (71%). Interestingly, none of the five single patients reported a steady heterosexual relationship. Of the 16 married individuals with TBI, 40% reported having a good or very good relationship compared to pre-injury.

In another study, Sandel and colleagues (1996) studied the prevalence of sexual dysfunction and its relationship to age, severity and locus of injury, time since injury, and physical and cognitive function in a group of 52 individuals (39 men and 13 women) with a history of TBI, 3 years post-injury (Sandel et al., 1996), using the Derogatis Interview for Sexual Function (DISF) which was designed for use in male and female heterosexual and homosexual populations. Results showed a reduction below non-injured individual levels in orgasm and drive/desire. Individuals with TBI with more recent injuries experienced more sexual arousal. Further, individuals with frontal lobe and right hemisphere lesions reported more sexual cognitions/fantasies, sexual experiences, and higher arousal than individuals with left hemisphere lesions. There was no relationship between sexual functioning and severity of injury, neuropsychological deficits, length of post-traumatic amnesia, or Glasgow Coma Scale score.

Kreuter and colleagues (1998) studied the impact of TBI on sexual ability, activity and satisfaction and their relationship to physical, social, emotional, and cognitive function in a group of 92 individuals with TBI (65 men and 27 women), with an average post-traumatic amnesia of four months, nine years post-injury (Kreuter et al., 1998). The Sexual Interest and Satisfaction

Scale was used as a measure of sexual functioning. Results indicated that after the injury, 30% of men reported decreased or absent ability to achieve an erection, 40% mentioned that their ability to experience orgasm was decreased or non-existent, 24% reported decreased intercourse, and 23% non-existent frequency of intercourse. Concerning sexual practices, 26% of the individuals with TBI who reported that they self-masturbated prior to the injury mentioned that they did so less often after the injury, whereas 19% used self-masturbation more often post-injury. Sexual adjustment was better predicted by a high degree of physical independence and maintained sexual ability in terms of occurrence of sexual intercourse and the ability to experience orgasm.

Another study investigated the incidence of disturbance of sexual arousal in a group of individuals with TBI, and the degree to which disturbances of visual imagery processes impinge upon the ability to form sexual images as an adjunct to arousal (Crowe & Ponsford, 1999). The sample, consisting of 14 moderate to severe individuals with TBI, 4 years post-injury, and 14 normal controls, was administered the Psychosexual Assessment Questionnaire. Results indicated that 59% of the sample showed a decrease in sexual function overall, 86% noted a decrease in sexual drive and intercourse frequency, and 79% reported a marked decrease in level of self-confidence. Compared to healthy controls, individuals with TBI were significantly more likely to have deficits in the ability to form sexual images, even after controlling for their current level of depression. The levels of decrease in sexual functioning were associated with a reduction in the level of ability to be able to form images on both sexual and non-sexual themes.

Aloni and colleagues (1999) studied whether sexuality and intimacy dysfunction were already present at the early rehabilitation phase in 44 male individuals with severe TBI without a

history of alcohol or drug abuse, six weeks post-injury, with a modified version of the Psychosexual Assessment Questionnaire (Aloni et al., 1999). Results indicated that only 14% of individuals with TBI reported having sexual dysfunction (7% of the individuals with TBI with partners, and 22% of the individuals with TBI without partners). Individuals with TBI who had partners complained about problems with erection, while those without partners complained about decreased libido. Further, these individuals with TBI who showed sexual dysfunction suffered from more severe initial brain injury, as measured by lower Glasgow Coma Scale scores and longer periods of unconsciousness.

Hibbard and colleagues (2000) conducted a study to determine the relative frequency of sexual difficulties in a group of 322 mild to severe individuals with TBI (193 men and 129 women), 9 years post-injury, and 264 individuals without disability (152 men and 112 women), both living in the community (Hibbard et al., 2000). Analysis of the sexual functioning subscales of the Quality of Life Interview (QOLI) indicated that compared to individuals without disability, men with TBI reported less involvement in sexual activities and relationships during the prior year, more difficulty in maintaining an erection, more physiological problems influencing their energy for sexual intercourse, physical difficulties concerning body movement and positioning, and body image difficulties related to attractiveness. For men with TBI, predictors of sexual dysfunction were depression, older age at interview, older age at injury, and milder injuries. Sexual activity and relationship involvement were similar in women with TBI and women without disability, but women with TBI reported more frequent pain during sex, and more difficulties in arousal, masturbation, and vaginal lubrication. For women with TBI, the presence of an endocrine disorder, level of depression, older age at injury, and milder injuries were predictors of sexual dysfunction.

To clarify the psychosocial problems of individuals with TBI, Gaudet and colleagues (2001) examined cognition, ego adaptability and sexuality in 50 mild to moderate individuals with TBI (26 males and 24 females) and 55 non-TBI participants (22 males and 33 females) (Gaudet et al., 2001). They used the Consequences of Traumatic Brain Injury Questionnaire that included 6 items concerning sexuality. Results indicated that compared to controls, individuals with TBI had more negative feelings about themselves, their sexuality, and their relationship with others. When comparing individuals with TBI by gender, women with TBI had more positive feelings about their sexuality than men with TBI.

Ponsford (2003) conducted a study aimed at identifying changes in sexual function/behavior, affect, self-esteem, and relationship quality following TBI in 208 moderate to severe individuals with TBI (143 males and 65 females), 1-5 years post-injury, and 150 healthy controls (97 males and 53 females) (Ponsford, 2003). The Sexuality Questionnaire adapted from Kreuter and colleagues, and Kreutzer and Zasler (Kreuter et al., 1998; Kreutzer & Zasler, 1989), was administered using a language appropriate for males and females. Compared to healthy controls, individuals with TBI reported post-injury decreases in the importance of sexuality (36%) and in their sex drive (41%), as well as in the ability to give their partner sexual satisfaction (39%), engage in intercourse (38%), enjoy sexual activity (38%), stay aroused (40%), and achieve orgasm (36%). When asked about the reasons for changes in their sexual behavior/enjoyment, individuals with TBI rated fatigue (47%), decreased mobility (31%), and low confidence (31%) as important factors, and these proportions were significantly higher than in controls. For affect and self-esteem, individuals with TBI reported decreased self-confidence (52%), diminished sex-appeal (47%),

higher levels of depression (42%), and decreased ability to communicate with their partner (29%) after the injury, compared to healthy controls.

The first longitudinal investigation of sexual functioning after TBI was conducted in a collaborative study among six TBI inpatient rehabilitation units in the United States, including 223 community-dwelling individuals with medically documented moderate to severe TBI (Sander et al., 2012). The aim of the study was to investigate the incidence and types of sexual difficulties in individuals with TBI one year post-injury, as well as their comfort level in discussing problems with health care professionals. Participants completed the Derogatis Interview for Sexual Functioning-Self-Report (DISF-SR), the Global Sexual Satisfaction Index (GSSI), the structured interview regarding changes in sexual functioning, and questions regarding the comfort level discussing sexuality with health care professionals. The results showed that one year post-injury, women with TBI had difficulties in sexual cognition/fantasy, arousal, sexual behavior/experience, and orgasm. Men with TBI showed the same sexual difficulties, except for arousal. Comparisons by gender revealed that women with TBI reported greater dysfunction than men for sexual cognition/fantasy and arousal. Also, compared to women with TBI (21.4%), a greater percentage of men with TBI reported sexual dissatisfaction (31.9%). Besides, 68% of participants indicated that they would spontaneously raise issues of sexual difficulties with health care professionals; surprisingly, the remainder would either mention it only if directly asked or would not discuss it at all. The authors conclude that sexual difficulties were present in a substantial portion of community-dwelling individuals with TBI at one year after injury, and that educational programs to increase awareness among individuals with TBI and rehabilitation professionals are warranted.

Another study provides the first validation of a questionnaire on sexuality (Brain Injury Questionnaire of Sexuality-BIQS), specifically developed for TBI (Stolwyk et al., 2013) and standardized in a sample of 865 individuals with TBI in Australia. The BIQS showed a three-factor structure (the sexual functioning subscale, the relationship quality subscale, and the mood subscale) and a high internal consistency (Cronbach alpha coefficient of .92). Besides, the BIQS showed convergent validity with the subscales of the Derogatis Interview for Sexual Functioning. The authors conclude that the BIQS is a promising tool for future TBI research about sexuality.

In a study conducted in Australia, the researchers compared sexuality in 865 individuals with predominantly moderate to severe TBI and 142 healthy controls matched for age and gender (Downing et al., 2013). They completed the BIQS, the Hospital Anxiety and Depression Scale, and the Rosenberg Self-Esteem Scale. The results indicated that compared to healthy controls, individuals with TBI showed a significant decrease in sexuality, relationship quality, and mood. Besides, the findings suggest that these differences were only apparent for the 46 to 55-year age group. The results also showed that individuals with TBI attributed sexual changes to various causes, including fatigue, low confidence, pain, decreased mobility, and feeling unattractive. The authors conclude that research aimed to investigate the factors contributing to sexual changes following TBI is needed.

Another longitudinal investigation of sexual functioning after TBI was conducted in a collaborative study among six TBI Model Systems centers in the United States, including 182 individuals with moderate to severe TBI (Hanks et al., 2013). The study aimed to investigate longitudinal changes in sexual functioning from 6 to 12 months following moderate to severe TBI. The results suggest that about 30% of individuals with TBI reported sexual concerns falling in the

clinical range regarding satisfaction with sexual functioning, sexual cognition/fantasy, sexual behavior/experience, and orgasm. In addition, these difficulties remain stable over a 6-month period.

In another investigation conducted in a collaborative study among six TBI Model Systems centers in the United States, researchers investigated the predictors of sexual functioning one year post-injury in 255 individuals with medically documented moderate to severe TBI (Sander et al., 2013). Participants completed the Derogatis Interview for Sexual Functioning-Self-Report (DISF-SR), the Global Satisfaction With Sexual Functioning (Global Sexual Satisfaction Index), the Participation Assessment With Recombined Tools-Objective and the Patient Health Questionnaire-9 (PHQ-9). The results showed that compared to males, females with TBI had a 2.5 increase in the odds to report sexual impairment, that older age and poorer social participation were associated with greater sexual dysfunction, and that depression was predictive of sexual satisfaction but not sexual functioning. The authors conclude that these groups may require specialized assessment and services to address sexual problems.

A study was conducted to explore the evidence of possible risk factors for sexual dysfunction in a sample of 986 individuals with predominantly moderate to severe TBI, ranging form 1 to 20 years post-injury in Australia (Ponsford et al., 2013). Participants completed the BIQS, the Hospital Anxiety and Depression Scale, the Rosenberg Self-Esteem Scale, and an independence assessment regarding activities of daily living. The results of this study suggest that being depressed and older in age, at shorter time post-injury, and less independent in activities of daily living significantly predicted poorer sexual functioning. In addition, older age and higher

levels of depression were significantly associated with relationship quality and lower self-esteem. The authors conclude that therapeutic interventions for sexuality after TBI are warranted, particularly focusing on depression, self-esteem, specific barriers to social participation and opportunities for sexual contact in individuals with TBI who are less independent in their activities of daily living.

Another study addressed the prevalence and clinical features of inappropriate sexual behavior (ISB) among a community-based cohort of 507 individuals with severe TBI who were clients of a brain injury rehabilitation program in Australia (Simpson et al., 2013). The following study measures were rated by 88 clinicians, mostly occupational therapists: the Overt Behavior Scale (primary measure), the Disability Rating Scale, the Sydney Psychosocial Reintegration Scale-2, the Health of the Nation Outcome Scale-Acquired Brain Injury, as well as the Care and Needs Scale. The results indicate a point prevalence rate of ISBs of 8.9% over the previous 3 months, with ISBs being part of a wider challenging behavior spectrum (disinhibition syndrome). In particular, the most common ISBs were inappropriate sexual talk (57.9%), genital and non-genital touching behaviors (29.8%), and exhibitionism/public masturbation (10.5%). In addition, individuals who sustained more severe injuries and who were younger were significantly more likely to display ISBs. Also, individuals with TBI showing ISBs had higher levels of behavioral disturbance, extremely poor levels of social participation, more severe functional disability, greater levels of care and support needs, and higher comorbid mental health issues. The authors conclude that ISBs remain a clinical challenge among a minority of individuals with severe TBI.

Finally, sexual activity was examined in a sample of 220 community-dwelling individuals with TBI who were 15 years post-injury and 83 healthy controls (Goldin et al., 2014). Sexual activity was assessed with one of the items of the Participation Objective, Participation Subjective questionnaire (POPS) regarding the frequency of sex, desired frequency of sex, importance of sex, and the degree of satisfaction. The results of the study showed that individuals with TBI did not differ from healthy controls in sexual frequency, desire frequency or satisfaction. Compared to individuals with TBI, individuals without head injury reported sex to be more important. In addition, fatigue significantly predicted frequency of sex in individuals with TBI. Gender differences indicated that compared to men with TBI, women with TBI reported having sex less frequently and rated sexual activity as less important. The authors conclude that fatigue may play a significant role in the sexual life of individuals with TBI, and as such, it may be a target for research and intervention.

There are thus quite a few studies concerning sexual difficulties from the perspective of the individual with TBI. These studies have contributed important information to this domain, but some of them have limitations that should be mentioned. Only six of the 17 studies included control groups. The small sample sizes of most studies, gender characteristics of the samples including more men than women (or only men), the use of self-report measures without obtaining equivalent information from partners when possible, the absence of control of factors related to associated psychopathology, to medication intake that may affect sexual performance, and to drug/alcohol abuse limit the generalizability of their findings. Taken together, these findings reflect the diversity of biopsychosocial factors contributing to sexuality after a TBI, as well as the need for

understanding specific relationships between these factors within an integrated framework of sexuality post-TBI.

Biopsychosocial approach to sexuality after TBI

Individuals with TBI can experience cognitive, psychiatric/behavioral, and physical/functional sequelae that interfere with sexuality (Podell, Gifford, Bougakov, & Goldberg, 2010; Rosenthal, 1999; Silver, McAllister, & Yudofsky, 2005). These changes can interfere with the ability to develop and maintain relationships, the expression of sexuality, and one's ability to give and receive love and affection. As functioning in one domain (e.g., physical) can affect functioning in other domains (e.g., relational), it is important to adopt a holistic perspective of sexuality after TBI. To help clinicians understand the complexity of interaction between these factors, and to help guide future research, a biopsychosocial model was proposed (Gan, 2005; Moreno, Arango-Lasprilla, et al., 2013; Moreno, Gan, Zasler, & McKerral, 2014; Moreno & McKerral, 2013; Moreno, McKerral, & Gan, 2013), which represents the interaction of three domains: a) neuropsychological and psychological effects, b) medical and physical issues, and c) relationship factors (Figure 1).

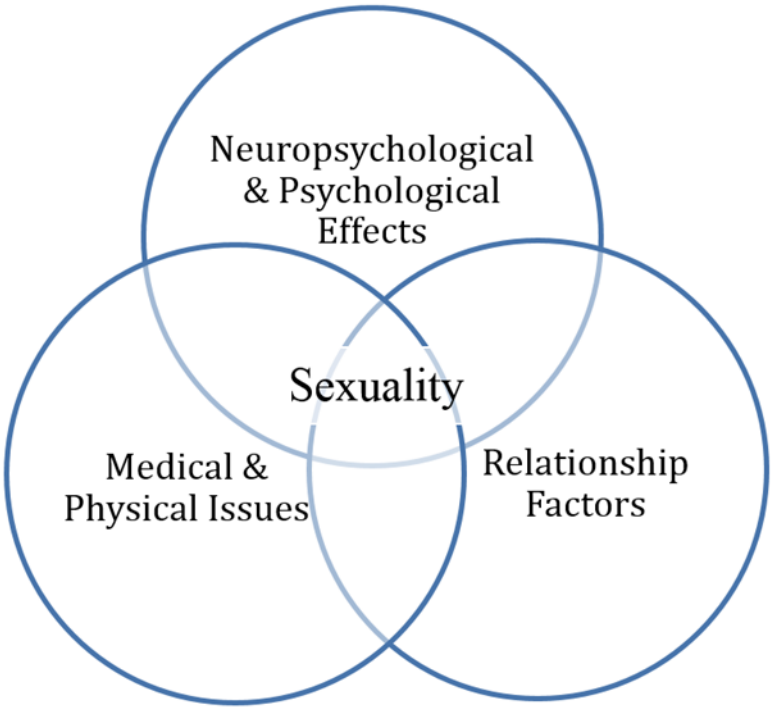

Figure 1. Biopsychosocial model of sexuality

Neuropsychological and psychological effects of TBI

Cognitive sequelae can include attention deficits (Hasegawa & Hoshiyama, 2009; Pare, Rabin, Fogel, & Pepin, 2009), diminished processing speed (Perbal, Couillet, Azouvi, & Pouthas, 2003), verbal memory impairment (Geary, Kraus, Pliskin, & Little, 2010; Wiegner & Donders, 1999), working memory deficits (Hoskison et al., 2009; Kumar, Rao, Chandramouli, & Pillai, 2013), language and communication disorders (Murdoch & Theodoros, 2001; Tavano et al., 2009), dysexecutive syndrome including problems with organization, reasoning, mental flexibility, problem solving, planning, execution, and self-regulation (García-Molina, Bernabeu-Guitart, & Roig-Rovira, 2010; Stuss, 2011), and deficits in facial emotion perception (Green, Turner, & Thompson, 2004). Cognitive deficits can be an obstacle to sexuality in many ways. Attention

deficits are associated with increased distractibility and it can interfere with sexual interaction as it can be interpreted as lack of interest in the sexual partner. Attention difficulties can also affect arousal as it reduces one's ability to fantasize and maintain focus. Furthermore, individuals with TBI can show difficulties in appropriate social interaction because they can forget a date, a recent sexual encounter, significant episodes concerning the relationship, or have difficulties in social communication.

Common psychological effects of TBI can include changes in body image (Hibbard et al., 2000), loss of identity (Gutman & Napier-Klemic, 1996), and adjustment issues (Hammond, Davis, Whiteside, Philbrick, & Hirsch, 2011), all of which can affect one's confidence and comfort in forming new relationships or relating to others. Compared to healthy controls, individuals with TBI show a decreased quality of life (Schiehser et al., 2014), as well as worse quality of life in its specific dimensions; diminished health-related quality of life has been documented after 10 (Andelic et al., 2009) and 22 years post-injury (Nestvold & Stavem, 2009). Also, the impact of these psychological changes on sexuality seems to be different for men and women (Goldin et al., 2014; Sander et al., 2012). For that reason, differences according to sex regarding psychological characteristics need to be studied following TBI. In fact, qualitative studies show that brain injury can affect gender roles differently (Gutman & Napier-Klemic, 1996). Compared to women, men have greater feelings of gender inadequacy post-injury and have greater difficulty resolving rites of passage related to the achievement of the adult work role, marriage, and parenting. Also, some psychological traits can show variation according to sex in the general population. That is the case of personality traits, with women showing higher levels of neuroticism, extraversion, agreeableness, and conscientiousness compared to men in different cultures (Schmitt, Realo,

Voracek, & Allik, 2008). Another example corresponds to sociosexuality or the fact that compared to women, men are more likely to be involved in casual sex (Bailey, Kirk, Zhu, Dunne, & Martin, 2000). However, sociosexuality has not yet been studied in individuals with TBI.

Psychiatric/behavioral consequences of TBI can include sleep disturbances (Orff, Ayalon, & Drummond, 2009; Shekleton et al., 2010), impulsivity (Rochat et al., 2010), depression (Ennis, Rosenbloom, Canzian, & Topolovec-Vranic, 2013; Jorge et al., 2004), anxiety (Baykara et al., 2012; Max et al., 2011), agitation (Bogner, Corrigan, Fugate, Mysiw, & Clinchot, 2001; Flanagan, Elovic, & Sandel, 2009), sexually inappropriate behavior (Simpson et al., 2013), perseveration and wandering (Vaughan, Agner, & Clinchot, 1997), personality changes (Ohara, Nishii, Nakajima, Kokai, & Morita, 2004; Warriner & Velikonja, 2006), obsessive-compulsive disorder (Berthier, Kulisevsky, Gironell, & Lopez, 2001; Coetzer, 2004), post-traumatic stress disorder (Kaplan, Vasterling, & Vedak, 2010; van Veldhoven et al., 2011), psychosis (Fujii & Ahmed, 2001; Viana, Prais, Nicolato, & Caramelli, 2010), and anosognosia (Bivona et al., 2014; Richardson, McKay, & Ponsford, 2014). These neuropsychiatric symptoms may lead to behaviors resulting in negative consequences for a person's health, defined as risky behaviors. Risky behaviors can be translated into alcohol consumption, drug use, unsafe sexual practices, illegal behaviors, dangerous driving, and smoking (Turchik, 2007).

These behavioral/emotional symptoms can limit sexuality in different ways: either from the changes associated with apathy, or from the other extreme of the spectrum through lack of self-control of behavior. For instance, in individuals with TBI, apathy (Andersson & Bergedalen, 2002) could lead to loss of social contacts, interfere with initiation abilities or be linked to indifference

to sex. Conversely, individuals with TBI presenting with behavioral dyscontrol (Arciniegas & Wortzel, 2014) can have difficulty in controlling their impulses, misinterpret social cues as sexual signals, exhibit sexually disinhibited behavior, be childish and selfish, and may become involved in unsafe sex practices and unwanted pregnancy. However, risky sexual behavior has not been studied in individuals with TBI.

Medical/Physical issues

Physical/functional symptoms after TBI can consist of limitations in functional mobility (Dumas & Carey, 2002), headaches (Packard, 2008; Walker, Seel, Curtiss, & Warden, 2005), sleep disorders (Orff et al., 2009; Shekleton et al., 2010), fatigue (Englander, Bushnik, Oggins, & Katznelson, 2010; Norrie et al., 2010), auditory and visual impairments (Lew et al., 2009), anosmia (Callahan & Hinkebein, 1999; Mann & Vento, 2006), ageusia (Reiter, DiNardo, & Costanzo, 2004), pituitary dysfunction (Moon, Sutton, Wilson, Kirkham, & Davies, 2010; Tanriverdi et al., 2013), spasticity (Zafonte, Elovic, & Lombard, 2004), impaired balance (Katz-Leurer, Rotem, Keren, & Meyer, 2009; Kaufman et al., 2006), hemiparesis or hemiplegia (Denes, 2009), tremor and ataxia (Aisen, Holzer, Rosen, Dietz, & McDowell, 1991), dizziness (Maskell, Chiarelli, & Isles, 2006, 2007), post-traumatic epilepsy (Prince, Parada, & Graber, 2012; Pugh et al., 2014), oro-pharyngeal dysphagia and swallowing disorders (Terre & Mearin, 2007), oro-facial hypersensitivity (Gilmore, Aram, Powell, & Greenwood, 2003), and urinary and fecal incontinence (Foxx-Orenstein et al., 2003; Keller, Liu, & Lin, 2013). Sensorimotor deficits and pain issues can adversely affect a person's ability to be aroused by sensory stimuli or to perform various movements involved in lovemaking. Oral-motor problems can interfere with kissing or romantic vocalizations. Individuals with TBI who suffer fatigue or sleep issues may have reduced

sex drive or reduced stamina for sexual activity. Loss of control of bodily functions can lead to anxiety or embarrassing situations.

Also, after a TBI, many individuals are prescribed a variety of medications, including antihypertensives, antidepressants, stimulants, anticonvulsants, and antipsychotics. These medications can interfere with sexual functioning as they often have sexual side effects such as decreased libido, erectile and ejaculatory difficulties, arousal problems, or orgasmic difficulties (Cohen, 2003). However, drug-related effects on sexual function can be modified when the medication is stopped or the dosage is adjusted.

In addition, a variety of the post-TBI physical/medical issues and neuropsychological and psychological changes are encompassed under the category of postconcussion symptoms. However, little is known about their impact on the quality of life of individuals with TBI (Schiehser et al., 2014). And even less is known about the relationship between postconcussion symptoms and sexuality, which is an important and often overlooked aspects contributing to quality of life.

Relationship factors

The physical, cognitive, emotional and behavioral changes that accompany TBI can place significant demands on family members. Issues such as family strain, depression, psychological distress, problems adjusting to new roles, and social isolation are frequently reported in studies of family caregivers (Arango-Lasprilla et al., 2011; Boschen, Gargaro, Gan, Gerber, & Brandys, 2007; Ennis et al., 2013; Turner et al., 2010). The role changes and the increased dependence of the injured partner make it difficult for couples to enjoy a mutually satisfying intimate and sexual

relationship. Intimacy has been defined as the involvement in an interpersonal and/or sexual relationship with another person in which positive emotional connections and a commitment have been established (Gill et al., 2011). Both the physical and emotional components (Arango-Lasprilla et al., 2011; Ennis et al., 2013; Turner et al., 2010) of intimacy are strained after TBI. The personality and behavioral changes in the injured partner can put a damper on intimacy as aggressive/impulsive behaviors can lead to fear, resentment, and withdrawal by the non-injured spouse. The spouses of individuals with TBI often perceive that their partners have changed personalities and some spouses evoke the feeling of living with a stranger (Gosling & Oddy, 1999; Oddy, 2001; Oddy, Coughlan, Tyerman, & Jenkins, 1985). Either partner can experience depression, grief and loss issues, perception of unattractiveness, loss of interest in sex, or sexual arousal and orgasmic difficulties.

Social skills deficits, communication impairments, poor judgment, and decreased displays of affection can lead to communication difficulties or emotional distance in relationships. Individuals who are single may become more alienated as the social impairments make it difficult to form new relationships or maintain established connections. In general, the greatest challenges to intimacy are centered broadly on change regarding functional limitations, loss of control, comparison with their pre-injury relationship or what they remember of it (Gill et al., 2011). Moreover, individuals with TBI may make poor choices or put themselves at risk because of poor judgment, disinhibition, or impulsive behaviors. Meeting people, learning to date, explaining the TBI to others, controlling impulsive behaviors, maintaining safety, and learning appropriate boundaries are some of the relationship skills that may need to be taught or relearned.

Even though there is ample evidence regarding marital stability after TBI (Arango-Lasprilla et al., 2008; Blais & Boisvert, 2005; Garden, Bontke, & Hoffman, 1990; Gosling & Oddy, 1999; Hammond et al., 2011; Liss & Willer, 1990; Resnick, 1993), other aspects of the couple dynamics are not understood. For instance, infidelity and the willingness to engage in uncommitted sexual relationships (also known as sociosexuality) have not yet been addressed in the TBI literature.

In conclusion, this thesis is an attempt to move towards the validation of a biopsychosocial perspective of sexuality post-TBI. Following that objective, three original studies will be presented to address: a) neuropsychological and psychological effects, as reflected by cognitive-sensory and affective postconcussion symptoms; b) medical and physical issues, as evidenced from sleep-arousal and vestibular-somatic postconcussion symptoms; c) neuropsychological and psychological effects, in terms of executive function and mental health (e.g., anxiety, depression), and d) relationship factors in terms of attitudes toward infidelity, and sociosexuality.

Thesis objectives and hypotheses

Objectives and hypotheses

The main objective of this thesis was to contribute empirical evidence towards the validation of a biopsychosocial perspective of sexuality after TBI. Following this general objective and based on the existing literature, three studies were conducted with the aim of partially capturing this framework. With that purpose, each of these studies includes a previously unexplored dimension of sexuality after TBI, as described in the introduction.

Study 1

This study aimed to: a) compare sexual quality of life in a sample of individuals with TBI and healthy controls; and b) explore the relationship between sexual quality of life and postconcussion symptoms in individuals with TBI.

Hypothesis 1. Compared to healthy controls, individuals with TBI have a reduced sexual quality of life.

Hypothesis 2. There is an association between sexual quality of life and postconcussion symptoms in individuals with TBI. That is, individuals with TBI reporting more frequent and intense postconcussion symptoms also report lower levels of sexual quality of life.

Study 2

This study aimed to: a) compare risky sexual behavior in a sample of individuals with mild, moderate or severe TBI and in healthy controls; b) explore the relationship between risky sexual

behavior and executive function in individuals with TBI, and c) describe the relationship between risky sexual behavior and mental health (anxiety, depression) in individuals with TBI.

Hypothesis 1. There are statistically significant differences between individuals with TBI and healthy controls in risky sexual behavior, with individuals with TBI showing greater frequency of risky sexual behavior compared to healthy controls.

Hypothesis 2. There is a statistically significant association between risky sexual behavior and dysexecutive problems in individuals with TBI. That is, individuals with TBI who report greater frequency of risky sexual behavior will also report more frequent and intense dysexecutive symptoms.

Hypothesis 3. For mental health, we predicted a relationship between increased anxiety and depression with more frequent risky sexual behavior in individuals with TBI.

Study 3

This study aimed to explore differences according to sex in sociosexuality and attitudes towards infidelity in individuals with TBI and healthy controls.

Hypothesis 1. There are statistically significant differences according to sex in sociosexuality for healthy controls. That is, compared to non-injured women, non-injured men have higher levels of sociosexuality.

Hypothesis 2. We did not have a prediction regarding sociosexuality or the nature of attitudes towards infidelity, as we could not find studies addressing this topic in the TBI literature.

Chapter 1. Article 1. The relationship between postconcussion symptoms and sexual quality of life in individuals with traumatic brain injury

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Abstract

Introduction: Sexual quality of life (sQoL) involves the impact of sexual dysfunction on general quality of life. Postconcussion symptoms (PCS) are frequent after TBI but their relationship with sQoL remains unexplored.

Objective: The current study aimed to: a) compare sQoL in a sample of individuals with TBI and healthy controls; and b) explore the relationship between sQoL and PCS in individuals with TBI.

Methods: Forty-one individuals with TBI and 41 healthy controls, comparable in age, gender, years of education, work and relationship status, and annual income. sQoL was assessed with the self-report Sexual Quality of Life Questionnaire, and PCS with the Post-concussion Symptom Scale (PCSS).

Results: Compared to healthy controls, individuals with TBI showed significantly lower sQoL. In individuals with TBI, diminished sQoL was significantly associated with self-reported PCS; the affective factor of the PCSS provided the most unique contribution to sQoL.

Conclusions: Affective PCS could partially explain the impact of TBI on sQoL. Ongoing screening and treatment of PCS, in particular affective symptoms, may lead to a secondary remediation/prevention of sexual difficulties in individuals with TBI.

Keywords: Sexuality, traumatic brain injury, sexual quality of life, postconcussion symptoms, affective symptoms.

Introduction

Traumatic brain injury (TBI) is considered both a public health and a clinical challenge as we are still unable to provide a treatment to prevent its sequelae (Mustafa & Alshboul, 2013). The effects of a TBI can be different for each individual as it ranges in severity from very mild concussions to severe injuries leading to death (Frattalone & Ling, 2013).

In Canada, TBI is one of the most common causes of death and disability in young adults (Kim & Colantonio, 2008). The annual incidence of hospital-treated cases of TBI ranges from 106.1 per 100 000 adults for mild TBI (Cassidy, Boyle, & Carroll, 2014), to 11.4 per 100 000 for severe TBI (Zygun et al., 2005). However, TBI cases resulting in hospitalization are more likely to be classified as moderate (Colantonio, Croxford, Farooq, Laporte, & Coyte, 2009).

TBI can produce changes in multiple areas including neuropsychological, psychological, and physical functioning (Podell et al., 2010). In terms of prognosis, in mild TBI, cognitive deficits are common during the acute stage, while recovery occurs mostly within 3-12 months post-injury, although long-term symptoms can persist (Carroll et al., 2014; Cassidy, Cancelliere, et al., 2014). In general, the magnitude of these changes increases with the degree of injury severity, with moderate to severe injuries recovering mostly within the first year (Iverson & Lange, 2011b).

TBI may thus result in neuropsychological problems in executive functions (García-Molina et al., 2010), working memory (Ozen, Skinner, & Fernandes, 2010), attention (Pare et al., 2009), ability to perceive emotions (Green et al., 2004), resistance to mental effort (Johansson, Berglund, & Ronnback, 2009), self-awareness (Ciurli et al., 2010), and communication (Coelho, 2007),

among others. In addition, neuropsychological problems are present many years following TBI and are associated with injury severity (Draper & Ponsford, 2008). Psychological disorders can include depression (Maric et al., 2010), anxiety (Pandey, Yadav, Mahesh, & Rajkumar, 2009), post-traumatic stress disorder (PTSD) (Kaplan et al., 2010), and even psychosis (Greene, Frank, Kremer, Bursztejn, & Foucher, 2010). Also, psychosocial consequences of TBI involve diminished health-related quality of life (Guilfoyle et al., 2010), marital instability (Arango-Lasprilla et al., 2008), emotional changes (Rochat, Ammann, Mayer, Annoni, & Van der Linden, 2009), loneliness (Wedcliffe & Ross, 2001), and sexual difficulties (Downing et al., 2013; Hanks et al., 2013; Kreutzer & Zasler, 1989; Moreno, Arango-Lasprilla, et al., 2013; Sander et al., 2012), among others.

Finally, the physical consequences of TBI documented in the literature can comprise increased risk of stroke (Chen et al., 2011), seizures (Masel & DeWitt, 2010), autonomic dysregulation (Kanjwal, Karabin, Kanjwal, & Grubb, 2010), dizziness and impaired balance (Peterson, 2010), contractures and spasticity (Lendraitiene & Krisciunas, 2010), gait disturbance (Neumann et al., 2009), sleep difficulties (Orff et al., 2009; Shekleton et al., 2010), physical fatigue (Englander et al., 2010; Norrie et al., 2010), pituitary dysfunction (Moon et al., 2010), coagulation disorders (Geeraerts, Haik, Tremey, Duranteau, & Vigue, 2010), headache (Lew et al., 2006), and it is also often associated with chronic pain due to comorbid musculoskeletal or orthopedic injuries (Gironda et al., 2009).

The course of these difficulties may vary over time and the outcome can be different for physical versus cognitive/emotional symptoms. For instance, patients with severe TBI showed, 2

to 5 years post-injury, relatively good physical and functional outcome, but poorer cognitive and emotional outcome (de Guise et al., 2008).

The expression of many of the aforementioned array of post-TBI changes is reflected by self-reported postconcussion symptoms (PCS) (Lange et al., 2013). Estimates of rates of persistent PCS following mild TBI range from 1 to 50% depending largely upon the method used to determine the clinical significance of the persisting symptoms, the post-injury interval, and the diagnostic criteria used (Ettenhofer & Barry, 2012; McCauley et al., 2013). In terms of injury severity, symptom reporting in the general TBI population as well as in the military showed that more serious brain injuries were associated with lower reports of PCS (Lange et al., 2013; Sigurdardottir, Andelic, Roe, Jerstad, & Schanke, 2009). However, it has also been shown that one year following injury, a substantial number of individuals with TBIs of all severities continues to report PCS (Dikmen, Machamer, Fann, & Temkin, 2010; Sigurdardottir et al., 2009). Surprisingly, in view of these findings, the relationship between PCS and various life activities and social roles, such as sexuality, remains unexplored.

TBI impacts people's sexuality, with 50 to 60% of individuals reporting some level of disruption post-injury (Kreuter et al., 1998; O'Carroll et al., 1991; Simpson, 2001). Sexual difficulties after TBI have been associated with medical and physical issues, neuropsychological and psychological effects, and relationship changes (Moreno, Arango-Lasprilla, et al., 2013). In addition, the impact of sexual dysfunction on quality of life is known as sexual quality of life (sQoL) (Abraham, Symonds, & Morris, 2008). sQoL involves sexual life and activities (e.g., physical sexual life, the emotional sexual relationship with a partner, and behaviors resulting in

sexual stimulation or sexual pleasure). To our knowledge, previous studies on sexuality and TBI have not addressed sQoL, nor have they explored the relationship between sQoL and PCS.

The current study aimed to: a) compare sQoL in a sample of individuals with TBI and healthy controls; and b) explore the relationship between sQoL and PCS in individuals with TBI. We hypothesized that compared to healthy controls, individuals with TBI have reduced sQoL, and that there is an association between sQoL and PCS in individuals with TBI, such that more PCS is associated with lower sQoL.

Methods

Participants

The sample consisted of 41 individuals with TBI and 41 healthy controls. Participants with TBI were recruited from a major rehabilitation center in Montreal, which offers social and vocational rehabilitation services to individuals with moderate or severe TBI, as well as to individuals with mild or complex mild TBI showing atypical recovery to which the brain injury appears to contribute predominantly. They had completed a comprehensive, post-acute, outpatient interdisciplinary TBI rehabilitation program. They were recruited based on the following inclusion criteria: (1) individuals who have sustained, according to the TBI guidelines put forward by the Québec Ministry of Health (Gouvernement du Québec/Ministère de la Santé et des Services Sociaux, 2005), a mild (Glasgow Coma Scale (GCS) score 13-15), moderate (GCS score 9-12) or severe TBI (GCS score 3-8); (2) six or more months post-injury; (3) 18 years or older; (4) report to be able to read, write, and speak either French or English. Exclusion criteria, as verified in medical records, included: (1) history of learning or language disability, including aphasia or

communication disorders; and (2) self-report of pre-injury psychiatric, sexual or neurological disorders other than TBI. A detailed description of the sociodemographic characteristics of the sample is provided in table 1.

Insert table 1

The majority of TBIs were mild (65.9%). The cause of the injury was predominantly associated with a motor vehicle accident (43.9%), followed by work related accidents (14.6%), and most of them had a history of loss of consciousness (48.8%) and post-traumatic amnesia documented in the medical chart (46.3%). Individuals with TBI were on average 2.6 years post-injury (SD=1.4). Positive findings on neuroimaging reports (CT-scan or MRI) suggesting a brain injury were documented in 58.5%. Glasgow coma scale at admission was on average 12.6 (SD=3.6), with a loss of consciousness of a mean of 6.1 hours (SD=29.4), and post-traumatic amnesia duration of 83.3 hours (SD=206.5) as indicated in medical records (see table 2).

Insert table 2

Healthy controls were recruited from the community following these inclusion criteria: (1) 18 years or older; and (2) report to be able to read, write, and speak either French or English. Exclusion criteria included: (1) self-reported history of learning or language disability; and (2) self-report of diagnosed psychiatric, sexual or neurological disorders.

The sociodemographic characteristics of both groups are described in table 1. There were no significant differences between groups in terms of age, gender, race/ethnicity, work status, relationship status, years of education, and annual income. Also, both groups were comparable in frequency of alcohol consumption and recreational drug use.

Procedure

The current study was approved by the Research Ethics Board (REB) of the Center for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR). Data collection was undertaken between April 2013 and August 2014.

From the rehabilitation center's database, a total of 345 individuals with TBI were eligible for participation. Following telephone contact by a person independent to the research project (e.g., archives technician) who proposed participation in the study, 13 of them refused to participate and 224 could not be reached. Individuals with TBI who accepted to participate were mailed two envelopes: a) a consent form (which included a thorough explanation of the study); and b) a package containing the questionnaires. Each of the envelopes contained a stamped and addressed envelope so that the participant could return each document independently. Questionnaires and consent forms were sent to 108 individuals with TBI and 41 of them successfully completed and returned both (40 in French and 1 in English).

In the context of a larger sexuality study, healthy controls were recruited from the general community through newspaper advertisements, as well as notices in community centers,

universities, and libraries. A total of 242 people from the community expressed their interest to participate in the sexuality study. Following a phone call by the research team to verify inclusion/exclusion criteria, questionnaires and consent forms were sent to 191 healthy controls. Twenty-eight of them were not returned, while 163 returned both the questionnaires and consent forms. For the purposes of this study, 41 healthy controls (37 in French and 4 in English) were matched to TBI participants, based on sociodemographic variables (e.g., age, gender, years of education, annual income, work and relationship status). Questionnaire data were subsequently analyzed.

Voicemail and an email accounts were created in order to receive and answer any questions from individuals with TBI or healthy controls. All participants received a financial compensation of CAN$15 (fifteen Canadian dollars) for their participation after returning their questionnaires and consent forms.

Instruments

Medical history and demographic information

Participants completed an in-house short medical and sociodemographic questionnaire that included questions related to participant's age (e.g., number of years), race/ethnicity (e.g., white, Hispanic), gender (e.g., male, female), years of education (e.g., number of years), relationship status (e.g., single, married), annual income (in Canadian dollars), work status (e.g., full time, unemployed), frequency of alcohol (e.g., never to everyday), and recreational drug use (e.g., yes, no). For TBI participants, data regarding pre-injury and injury related variables (e.g., severity of injury, number of years post-injury, length of loss of consciousness in hours, length of post-

traumatic amnesia in hours, and presence/absence of neuroradiological abnormalities) were extracted from medical records.

Each of the participants completed the following questionnaires:

Sexual Quality of Life Questionnaire (SQoL-Q) **–** The SQoL-Q comes in male (SQoL-M) and female forms (SQoL-F). It was developed to evaluate the impact of sexual dysfunction on quality of life, specifically to assess sexual confidence, emotional well-being, and relationship issues (e.g., "I have lost confidence in myself as a sexual partner", "I have lost pleasure in sexual activity"). The SQoL-M has 11 items and the SQoL-F has 18 items, each with a 6-point response scale (completely agree to completely disagree). With items scored 1-6, higher scores indicate better functioning. It has been used to assess sQoL with good internal consistency (Cronbach's α=0.95) and convergent validity (Abraham et al., 2008; Symonds, Boolell, & Quirk, 2007). The linguistic validation certificate corresponds to the translation of the questionnaire into French for Canada, as provided by the Mapi Research Institute in 2006. In the current study, the internal consistency of the SQoL-Q was very good (Cronbach's α=0.92).

Post-concussion Symptom Scale (PCSS) **–** The PCSS is a 22-item scale designed to measure the severity of symptoms in the acute phase of recovery from concussion (Lovell et al., 2006). This scale was developed in the late 1980s in an attempt to provide a formal method of documenting PCS, trying to objectively record the highly subjective symptoms and avoiding medical jargon. For each of the 22 items, the subject is asked to rate the severity of each symptom compared to their pre-injury state on a 7-point scale with 0 (asymptomatic) and 6 (severely symptomatic). Higher scores indicate worse functioning. It has been used as an outcome measure

in several published studies (Collins, Field, et al., 2003; Collins et al., 1999; Collins, Iverson, et al., 2003; Field, Collins, Lovell, & Maroon, 2003; Lau, Collins, & Lovell, 2011; Lovell et al., 2007; Majerske et al., 2008; McClincy, Lovell, Pardini, Collins, & Spore, 2006; Schatz, Pardini, Lovell, Collins, & Podell, 2006) and it has good internal consistency (Cronbach's α=0.87) (Valovich & Leach, 2012). Proposed classification ranks are different for men (Low-normal = 0; Broadly normal = 1-5; Borderline = 6-12; Very high = 13-26, and Extremely high = 27 and more) and women (Low-normal = 0; Broadly normal = 1-9; Borderline = 10-20; Very high = 21-43, and Extremely high = 44 and more) (Lovell et al., 2006). Four factors have been described: cognitive-sensory (items 1, 12, 13, and 19-22), sleep-arousal (items 7, 8, 10, and 11), vestibular-somatic (items 2-6), and affective (items 14-17) (Kontos et al., 2012). The four factors and the total score were included in the analyses as the variables for this study. This questionnaire is currently available in many languages including Spanish, French, Russian, and Czech (Lovell et al., 2006). In the current study, the internal consistency of the PCSS was very good (Cronbach's α=0.96).

Statistical Analyses

Demographic characteristics of individuals with TBI were compared to those of healthy controls using *t*-tests for continuous variables and χ^2 tests for nominal variables, taking into account a significance level $p < 0.05$.

An independent-samples *t*-test was performed in order to compare sQoL between individuals with TBI and healthy controls. Then, Pearson correlation analyses were used to examine the relationship between sQoL, PCSS factors (cognitive sensory, sleep-arousal, vestibular-somatic, and affective), and injury characteristics (years post-injury, hours of loss of

consciousness, and hours of post-traumatic amnesia) in individuals with TBI. Then, a multiple regression analysis was performed in order to establish the relative contribution of each of the PCSS factors (cognitive sensory, sleep-arousal, vestibular-somatic, and affective) to sQoL.

Statistical analyses were conducted with IBM SPSS version 21 (IBM, 2012).

Results

Compared to healthy controls, individuals with TBI showed lower sQoL, (t (73) = 2.5, p < .05) and more PCS as measured by the total score of the PCSS (t (79) = -6.0, p < .01) (See table 3).

Insert table 3

Correlation Matrix

sQoL was very negatively and significantly correlated with the total PCSS score (r = -.69, p < .01), including all of the four factors: Cognitive-Sensory (r = -.59, p < .01), Sleep-Arousal (r = -.61, p < .01), Vestibular-Somatic (r = -.57, p < .01), and Affective (r = -.71, p < .01). Lower scores on sQoL were thus associated with more PCS. Additionally, neither sQoL nor the total PCSS score were associated with the severity of injury or time since injury.

Insert table 4

A multiple regression analysis was performed in order to establish the unique contribution of the four PCSS factors on sQoL. The total score of each of the PCSS factors of cognitive-sensory, sleep-arousal, vestibular somatic, and affective were regressed onto sQoL. The overall model was statistically significant, F (4, 32) = 9.5, $p < .01$, $R^2 = .63$, and accounted for 63% of variability in sQoL. Additionally, the affective PCSS factor was the only variable independently related to sQoL (See table 5).

Insert table 5

Discussion

The purpose of this study was to compare sQoL in a sample of individuals with TBI and in a sample of matched healthy controls, as well as to explore the relationship between sQoL and PCS in individuals with TBI. Results indicate that compared to healthy controls, individuals with TBI showed lower sQoL. In addition, lower scores on sQoL in individuals with TBI were associated with more PCS. Finally, the only variable independently related to sQoL was affective PCS. To our knowledge, this study was the first to examine the influence of injury characteristics and PCS on sQoL of individuals with TBI.

The implications of these findings are important from both theoretical and clinical perspectives. From the theoretical perspective, the findings of this study are of high relevance because they illustrate the impact that PCS could have on general quality of life following TBI, and add evidence to the relationships between sexuality and PCS. The results are convergent with a study exploring general quality of life in a sample of veterans with mild to moderate TBI (Schiehser et al., 2014) showing that affective PCS were associated with worse general quality of life. It is then possible that affective PCS have an impact not only in specific and often overlooked aspects such as sQoL, but that PCS are associated with worse general quality of life. However, the results must be interpreted with caution because the sample of the aforementioned study and the sample of the current study are different (e.g., civilians versus veterans).

Another theoretical implication corresponds to the convergence of our results with a biopsychosocial conception of sexual difficulties after TBI (Moreno, Arango-Lasprilla, et al., 2013), and findings coming from studies of different clinical groups with PCS-like symptoms. A biopsychosocial conceptualization suggests that sexual difficulties after TBI are the result of three interacting domains: a) medical and physical issues; b) neuropsychological and psychological effects; and c) relationship changes. Based on the results of the current study, worse sQoL after TBI (e.g., physical sexual life, the emotional aspects of a sexual relationship, and behaviors resulting in sexual stimulation or sexual pleasure) can be strongly associated with medical and physical issues (vestibular-somatic) and neuropsychological symptoms (cognitive-sensory), but more particularly with psychological effects (affective PCS).

Furthermore, evidence coming from other clinical populations indicates that sexual problems are associated with symptoms that are comprised in the PCS categories. For instance, sexual problems are associated with migraine and tension type headache in males (Aksoy et al., 2013; Rothrock, 2011), weakness secondary to a brain tumor (Schuetz, Peterli, Ludwig, & Peters, 2004), and fatigue in survivors of prostate cancer (Monga, Kerrigan, Garber, & Monga, 2001). In addition, it has been shown that distraction during sexual stimulation can decrease responses to sexual stimuli in a non-clinical sample (Elliott & O'Donohue, 1997). In such instances, it is not entirely surprising that diminished sQoL is associated with PCS. Understanding and validating a theoretical conception of sexuality following TBI is very important in the development of a theory of neuropsychosexual functioning after TBI, and further studies are needed in this important area.

From the clinical viewpoint, clinicians must be aware that individuals presenting with PCS, particularly those in the affective spectrum, may also have difficulties related with sQoL. As previous studies have shown that PCS (Barlow et al., 2010; Donnell, Kim, Silva, & Vanderploeg, 2012; Lange et al., 2013; Verfaellie, Lafleche, Spiro, Tun, & Bousquet, 2013) are prevalent following TBI, these findings may help clinicians to identify individuals with TBI whose sQoL may be diminished. As sexuality issues are not frequently discussed by rehabilitation professionals (Dyer & das Nair, 2013b), PCS may be an indirect way to identify and provide treatment options for individuals with TBI having problems in this important area of human health. Even when some clinicians are not comfortable addressing sexual concerns, most of them are familiar with PCS. Careful identification of individuals with TBI presenting such difficulties might be a strategy to recognize those who would be at risk to reduced sQoL. In individuals with TBI who seem to be at risk for poor sQoL, earlier identification would also lead to earlier treatment options.

Rehabilitation professionals should work to include sexuality in their assessment protocols. Then, the results of the current study emphasize the need of interventions targeting quality of life in individuals with TBI, with a special focus on sQoL.

sQoL and sexual rehabilitation, or interventions aimed at preventing/treating sexual dysfunction (Bélanger, 2009), must be included as a component of comprehensive rehabilitation programs, and should concern not only clinical neuropsychologists, but all rehabilitation professionals who work with individuals having sustained a TBI. Rehabilitation professionals should use a holistic approach when assessing and treating individuals with TBI. This can include premorbid and post-accident factors, the formulation of a comprehensive and accurate picture of the individuals' pre-TBI functioning, and the exploration of multiple types of treatment (Podell et al., 2010). The PLISSIT model (Permission, Limited Information, Specific Suggestions, and Therapeutic Intervention) is a structured interdisciplinary treatment approach taking into account that not all clinicians have the knowledge, comfort level, or training to address sexual concerns after TBI (Taylor & Davis, 2006). Based on this approach, clinicians can inquire about PCS having in mind that they are associated with diminished sQoL. Then, addressing PCS can be a port of entry into the clients' sexual difficulties. As such, clinicians having less comfort with sexuality issues would be able to identify and refer clients with PCS who might also present with diminished sQoL.

Another clinical implication corresponds to the role of mental health in sQoL. Particularly, affective PCS emerged as the strongest contributor. Anxiety (Baykara et al., 2012; Chaves et al., 2012; Demakis, Hammond, & Knotts, 2010; Gould, Ponsford, & Spitz, 2014; Max et al., 2011)

and depression (Cook et al., 2011; Fann, Hart, & Schomer, 2009; Jorge et al., 2004; Rowland, Lam, & Leahy, 2005) are frequent complications of TBI. For that reason, professionals need to watch closely for the presence of mood disorders, PCS, and sexual problems in individuals with TBI. That is, when individuals with TBI complain of mental health difficulties (e.g., affective PCS), clinicians might recognize that sexual concerns can become more salient. PCS and mood disorders have been associated with poor vocational outcome following mild, moderate or severe TBI (Guérin, Kennepohl, Leveille, Dominique, & McKerral, 2006; van der Horn, Spikman, Jacobs, & van der Naalt, 2013). In consequence, PCS should not be underestimated. This finding could thus be valid for all severities of TBI and various TBI populations – individuals with milder injuries sustained during military service who are more at risk for PCS (Lange et al., 2013), as well as for general-population individuals with severe TBIs, even in chronic phases, given that poor cognitive and emotional outcome can persist 2 to 5 years post-injury with a relatively good physical and functional outcome (de Guise et al., 2008). Our current findings echo those of previous studies because we did not find an association between time post-injury and injury severity with PCS or sQoL. Consequently, PCS and diminished sQoL can be present at any time post-injury and can include the entire spectrum of injury severity.

Limitations and future directions

The current study has several limitations. First, the sample was drawn from a rehabilitation center in Montreal where individuals with TBI received comprehensive interdisciplinary interventions after TBI. In this respect, results should not be generalized to individuals with TBI who have not received rehabilitation services. In addition, these results cannot be extrapolated to other countries where rehabilitation resources are scarce or absent. Consequently, future studies

must use cross-cultural samples and compare sQoL in individuals with TBI who have and have not participated in rehabilitation programs. Second, the current study was correlational/cross-sectional, such that it is not possible to infer directional relationships between sQoL and PCS in this group of individuals with TBI. As the relationship between PCS and sQoL may change over time, prospective and longitudinal studies with larger samples will permit to carefully monitor sQoL and PCS, together with their relationships through time.

Furthermore, as previously mentioned, relationship factors are also associated with sexual difficulties after TBI. Since the sample of partnered individuals with TBI in our study was of 34.2%, it was not possible to determine the influence of relationship factors. Recruiting couples and evaluating quality and satisfaction with the relationship, as well as sQoL, will allow such study of the influence of relationship factors on sexuality after TBI. Also, we were not able to test gender differences in TBI outcomes and PCS in our small sample. For instance, in a retrospective cohort study of 306 individuals who sustained a moderate to severe traumatic brain injury 8 to 24 years, men reported sensitivity to noise and sleep disturbances as significantly more problematic than women, whereas headaches, dizziness and loss of confidence were significantly more challenging for women (Colantonio, Harris, Ratcliff, Chase, & Ellis, 2010). Therefore, with a bigger sample, the relationship between PCS and sQoL in men and women could be investigated.

Another limitation concerns the use of the PCSS, as there may be other PCS that are not included in this scale. Further research using complementary PCS scales could permit to determine if other cluster of symptoms are also associated with sQoL. Another general methodological limitation to all the studies regarding psychological variables such as sexuality and quality of life

concerns the use of self-report measures in individuals with TBI. As we did not evaluate awareness, anosognosia may lead to an underestimation of different problems (Prigatano, 2009). Prospective studies should then include the report of a partner (when available) or more objective measures of sQoL. Regarding injury severity, many participants in the current study were in the range of mild injuries (65.9%). More research is needed in the moderate to severe groups. As individuals with mild TBI are more at risk for PCS (Lange et al., 2013), further research with bigger samples in moderate to severe TBI is needed to determine if sQoL is associated with a different profile of PCS in more severe injuries.

More research is also needed regarding PCS and mental health variables (e.g., anxiety/depression) for different injury severities. Previous investigations have evaluated the impact of PCS related to anxiety (Wood, O'Hagan, Williams, McCabe, & Chadwick, 2014) and depression (Verfaellie et al., 2013), without any clear attributions, in particular in milder injuries. This is mainly because symptom presentation following TBI results from complex interactions between neurological effects of TBI, psychological adaptation factors, and environmental factors around the individual, which can facilitate or complicate recovery and social participation following TBI. Finally, we do not have pre-injury data of sQoL for individuals with TBI. It is thus also possible that some individuals with TBI had problems on this area before the injury. However, medical records did not indicate the existence of premorbid sexual difficulties in this sample. To our knowledge, this is a limitation shared by of all the studies published on sexuality and TBI.

Conclusions

The current study shows that sQoL is significantly lower in individuals with TBI than in matched healthy controls, and that there is a strong association between sQoL and PCS in individuals with TBI. Individuals with TBI with high levels of PCS present with lower levels of sQoL. On the contrary, individuals with TBI reporting less frequent and less severe PCS report higher levels of sQoL. Moreover, affective PCS provide the most unique contribution to diminished sQoL. A proactive approach to rehabilitation following TBI which includes screening and treating issues related to sexuality should be conducted by interdisciplinary teams (Levine & Flanagan, 2010), where each health professional has an expertise to provide in order to address the complexity such issues post-TBI. PCS are not only frequent but often complicate other aspects of the client's life, and one of the main reasons could be that they appear to be related to several biopsychosocial variables, including sexuality. In this regard, PCS must be considered in the overall management of the post-traumatic patient (Packard, 2008).

Early recognition and treatment of problems related to TBI is mandatory to successfully reach positive health outcomes and support reintegration to society, using a mixed approach including various rehabilitation modalities and medical alternatives (Levine & Flanagan, 2010). Consequently, the study of sexuality following TBI is an opportunity to establish the specific needs of this group, and to focus strategies to improve their general health and quality of life.

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Table 1. Sociodemographic characteristics of the sample (N = 82)

		TBI	Healthy controls	TBI	Healthy controls
		N (%)	N (%)	Mean (SD)	Mean (SD)
Gender	Male	18 (43.9%)	22 (53.7%)		
	Female	23 (56.1%)	19 (46.3%)		
Race and ethnicity	White	37 (90.2%)	39 (95.1%)		
	Hispanic	4 (9.8%)	2 (4.9%)		
Work status	Full-time	16 (39%)	24 (60%)		
	Part-time	7 (17.1%)	4 (10%)		
	Unemployed	18 (43.9%)	12 (30%)		
Relationship status	Single	25 (61%)	17 (41.5%)		
	Married	4 (9.8%)	4 (9.8%)		
	Separated	0 (0%)	4 (9.8%)		
	Divorced	2 (4.8%)	2 (4.8%)		
	Common-law	10 (24.4%)	13 (31.7%)		
	Widow/Widower	0 (0%)	1 (2.4%)		
Alcohol consumption	Never	16 (39%)	14 (34.1%)		
	Once or twice per week	18 (43.9%)	18 (43.9%)		
	3-5 times per week	5 (12.3%)	6 (14.7%)		
	Everyday	1 (2.4%)	1 (2.4%)		
	Stopped drinking alcohol	1 (2.4%)	2 (4.9%)		
Recreational drug use	Yes	10 (24.4%)	7 (17.1%)		
	No	31 (75.6%)	34 (82.9%)		
Age (Years)				38 (9.8)	39.9 (11.9)
Education (Years)				12.7 (3.3)	12.8 (2.9)
Annual income (CAD)				40007.7 (18407.4)	35794.1 (18114.2)

Note: CAD, Canadian dollars.

Table 2. Characteristics of the sample of individuals with TBI (N = 41)

		Frequency (%)	**Mean (SD)**
Cause of the injury	Motor vehicle accident	18 (43.9%)	
	Violence	2 (4.9%)	
	Falls	3 (7.3%)	
	Sports-related	5 (12.2%)	
	Work accident	6 (14.6%)	
	Other	3 (7.3%)	
	Missing	4 (9.8%)	
LOC	Yes	20 (48.8%)	
	No	17 (41.4%)	
	Missing	4 (9.8%)	
PTA	Yes	19 (46.3%)	
	No	18 (43.9%)	
	Missing	4 (9.8%)	
Positive CAT or MRI	Yes	24 (58.5%)	
	No	10 (24.4%)	
	Missing	7 (17.1%)	
Severity of the injury	Mild TBI	27 (65.9%)	
	Moderate TBI	3 (7.3%)	
	Severe TBI	7 (17.1%)	
	Missing	4 (9.8%)	
GCS			12.6 (3.6)
Years post-injury			2.6 (1.4)
Length of LOC (Hours)			6.1 (29.4)
Length of PTA (Hours)			83.3 (206.5)

Note: LOC, loss of consciousness; PTA, post-traumatic amnesia; CAT, computed axial tomography; MRI, magnetic resonance imaging; GCS, Glasgow coma scale.

Table 3. Differences in sQoL and PCS in individuals with TBI and in healthy controls

Measure	**TBI**		**Healthy controls**				
	M	SD	M	SD	*df*	*t*	*p*
TOTAL sQoL	76.2	23.1	87.7	15.0	73	2.5	0.013
TOTAL SCORE PCS	34.7	30.8	4.6	5.7	79	-6.0	0.001
COG-SEN	11.1	10.2	1.2	2.5	79	-5.9	0.001
SLEEP-AR	7.5	6.5	1.3	1.7	79	-5.7	0.001
VEST-SOM	5.9	6.9	0.2	0.7	79	-5.1	0.001
AFFECT	7.4	7.0	1.3	2.9	79	-5.0	0.001

Note: sQoL, sexual quality of life; PCS, postconcussion symptoms; COG-SEN, cognitive sensory symptoms subscale of the PCS-R; SLEEP-AR, sleep-arousal symptoms subscale of the PCS-R; VEST-SOM, vestibular-somatic symptoms of the PCS-R; AFFECT, affective symptoms subscale of the PCS-R.

Table 4. Correlation matrix between sQoL, PCS, and brain injury characteristics of individuals with TBI (N = 41)

		1	2	3	4	5	6	7	8	9
1	sQoL	-								
2	PCS	-.69**	-							
3	COG-SEN	-.59**	.95**	-						
4	SLEEP-AR	-.61**	.84**	.73**	-					
5	VEST-SOM	-.57**	.91**	.86**	.69**	-				
6	AFFECT	-.71**	.88**	.79**	.74**	.68**	-			
7	GCS	.09	.16	.16	.09	.14	.21	-		
8	Years post-TBI	-.21	.07	.01	-.03	.01	.17	.13	-	
9	PTA (Hours)	.02	.19	.13	.29	.21	.11	-.58**	-.06	-
10	LOC (Hours)	.12	.02	-.06	.08	.16	-.12	-.51*	.02	.93**

Note: * $p < .05$; ** $p < .01$; sQoL, sexual quality of life; PCS, postconcussion symptoms; COG-SEN, cognitive sensory symptoms subscale of the PCS-R; SLEEP-AR, sleep-arousal symptoms subscale of the PCS-R; VEST-SOM, vestibular-somatic symptoms of the PCS-R; AFFECT, affective symptoms subscale of the PCS-R; GCS, Glasgow coma scale; PTA, post-traumatic amnesia; LOC, loss of consciousness.

Table 5. Regression analysis summary for PCS variables associated with sQoL

Variable	B	SE B	β	*t*	*p*
COG-SEN	0.29	0.71	0.13	0.42	0.681
SLEEP-AR	0.38	0.92	0.11	0.41	0.683
VEST-SOM	-0.91	0.99	-0.28	-0.91	0.372
AFFECT	-2.68	0.92	-0.76	-2.90	0.008

Note: $R^2 = .63$ ($p < .01$); COG-SEN, cognitive sensory symptoms subscale of the PCS-R; SLEEP-AR, sleep-arousal symptoms subscale of the PCS-R; VEST-SOM, vestibular-somatic symptoms of the PCS-R; AFFECT, affective symptoms subscale of the PCS-R.

Chapter 2. Article 2. The relationship between risky sexual behavior, dysexecutive problems, and mental health after traumatic brain injury

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Abstract

Introduction: Cognitive difficulties (dysexecutive problems) following traumatic brain injury (TBI) can be associated with risk taking behaviors. Little is known about risky sexual behavior in the area of post-TBI sexuality.

Objectives: To compare risky sexual behavior as measured in a sample of individuals with TBI with that of healthy controls. To explore the relationship between risky sexual behavior, executive function, and mental health (anxiety, depression) in individuals with TBI.

Methods: Forty-two individuals with TBI with a mean age of 37.9 years (SD=9.7), 12.8 years of education (SD=3.3), a Glasgow Coma Scale score at admission of 12.5 (SD=3.6), and 3.3 years post-injury (SD=4.3). The sample of healthy controls consisted of 47 participants, with a mean age of 37.6 (SD=10.7) years, and 13 years of education (SD=3). Groups were comparable in age, gender, and years of education. Risky sexual behavior was measured with the Sexual Risk Survey and executive function with the Dysexecutive Questionnaire. Mental health measures included the Generalized Anxiety Disorder Scale, and the Patient Health Questionnaire for depression.

Results: Compared to healthy controls, individuals with TBI reported more dysexecutive problems, anxiety, and depression, without differences in risky sexual behavior. In individuals with TBI, risky sexual behavior was, however, significantly associated with dysexecutive problems, but not with anxiety or depression.

Conclusions: The association found between risky sexual behavior and post-TBI dysexecutive problems suggests that special attention should be given to individuals with TBI showing difficulties in executive functions in terms of evaluation and interventions that could lead to the prevention or remediation of risky behaviors in the sexuality domain.

Keywords: Sexuality, traumatic brain injury, risky sexual behavior, executive function, anxiety, depression.

Introduction

Traumatic brain injury (TBI) is an international public health problem, also referred to as a silent epidemic (Zinay, 2005), which can be classified depending on its severity ranging from mild concussions to severe injuries leading to death (Frattalone & Ling, 2013). Epidemiological data of TBI in industrialized and non-industrialized countries indicate a high incidence with annual estimates of 150-250 cases per 100 000 population (Leon-Carrion, Dominguez-Morales, Barroso y Martin, & Murillo-Cabezas, 2005). However, this could be an underestimation as not all of the cases are quantified because of differences in the conceptualization of TBI, leading to different epidemiological patterns (Roozenbeek, Maas, & Menon, 2013). TBI can result in physical (Nada Andelic et al., 2010), cognitive (Grossman et al., 2013), and psychosocial consequences (McCarthy et al., 2006) causing long-term disability in a significant number of injured persons, and even in some with milder injuries (Carroll et al., 2014). TBI-related disability can have an important impact on social and vocational roles (Benedictus, Spikman, & van der Naalt, 2010), as well as on relationships (Liss & Willer, 1990), all at a high economic and personal cost to families and the society (Roebuck-Spencer & Cernich, 2014). TBI frequently affects attention and executive functions such as working memory, reasoning, mental flexibility, problem solving, planning, execution, and self-regulation (Beauchamp et al., 2011; Catale, Marique, Closset, & Meulemans, 2009; García-Molina et al., 2010; Kumar et al., 2013; Rochat et al., 2009; Serino et al., 2006; Stuss, 2011), among others. In addition, cognitive changes are present many years following TBI and are associated with injury severity (deGuise et al., 2008; Draper & Ponsford, 2008). Furthermore, consequences of TBI can involve not only cognition, but also the psychological, physical, and sexual function of an individual (Podell et al., 2010). In fact, TBI

impacts people's sexuality, with 50 to 60% of persons reporting some level of disruption post-injury (Kreuter et al., 1998; O'Carroll et al., 1991; Simpson, 2001). Hyposexuality is common and estimates indicate that approximately 40–57% of people with acquired brain injury report that following the injury, their sexual drive declined (Kelly & Simpson, 2011). Post-TBI changes can thus limit the expression of sexuality as individuals with TBI can lose social contacts, show lack of initiation abilities, and become indifferent to sex. On the other hand, individuals with TBI can rather have difficulty in controlling their impulses, misinterpret social cues as sexual signals, exhibit sexually disinhibited behavior, and get involved in risky sexual behavior. An estimate for inappropriate sexual behaviors (e.g., non-consensual genital and non-genital touching, inappropriate sexual talk, exhibitionism, and coercive sexual behavior) is thought to range between 7-15% in people with TBI (Kelly & Simpson, 2011; Simpson et al., 2013). Such post-injury changes may lead to behaviors resulting in negative consequences for the person's health.

Interestingly, locus of the brain lesion after TBI has been associated with sexual changes (Sandel et al., 1996): individuals with frontal lobe lesions reported an overall higher level of sexual satisfaction, and individuals with right hemisphere lesions reported higher sexual arousal and more sexual experiences. Such lesions are also associated with cognitive and behavioral impairment post-TBI, in particular of executive functions described above, which have their neurobiological basis in the prefrontal cortex (Grossman et al., 2013; Zgaljardic & Temple, 2010). These findings, taken together, suggest that there could be a possible link between sexual behavior that is considered risky, and executive functioning.

Risky sexual behavior has previously been defined as "any behavior that increases the probability of negative consequences associated with sexual contact, including AIDS or other sexually transmitted diseases (STDs), and unplanned pregnancy" (p. 101) (Cooper, 2002). Risky sexual behavior can be conceptualized in two categories (Cooper, 2002; Nguyen et al., 2012): hazardous behaviors (e.g., multiple sex partners or casual partners, lack of discussion about risky sex before sexual intercourse) and poor protective behaviors (e.g., condom use and birth control). Negative health consequences in terms of sexual health have mainly focused on unintended pregnancies and STDs, including human immunodeficiency virus infection and acquired immune deficiency syndrome (HIV/AIDS) (Nguyen et al., 2012; Turchik, 2007). Furthermore, social consequences associated with risky sexual behavior can include the destruction of romantic relationships, changes in family dynamics, loss of social reputations, as well as financial and legal issues (Turchik & Garske, 2009). Risky sexual behavior has been associated with having a high number of sex partners (Beadnell et al., 2005), inconsistent condom use (Brown, Lubman, & Paxton, 2011; Lau et al., 2013; Stutterheim, Bertens, Mevissen, & Schaalma, 2013), recreational drug use (Voisin, King, Schneider, Diclemente, & Tan, 2012), alcohol use (Connor, Psutka, Cousins, Gray, & Kypri, 2013; Vagenas et al., 2013), and poor mental health. Poor mental health is associated with risky sexual behavior in low and high-income countries (Agardh, Cantor-Graae, & Ostergren, 2012; Glasier, Gulmezoglu, Schmid, Moreno, & Van Look, 2006; Lundberg et al., 2011). For instance, compared to people of the general population, individuals with severe mental disorders seem to have higher proportion of HIV infection (Senn & Carey, 2008). Particularly, the association between such behavior and mental disorder appears to be stronger in mania, conduct disorder, attention-deficit/hyperactivity, anxiety, and depressive disorders; impulsivity and loss of self-esteem being the behavioral and attitudinal basis for higher levels of risky sexual behavior

(Brown et al., 2010). Hence, higher rates of risky sexual behavior could also be found in the context of acquired neurological conditions, such as TBI, because of resulting neurobehavioral changes.

A study aiming to examine the frequency of TBI in an HIV/AIDS population showed that individuals with TBI could be at higher risk for HIV (Jaffe, O'Neill, Vandergoot, Gordon, & Small, 2000). They included an HIV group with no self-reported history of having sustained a blow to the head and a group with one or more self-reported blows to the head which rendered them, at minimum, dazed and confused. Individuals with HIV with a history of blow to the head reported a greater number of total symptoms and a greater number of mild TBI symptoms than the HIV with no history of blow to the head. However, uncontrolled methodological issues related to time since TBI versus HIV diagnosis limit this study's conclusions.

Another study has explored AIDS knowledge and risky sexual behavior in a sample of 29 institutionalized individuals with the dual diagnosis of TBI and substance abuse (Kramer, Nelson, & Li, 1993). The results showed that the participants had a moderate level of information about AIDS and misinformation surrounding the use of condoms. Interestingly, the authors concluded that the gap between knowledge and sexual activity was particularly disturbing considering that there was a high proportion of the sample engaging in risky sexual behaviors, such as having multiple sex partners or same-sex partners without using condoms. However, this study had many limitations, mainly the comorbidity of substance abuse and TBI that limited the generalizability to a specific sector of the TBI population, and the lack of a control group without drug/alcohol dependence, among others.

To our knowledge, previous studies on sexuality and TBI have not addressed risky sexual behavior in individuals with a single diagnosis of TBI. As previously mentioned, deficits in executive functions represent part of the cognitive changes that are frequently seen following TBI. They encompass a variety of higher-order abilities such as judgment, planning, decision-making, response monitoring, insight, and self-regulation (Robinson, Calamia, Glascher, Bruss, & Tranel, 2014), which are key aspects when evaluating a situation as risky or safe. Hence, the relationship between risky sexual behavior and executive function in individuals with TBI needs to be explored.

The current study aimed to: a) compare risky sexual behavior in a sample of individuals with mild, moderate or severe TBI and in healthy controls; b) explore the relationship between risky sexual behavior and executive function in individuals with TBI; and c) describe the relationship between risky sexual behavior and mental health (anxiety, depression) in individuals with TBI.

We hypothesized that individuals with TBI present increased risky sexual behavior compared to healthy controls, and that there is an association between risky sexual behavior and dysexecutive problems in individuals with TBI, such that more frequent and severe difficulties in executive function are associated with more risky sexual behavior. For mental health, we predicted that increased anxiety and depression is associated with more risky sexual behavior in individuals with TBI.

Methods

Participants

The sample consisted of 42 individuals with TBI and 47 healthy controls, all of them living in the community. Participants with TBI were recruited from a major rehabilitation center in Montreal, which offers social and vocational rehabilitation services to individuals with moderate or severe TBI, as well as to individuals with mild or complex mild TBI showing atypical recovery to which the brain injury appears to contribute predominantly. They were recruited based on the following inclusion criteria: (1) individuals who have sustained, according to the TBI guidelines put forward by the Québec Ministry of Health (Gouvernement du Québec/Ministère de la Santé et des Services Sociaux, 2005), a mild (Glasgow Coma Scale (GCS) score 13-15), moderate (GCS score 9-12) or severe TBI (GCS score 3-8); (2) six or more months post-injury; (3) 18 years or older; (4) report to be able to read, write, and speak either French or English. Exclusion criteria, as verified in medical records, included: (1) a history of learning or language disability, including aphasia or communication disorders; (2) self-report of pre-injury psychiatric, sexual or neurological disorders; and (3) a diagnosis of substance abuse or substance dependence according to the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (American Psychiatric Association & Task Force on DSM-IV, 2000). A detailed description of the sociodemographic characteristics of the sample is provided in Table 1.

Insert table 1

In terms of clinical characteristics, as indicated in table 2, the majority corresponds to mild TBIs (66.8%). The cause of the injury was predominantly associated with a motor vehicle accident (42.9%) followed by work and sports-related accidents (14.3%). Half of them had a history of loss of consciousness (50%) and 47.6% had also a history of post-traumatic amnesia documented in the medical chart. Individuals with TBI were on average 3.3 years post-injury (SD=4.3). Positive findings on CT scan or MRI suggesting a brain injury were documented in 59.5%. Glasgow coma scale at admission was on average 12.5 (SD=3.6), with a loss of consciousness of a mean of 5.8 hours (SD=28.8), and a mean post-traumatic amnesia duration of 80.8 hours (SD=203.8) where documented as indicated in medical records (see Table 2).

Insert table 2

Healthy controls were recruited from the community following these inclusion criteria: (1) 18 years or older; and (2) report to be able to read, write, and speak either French or English. Exclusion criteria included: (1) self-reported history of learning or language disability; and (2) self-report of diagnosed psychiatric, sexual or neurological disorders. Their sociodemographic characteristics are presented in table 1.

Procedure

The current study was approved by the Research Ethics Board (REB) of the Center for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR). Data collection was undertaken between April 2013 and August 2014.

From the rehabilitation center's database, a total of 345 individuals with TBI were eligible for participation. Following telephone contact by a person independent to the research project (e.g., archives technician) who proposed participation in the study, 13 of them refused to participate and 224 could not be reached. Individuals with TBI who accepted to participate were mailed two envelopes: a) a consent form (which included a thorough explanation of the study); and b) a package containing the questionnaires. Each of the envelopes contained a stamped and addressed envelope so that the participant could return each document independently. Questionnaires and consent forms were sent to 108 individuals with TBI and 42 of them successfully completed and returned both (41 in French and 1 in English).

In the context of a larger sexuality study, healthy controls were recruited from the general community through newspaper advertisements, as well as notices in community centers, universities, and libraries. A total of 242 people from the community expressed their interest to participate in the sexuality study. Following a phone call by the research team to verify inclusion/exclusion criteria, questionnaires and consent forms were sent to 191 healthy controls. Twenty-eight of them were not returned, while 163 returned both the questionnaires and consent forms. For the purposes of this study, 47 healthy controls (41 in French and 6 in English) were matched to TBI participants, based on sociodemographic variables (e.g., age, gender, years of education, annual income, work and relationship status). Questionnaire data were subsequently analyzed.

Voicemail and email accounts were created in order to receive and answer any questions from individuals with TBI or healthy controls. All participants received a financial compensation

of CAN$15 (fifteen Canadian dollars) for their participation after returning their questionnaires and consent forms.

Instruments

Medical history and demographic information

Participants completed an in-house short medical and sociodemographic questionnaire that included questions related to participant's age (e.g., number of years), race/ethnicity (e.g., white, Hispanic), gender (e.g., male, female), years of education (e.g., number of years), relationship status (e.g., single, married), annual income (in Canadian dollars), work status (e.g., full time, unemployed), frequency of alcohol consumption (e.g., never to everyday), and recreational drug use (e.g., yes, no). The questionnaire also included items related to whether they had been tested for HIV/AIDS during the past six months (e.g., yes, no), whether they had been tested for syphilis in the past three years (e.g., yes, no), the history of STD's (e.g., yes, no), the number of main/casual sexual partners in the past six months, and the use of alcohol and drugs during sex. For TBI participants, data regarding pre-injury and injury related variables (e.g., severity of injury, number of years post-injury, length of loss of consciousness in hours, length of post-traumatic amnesia in hours, and presence/absence of neuroradiological abnormalities) were extracted from medical records.

Each of the participants completed the following questionnaires:

The Sexual Risk Survey (SRS) – The SRS is a 23-item self-report measure developed to assess the frequency of risky sexual behavior in the past 6 months (Turchik, 2007). This measure

was designed is such a way to avoid potential problems such as participation bias (e.g., underreporting of risky sexual behavior associated to social desirability or self-disclosure in face-to-face interviews), question formatting (e.g., questions with open format preventing the individual from feeling abnormal by selecting a point in the upper/lower point of the scale in an item or being compared to any kind of standard), wording (e.g., avoiding technical formal language), memory and recall bias (e.g., providing a strategy to calculate a behavior based on the estimation of the risky sexual behavior for a given time period and the multiplication of that rate to get a total for a longer period of time) to minimize measurement error. Each item is scored on an open-ended format (e.g., "In the past six months, how many times have you had sex with someone you don't know well or just met?"). Five factors have been described: sexual risk taking with uncommitted partners (items 8, and 16-23), risky sex acts (items 9-12, and 18), impulsive sexual acts (items 1-3, 6, and 7), intent to engage in risky sexual behavior (items 4 and 5), and risky anal sexual acts (items 13-15). The SRS has shown evidence of internal consistency, test-retest reliability, content, concurrent, and convergent validity (Turchik & Garske, 2009). When administering the SRS, participants should be allowed to write in a frequency (Turchik, Walsh, & Marcus, 2015). Later, items are recoded into ordinal series of categories and then summed to get each domain score, as well as single subscale scores. Higher scores correspond to higher risky sexual behavior. The same factors described in the American sample have been found in a sample of 407 French-Canadians (Laberge, 2013). In the current study, the internal consistency of the French version of the SRS was very good (Cronbach's α=0.88). The total score and the scores by domain were used in the analyses as the outcome variables.

Dysexecutive questionnaire (DEX) – The DEX from the Behavioural Assessment of the Dysexecutive Syndrome (BADS) is a 20-item questionnaire sampling many of the symptoms associated with executive impairment and emotional problems after neuropathology, such as impulsivity, inhibition control, monitoring, and planning (Bodenburg & Dopslaff, 2008; Shinagawa et al., 2007). It is available in two forms (patient and significant other). Items are rated on a 5-point scale from 0 to 4 ("never" to "very often"). Only the self-respondent questionnaire was used. It is sensitive to executive dysfunction (Bennett, Ong, & Ponsford, 2005) and its psychometric properties have been demonstrated cross-culturally (Barker, Morton, Morrison, & McGuire, 2011; Gerstorf, Siedlecki, Tucker-Drob, & Salthouse, 2008; Llanero-Luque et al., 2008; Pedrero-Perez et al., 2011; Shinagawa et al., 2007; Simblett & Bateman, 2011). Item scores must be added to obtain full-scale score. Subscales can be calculated by adding the corresponding items (Behavior: items 2, 7, 9, 12, 13, 15, 16, 20; Cognition: items 3, 6, 14, 18, 19; Emotion: 5, 8, 11). In the current study, the internal consistency of the French version of the DEX was very good (Cronbach's α=0.89).

Generalized Anxiety Disorder Scale (GAD-7) – The GAD-7 is a self-administered examination used to identify probable cases of generalized anxiety disorders (Spitzer, Kroenke, Williams, & Lowe, 2006). Each of the 7 items are scored from 0 to 3 (''not at all'' to ''nearly every day''), depending on how often the respondent has been bothered by each problem over the past 2 weeks. The response scores are totaled, and the total score ranges from 0 to 21, with higher scores reflecting higher levels of anxiety. The GAD-7 is a valid and reliable screening tool for generalized anxiety disorders and has been translated and adapted to several languages (Delgadillo et al., 2012; Donker, van Straten, Marks, & Cuijpers, 2011; García-Campayo et al., 2010; Lowe et

al., 2008; Ruiz et al., 2011; Sidik, Arroll, & Goodyear-Smith, 2012; Swinson, 2006; Terluin, 2012; Wild et al., 2013) including French (Barthel, Barkmann, Ehrhardt, & Bindt, 2014). A translation/back-translation procedure was implemented in order to obtain the French version that was used in the present study and its internal consistency was excellent (Cronbach's α=0.92).

Patient Health Questionnaire (PHQ-9) – The PHQ is a self-administered examination used to diagnose mental disorders. The PHQ-9 is the module of the PHQ that specifically evaluates depression. The evaluation consists of 9 items that reflect typical symptoms of depression, and directs the respondent to indicate a response from 0 to 3 (''not at all'' to ''nearly every day''), depending on how often they have been bothered by each problem over the past 2 weeks. The response scores are totaled, and the total score ranges from 0 to 27, with higher scores reflecting higher levels of depression. The PHQ-9 is a valid and reliable screening tool for detecting major depressive disorder in individuals with TBI (Cook et al., 2011; Fann et al., 2005). Minor differential item functioning for the PHQ-9 has been documented in Canadian English- and French-speaking samples, but it can be used without affecting the overall estimate of depression latent scores (Arthurs et al., 2012). In the current study, the internal consistency of the PHQ-9 was excellent (Cronbach's α=0.90).

Statistical Analyses

Demographic characteristics of individuals with TBI were compared to those of healthy controls using *t*-tests for continuous variables and χ^2 tests for nominal variables, taking into account a significance level $p < 0.05$.

An independent-samples *t*-test was performed in order to compare risky sexual behavior between individuals with TBI and healthy controls. Chi-square tests were conducted to compare risky sexual behavior data of nominal variables, including whether participants had been tested for HIV/AIDS during the past six months (e.g., yes, no, do not know), whether they had been tested for syphilis in the past three years (e.g., yes, no, do not know), the history of STD's (e.g., yes, no), and the use of alcohol and drugs during sex in the past six months (e.g., yes, no). Pearson correlation analyses were used to examine the relationship between executive function (behavior, cognition, and emotion), risky sexual behavior (sexual risk taking with uncommitted partners, risky sex acts, impulsive sexual acts, intent to engage in risky sexual behavior, and risky anal sexual acts), mental health variables (anxiety and depression), and injury characteristics (years post-injury, hours of loss of consciousness, GCS score, and hours of post-traumatic amnesia) in individuals with TBI.

Statistical analyses were conducted with IBM SPSS version 21 (IBM, 2012).

Results

As per data indicated in table 1, there were no significant differences between groups in terms of age, gender, race/ethnicity, work status, relationship status, years of education, and annual income. Also, both groups were comparable in frequency of alcohol consumption, and recreational drug use.

Table 3 shows a detailed description of risky sexual behavior variables by group, including the number of participants who reported having had a blood test to check whether they had been

exposed to the virus that causes AIDS during the past six months, whether they had been tested for syphilis in the past three years, the history of STD's, the number of sexual partners (main and casual) and the use of alcohol and drugs during sex. A Chi-square test for independence indicated that there were no statistically significant differences between the groups concerning these risky sexual behavior variables (all p's > .05).

Insert table 3

Also, independent-samples t-tests showed that compared to healthy controls, individuals with TBI did not show statistically significant differences regarding the number of casual sex partners or the frequency of condom use for vaginal or anal sex in the past six months (either with main or casual sex partners) (all p's > .05).

Compared to healthy controls, individuals with TBI did not show statistically significant differences in risky sexual behavior, as measured by the total score of the SRS. Conversely, compared to healthy controls, individuals with TBI showed higher scores in dysexecutive problems, as measured by the total score of the Dysexecutive Questionnaire, t (86) = -4.9, p < .01; and more symptoms of anxiety, t (87) = -7.0, p < .01, and depression, t (86) = -7.9, p < .01, as measured by the GAD-7 and PHQ-9, respectively. Group differences are presented in Table 4.

Insert table 4

Correlation Matrix

There was a positive correlation between the total score of the SRS and the DEX score (r = .36, p < .05), with more frequent and severe dysexecutive problems associated with higher levels of risky sexual behavior. In particular, the ***behavior subscale*** of the DEX was significantly associated with sexual risk taking with uncommitted partners (r = .45, p < .01) and impulsive sexual acts (r = .38, p < .05). In addition, cognitive difficulties, as measured by the ***cognition subscale*** of the DEX, were significantly associated with sexual risk taking with uncommitted partners (r = .46, p < .01), impulsive sexual acts (r = .32, p < .05), and the intent to engage in risky sexual behavior (r = .37, p < .05). Finally, the ***emotion subscale*** of the DEX was significantly associated with sexual risk taking with uncommitted partners (r = .38, p < .01) and the intent to engage in risky sexual behavior (r = .32, p < .05). In the group of healthy controls, only the intent to engage in risky sexual behavior subscale of the SRS had a positive correlation with the behavioural subscale of the DEX (r = .29, p < .05), while the rest of the sexual risk variables did not show significant correlations with dysexecutive symptoms (p's > .05).

Risky sexual behavior, as indicated by the total score of the SRS, was significantly associated with the number of hours of loss of consciousness, as documented in the medical charts (r = .48, p < .05). Conversely, the total score of the SRS was not associated with injury severity, time since injury, or levels of anxiety or depression (p's > .05). The correlation matrices are displayed in Tables 5 and 6.

Insert tables 5 and 6

Discussion

The current study compared risky sexual behavior as measured in a sample of individuals with TBI with that of healthy controls, and explored the relationship between risky sexual behavior and dysexecutive problems, as well as with mental health variables (e.g., anxiety and depression). It was hypothesized that compared to healthy controls, individuals with TBI would report more risky sexual behavior. Contrary to expectations, the obtained results did not support the first hypothesis. That is, compared to healthy controls, individuals with TBI showed comparable levels of risky sexual behavior. In addition, the frequency of risky sexual behavior among individuals with TBI seemed to be similar to those of the healthy controls, such as the number of casual sex partners, the frequency of condom use in the past six months (either with main or casual sex partners), and the use of alcohol and drugs with main and casual partners during sex. The fact that individuals with mild TBI represented 66.8% of our TBI sample could be at the basis of this result. More specifically, in more severe injuries the level of risky sexual behavior could be higher since greater levels of injury severity generally involve more pronounced cognitive and behavioral difficulties, which can be linked to risky sexual behaviors.

In that respect, it was also hypothesized that there is a relationship between risky sexual behavior and dysexecutive problems in individuals with TBI, with higher risky sexual behavior in individuals reporting more intense and frequent dysexecutive problems. The results of this study showed that compared to healthy controls, individuals in our TBI sample reported significantly more behavioral, cognitive, and emotional dysexecutive problems. In addition, correlational analyses by group showed that individuals with TBI who reported higher levels of dysexecutive problems also showed higher levels of risky sexual behavior. In particular, individuals with TBI

with more ***behavioral executive difficulties*** also reported higher sexual risk taking with uncommitted partners and impulsive sexual acts. After a TBI, emotional and behavioral control difficulties are frequently reported and constitute a clinical challenge (Arciniegas & Wortzel, 2014). Risky sexual behavior could represent a separate category of behavioral changes or rather that it is part of general behavioral changes that can be seen following TBI (e.g., affective lability, irritability and disinhibition). In addition, our TBI sample of individuals, who reported more frequent ***cognitive dysexecutive problems***, also mentioned high sexual risk taking with uncommitted partners, impulsive sexual acts, and the intent to engage in risky sexual behavior. Cognition is important when evaluating a situation as risky or safe, and when putting in practice healthy behaviors. For instance, the results of a study aiming to explore executive cognitive functioning in 1063 older adults showed that compared to participants without diabetes, executive difficulties were present in individuals with type 2 diabetes and those difficulties were associated with a decreased ability to engage in health-related behaviors (Tran, Baxter, Hamman, & Grigsby, 2014). Another study demonstrated that a subgroup of gay and bisexual individuals with substance dependence and executive difficulties (e.g., as measured by low performance in five neuropsychological measures) reported the highest rates of risky sexual behavior, including high-risk sex acts and high-risk sex acts under the influence of drugs (Golub, Starks, Kowalczyk, Thompson, & Parsons, 2012). Finally, our results indicated that individuals with TBI who reported more frequent and severe ***emotional executive problems*** also reported being involved in high sexual risk taking with uncommitted partners and intended to engage in risky sexual behavior. This association converges with another study conducted in individuals with TBI and substance use disorders showing that they can engage in other risky behaviors associated with worse health

outcomes (e.g., increased possibility of another TBI, increase substance use, psychiatric difficulties, and self-directed violence) (Olson-Madden, Forster, Huggins, & Schneider, 2012).

To our knowledge, this study is the first to examine the relationships between risky sexual behavior and the presence of dysexecutive problems post-TBI. Our findings imply that TBI individuals with dysexecutive problems could present a co-occurrence of risky sexual behavior. Interestingly, executive problems are common and persist as long as 10 years post-injury in up to 45% of individuals with TBI (Ponsford et al., 2014). In addition, specific aspects of executive function (e.g., mental flexibility and working memory) seem to be determinant for functional outcome (Hart et al., 2003). Also, executive functions have been linked to the ability to fully participate in other meaningful life situations including participation in social, rehabilitation, and leisure activities, return to school and to work, and the management of home responsibilities (Cicerone & Maestas, 2014). Given the high frequency of executive problems post-TBI and their repercussion in everyday living, the association between executive function and risky sexual behavior suggest that special attention should be given to individuals with TBI showing difficulties in executive functions in terms of evaluation and interventions that could have a favorable impact on the prevention and remediation of risky behaviors in the sexuality domain.

We also predicted an association between post-TBI mental health and risky sexual behavior, were individuals with TBI with more anxiety and depression would report higher levels of risky sexual behavior. Previous investigations conducted in the general population, as well as in specific groups (e.g., college women, adolescents, men with have sex with men, HIV-positive people, HIV-negative gay and bisexual men, and transgender individuals) have shown

relationships between anxiety (Lelutiu-Weinberger et al., 2013; O'Cleirigh, Traeger, Mayer, Magidson, & Safren, 2013; Schry & White, 2013) or depression and risky sexual behavior (Alvy et al., 2011; Brawner, Gomes, Jemmott, Deatrick, & Coleman, 2012; Langille, Asbridge, Kisely, & Wilson, 2012; Musisi et al., 2014; O'Cleirigh, Newcomb, et al., 2013; Wilson, Stadler, Boone, & Bolger, 2014; Yadegarfard, Ho, & Bahramabadian, 2013). The results of the current study did not find this link in our TBI sample, although significantly higher levels of depression and anxiety symptoms were reported by individuals with TBI compared to healthy controls. This finding may indicate that in terms of the contribution to risky sexual behavior following TBI, dysexecutive problems could be more important than anxiety and depression. This could appear to be contradictory given the associations of mental health variables with the emotional aspects of the DEX, but in fact the emotional subscale of the DEX targets the regulation and expression of emotions, and not the presence of anxiety or depression. Hence, risky sexual behavior seems to be associated with post-TBI emotional regulation changes (Rochat et al., 2009).

These results have several implications both for clinical practice and research. Firstly, these findings highlight that individuals with TBI are not sexually abstinent, challenging some societal attitudes and perceptions of asexuality in individuals with disabilities (Esmail, Darry, Walter, & Knupp, 2010). On the contrary, similarly to healthy controls, they reported being sexually active, and engaged in behaviors that can put them at risk for negative health consequences. The fact that participants with TBI showed comparable rates of risky sexual behavior to those of healthy controls suggests that individuals with TBI need interventions regarding sexual health, as does the general population.

In terms of service delivery, it can indeed be challenging to promote sexual health and implement risky sexual behavior reduction interventions in individuals with TBI, for several reasons: a) neuropsychological impairment associated to TBI and cognitive processing difficulties may interfere with their ability to attend to, understand, or process information, and may make it difficult for them to participate actively and consistently in interventions (Anand, Springer, Copenhaver, & Altice, 2010); b) the comfort level of people with TBI in discussing sexual problems with their physicians or other health care professionals has implications for the accurate diagnosis of sexual dysfunction or difficulties, as well as for access to needed treatments or interventions (Sander et al., 2012); c) some staff may be uncomfortable with the topic of sexual behavior, or may be concerned that talking about sexuality will lead to increased sexual behavior (Dyer & das Nair, 2013a); and d) heterogeneity among individuals with TBI, which is translated into different needs and concerns relating to sexuality.

Another clinical implication is that since individuals with TBI with more dysexecutive symptomatology show higher risky sexual behavior, cognitive rehabilitation of executive functions could also have a positive impact on healthy behaviors. Dysexecutive problems (e.g., problem solving, specific impairments in planning, initiation/plan implementation, impulse control, self-monitoring, self-awareness) represent important targets in order to attain optimal social participation after a TBI (Manly, Hawkins, Evans, Woldt, & Robertson, 2002; Manly & Murphy, 2012). If risky sexual behavior is associated with executive difficulties in some individuals with TBI, then the implementation of specific rehabilitation interventions for executive functions (Cicerone, Levin, Malec, Stuss, & Whyte, 2006; Eslinger, Flaherty-Craig, & Chakara, 2013; Kesler, Lacayo, & Jo, 2011; Manly et al., 2002; Mateer, 1999; Studer, 2007; Zoccolotti et

al., 2011) could, hypothetically, lead to a reduction in risky sexual behavior in these individuals. However, this interpretation remains to be verified in the context of well-controlled intervention studies.

These results highlight the importance of neuropsychological effects on sexuality after TBI, and are convergent with a biopsychosocial conception of sexual difficulties after TBI (Moreno, Arango-Lasprilla, et al., 2013). In this perspective, sexual difficulties after TBI are the result of three interacting domains: a) medical and physical issues, b) neuropsychological and psychological effects, and c) relationship changes. Based on the current findings, neuropsychological difficulties such as those involving executive functions can be associated with one specific aspect of sexuality (e.g., risky sexual behavior). Similarly, it has been suggested that clinical neuropsychologists should play a crucial role in the context of sexuality and disability after TBI (DenBoer & Hough, 2010). They are specialists in the evaluation and rehabilitation of cognitive functioning, including executive functions, and other behavioral effects of brain damage (Caplan, 1982; Dodrill & Matthews, 1992; Echemendia & Cantu, 2003; McCrea et al., 2008; Spinnler & Della Sala, 1988). Thus, their interventions could have direct impacts on reducing risky sexual behavior, in particular in individuals with dysexecutive problems.

Limitations and future directions

The results of this study should be interpreted with caution due to several limitations. First, this small sample was drawn from an urban rehabilitation center. Risky sexual behavior and drug use seems to be more frequent in rural versus urban areas (Milhausen et al., 2003; Yan, Chiu, Stoesen, & Wang, 2007). For that reason, results should not be extrapolated to rural areas and

research comparing risky sexual behavior in individuals with TBI living in urban and rural regions needs to be conducted, with larger samples to increase generalizability. Furthermore, these results cannot be extrapolated to other countries with different cultural backgrounds and sexual minorities. Future studies of risky sexual behavior following TBI should try to understand differences in risky sexual behavior across racial, ethnic, and sexual minority groups. This research is needed in order to understand specific factors contributing to post-TBI risky sexual behavior in these specific groups and to tailor public health interventions. Consequently, future studies concerning risky sexual behavior in individuals with TBI must involve cross-cultural samples with diversity regarding race, ethnicity, sexual orientation and gender identity.

Also, the TBI sample of this study included individuals who participated in a comprehensive rehabilitation program. Following the same rationale, these results cannot be extrapolated to other countries, where these rehabilitation resources are scarce or non-existent, nor be generalized to individuals with TBI who have not received rehabilitation services. For that reason, it would be important to compare risky sexual behavior in individuals with TBI who have not participated in rehabilitation programs with individuals with TBI having previously received rehabilitation. This could contribute to a better understanding of the effect of rehabilitation services on risky sexual behavior via the comparison of groups pre- and post-treatment regarding risky sexual behavior.

Since individuals with mild TBI represented 66.8% of our TBI sample, our results cannot be completely generalized to more severe injuries. This aspect warrants further study, but it is

likely that interventions aimed at preventing risky sexual behaviors would be particularly indicated in more severe TBI.

This study was correlational/cross-sectional, such that it is not possible to infer directional relationships between risky sexual behavior and dysexecutive problems in our sample of individuals with TBI. Prospective and longitudinal studies with larger samples will permit to carefully monitor risky sexual behavior and executive function over time, as the relationship between risky sexual behavior and neuropsychological functioning through time has not been studied.

Another limitation pertains to the fact that even if the DEX questionnaire was found to be almost as sensitive to executive dysfunction as the total score obtained on the BADS battery, and as the extended 65-item version of the scale completed by either the occupational therapist or clinical neuropsychologist working with individuals with TBI (Bennett et al., 2005), the assessment of executive functions is highly complex and ideally requires more ecological approaches (Di Stefano et al., 2012; Garcia-Molina, Tirapu-Ustarroz, & Roig-Rovira, 2007; Krch, Vazquez, Koenig, Rizzo, & Chiaravalloti, 2014; McAlister & Schmitter-Edgecombe, 2013). Also, this study did not include measures of other domains of neuropsychological functioning that could be associated with risky sexual behavior.

Another limitation relates to the fact that the literature shows the existence of gender differences in risky sexual behavior, with women being more at risk. These groups include homeless young women (Valente & Auerswald, 2013), women who use crack/cocaine (Kopetz et

al., 2013), female adolescents (Seth et al., 2012), women who are victims of physical and sexual abuse (Pitpitan et al., 2012), and female orphans (Nyirenda, McGrath, & Newell, 2010). We did not aim to study gender differences here, but future studies should address gender differences in risky sexual behavior following TBI.

Our study included exclusively a sample of adults, such that these results cannot be generalized to teenagers or older adults with TBI. In consequence, research needs to examine adolescents with TBI regarding sexuality and risky sexual behavior. This is even more important considering that the development of the prefrontal cortex, which underlies executive functioning, continues until late adolescence/early adulthood (Johnson, Blum, & Giedd, 2009). Risky sexual behavior also deserves to be studied, as do other risky behaviors, in older individuals with and without TBI.

Finally, there are some methodological limitations that deserve consideration. We do not have information about the history of risky sexual behavior before the injury. However, this represents a limitation of all the studies in this area. Hence, we acknowledge the fact that some of our participants could have presented risky sexual behavior before the injury, and as such, post-TBI dysexecutive problems could not be related to them. Also, the DEX and the SRS are self-report measures and we did not include a reliable collateral assessment as an alternative source of information.

Conclusions

The current study showed that compared to healthy controls, our sample of individuals with TBI reported more dysexecutive problems, anxiety, and depression, but presented comparable levels of risky sexual behavior. There was an association between risky sexual behavior and dysexecutive problems following TBI, but not with mental health (e.g., anxiety, depression). These findings are discussed in terms of their implications for clinical practice and research. Continuing research on risky sexual behavior following TBI is warranted.

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Table 1. Sociodemographic characteristics of the sample (N = 89)

		TBI (N = 42)	**Healthy controls (N = 47)**	**TBI (N = 42)**	**Healthy controls (N = 47)**
		Frequency (%)		**Mean (SD)**	
Gender	Male	19 (45.2%)	24 (51.1%)		
	Female	23 (54.8%)	23 (48.9%)		
Race and ethnicity	White	38 (90.5%)	45 (95.7%)		
	Hispanic	4 (9.5%)	2 (4.3%)		
Work status	Full-time	16 (38.1%)	26 (55.3%)		
	Part-time	7 (16.7%)	7 (14.9%)		
	Unemployed	19 (45.2%)	13 (27.7%)		
	Missing	0 (0%)	1 (2.1%)		
Relationship status	Single	26 (61.9%)	21 (44.7%)		
	Married	4 (9.5%)	5 (10.6%)		
	Separated	0 (0%)	4 (8.5%)		
	Divorced	2 (4.8%)	2 (4.3%)		
	Common-law	10 (23.8%)	14 (29.8%)		
	Widow/Widower	0 (0%)	1 (2.1%)		
Alcohol consumption	Never	17 (40.5%)	14 (29.8%)		
	Once or twice per week	18 (42.9%)	22 (46.8%)		
	3-5 times per week	5 (11.8%)	8 (17%)		
	Everyday	1 (2.4%)	1 (2.1%)		
	Stopped drinking alcohol	1 (2.4%)	2 (4.3%)		
Recreational drug use	Yes	10 (23.8%)	8 (17%)		
	No	32 (76.2%)	39 (83%)		
Age (Years)				37.9 (9.7)	37.6 (10.7)
Education (Years)				12.8 (3.3)	13 (3.0)

Annual income (CAD)	39 007.5 (19 239.6)	31 975.6 (18 909.9)

Note: CAD, Canadian dollars.

Table 2. Clinical characteristics of the sample of individuals with TBI (N = 42)

		Frequency (%)	**Mean (SD)**
Cause of the injury	Motor vehicle accident	18 (42.9%)	
	Violence	2 (4.8%)	
	Falls	4 (9.5%)	
	Sports-related	6 (14.3%)	
	Work accident	6 (14.3%)	
	Other	3 (7.1%)	
	Missing	3 (7.1%)	
LOC	Yes	21 (50%)	
	No	18 (42.9%)	
	Missing	3 (7.1%)	
PTA	Yes	20 (47.6%)	
	No	19 (45.3%)	
	Missing	3 (7.1%)	
Positive CT or MRI scan	Yes	25 (59.5%)	
	No	10 (23.8%)	
	Missing	7 (16.7%)	
Severity of the injury	Mild TBI	28 (66.8%)	
	Moderate TBI	3 (7.1%)	
	Severe TBI	8 (19%)	
	Missing	3 (7.1%)	
GCS score			12.5 (3.6)
Years post- injury			3.3 (4.3)
Length of LOC (Hours)			5.8 (28.8)
Length of PTA (Hours)			80.8 (203.8)

Note: LOC, loss of consciousness; PTA, post-traumatic amnesia; CT, computerized tomography; MRI, magnetic resonance imaging; GCS, Glasgow Coma Scale.

Table 3. Risky sexual behavior variables (N = 89)

		TBI (N = 42)	**Healthy controls (N = 47)**	**TBI (N = 42)**	**Healthy controls (N = 47)**
		Frequency (%)		Mean occurrence (SD)	
HIV test (PSM)	Yes	7 (16.7%)	17 (36.2%)		
	No	35 (83.3%)	30 (63.8%)		
Syphilis test in the past three years	Yes	12 (28.6%)	17 (36.2%)		
	No	25 (59.5%)	25 (53.2%)		
	Do not know	5 (11.9%)	5 (10.6%)		
Tested positive for STD's (PSM)	Yes	11 (26.2%)	8 (17%)		
	No	30 (71.4%)	39 (83%)		
	Do not know	1 (2.4%)	0 (0%)		
Previously diagnosed with STD's	None	30 (71.4%)	39 (83%)		
	HIV / AIDS	4 (9.5%)	1 (2.1%)		
	Chlamydia	2 (4,8%)	0 (0%)		
	Syphilis	1 (2.4%)	1 (2.1%)		
	Herpes simplex	3 (7.1%)	1 (2.1%)		
	HPV	1 (2.4%)	3 (6.4%)		
	Other	0 (0%)	2 (4.3%)		
	Missing	1 (2.4%)	0 (0%)		

MP HIV / AIDS status	HIV+	0 (0%)	1 (2.1%)
	HIV-	23 (54.8%)	34 (72.3%)
	Do not know	5 (11.9%)	2 (4.3%)
	Without a main partner	14 (33.3%)	10 (21.3%)
Alcohol use during sex with MP (PSM)	Yes	16 (38%)	21 (44.7%)
	No	12 (28.7%)	14 (29.8%)
	Without a main partner	14 (33.3%)	10 (21.2%)
	Missing	0 (0%)	2 (4.3%)
Drug use during sex with MP (PSM)	Yes	4 (9.5%)	5 (10.7%)
	No	24 (57.2%)	30 (63.8%)
	Without main partner	14 (33.3%)	10 (21.2%)
	Missing	0 (0%)	2 (4.3%)
Sex with CP (PSM)	Yes	12 (28.6%)	16 (34%)
	No	29 (69%)	31 (66%)
	Missing	1 (2.4%)	0 (0%)
Alcohol use during sex with CP (PSM)	Yes	9 (21.5%)	10 (21.2%)
	No	3 (7.1%)	6 (12.8%)
	Without casual partners	29 (69%)	31 (66%)
	Missing	1 (2.4%)	0 (0%)
	Yes	3 (7.2%)	2 (4.3%)

Drug use during sex with CP (PSM)	No	9 (21.4%)	14 (29.7%)		
	Without casual partners	29 (69%)	31 (66%)		
	Missing	1 (2.4%)	0 (0%)		
Vaginal sex with MP (PSM)				41.2 (62.6)	38.7 (38.2)
Condom use in vaginal sex with MP (PSM)				6.0 (10.0)	5.8 (16.0)
Anal sex (active) with MP (PSM)				5.2 (19.4)	5.8 (14.1)
Condom use in anal sex (active) with MP (PSM)				0.2 (0.9)	1.5 (8.1)
Anal sex (passive) with MP (PSM)				0.3 (1.0)	1.3 (5.1)
Condom use in anal sex (passive) with MP (PSM)				0.1 (0.4)	0.9 (5.0)
Number of male CP (PSM)				2.2 (2.5)	2.1 (1.9)
Number of female CP (PSM)				1.0 (1.6)	1.0 (2.5)
Vaginal sex with CP (PSM)				32.2 (84.8)	10.2 (16.7)
Condom use in vaginal sex with CP (PSM)				5.0 (7.9)	6.6 (11.6)
Anal sex (active) with CP (PSM)				12.7 (30.7)	4.0 (8.2)
Condom use in anal sex (active) with CP (PSM)				4.2 (13.5)	0.9 (2.5)
Anal sex (passive) with CP (PSM)				2.0 (6.9)	0.7 (1.6)
Condom use in anal sex (passive) with CP (PSM)				1.9 (6.6)	0.5 (1.5)

Note: STD, sexually transmitted diseases; HIV/AIDS, human immunodeficiency virus infection/acquired immunodeficiency syndrome; HPV, human papillomavirus; MP, main partner; CP, casual partners; PSM, in the past six months.

Table 4. Differences in risky sexual behavior, executive functioning, and mental health in individuals with TBI and healthy controls

Measure	**TBI**		**Healthy controls**				
	M	SD	M	SD	*df*	*t*	*p*
TOTAL SCORE SRS	0.7	0.6	0.7	0.5	87	0.2	0.728
SRT-UP	0.6	0.9	0.7	0.9	86	0.3	0.737
RSA	1.1	1.0	1.2	0.9	86	0.4	0.651
ISA	0.6	0.7	0.5	0.7	87	-0.1	0.882
IE-RSB	0.4	0.9	0.4	0.7	87	-0.2	0.792
RASA	0.3	0.6	0.7	0.6	86	0.3	0.728
TOTAL SCORE DEX	23	12.4	12.5	6.9	86	-4.9	0.001
DEXBEH	9.0	5.3	5.0	3.6	86	-4.2	0.001
DEXCOG	6.0	3.7	2.9	2.2	86	-4.7	0.001
DEXEMO	3.6	2.7	2.3	1.4	87	-2.9	0.004
TOTAL SCORE GAD-7	6.9	5.3	1.3	1.3	87	-7.0	0.001
TOTAL SCORE PHQ-9	9.3	6.3	1.7	1.4	86	-7.9	0.001

Note: SRS, Sexual Risk Survey; SRT-UP, sexual risk taking with uncommitted partners; RSA, risky sex acts; ISA, impulsive sexual acts; IE-RSB, intent to engage in risky sexual behaviors; RASA, risky anal sexual acts; DEX, Dysexecutive Questionnaire; DEXBEH, Behavior subscale of the DEX; DEXCOG, Cognition subscale of the DEX; DEXEMO, Emotion subscale of the DEX; GAD-7, Generalized Anxiety Disorder Scale, PHQ-9, Patient Health Questionnaire.

Table 5. Correlation matrix between risky sexual behavior, executive functioning, mental health, and brain injury characteristics

		1	2	3	4	5	6	7
1	SRS	-						
2	DEX	.36*	-					
3	GAD-7	.07	.73**	-				
4	PHQ-9	.09	.42**	.58**	-			
5	GCS score	-.18	-.03	.12	.20	-		
6	Years post-TBI	-.19	-.18	-.08	-.10	.05	-	
7	PTA (Hours)	-.20	-.13	-.19	-.02	.28	.01	-
8	LOC (Hours)	.48*	-.15	-.09	.07	-.50**	.02	-.27

Note: * $p < .05$; ** $p < .01$.

Abbreviations: SRS, Sexual Risk Survey; DEX, Dysexecutive Questionnaire; GAD-7, Generalized Anxiety Disorder Scale, PHQ-9, Patient Health Questionnaire, GCS, Glasgow Coma Scale; PTA, post-traumatic amnesia; LOC, loss of consciousness.

Table 6. Correlation matrix between executive functioning and risky sexual behavior

		1	2	3	4	5	6	7
1	SRT-UP	-						
2	RSA	.26	-					
3	ISA	.69**	.23	-				
4	IE-RSB	.70**	.12	.73**	-			
5	RASA	.11	.60**	.01	.03	-		
6	DEXBEH	.45**	.01	.38*	.26	-.17	-	
7	DEXCOG	.46**	-.02	.32*	.37*	-.06	.72**	-
8	DEXEMO	.38*	-.12	.29	.32*	-.20	.52**	.53**

Note: * $p < .05$; ** $p < .01$.

Abbreviations: SRT-UP, sexual risk taking with uncommitted partners; RSA, risky sex acts; ISA, impulsive sexual acts; IE-RSB, intent to engage in risky sexual behaviors; RASA, risky anal sexual acts; DEXBEH, Behavior subscale of the DEX; DEXCOG, Cognition subscale of the DEX; DEXEMO, Emotion subscale of the DEX.

Chapter 3. Article 3. Investigation of sociosexuality and infidelity after traumatic brain injury

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Abstract

Objective: To explore differences according to sex in sociosexuality and infidelity in individuals with TBI and in healthy controls.

Design: Descriptive, correlational, cross-sectional study.

Setting: Community-dwelling individuals with TBI having completed a post-acute TBI rehabilitation program.

Participants: Forty-two individuals with mild, moderate, or severe TBI, at least six months post-injury, and 47 healthy controls; comparable in age, gender, and education.

Main Measures: Sociosexual Orientation Inventory-Revised (SOI-R) and Attitudes Toward Infidelity Scale.

Results: Overall, men score significantly higher than women in sociosexuality. However, there was a non-significant trend towards a reduction of sociosexuality levels in men with TBI. Infidelity levels were comparable in healthy controls and individuals with TBI. In individuals with TBI, less acceptance of infidelity was significantly associated with an unrestricted sociosexual orientation, but not in healthy controls.

Conclusions: As documented in previous cross-cultural studies, men have higher levels of sociosexuality than women. However, men with TBI showed a tendency towards the reduction

of sociosexuality. The possibility of a latent explanatory variable is suggested (e.g., post-TBI neuroendocrinological changes). TBI does not seem to have an impact on infidelity, but individuals with TBI who express less acceptance of infidelity also report a more promiscuous mating strategy in terms of behavior, attitudes, and desire. Theoretical implications are discussed in terms evolutionary theories of human sexuality, and neuropsychology. Further research is needed to elucidate these relationships.

Keywords: Sociosexuality, sociosexual orientation, infidelity, traumatic brain injury, evolutionary psychology, neuropsychology.

Introduction

Non-monogamy is part of the evolutionary trends preserved in humans (Josephs, 2012). In fact, infidelity constitutes probably one of the most complex problems faced by mental health professionals, especially couple therapists, marriage and family therapists, and psychotherapists (Blow & Hartnett, 2005a, 2005b). Based on evolutionary theories, there are sex differences regarding reactions to infidelity. For instance, men seem to be more distressed by sexual infidelity (e.g., sexual relationship or sexually-oriented physical contact with another person), while women may be more distressed by emotional infidelity (e.g., diversion of the partner's emotional commitment toward another person) (Treger & Sprecher, 2011).

Interestingly, human brains show different activation patterns in response to different types of infidelity (Takahashi et al., 2006). The results of a functional magnetic resonance imaging (fMRI) study showed that although 11 men and 11 women did not differ in the self-rating score for sexual and emotional infidelity, they showed different brain activation patterns in response to the two types of infidelity. Compared to women, men demonstrated greater activation in the brain regions involved in sexual and aggressive behaviors (e.g., amygdala and hypothalamus) during infidelity conditions. In contrast, women demonstrated greater activation in the areas involved in the detection of intention, deception, and trustworthiness (e.g., posterior superior temporal sulcus). Researchers concluded that their fMRI results were in favor of the notion that men and women process sexual and emotional infidelity using different neuropsychological networks.

Nonetheless, the experience of infidelity is linked to the individuals' proneness to be unfaithful. This is the research area of sociosexuality, also known as sociosexual orientation (SO). Alfred Kinsey was the first to introduce the term in his pioneer studies describing individual differences in people's willingness to engage in uncommitted sexual relationships (Kinsey, 1965; Kinsey, Pomeroy, & Martin, 1948). Sociosexuality levels range from an unrestricted SO to a restricted SO. Individuals with an unrestricted SO tend to a more promiscuous mating strategy, are quicker to have sex, and may experience lower levels of romantic relationship closeness or commitment. Conversely, individuals with a restricted SO tend to a more monogamous mating approach, they invest more time in courtship, and develop strong emotional connections in long-term relationships (Simpson & Gangestad, 1991).

Undoubtedly, the most striking cross-cultural evidence of the existence of SO comes from the international sexuality description project (Schmitt, 2005). This groundbreaking analysis of sociosexuality in 48 nations demonstrated that compared to women, men have higher levels of sociosexuality across cultures, and that sex differences in sociosexuality are culturally universal. Furthermore, even though sex differences in sociosexuality are attenuated in cultures with more gender equality in terms of political, economic, and relational freedom, the findings of this study did not suggest that men and women tend to become equally promiscuous in attitudes and behaviors.

Interestingly, a study conducted with 260 undergraduate university students demonstrated the existence of a sociosexuality-testosterone association in both men and women, and revealed that the nature of these associations varies by gender and relationship status (e.g.,

partnered men who reported an unrestricted sociosexuality had testosterone levels that were comparable to those of single men) (Edelstein, Chopik, & Kean, 2011). Research in the area of sociosexuality has included not only differences according to sex (Quist et al., 2012), but also many other variables, such as racial differences (e.g., black men are generally more sociosexually unrestricted than White, Hispanic, and Asian men) (Sprecher, Treger, & Sakaluk, 2013), infidelity (e.g., an unrestricted sociosexual orientation is associated with a greater willingness to engage in infidelity) (Mattingly et al., 2011), attachment style (e.g., greater sociosexuality is associated with selecting a mate's sexual infidelity as more distressing, particularly in men with a preoccupied attachment style) (Treger & Sprecher, 2011), self-image (e.g., accentuation of body presentation represents a goal-directed behavior to increase the likelihood of having uncommitted sex in males) (Rammsayer & Troche, 2013), physical attractiveness and sexual aggression perpetration (e.g., women with an unrestricted sociosexuality showed more frequent sexual fantasies of dominance and lower levels of sexual conservatism) (Yost & Zurbriggen, 2006), and personality styles (e.g., women with traits of agreeableness and conscientiousness showed lower levels of sociosexuality) (Hofer et al., 2010), among others.

Overall, the aforementioned studies highlight the importance of sociosexuality, from both an evolutionary and an environmental/sociocultural perspective to explain the reasons behind the fact that on average, men are more willing than women to engage in casual sex. Two different interpretations have been suggested. In his seminal theory of parental investment and sexual selection, Trivers (1973) defined parental investment as the resources that a parent spends on his offspring in order to increase the chances of surviving and reproducing, at the cost of this

parent's ability to invest in other offspring (Buss & Schmitt, 1993; Trivers, 2002; Trivers & Willard, 1973). Together, these studies outline that from an evolutionary perspective, men have more to gain and less to lose by having sex outside a committed relationship. In contrast, women have to invest time and energy devoted to pregnancy and childbearing. This interpretation contrasts with an environmental/sociocultural perspective, suggesting the possibility that differences in sociosexuality can be associated, in part, with the variations in the regional prevalence of infectious diseases. People in regions with a history of a high prevalence of infectious diseases report lower levels of sociosexuality (Schaller & Murray, 2008).

Given the evolutionary, neuropsychological, and environmental/sociocultural rationales put forward in the research literature on sociosexuality, its presentation in acquired medical conditions where changes in brain functions are induced warrants investigation. Traumatic brain injury (TBI), which is among the most common neurological conditions (Ryu, Feinstein, Colantonio, Streiner, & Dawson, 2009), is a form of brain injury which is receiving increasing attention in the area of research on sexuality, given its biopsychosocial consequences (Downing et al., 2013; Moreno, Arango-Lasprilla, et al., 2013; Moreno, Gan, et al., 2014; Moreno, McKerral, et al., 2013; Ponsford et al., 2013; Sander & Little, 2014).

Also, TBI impacts people's sexuality, with 50 to 60% of persons reporting some level of disruption post-injury (Kreuter et al., 1998; O'Carroll et al., 1991; Simpson, 2001), and sexual function is compromised as a result of the post-TBI changes involving the neurological aspects of sexuality (Moreno, McKerral, et al., 2013). Sexual difficulties after TBI have thus been associated with medical and physical issues (e.g., neuroendocrine and hormonal disorders

(Cohen, 2003; Sandel, Delmonico, & Kotch, 2007), neuropsychological and psychological effects (e.g., depression (Sander et al., 2013)), and relationship changes (e.g., intimacy (Sandel, Delmonico, & Kotch, 2013)) (Moreno, Arango-Lasprilla, et al., 2013).

To our knowledge, previous studies on sexuality and TBI have not addressed attitudes towards infidelity and sociosexuality in individuals with TBI. The current study thus aimed to explore differences according to sex in sociosexuality and attitudes towards infidelity in individuals with TBI and in healthy controls. In the current study, infidelity is defined as a person being unfaithful while in a committed monogamous relationship. Since this is a novel and exploratory study, no specific hypotheses related to TBI participants are advanced, but it is postulated that there are statistically significant differences according to sex in sociosexuality for healthy controls, with men having higher levels of SO compared to women.

Methods

Participants

The sample consisted of 42 individuals with TBI and 47 healthy controls. Individuals with TBI were recruited from a TBI outpatient rehabilitation center in Montreal, which offers social and vocational rehabilitation services to individuals with moderate or severe TBI, as well as to individuals with mild or complex mild TBI showing atypical recovery to which the brain injury appears to contribute predominantly. Individuals with TBI were recruited based on the following inclusion criteria: (1) individuals who have sustained, according to the TBI guidelines put forward by the Québec Ministry of Health (Gouvernement du Québec/Ministère de la Santé et des Services Sociaux, 2005), a mild (Glasgow Coma Scale (GCS) score 13-15), moderate

(GCS score 9-12) or severe TBI (GCS score 3-8); (2) are six or more months post-injury; (3) 18 years or older; (4) report to be able to read, write, and speak either French or English. Exclusion criteria, as verified in medical records, included: (1) history of learning or language disability, including aphasia or communication disorders; and (2) self-report of pre-injury psychiatric, sexual or neurological disorders other than TBI. A detailed description of the sociodemographic characteristics of the sample is provided in Table 1.

Insert Table 1

In terms of clinical characteristics, as indicated in Table 2, the majority corresponds to mild TBIs (66.8%). The cause of the injury was predominantly associated with a motor vehicle accident (42.9%) followed by work and sports-related accidents (14.3%). Half of them had a history of loss of consciousness (50%) and 47.6% had also a history of post-traumatic amnesia documented in the medical chart. Individuals with TBI were on average 3.3 years post-injury (SD = 4.3). Positive findings on CT scan or MRI suggesting a brain injury were documented in 59.5%. Glasgow coma scale at admission was on average 12.5 (SD = 3.6), with a loss of consciousness of a mean of 5.8 hours (SD = 28.8), and post-traumatic amnesia duration of 80.8 hours (SD = 203.8) as indicated in medical records.

Insert Table 2

Healthy controls were recruited from the community following these inclusion criteria: (1) 18 years or older; and (2) report to be able to read, write, and speak either French or English. Exclusion criteria included: (1) self-reported history of learning or language disability; and (2) self-report of diagnosed psychiatric, sexual or neurological disorders. Their sociodemographic characteristics are presented in Table 1.

Procedure

The current study was approved by the Research Ethics Board (REB) of the Center for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR). Data collection was undertaken between April 2013 and August 2014.

From the rehabilitation center's database, a total of 345 individuals with TBI were eligible for participation. Following telephone contact by a person independent to the research project (e.g., archives technician) who proposed participation in the study, 13 of them refused to participate and 224 could not be reached. Individuals with TBI who accepted to participate were mailed two envelopes: a) a consent form (which included a thorough explanation of the study); and b) a package containing the questionnaires. Each of the envelopes contained a stamped and addressed envelope so that the participant could return each document independently. Questionnaires and consent forms were sent to 108 individuals with TBI and 42 of them successfully completed and returned both (41 in French and 1 in English).

In the context of a larger sexuality study, healthy controls were recruited from the general community through newspaper advertisements, as well as notices in community centres,

universities, and libraries. A total of 242 people from the community expressed their interest to participate in the sexuality study. Following a phone call by the research team to verify inclusion/exclusion criteria, questionnaires and consent forms were sent to 191 healthy controls. Twenty-eight of them were not returned, while 163 returned both the questionnaires and consent forms. For the purposes of this study, 47 healthy controls (41 in French and 6 in English) were matched to TBI participants from the database of the aforementioned large sexuality study, based on sociodemographic variables (e.g., age, gender, years of education, annual income, work and relationship status). Questionnaire data were subsequently analysed.

Voicemail and email accounts were created in order to receive and subsequently answer any questions for individuals with TBI or healthy controls. All participants received a financial compensation of CAN$15 (fifteen Canadian dollars) for their participation after returning their questionnaires and consent forms.

Instruments

Medical history and demographic information

Participants completed an in-house short medical and sociodemographic questionnaire that included questions related to participant's age (e.g., number of years), race/ethnicity (e.g., white, Hispanic), gender (e.g., male, female), years of education (e.g., number of years), relationship status (e.g., single, married), annual income (in Canadian dollars), work status (e.g., full time, unemployed), frequency of alcohol (e.g., never to everyday), and recreational drug use (e.g., yes, no). For TBI participants, data regarding pre-injury and injury related variables (e.g., severity of injury, number of years post-injury, length of loss of consciousness in hours,

length of post-traumatic amnesia in hours, and presence/absence of neuroradiological abnormalities) were extracted from medical records.

Each of the participants was administered the following questionnaires:

Sociosexual Orientation Inventory - Revised (SOI-R) – The SOI-R is a 9-item self-report questionnaire, each with a 9-point response scale, developed to measure individual differences in willingness to engage in casual, uncommitted sexual relationships (Simpson & Gangestad, 1991). In particular, the SOI-R assesses individual's past behavior in terms of number of casual and changing sex partners, the explicit attitude towards uncommitted sex, and sexual desire for people with whom no romantic relationship exists (Davis, 1998). Scores for behavior, attitude, and desire facets, as well as a total score are obtained (Penke & Asendorpf, 2008). Higher scores on the SOI-R correspond to individuals who have an unrestricted sociosexual orientation (or have a more promiscuous mating strategy) whereas lower scores correspond to restricted sociosexual orientation (or individuals who follow a more monogamous mating strategy). The SOI-R proposes adequate reliability and validity both within and across the diverse range of human cultures (Schmitt, 2005) and has been used widely in a variety of research and clinical samples (Allen & Bailey, 2007; Duncan et al., 2007; Eisenberg, Campbell, Mackillop, Lum, & Wilson, 2007; McIntyre et al., 2006; Penke & Asendorpf, 2008; Seal & Agostinelli, 1994; Townsend & Wasserman, 1997; Wilson, Mattingly, Clark, Weidler, & Bequette, 2011). For items 1 to 3, values of 1 to 9 should be assigned to the responses. Thus, all nine items have values from 1 to 9 (9-point scale). Item 6 should be reverse-keyed. Items 1 to 3 are aggregated (summed or averaged) to form the Behavior facet, items 4 to 6 form the Attitude

facet, and items 7 to 9 form the Desire facet. Finally, all nine items can be aggregated to form a full-scale score that represents the global SO. In the current study, the internal consistency of SOI-R (Cronbach's α=.89), as well as all of the three facets of the SOI-R was very good (behavior Cronbach's α=.91; attitude Cronbach's α=.84; and desire Cronbach's α=.88).

Attitudes Toward Infidelity Scale – This is a 12-item self-report questionnaire to measure the acceptance of infidelity. In the context of this scale, infidelity is defined as a person being unfaithful in a committed monogamous relationship. Each item is rated on a 7-point Likert scale with 1 reflecting the least acceptance of infidelity and 7 the greatest acceptance of infidelity. The lower the total score (12 is the lowest possible score) the less the person's acceptance of infidelity whereas the higher the total score (84 is the highest possible score) the greater the respondent's acceptance of infidelity (Knox, Zusman, Kaluzny, & Sturdiviant, 2000). A score of 48 places the person at the midpoint between being very disapproving of infidelity and very accepting of infidelity. Before adding the numbers, score items 2, 5, 6, 7, 8, and 12 must be reversed (e.g., 1 = 7; 2 = 6; 3 = 5; 4 = 4; 5 = 3; 6 = 2; 7 = 1). After making these changes, the numbers must be added to obtain the full-scale score (Barthel et al., 2014). A translation/back-translation procedure was implemented in order to obtain the French version that was used in the present study and its internal consistency was good (Cronbach's α=.79).

Statistical Analyses

Demographic characteristics of individuals with TBI were compared to those of healthy controls using *t*-tests for continuous variables and χ^2 tests for nominal variables, taking into account a significance level $p < 0.05$.

Two-way between-groups analyses of variance (two-way ANOVA) were performed to explore the impact of sex (e.g., male and female) and group (e.g., individuals with TBI and healthy controls) in sociosexuality.

An independent-samples *t*-test was performed to compare infidelity levels between individuals with TBI and healthy controls. Pearson correlation analyses were used to examine the relationship between sociosexuality facets (behavior, attitude, and desire), infidelity levels, and injury characteristics (years post-injury, GCS score, and hours of post-traumatic amnesia) in individuals with TBI.

Statistical analyses were conducted with IBM SPSS version 21 (IBM, 2012).

Results

Comparison of the sociodemographic characteristics of the TBI and healthy control groups, described in Table 1, indicates that there were no significant differences between groups in terms of age, gender, race/ethnicity, work status, relationship status, years of education, and annual income. Also, both groups were comparable in frequency of alcohol consumption, recreational drug use and the use of one prescribed medication. Comparison of the sociodemographic and clinical characteristics of the TBI group by gender indicate that there were no significant differences between men and women with TBI in terms of age, race/ethnicity, work status, relationship status, years of education, annual income, alcohol consumption, recreational drug use, medication intake, injury severity, time post-injury,

neuroimaging evidence of brain injury, or loss of consciousness/post-traumatic amnesia duration (all p's > .05).

As summarized in Table 3, a two-way between-groups analysis of variance was performed to explore the impact of sex (male-female) and group (individuals with TBI and healthy controls) in sociosexuality, as measured by the SOI-R. The interaction effect between sex and group was not statistically significant, F (1, 85) = .6, p > .05. There was a statistically significant main effect for sex, F (1, 85) = 7.2, p < .05; and the effect size was in the range of medium to large effect size (partial eta squared = .07) according to the guidelines for the behavioral sciences (Cohen, 1969). The main effect for group, F (1, 85) = 1.0, p > .05, did not reach statistical significance. Compared to females, overall males had higher levels of sociosexuality. However, there appeared to be a tendency towards a reduction of sociosexuality levels in males with TBI (see figure 1).

Finally, compared to healthy controls, individuals with TBI did not show statistically significant differences in infidelity, as measured by the total score of the Attitudes Toward Infidelity Scale, t (85) = -0.8, p > .05.

Insert Table 3 and Figure 1

Correlation Matrix

The relationship between infidelity (as measured by the Attitudes Toward Infidelity Scale), sociosexuality (as measured by the SOI-R), and TBI characteristics (severity as

measured by the score on the GCS scale and by length of posttraumatic amnesia in hours; years post-injury) in the group of individuals with TBI was investigated using Pearson product-moment correlation coefficient (see Table 4). There was a large negative correlation between the scores on the infidelity scale and the SOI-R (r = -.58, p < .01), with low levels of infidelity scores (less permissiveness regarding infidelity) associated with high levels of SO (unrestricted SO). In addition, infidelity scores were moderately associated with behavioral sociosexuality (r = -.34, p < .05) and sociosexual desire (r = -.49, p < .01). Also, infidelity scores showed a large correlation with sociosexual attitudes (r = -.57, p < .01). In contrast, these associations were not significant in the group of healthy controls (all p's > .05).

Finally, neither infidelity scores nor sociosexuality were associated with severity of the injury (GCS score or length of posttraumatic amnesia), or with time since injury (all p's > .05).

Insert Table 4

Discussion

The current study aimed to explore differences according to sex in sociosexuality and attitudes towards infidelity in individuals with TBI and healthy controls. The main finding of the current study is that compared to healthy controls, our TBI sample appeared to show a tendency towards a reduction of differences according to sex in sociosexuality. Interestingly, there was a trend suggesting a decrease in sociosexuality levels in men with TBI. To our knowledge, this study is the first suggesting the possibility of a decline of this cross-cultural and

evolutionary distinction following TBI in males. This finding is important since it could suggest that a complex and deeply rooted psychosexual trait, such as sociosexuality, could be modified after a neurological insult such as TBI.

The tendency towards the reduction of differences according to sex in sociosexuality levels following TBI does not seem to be explained by sociodemographic or clinical variables. Then, it is possible that a latent variable could account for this trend. From the standpoint of neuropsychology, a possible explanation for this might be the existence of post-TBI neuroendocrine changes. Previous research indicating the existence of a link between testosterone and sociosexuality could represent a basis for such modifications (Edelstein et al., 2011); the effects of neuroendocrine post-TBI dysfunction on testosterone levels and its precursors could modify sociosexuality levels. In fact, post-traumatic hypopituitarism is an under-diagnosed complication of TBI (Waterhouse, 2012) and reports indicating that TBI is a common cause of pituitary dysfunction are compelling (Munoz & Urban, 2013). The main gonadal male hormone is testosterone, which is essential for the development of secondary sexual characteristics and behavioral patterns (Zasler & Martelli, 2011). In addition, evidence from animal models of sexuality following TBI indicate that TBI-induced hypopituitarism in male rats causes decreased testosterone production and changes in sexual behavior (Greco, Hovda, & Prins, 2015). However, this interpretation must be considered with caution since we did not measure testosterone levels in our study participants. Hence, further research in individual with TBIs of different severities needs to be conducted to determine if this is an actual contributing cause.

As expected and consistent with previous reports, our results showed that there are statistically significant differences according to sex in sociosexuality. The results of the current study support our hypothesis and add new evidence to the fact that compared to women, men have higher levels of sociosexuality across cultures (Schmitt, 2005). These findings corroborate a great deal of the previous work in the field of sociosexuality (Cross, 2010; Lippa, 2009; Penke & Asendorpf, 2008; Quist et al., 2012; Rammsayer & Troche, 2013; Simpson & Gangestad, 1991; Simpson & Gangestad, 1992; Yost & Zurbriggen, 2006; Zheng, Zhou, Wang, & Hesketh, 2014). The results are also in the same direction of Canadian reports of sexual attitudes and behaviors. Specifically, the results of a Canadian study revealed that compared to women, men had more frequent sexual thoughts, were more likely to report having engaged in oral sex, had a lower age at first intercourse, had more sexual partners, and were more willing to have casual sex (Fischtein, Herold, & Desmarais, 2007).

Theories from evolutionary and comparative psychology bring elements to try to understand the fact that on average, men are more willing than women to engage in casual sex, as can be explained by the theory of parental investment and sexual selection. The literature in the area of evolutionary psychology suggests that compared to males, viviparity and the development of the placenta placed an important burden of time and energy in females (Keverne, 2014). This differential investment would be responsible for hypothalamic distinctions in the course of evolution, with differential hormonal effects during the development of the brain. It is therefore likely that post-TBI neuroendocrine dysfunction could change the expression of these evolutionary characteristics. However, this interpretation needs to be considered with caution not only because we did not measure hormonal changes, but also

because human sexual behavior does not rely only on hormones. Human sexuality is multifactorial and based on psychological traits, behaviors, and cultural specificities, among others. Studies incorporating a more environmental/sociocultural perspective in this area are thus warranted considering the complexity and inherent multidisciplinary nature of sexuality.

Our third main finding is that infidelity levels, with infidelity defined as a person being unfaithful in a committed monogamous relationship, were comparable in healthy controls and individuals with TBI. Also, there were no differences according to sex. Taken together, these results are the first to reveal the nature of attitudes toward infidelity following TBI. It can thus be suggested that attitudes towards infidelity following TBI are not different from those of healthy controls. Therefore, a possible explanation is that after a TBI, people's attitudes toward infidelity do not change.

In contrast to earlier findings showing that an unrestricted sociosexual orientation is associated with a greater willingness to engage in infidelity (Mattingly et al., 2011), the results of the current study could not find evidence of this link. A possible explanation of this might be that we used a general infidelity scale, while Mattingly et al.'s study included ambiguous, deceptive, and explicit infidelity (Mattingly et al., 2011). This lack of uniformity in instruments to measure infidelity is one of the challenges regarding research in this area and may be responsible for incongruent findings (Blow & Hartnett, 2005a).

Surprisingly, infidelity scores were negatively associated with sociosexual behavior, sociosexual attitudes, and sociosexual desire in individuals with TBI but not in healthy controls.

This finding was unexpected and suggests that individuals with TBI reporting low levels in infidelity scores (e.g., disapproving of infidelity) also show high levels of SO (unrestricted SO). This finding indicates that individuals with TBI who express less acceptance of infidelity also report a more promiscuous mating strategy in terms of behavior (e.g., number of sexual partners in the last year), attitudes (e.g., imagine themselves enjoying casual sex with different partners), and desire (e.g., report a high frequency of spontaneous sexual fantasies with someone they have just met).

There are several possible explanations for these results. Firstly, individuals with TBI may have problems with emotional regulation that contribute to difficulties to control their own behavior (Cattran, Oddy, & Wood, 2011). As a consequence, thinking that being unfaithful in a committed monogamous relationship is not acceptable does not necessarily translate into regulating their own behaviors, attitudes, and desires regarding their willingness to engage in uncommitted sex. In fact, difficulties with behavioral regulation and social cognition are also common symptoms following TBI (Manly & Murphy, 2012). Another possible explanation is related to difficulties involving lack of awareness or anosognosia (Goldberg et al., 2010). Anosognosia can affect emotional recognition and the interpretation of social signals (Spikman et al., 2013). This could explain the existence of this discrepancy where individuals with TBI can have difficulties in integrating what they do, with what they think, and what they feel. Another possible explanation to address this result can be related to hypersexuality. However, in a multicenter study, the estimated prevalence of inappropriate sexual behaviors following TBI was 8.9%, and particularly evidenced in a minority of younger individuals with more severe

injuries (Simpson et al., 2013). Such an explanation seems to be less probable as the sample of this study included a majority of milder injuries.

Limitations and future directions

The current study investigated the relationship between sociosexuality and attitudes towards infidelity following TBI. However, the results should be interpreted with caution in the face of several limitations. First, contrary to the epidemiological data of TBI in Canada, the sample included predominantly women with TBI whilst, regardless of age group, TBI's are higher among men than women (Government of Canada & Public Health Agency of Canada, 2014). However, most of research conducted in sexuality and TBI has an underrepresentation of women (Colantonio et al., 2010), so this could also be interpreted as one of the strengths of our study which included more than 45% of males. Furthermore, in the current study 67% of TBI individuals had a mild TBI. Hence, caution is warranted in generalizing our results to moderate to severe TBI. In consequence, research on sociosexuality and infidelity needs to be conducted in larger samples, in particular with moderate to severe TBI.

Secondly, participants completed self-report measures to describe their sexual behavior. As sex is typically a highly private activity, people can conceal their true sexual behavior in an interview because sometimes they feel intensely embarrassed, threatened, and may experience fear of reprisals when asked to reveal their sexual life (Catania, Gibson, Chitwood, & Coates, 1990). However, to increase the validity of self-reported sexual behavior and avoid self-presentation bias, the questionnaires were completed anonymously. The study was conducted in a province that is highly open with respect to sexuality. For example, the results of a study

revealed that people living in Quebec were more likely than participants from all other regions of Canada to report an interest in engaging in casual sex (Fischtein et al., 2007). In this respect, our results cannot be extrapolated to other countries with different cultural backgrounds, especially those with more conservative attitudes towards sexuality. Future research should therefore concentrate on the investigation of cultural differences in sociosexuality and attitudes towards infidelity, by carefully controlling for methodological difficulties, such as presentation bias, among others (Stone, 1999).

As a third limitation, the current study was correlational/cross-sectional so it was not possible to infer directional relationships between sociosexuality and attitudes towards infidelity in this group of individuals with TBI. Consequently, we cannot make inferences about causation and our interpretations should be treated as exploratory hypotheses. Prospective and longitudinal studies with larger samples will allow further more solid study of attitudes towards infidelity. The reasons are twofold: attitudes can change over time and also the relationships between attitudes with other psychological variables can also change with time. More broadly, additional research is required to understand this dynamics. This information would be useful when addressing psychosexual issues in individuals with TBI.

As a fourth limitation, the current research was not specifically designed to evaluate the effect of rehabilitation services on sexuality. However, our TBI sample included a small sample of individuals with TBI who participated in a comprehensive rehabilitation program. We do not know if rehabilitation could have had an impact on attitudes and behaviors related to sociosexuality and infidelity. For that reason, these results cannot be extrapolated to individuals

with TBI who have not been involved in rehabilitation, or to individuals with TBI living in areas where rehabilitation resources are scarce or non-existent. A cross-national/cross-cultural study examining these constructs in a large sample of individuals with TBI on waiting lists for rehabilitation, in rehabilitation, or post-rehabilitation is definitely warranted.

Finally, our study included exclusively a small sample of adults and as such, results cannot be generalized to teenagers or older adults with TBI. In fact, most research has focused on adult TBI brain-behavior correlates with minimal involvement of adolescents (das Nair, Talbot, Hughes, & Starza-Smith, 2007). In consequence, research needs to examine adolescents with TBI regarding sociosexuality and attitudes toward infidelity. Also, it would be interesting to compare experiences of sexually diverse people regarding infidelity and sociosexuality, such as lesbian, gay, bisexual, transgender, and intersex individuals with TBI (Moreno & McKerral, 2012).

As a closing remark, little attention has been given to within-sex individual differences in the type of infidelity found to be more distressing. This was not part of our study objectives. However, it is recommended to explore the hypothesis that greater sexual permissiveness (e.g., higher scores on sociosexuality) is associated with greater distress to sexual infidelity (Treger & Sprecher, 2011). Sexual and emotional types of infidelity need to be addressed following TBI.

Despite all these limitations, the present study makes a unique contribution to the field of sexuality following TBI. Our study provides additional evidence with respect to sociosexuality after TBI and suggests a link between evolutionary psychology and

neuropsychological effects of TBI. A better understanding of the interplay between biological, psychological, and socio-cultural processes is needed to do justice to the complexity of this subject matter (Choudhury & Slaby, 2012), in particular as it is expressed or modified following TBI.

Conclusions

This paper reports the fact that men with with TBI show a trend towards the reduction of sociosexuality levels, suggesting the possible modification of a complex and deeply rooted psychosexual trait after a TBI. In addition, our results confirm that there are statistically significant differences according to sex in sociosexuality, supporting previous evidence that compared to women, men have higher levels of sociosexuality across cultures. Finally, our findings indicate that although infidelity was comparable in healthy controls and individuals with TBI, individuals with TBI who express less acceptance of infidelity also report a more promiscuous mating strategy in terms of behavior, attitudes, and desire. This work contributes to existing knowledge in the field of sexuality and psychosexual changes following TBI. Taken together, the main theoretical implications correspond to the development of a link between evolutionary psychology and neuropsychology.

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Table 1. Sociodemographic characteristics of the TBI and healthy control samples (N = 89)

		TBI	**Healthy controls**	**TBI**	**Healthy controls**
		Frequency (%)		**Mean (SD)**	
Gender	Male	19 (45.2%)	24 (51.1%)		
	Female	23 (54.8%)	23 (48.9%)		
Race and ethnicity	White	38 (90.5%)	45 (95.7%)		
	Hispanic	4 (9.5%)	2 (4.3%)		
Work status	Full-time	16 (38.1%)	26 (55.3%)		
	Part-time	7 (16.7%)	7 (14.9%)		
	Unemployed	19 (45.2%)	13 (27.7%)		
	Missing	0 (0%)	1 (2.1%)		
Relationship status	Single	26 (61.9%)	21 (44.7%)		
	Married	4 (9.5%)	5 (10.6%)		
	Separated	0 (0%)	4 (8.5%)		
	Divorced	2 (4.8%)	2 (4.3%)		
	Common-law	10 (23.8%)	14 (29.8%)		
	Widow/Widower	0 (0%)	1 (2.1%)		
Age (Years)				37.9 (9.7)	37.6 (10.7)
Education (Years)				12.8 (3.3)	13 (3.0)
Annual income (CAD)				39 007.5 (19 239.6)	31 975.6 (18 909.9)

Note: CAD, Canadian dollars.

Table 2. Clinical characteristics of the sample of individuals with TBI (N = 42)

		Frequency (%)	**Mean (SD)**
Cause of the injury	Motor vehicle accident	18 (42.9%)	
	Violence	2 (4.8%)	
	Falls	4 (9.5%)	
	Sports-related	6 (14.3%)	
	Work accident	6 (14.3%)	
	Other	3 (7.1%)	
	Missing	3 (7.1%)	
LOC	Yes	21 (50%)	
	No	18 (42.9%)	
	Missing	3 (7.1%)	
PTA	Yes	20 (47.6%)	
	No	19 (45.3%)	
	Missing	3 (7.1%)	
Positive CAT or MRI	Yes	25 (59.5%)	
	No	10 (23.8%)	
	Missing	7 (16.7%)	
Severity of the injury	Mild TBI	28 (66.8%)	
	Moderate TBI	3 (7.1%)	
	Severe TBI	8 (19%)	
	Missing	3 (7.1%)	
GCS			12.5 (3.6)
Years post- injury			3.3 (4.3)
Length of LOC (Hours)			5.8 (28.8)
Length of PTA (Hours)			80.8 (203.8)

Note: LOC, loss of consciousness; PTA, post-traumatic amnesia; CAT, computed axial tomography; MRI, magnetic resonance imaging; GCS, Glasgow coma scale.

Table 3. Means, standard deviations, and Analysis of Variance (ANOVA) results for sociosexuality and infidelity as a function of group and sex

	TBI		**Healthy controls**		**ANOVA F**		
Measure	M	SD	M	SD	Group (G)	Sex (S)	G x S
SOI-R					1.0	7.2*	0.6
Female	30.7	14.8	31.3	12.9			
Male	36.9	19.2	43.1	16.0			
SOI-BEH					0.3	2.5	3.5
Female	8.2	5.0	6.6	3.0			
Male	7.8	7.3	11.0	7.6			
SOI-ATT					2.0	3.3	0.1
Female	14.1	7.8	15.7	7.2			
Male	16.4	7.9	19.2	6.2			
SOI-DES					0.1	10.3*	0.0
Female	8.3	4.9	9.0	5.5			
Male	12.7	7.9	12.9	5.9			
ATIS					0.7	0.6	0.0
Female	62.7	12.9	60.5	15.4			
Male	60.7	14.8	58.0	10.9			

Note: * $p < .05$.

Abbreviations: SOI-R, total score of the Sociosexual Orientation Inventory - Revised; SOI-BEH, sociosexual behavior; SOI-ATT, sociosexual attitudes; SOI-DES, sociosexual desire; ATIS, attitudes toward infidelity scale.

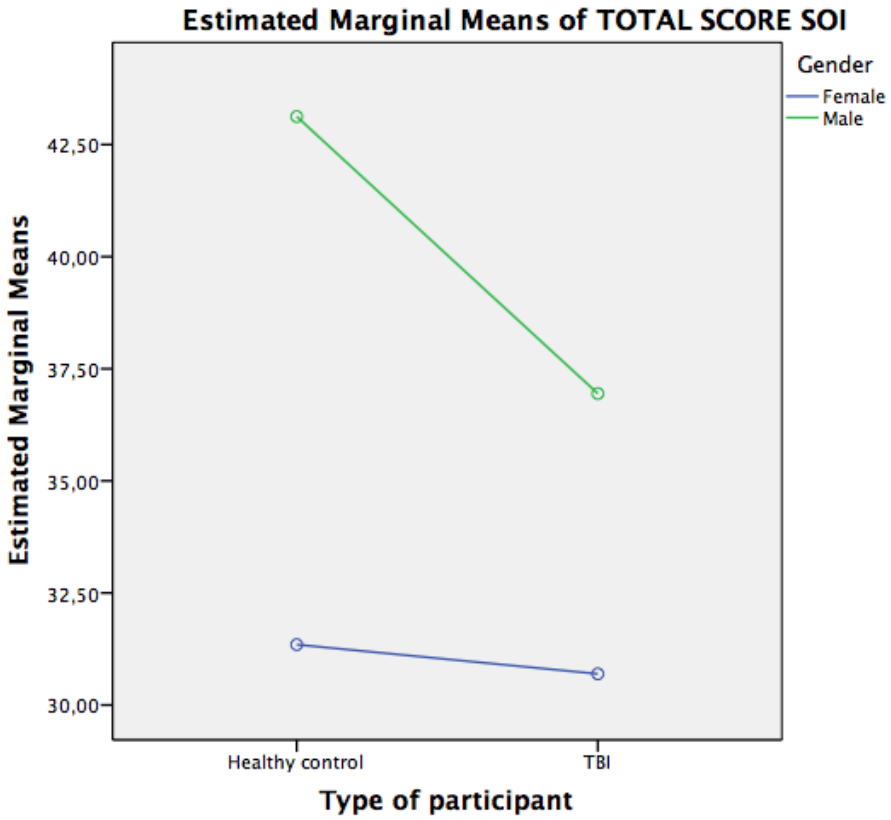
Table 4. Correlation matrix between infidelity, sociosexuality and brain injury characteristics

		1	2	3	4	5	6	7
1	ATIS	-						
2	SOI-R	-.58**	-					
3	SOI-BEH	-.34*	.77**	-				
4	SOI-ATT	-.57**	.84**	.45**	-			
5	SOI-DES	-.49**	.84**	.52**	.57**	-		
6	GCS	.12	-.30	-.22	-.30	-.21	-	
7	Years post-TBI	.17	-.18	-.15	-.27	.01	.05	-
8	PTA (Hours)	-.01	.18	.31	.12	.02	-.58**	-.05

Note: * $p < .05$; ** $p < .01$.

Abbreviations: ATIS, scores of the attitudes toward infidelity scale; SOI-R, total score of the Sociosexual Orientation Inventory - Revised; SOI-BEH, sociosexual behavior; SOI-ATT, sociosexual attitudes; SOI-DES, sociosexual desire; GCS, Glasgow coma scale; PTA, post-traumatic amnesia.

Figure 1. Estimated marginal means for sociosexuality as a function of group and gender



Abbreviations: SOI, total score of the Sociosexual Orientation Inventory.

Chapter 4. General discussion

The main objective of this thesis was to provide empirical support towards the validation of a biopsychosocial perspective of sexuality after TBI. The results of the three studies conducted provide empirical evidence that sexuality can change after a TBI and that the mechanisms of these changes can be multifactorial. In addition, the results illustrate the interconnections of the three interacting domains: 1) neuropsychological and psychological effects, 2) medical and physical issues, and 3) relationship factors.

Postconcussion symptoms and sexual quality of life in individuals with TBI

We first explored the relationship between sexuality, as expressed in sexual quality of life, and two of the domains included in the biopsychosocial model: a) neuropsychological and psychological effects, as reflected by cognitive-sensory and affective postconcussion symptoms; and b) medical and physical issues, as evidenced from sleep-arousal and vestibular-somatic postconcussion symptoms. The objectives were twofold: to compare sexual quality of life in a sample of individuals with TBI and healthy controls, and to explore the relationship between sexual quality of life and postconcussion symptoms in individuals with TBI.

Compared to healthy controls, in addition to presenting significantly more post-concussion symptoms, individuals with TBI showed significantly lower sexual quality of life as predicted. Interestingly, the results show that even when the groups were comparable in age, gender, years of education, work and relationship status, and annual income, individuals with TBI reported lower sexual quality of life when compared to healthy controls. This finding is

important because it provides new evidence about sexuality changes following TBI. The results also go in the same direction of another study regarding sexual quality of life, sexual satisfaction, and relationship satisfaction in partnered individuals with traumatic brain injury from Colombia (Moreno, Olivera, et al., 2014). Then, the fact that both of these studies have been conducted in different populations suggests some degree of generalization.

Previous studies have shown that compared to non-injured persons, community-dwelling individuals with TBI (Dijkers, 2004) and veterans with TBI show a decreased quality of life (Schiehser et al., 2014). Moreover, specific dimensions of quality of life, such as health-related quality of life, are compromised after 10 (Andelic et al., 2009) and 22 years post-injury (Nestvold & Stavem, 2009). Sexual quality of life is one of the dimensions of quality of life that is often overlooked. In consequence, our results provide evidence filling this gap in the TBI literature and the findings contribute to the global picture of the negative consequences of TBI in sexuality. If other domains of quality of life show long-term negative effects, it would not be surprising that lower sexual quality of life could be present many years post-injury.

We also anticipated the existence of an association between sexual quality of life and postconcussion symptoms in persons with TBI. The predicted association suggested that individuals with TBI who report more frequent and intense postconcussion symptoms would also report lower sexual quality of life. Results obtained provided evidence to empirically support the second hypothesis. The endorsement of more frequent and intense postconcussion symptoms (total score of cognitive-sensory, sleep-arousal, vestibular-somatic, and affective

symptoms) was associated with lower sexual quality of life. However, when different types of postconcusion symptoms were analyzed separately, affective postconcussion symptoms provided the most unique contribution to sexual quality of life. In a recent study that assessed the relationship between postconcussive symptoms and quality of life in veterans with TBI, affective symptoms, specifically fatigue, depression, and sleep difficulty, appeared to be the most relevant postconcussive symptoms predicting general quality of life (Schiehser et al., 2014). The authors used a different scale to evaluate three different categories of postconcussion symptoms: somatic/sensory, cognitive, and affective (Neurobehavioral Symptom Inventory). However, in the scale that we used to measure postconcussion symptoms, fatigue and sleep problems were part of the sleep-arousal category and not of the affective domain. It is then possible that affective symptoms have a specific impact on sexual quality of life, while a combination of affective and sleep-arousal postconcussion symptoms could have a negative effect on general quality of life. However, this interpretation requires verification as this study included a sample of mild to moderate veterans with TBI, with a mean age of 61 months post-injury.

In fact, affective factors (e.g., depression and anxiety) appear to play a role in the expression of postconcussion symptoms. However, the dynamics between anxiety, depression, and the aetiology of postconcussion symptoms is highly complex (Silverberg & Iverson, 2011). For instance, there is evidence suggesting that low mood in combination with some anxious personality traits (e.g., anxiety sensitivity) can be at the basis of the development of persisting postconcussion symptoms (Wood et al., 2014). Individuals with TBI presenting higher anxiety with comorbid depressive symptoms could be more at risk to develop postconcussion

symptoms. In consequence, after a TBI, affective symptoms can contribute to persistent postconcussion symptoms, and the latter can have a negative impact on sexual quality of life. However, these relationships need to be investigated further and the longitudinal presentation of these variables has yet to be examined.

Postconcussion symptoms have also been associated with negative functional outcomes, including physical and psychosocial ones (Verfaellie et al., 2013). Diminished sexual quality of life can also be part of the negative physical and psychosocial consequences following TBI. In conclusion, the significant relationships documented here provide empirical evidence for the existence of a link between neuropsychological / psychological effects and medical / physical issues after TBI, as postulated in a biopsychosocial perspective.

Risky sexual behavior, executive function, and mental health following TBI

We then explored the relationship between sexuality in terms of risky sexual behavior, and one of the domains of the biopsychosocial model: neuropsychological and psychological effects, in terms of executive function and mental health (anxiety, depression), respectively. We aimed to compare risky sexual behavior in a sample of individuals with mild, moderate, or severe TBI with that of healthy controls. To investigate the connections as conceived in the biopsychosocial model, the second objective was to explore the relationship between risky sexual behavior, executive function and mental health in individuals with TBI.

It was predicted that risky sexual behavior would be significantly different between individuals with TBI and healthy controls; individuals with TBI would report higher risky sexual behavior when compared to healthy controls. There was not enough evidence in favor of our first hypothesis. However, it is noteworthy that risky sexual behavior was comparable to the levels reported by healthy controls, while some studies show a decrease of sex drive of up to 40% after a TBI (Downing et al., 2013). That is, even when loss of desire can be present, individuals with TBI appear to engage in sexual behaviors that could put them at risk for negative health consequences, similarly to healthy controls. Our findings did not show evidence of higher levels of risky sexual behavior in terms of life history of STDs, STDs in the past six months, number of casual partners, drug and alcohol use during sex with casual partners, or condom use with casual partners. Risky sexual behaviors after TBI seem to be comparable to those of the general population.

Based on the biopsychosocial model, we expected to find empirical evidence of an association between risky sexual behavior and dysexecutive symptoms in individuals with TBI. Our results showed that individuals with TBI reported significantly more dysexecutive problems compared to healthy controls, and that those reporting more frequent and severe dysexecutive symptoms presented with higher levels of risky sexual behavior, thus supporting our hypothesis. Even if this evidence is correlational, these results suggest that there may be a subgroup of individuals with TBI who could be more at risk for negative health outcomes, such as contracting STDs or HIV/AIDS. Another source of evidence comes from the results of a study aiming to explore executive cognitive functioning in 1063 older adults with and without diabetes showed that executive difficulties were associated with a decreased ability to engage in health-

related behaviors (Tran et al., 2014). The decision-making process involved in performing healthy behaviors to avoid risky sexual behavior can be complex and requires the integrity of executive functions. For instance, another study demonstrated that a subgroup of gay and bisexual individuals with substance dependence and executive difficulties (e.g., as measured by low performance in five neuropsychological measures) reported the highest rates of risky sexual behavior, including high-risk sex acts and high-risk sex acts under the influence of drugs (Golub et al., 2012). In addition, another subgroup with executive difficulties (e.g., individuals scoring poorly on measures of reward processing) reported the lowest rate of risky sexual behavior. These results illustrate that different types of dysexecutive impairments could be associated with different risk patterns of sexual behavior, an aspect that warrants further research in TBI populations.

On the other hand, although individuals with TBI reported significantly more anxiety and depression compared to healthy controls, our results differed from previous research, which suggested a link between mental health and risky sexual behavior. For instance, depression and higher risky sexual behavior have been associated in different groups of individuals including male partners of female sex workers (Ulibarri et al., 2014), primary partners of HIV-positive people (Musisi et al., 2014), men who have sex with men (O'Cleirigh, Newcomb, et al., 2013), members of the military (Harbertson et al., 2013), individuals with HIV (Wagner, Ghosh-Dastidar, Holloway, Kityo, & Mugyenyi, 2012), women (Lennon, Huedo-Medina, Gerwien, & Johnson, 2012), adolescents (Langille et al., 2012), and adults living in the community (Khan et al., 2009). Likewise, results are different from previous reports of an association between anxiety and sexual risk in gay and bisexual men (Lelutiu-Weinberger et al., 2013). However,

our findings are consistent with previous research demonstrating that anxiety is not linked to risky sexual behavior in a sample of 503 HIV positive gay and bisexual men (O'Cleirigh, Traeger, et al., 2013). Differences in the samples studied may account for disparate results. Discrepancies may also suggest that following TBI the nature of anxiety and depression in relation to risky sexual behavior is different from that in the aforementioned populations. More particularly, these findings could indicate that interventions targeting the rehabilitation of executive functions could have an impact in the reduction or prevention of risky sexual behavior in TBI individuals presenting dysexecutive problems.

Taken together, results obtained show that dysexecutive problems could contribute to risky sexual behavior in individuals with TBI. Hence, dysexecutive problems and their impact on sexual behavior deserve more attention in terms of research and intervention. In conclusion, the significant relationships documented between executive function and risky sexual behavior in this sample of individuals with TBI provide empirical evidence for the existence of a relationship between these two aspects after a TBI, as conceived in a biopsychosocial perspective.

Attitudes towards infidelity and sociosexuality after TBI

We further explored the relationship between sexuality in terms of sociosexuality, and another domain of the biopsychosocial model: relationship factors, more specifically attitudes towards infidelity. The aim was to explore differences according to sex in sociosexuality and attitudes towards infidelity in individuals with TBI and in healthy controls.

Based on previous literature, we predicted that compared to non-injured women, non-injured men would show higher levels of sociosexuality. Furthermore, even though we did not have a formal hypothesis given that this was an unexplored area of research, based on the literature on neuroendocrinological changes following TBI and the neurobiological foundations of sociosexuality, it could have been anticipated that these differences according to sex in sociosexuality would not be present following TBI. Our findings show that compared to women, men reported significantly higher levels of sociosexuality. These results mirror those of the previous studies that have examined cross-cultural differences according to sex in sociosexuality in the general population (Schmitt, 2005).

In addition, the results also showed a tendency towards a reduction of sociosexuality levels in a sample of males with TBI. These findings are important because they illustrate previously unreported changes related to sexuality, which could be a consequence of the TBI. This increases our knowledge about the impacts of TBI, helps to advance our understanding of post-TBI sexuality, and contributes to existing knowledge about the neurobiological basis of sociosexuality.

The results can be interpreted following a combined evolutionary (e.g., theory of parental investment and sexual selection) and neuropsychological perspective. Careful attention was paid to the environmental/sociocultural factors that could also be suggested as possible explanations for this difference. For instance, the groups were comparable in age, gender, years of education,

work and relationship status, and annual income. Individuals with TBI were also equivalent in terms of clinical characteristics. Another contributing factor to explain the trend towards the decrease of sociosexuality in men with TBI could be an under-diagnosed clinical entity known as post-traumatic hypopituitarism (Waterhouse, 2012) or neuroendocrinological changes associated with testosterone precursors (Czirjak, Racz, & Goth, 2012; Munoz & Urban, 2013; Sandel et al., 2007). However, conducting a neuroendocrinological screening was beyond the scope of this thesis. This explanation must then be considered with caution and kept as merely hypothetical. However, this hypothesis is supported by previous research demonstrating a link between unrestricted sociosexuality and high testosterone levels (Edelstein et al., 2011). Also, the groups were equivalent regarding relationship status as there is evidence suggesting that testosterone levels can change according to relationship status, with partnered heterosexual men (but not women) having lower testosterone levels than unpartnered individuals (van Anders & Watson, 2006). Research indicates that TBI can cause complex hormonal responses of the pituitary end-organ axis, including an impairment of thyroid function and hypogonadotrophic hypogonadism, which affects testosterone and its precursors (Acerini & Tasker, 2008; Cernak, Savic, Lazarov, Joksimovic, & Markovic, 1999; Czirjak et al., 2012; Glynn & Agha, 2013; Lieberman, Oberoi, Gilkison, Masel, & Urban, 2001; Munoz & Urban, 2013). As previously mentioned, neuroendocrine disorders affect sexuality following TBI (Blaustein, 2008; Sandel et al., 2007) and sociosexuality has been linked to testosterone levels (Edelstein et al., 2011).

Nonetheless, sociosexuality is a multidimensional construct and seems to be affected by different factors, such as culture (Zheng et al., 2014), sexual minority identity (Calzo, 2014), ethnicity (Sprecher et al., 2013), body image (Rammsayer & Troche, 2013), impulsivity (Boothroyd & Brewer, 2013), and partner choice (Simpson & Gangestad, 1992), among others.

Our results thus shed additional light onto this complex construct and its presentation following TBI, and open the door for new research in the area.

In addition, this is the first report exploring attitudes toward infidelity after a TBI. Infidelity was defined as a person being unfaithful in a committed monogamous relationship. We did not have a prediction regarding the nature of attitudes towards infidelity, as we could not find studies addressing this topic in the TBI literature. We did not find evidence suggesting that attitudes toward infidelity after TBI are different from those of healthy controls. It is possible that TBI does not change the way people think or feel about extra-dyadic involvements while being in a committed monogamous relationship. However, this conclusion must be interpreted with caution because infidelity was assessed as a unitary construct. On the contrary, research indicates the importance of differentiating sexual and emotional infidelity (Treger & Sprecher, 2011). Also, research on infidelity can be challenging because its complexity includes many variables, such as sexual orientation (Leeker & Carlozzi, 2014), gender (Tagler & Jeffers, 2013), culture and power (Williams, Galick, Knudson-Martin, & Huenergardt, 2013), marital status (Russell, Baker, & McNulty, 2013), complex decision-making processes (Owen, Rhoades, & Stanley, 2013), self-regulation (Ciarocco, Echevarria, & Lewandowski, 2012), and online interactions (Dijkstra, Barelds, & Groothof, 2013), among others.

However, if attitudes toward infidelity following TBI appear comparable to those of healthy controls, it has been suggested that after a TBI, couples go through a process of marital adjustment and their stability can be affected as a result of the effects of the TBI, for example personality changes (Hammond et al., 2011). For that reason, attitudes toward infidelity after a

TBI could be even more complex than in non-injured individuals, but this exceeds the scope of this thesis.

When examining the relationships between sociosexuality and attitudes toward infidelity, results showed an association, but in an unexpected direction. According to previous research, an unrestricted sociosexual orientation is associated with higher probability to engage in infidelity (Barta & Kiene, 2005). An unanticipated finding was the relationship between an unrestricted sociosexuality and more conservative attitudes toward infidelity in individuals with TBI. Problems with emotional and behavioral regulation following TBI might explain this rather contradictory result. In addition, self-awareness could play a role via its influence in the interpretation of social cues and self-emotional recognition (Prigatano, 2009). TBI might then influence or change the relationship between attitudes toward infidelity and sociosexuality (including attitudes, behavior, and desire as conceptualized by sociosexuality theories) (Penke & Asendorpf, 2008; Schmitt, 2005; Simpson & Gangestad, 1991).

In conclusion, we provide empirical evidence for the existence of a link between relational aspects in terms of attitudes toward infidelity, and sexuality, as expressed in sociosexuality, following TBI, which remain to be further studied.

Towards the validation of a biopsychosocial conceptualization of sexuality after TBI

For the purpose of this thesis, three studies were conducted with the aim of capturing and advancing towards a validation of a biopsychosocial framework of sexuality after TBI. With that purpose, each of these original studies includes a previously unexplored dimension of

sexuality after TBI. Results obtained provide empirical evidence of the existence of a link between different aspects of sexuality with three domains: a) neuropsychological and psychological effects, b) medical and physical issues, and c) relationship factors.

Based on this biopsychosocial model, there are some inferences that can be attempted: a) difficulties in sexuality following TBI can be related to problems restricted to one of the three domains; b) sexuality after TBI can be negatively affected as a result of the interaction of two or more of the components that are dysfunctional; c) the assessment of sexual difficulties after TBI should include the evaluation of each one of this domains, d) modifying one domain may have repercussions in the other interacting domains; and e) sexual rehabilitation should include a multidisciplinary perspective.

However, the biopsychosocial model of sexuality after TBI is not the first to address sexual difficulties in the context of chronic diseases. For instance, a generic conceptual framework for the impact of disease on sexual functioning and sexual wellbeing was proposed (Verschuren, Enzlin, Dijkstra, Geertzen, & Dekker, 2010). In this model, there is an attempt to provide a framework to understand the impact of chronic disease in sexual functioning based on the available evidence, but some specificities are not addressed in this model. For example, neuropsychological aspects, which are a very important part of TBI changes, are not included. As the authors state, their conceptual framework is the first step to develop a comprehensive theory of sexuality and chronic disease. The empirical validation of such models is thus mandatory in the research agenda. There are three main reasons for this: a) to increase our understanding of the relationships between the various elements implicated in the intersection

of sexuality and disability; b) to provide evidence-based clinical recommendations in order to deliver adequate interventions; and c) to delineate a framework to orient research in this area.

This thesis is an attempt to provide some evidence toward contributing to the development of a formal theory of sexuality and TBI within the framework of sexuality in neurological disorders. By reviewing and organizing the available peer-reviewed literature in the area of post-TBI sexuality, and by providing new empirical evidence on the biopsychosocial relationships involved, we are increasing our understanding of TBI. However, every model has its drawbacks in trying to depict basic relationships of a highly complex multi-factorial attribute, such as sexuality. When studying sexuality and disability, we need to keep in mind this complexity in both the theoretical and the clinical context. For example, both models fail to indicate how to prevent sexual difficulties or how to potentiate sexual wellbeing. These models formalize a theoretical perspective to facilitate our understanding, but they were not conceived from the point of view of an intervention approach. However, increasing our comprehension of sexuality following TBI will lead to the development of specific interventions. Finally, these models do not include the perspective of evolutionary psychology or a sociological/anthropological viewpoint of sexuality. Those aspects are relevant in a theory of sexuality and disability aiming to be universal. For instance, different societies can address sexuality and sexual issues in a complete different manner, and the way they conceive sexuality has changed over time (Parker, 2009).

Finally, there is some degree of arbitrariness when we classify a construct as belonging mainly to a specific domain in the model. For instance, postconcussion symptoms are considered

mainly as belonging to the medical and physical issues, but different clusters of postconcussion symptoms fall in different categories. It is also the case of attitudes toward infidelity. Attitudes have a psychological component as they reflect the way people think or feel about a specific situation, but in the case of infidelity, they are classified as relational factors for its potential impact on the couple. Then, to a certain extent, we could be simplifying multidimensional constructs to understand them.

With its limitations and strong points, the biopsychosocial model of sexuality after TBI provides a way to understand sexuality following TBI and to categorize the different aspects involved. The model may help practitioners and researchers to better conceptualize the elements implicated in sexuality following TBI, and is important as it provides a framework to more easily understand highly complex relationships.

Implications for clinical practice and rehabilitation

This thesis has several implications for clinical practice and rehabilitation. According to the World Health Organization (WHO), sexuality is important throughout the lifespan (WHO, 2014) and sexual health goes beyond procreation or STD prevention; it is about the enhancement of life and personal relationships. Keeping this objective in mind, the relevance of a biopsychosocial perspective becomes evident.

If rehabilitation professionals in the field of TBI are aware of this conception regarding sexual health, we need to understand the reasons why sexuality is not always addressed or

considered as a health outcome. Studies with students and rehabilitation professionals provide reasons to understand the existence of this gap.

The results of a study examining educational factors and their relationship with attitudes about sexuality and disability among 479 students in health professions fields revealed a lack of adequate sexual health education in current training programs (Valvano et al., 2014). A total of 38% of medicine and 94% psychology students reported that they never had direct patient contact related to sexual health problems in their current program. Also, 69% of psychology students reported that they did not have classroom hours devoted to sexual health topics in their programs. The authors conclude that compared to other students in the health profession fields (e.g., medicine, nursing, dentistry, among others), psychology students reported the lowest quantity and quality of education regarding sexual health training. Compared to other students in the health profession fields, dentistry students reported the most negative attitudes towards sexuality and disability. Then, the authors expressed their concern about the important number of unequipped and inexperienced psychology professionals in the domain of sexuality given that they play a role in the care of people with and without disabilities.

Qualitative studies with health care professionals suggest that the interdependence of structural factors, health care organizational factors, and health care practitioner personal aspects are at the core of the lack of discussion about sexuality with their clients (Dyer & das Nair, 2013b). The interaction of these factors may refrain health care professionals from proactively discussing sexuality with their clients as follows: restrictions associated with local policies and negative attitudes towards sexuality in specific groups of individuals (e.g., ageism,

homonegativity) (structural factors); lack of time, insufficient resources, absence of a clear institutional policy (health care organizational factors); and lack of training, insufficient motivation, personal attitudes (e.g., liberal versus conservative), and cultural / religious beliefs (personal factors). The authors suggest that in order to improve the extent to which sexuality concerns are addressed, these factors have to be taken into account. With this thesis we hope to increase knowledge (personal factors) and raise awareness about the limitations and possibilities of our local policies (health care organizational factors).

The biopsychosocial perspective of sexuality after TBI also implies that the treatment of sexuality concerns following TBI is multidisciplinary. The results of this thesis could serve as a basis to modify the perceptions and experiences of some professionals who work with people with TBI regarding their belief that sexuality post-TBI is a specialist issue, requiring specific knowledge, skills, and training (Dyer & das Nair, 2013a). As sexual difficulties post-TBI have multiple causes and they are the result of complex interactions, all professionals, including those in rehabilitation contexts, can contribute to their treatment, providing their own expertise. The PLISSIT model (Permission, Limited Information, Specific Suggestions, and Intensive Therapy) (Annon, 1976; Dixon & Dixon, 2006) and the extended PLISSIT (ex-PLISSIT) model (Taylor & Davis, 2007) offer a framework to provide multidisciplinary care, irrespective of the degree and the amount of expertise. Both of these models are entirely compatible with a biopsychosocial perspective. According to their framework, permission (implicit or explicit) to discuss sexual issues is required so that clients can freely ask questions as needed. Limited information implies that the professional can provide information relevant to the client, taking into account their particular sexual background and needs. These first two stages require general

knowledge and health care professionals should be able to understand their limits in terms of knowledge, and be able to refer to another health care provider when they feel that they do not have the competence to address more complex issues. For instance, setting the ground to discuss about risky sexual behavior (explicit permission) could open the door for an individual with TBI to discuss, with the professional, specific risky sexual behaviors with uncommitted partners. Then, general recommendations about safer sex practices can include specific suggestions about condom use. However, if the primary provider finds out that this person has difficulties to understand or put in practice the desired behavior, they may suspect that cognitive impairment is contributing to the difficulty in adherence to healthy behaviors. This professional can then refer to a neuropsychologist in order to determine if cognitive difficulties (e.g., dysexecutive problems, memory disorders) are a major issue and how to provide a cognitive rehabilitation program that can generalize to healthy behaviors. In this example, specific suggestions take into account the particular needs of the individual with TBI, including a precise sexual history and expectations using a problem-solving approach. Finally, intensive therapy is provided to clients with more complex problems, including those predating the injury. Following with the same hypothetical example, if the individual with TBI discloses an antecedent of a previously unreported sexual abuse that seems to have repercussions in their current post-injury sexual functioning, intensive therapy with a sexologist will be necessary. Then, based on this perspective, all professionals, regardless of their profession or expertise, can have a role in the process.

In addition, the PLISSIT model can be used to deliver interventions to health care professionals. For instance, the PLISSIT model has been successfully used as a framework to

improve staff knowledge, comfort, and attitudes towards sexuality for people with spinal cord injury (SCI) (Fronek, Booth, Kendall, Miller, & Geraghty, 2005). The effects of this randomized controlled trial of a sexuality program were maintained two years after the training period (Fronek, Kendall, Booth, Eugarde, & Geraghty, 2011), indicating the long-term effects of a one day sexuality training program for practitioners involved in SCI rehabilitation. Also, the results of another study conducted among 283 rehabilitation professionals indicated an increase in self-perceived sexological competence after a brief discipline-specific sexological training to improve knowledge and attitudes (two or three sessions of 3h each, according to the discipline) (Post, Gianotten, Heijnen, Lambers, & Willems, 2008). The improvement in knowledge and attitudes was maintained during a 3-4 month follow-up and the authors conclude that the implementation of this training is recommended, together with an evaluation of patient satisfaction.

Health care professionals also need to reflect on their personal values and culture before they can address sexuality with their clients. This reflection is needed because sexual beliefs, attitudes, and experiences can be facilitative or inhibiting when addressing sexuality following TBI (Medlar, 1993). For that reason, rehabilitation teams need to have open discussions about sexual concerns and their implication for the rehabilitation of their clients, including the use of alternative therapeutic approaches, such as the use of erotic services, online dating websites, night clubs, and pornography, among others (Kreutzer & Zasler, 1989; Zasler & Martelli, 2011). While some rehabilitation professionals are not comfortable in addressing these issues and to discuss them regarding the ethical and legal questions that they raise, individuals with TBI need to fulfill their sexual needs and will try to find answers elsewhere. Furthermore, conceptions

about gender, sexual diversity, older people, and rehabilitation may be challenging in some countries and cultures (Zasler & Martelli, 2011). However, there is evidence suggesting that even in cultures known for their strict regulation of sexuality contents and a clear division of gender roles, interventions to treat sexual difficulties can be implemented with success (Farnam, Janghorbani, Raisi, & Merghati-Khoei, 2014).

Another implication is that rehabilitation professionals need more continuing education about sexuality and students in the health sciences need specific curriculum about sexuality and brain injury (Moreno, Gan, et al., 2014). Lack of training and experience regarding sexuality and disability may contribute to disparities in sexual health care, even when it is provided by well-intentioned professionals (Lezzoni & Long-Bellil, 2012). There are many resources intended for different groups that could be used to raise awareness and educate students and professionals working with individuals with TBI. For example, Griffith and Lemberg (1993) developed a guide for families that includes a section about intervention, describing the principles of interdisciplinary care and the roles of each discipline in comprehensive assessment and treatment of sexual issues after TBI (Griffith & Lemberg, 1993). The roles and functions of rehabilitation team members are also based on the PLISSIT model conception, through different levels of care, and go in the same direction of our conclusions and recommendations. In addition, there are other resources available to address sexuality in individuals with TBI including a manual for the survivor (Sander, Moessner, Kendall, Hammond, & Cyborski, 2011), a book for professionals working with individuals with TBI (Aloni & Katz, 2003), a book involving treatment issues about sexual function in people with disabilities (Sipski & Alexander, 1997),

an intervention program (Simpson, 1999a, 1999b), and the use of the online resources about sexual difficulties for individuals with TBI (Moreno & das Nair, 2015), among others.

To date, only one study has evaluated the quality of sexual education resources for individuals with TBI and examined the way a group of brain injury service providers have addressed their needs (Simpson & Long, 2004). This study was conducted among 36 brain injury agencies using the "You and Me" sex education program, developed to provide education to individuals with TBI, including 15 different modules (Talking about sexuality, definition of sexuality, being sexually active, sexual rights, self-pleasuring, meeting people, protective behaviors, established relationships, sexual dysfunction, physical disabilities, sex workers, sexual responsibility, safer sex, contraception and pregnancy) (Simpson, 1999a, 1999b). The results of the study showed that service providers' evaluation of these resources was extremely positive. The most frequent subjects addressed with individuals with TBI corresponded to the topics of sexual dysfunction, how to meet people, the definition of sexuality, and sexual adjustment post-injury. The authors acknowledged that staff from multiple professional and paraprofessional backgrounds can effectively provide sex education to individuals with TBI, although psychologists and social workers are more likely to be the key users.

In conclusion, a global approach to sexuality as conceived by the WHO requires more public awareness and the participation of different professionals working with sexual difficulties. It includes an integrated and inclusive approach to promote well-being, self-fulfillment through the lifespan, and the respect of diverse sexualities and forms of gender expression (WHO, 2010). Taking into account the available evidence, designing and

implementing interventions addressing sexuality is one of the key elements to provide comprehensive and global rehabilitation in individuals with TBI (Bélanger, 2009). The objective should be to formally include sexuality as part of health outcomes in clinical practice guidelines for TBI in order to guide rehabilitation professionals through the process of providing the best intervention for their clients. This is important as guidance on treatment and management of individuals with TBI who experience persistent symptoms, particularly mild TBI, is severely lacking (Berrigan, Marshall, McCullagh, Velikonja, & Bayley, 2011). And as we know that sexual difficulties appear in the chronic stages post-injury, moving toward the development of such guidelines becomes highly relevant.

General limitations and future directions

The studies presented in this thesis have several limitations that need to be acknowledged. They are summarized mainly as sampling characteristics, methodological aspects, and issues related to definitions.

Sampling limitations include the fact that the number of individuals with TBI and of healthy controls included in the studies was relatively small, that the TBI samples included in the studies were comprised of about 67% of individuals with mild TBI, and the use of a convenience sample. Future research should include larger samples in order to perform more fine-grained statistical analyses to uncover the relationships between different aspects of the biopsychosocial perspective of sexuality post-TBI. That will allow investigating risks factors for sexual difficulties, predictors of sexual function, and comparisons of specific groups of

individuals with TBI, among others. Another sampling issue concerns the severity of the injury. A majority of the participants in the studies were in the range of mild TBI, although they were mostly complex mild TBIs (with positive neuroimaging). It is possible that we could not find significant differences for some of the variables investigated (e.g., risky sexual behavior and infidelity) because of the milder severity of the TBI participants in our studies. Conducting studies in moderate to severe groups could possibly permit to establish such differences. Consequently, we cannot generalize our findings to individuals with more severe injuries. In addition, the fact that the sample was drawn from a rehabilitation center in Montreal where individuals with TBI had participated in a comprehensive, post-acute TBI rehabilitation program makes this sample very specific. For example, we recognize that such programs are not available in every country and when available, they can be different in the approach with which they are delivered or in the number and content of the intervention sessions. What is needed is a cross-national and cross-cultural study to reliably represent different subgroups of individuals with TBI. Also, this is an urban sample, and we know that for some of the variables studied (e.g., risky sexual behavior), urban and rural samples can show dissimilar results (Milhausen et al., 2003; Veinot & Harris, 2011). Another sampling limitation is the lack of studies in adolescents and older people. Sexuality changes through the lifespan and in adolescents with TBI have been overlooked (das Nair et al., 2007), as well as those in older adults; in some cases this could be linked with diverse societal conceptions associated with ageism, disability and sexuality (Kazer, 2013; Taylor & Gosney, 2011; Thompson, O'Sullivan, Byers, & Shaughnessy, 2014). We only could find one qualitative study addressing older people and the impact of TBI on partner relationships (Layman, Dijkers, & Ashman, 2005). Notably, research indicates that older persons and females appear to be at greater risk for sexual dysfunction after TBI (Sander

et al., 2013). Future investigations of sexuality in adolescents, women, as well as in young and older adults with TBI are thus warranted. Finally, our sample sizes did not permit the study of sexual diversity in lesbian, gay, bisexual, transgender, and intersex (LGBTI) individuals with TBI. The results of this thesis cannot be generalized to LGBTI people because this group can be different in terms of their needs after the injury (Mapou, 1990). There are psychosocial particularities of this population including the mixed stigmatizing effect of their sexual orientation and the disability resulting from the TBI, the existence of alternative family configurations based on social systems of different people being supportive of their sexual orientations (e.g., friends, extended family members), cross-cultural variations in the acceptance of sexual diversity, and legal issues in some countries where the responsibility of the partner is not recognized, excluding them from the participation in the post-TBI recovery process, among others (Morales, 2000; Moreno & McKerral, 2013). For that reason, future studies on LGBTI people with TBI should be encouraged.

Methodological aspects include the research design and the measures used. Regarding our research design, exploratory, correlational/cross-sectional studies permit to determine relationships in a specific moment of time, but cannot be used as evidence of causality or temporal change. For that reason, it is important to bear in mind that it is not possible to infer directional relationships or make interpretations about causation between the variables studied in this thesis. Further prospective and longitudinal research is required in order to capture the evolution of sexuality after TBI. This is a complex challenge because it requires repeated measurement of large samples with different injury severities, during long periods of time,

taking into account a comprehensive approach to reliably capture the multifaceted nature of sexuality.

The validation of measures to assess sexuality after TBI is in its early beginnings as there is no gold standard to evaluate it in this population. As long as this is a limitation for most of the studies conducted in this area, the recruitment of control groups becomes mandatory. To date, only one measure of sexuality has been recently studied in terms of its psychometric properties in individuals with TBI (Brain Injury Questionnaire of Sexuality - BIQS) (Stolwyk et al., 2013). However, this validation was not available when the three studies of this thesis were conceived and initiated. Another aspect of measurement concerns the reliability of self-reported information to assess sexual behavior. In this thesis, careful attention was paid to avoid self-presentation bias (e.g., underreporting of sexual behavior in face-to-face interviews) and to capture valid information of self-reported sexual behavior (Catania et al., 1990). Following that objective, participants in this study completed the questionnaires anonymously. This is an approach that requires an important amount of time and resources. Future studies using similar recruitment strategies intending to preserve confidentiality are highly encouraged, as this is the only way to reliably assess an extremely private aspect of human health, such as sexuality. Of course, this is even more important in different cultures and societies where sexual concerns are taboo or where people may have fear of reprisals when revealing their sexual lives. However, we did not collect collateral information from other sources to compare the information obtained by self-report. This could be a strategy to use in future studies, keeping in mind that a reliable informant is not always available and that it can be time-consuming. Some would argue that anosognosia or lack of awareness of deficits could affect the ability of people to accurately

report their behavior. However, anosognosia has been described to affect mainly the self-report of memory problems (Croteau & Nolin, 1997; Jankowiak & Shahrokhi, 1997; Ranseen, Bohaska, & Schmitt, 1990), and we do not know of any study claiming that it affects the self-report of sexual behavior following TBI.

Finally, issues related to definitions are important in terms of clarifying what is meant by sexuality and the variables assessed in this thesis, as the meaning can vary in different studies. This is one of the reasons that could explain the existence of discrepant findings. For instance, we used a broad definition of sexuality as conceived by the WHO (WHO, 2014), but some studies on sexual function were more focused on intercourse, equating sex to sexuality. In this thesis, we are not dealing with unitary constructs but with multidimensional attributes. Topics such as infidelity provide a clear example of this point. The lack of a clear definition of the meaning of infidelity, the number of activities that it can encompass, and the existence of at least two different types (e.g., sexual and emotional infidelity) makes difficult to adequately reach consensus across studies (Blow & Hartnett, 2005a). Several questions thus remain unanswered at present. Part of the answer could consist in more specifically defining the construct to be addressed. Future research in this area needs to explicit how these concepts are used in studies, with the aim of facilitating comparisons across studies and promoting the integration of findings to develop a solid theoretical framework.

Despite these limitations, the present thesis makes original contributions to the field of sexuality in the context of neurological disorders and more specifically, provides some evidence towards the formalization of a comprehensive theory of sexuality following TBI. Additional

recommendations for future studies include working with couples, non-injured partners, and rehabilitation professionals who are less represented on research (Moreno, Arango-Lasprilla, et al., 2013). As a closing remark, more qualitative studies are needed for capturing the subjective experience of individuals with TBI and their partners. Quantitative research is appropriate for successfully unveiling central tendencies in some areas of sexuality, but qualitative approaches can also be interesting when addressing diversity and heterogeneity, which is rather characteristic of sexual behavior and functioning (van Lankveld, 2013). Together with quantitative studies, mixed methodologies could contribute to a better understanding of the complexity of sexuality following TBI.

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