Frontiers in Neuroendocrinology 41 (2016) 87–98

Contents lists available at ScienceDirect

Frontiers in Neuroendocrinology

journal homepage: www.elsevier.com/locate/yfrne

Sexual trauma and the female brain

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ARTICLE INFO

Article history:
Received 30 December 2015
Received in revised form 11 April 2016
Accepted 12 April 2016
Available online 13 April 2016

Keywords:
Neurogenesis
Depression
Stress
Hippocampus
Fear
Sexual violence
Rumination
Learning
Memory
Post-traumatic stress disorder (PTSD)
Maternal behavior
Meditation
Exercise
Violence against women
Puberty

ABSTRACT

Sexual aggression and violence against women (VAM) are not only social problems; they are mental health problems. Women who experience sexual trauma often express disruptions in emotional and cognitive processes, some of which lead to depression and post-traumatic stress disorder (PTSD). Animal models of neurogenesis and learning suggest that social yet aggressive interactions between a pubescent female and an adult male can disrupt processes of learning related to maternal care, which in turn reduce survival of new neurons in the female hippocampus. Mental and Physical (MAP) Training is a novel clinical intervention that was translated from neurogenesis research. The intervention, which combines meditation and aerobic exercise, is currently being used to help women learn to recover from traumatic life experiences, especially those related to sexual violence and abuse.

1. Introduction: sexual violence and trauma in women

1.1. Prevalence rates of trauma exposure in women

Sexual violence and aggression are some of the most stressful of all human life experiences. Women are most often the victims, although a great number of men have had similarly aversive encounters. It was recently estimated that more than 30% of women worldwide experience physical or sexual violence (World Health Organization, 2013), with similar estimates (27%) in the United States (Kessler, 2000). Exact statistics are difficult to obtain because many women do not report the event, nor do many seek medical assistance afterwards. Sexual assaults are most often inflicted on the young with the majority of rapes occurring before the age of 18 (Tjaden and Thoennes, 1998). These early life experiences have devastating and lasting repercussions for normal healthy development in both boys and girls (De Bellis and Thomas, 2003; De Bellis et al., 2013; Toth and Cicchetti, 2013), not to mention the fact that women who are sexually assaulted in childhood are twice as likely to be sexually assaulted as adults (Sarkar and Sarkar, 2005). In this review, we limit our discussion to sexual trauma adolescents and/or adults with related references to similar ages in animal models of stress and aggression (Shors, 2016; Shors et al., 2016) because antecedent events and consequences of abuse in childhood can be quite different from those during puberty and adulthood.

Sexual aggression and violent experiences are as a rule traumatic for the individual and therefore considered "traumatic" life events. Whether they necessarily result in long-lasting symptomatology or mental illness is an important question to answer and in clinical terms is often a matter of nomenclature. The Diagnostic Statistical Manual of Mental Disorders (DSM-5) defines trauma as "an event or events that involved actual or threatened death, serious injury or sexual violation to the self or a close other." However, this definition does not necessarily specify the features that make a sexual event traumatic. As outlined by Green (1990) and analyzed by McNally (2005), trauma can be defined in at least three ways: (1) the nature of the event itself, (2) the person's subjective experience of it, and (3) the physical and emotional response to it. In

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http://dx.doi.org/10.1016/j.yfrne.2016.04.001
0091-3022/

this review, we do not attempt to delineate traumatic events from non-traumatic yet stressful ones because much of our review relies on the literature from animal models of stress and sexual aggression, wherein the subjective experiences and interpretations of trauma cannot be ascertained. Nonetheless, it is presumed that the vast majority of sexually aggressive experiences are traumatic.

A variety of terms are used to refer to sexual violence against women (VAW). The word "rape" refers to vaginal penetration with force or threat, whereas the word "sexual assault" includes sexual coercion and touching behaviors, which can occur while a victim is incapacitated. The term "sexual violence" is more inclusive still, including acts that do not necessarily involve touch, but are nonetheless harmful, often psychologically so, such as stalking behaviors. Of the seemingly infinite sources of trauma, sexual assault is the most likely to induce post-traumatic stress disorder (PTSD) (e.g., Kessler, 2000; Ozer et al., 2003), a form of mental illness characterized by abnormal responses of fear, helplessness and horror during the traumatic event, followed by months and sometimes years of symptoms which include re-experiencing the trauma, avoiding reminders of the trauma, and hyperarousal, along with negative cognition and mood (American Psychiatric Association, 2013). As discussed, the definition of trauma can be debated and therefore the criteria necessary for a diagnosis of PTSD is likewise debatable and under some scrutiny, especially with the advent of the newly adopted R-DOC (The National Institute of Mental Health, 2013). R-DOC attempts to remedy the categorical approach to diagnosis with more continuous and mechanistic analyses from laboratory and clinical studies. Nonetheless, the risk of developing PTSD in women, as defined by various editions of the DSM, is approximately twice as high as that in men (e.g., Breslau, 2009; Kessler et al., 1995; Kilpatrick et al., 2013). Statistics further indicate that women are more than four times as likely as men to experience sexual assault and nine times as likely to experience rape (Kessler, 2000). Given these two sets of statistics, it is no surprise that PTSD is common among women. In what follows, we discuss the psychological and neuroanatomical changes that can occur in women as a result of sexual trauma, followed by a review of animal studies that model the effects of sexual aggression on processes of learning and neurogenesis in the female brain, including changes in the survival of new neurons in the hippocampus. We end with the description of an intervention that was inspired by studies on neurogenesis and designed to reduce ruminations about the past, especially in women who have suffered psychological and/or physical abuse.

1.2. Psychological consequences of trauma in women

It is long appreciated that women are more likely than men to experience symptoms of PTSD but the reasons for these differences are not easily explained. Initially, the sex difference was explained by exposure to differing types of trauma: war more often for men and sexual violence for women. However, more recent studies have compared PTSD diagnosis in men and women who have experienced similar types of trauma, such as those related to natural disasters or terrorism; irrespective of trauma type, sex differences persist (Kessler, 2000). Studies also have compared the incidence of PTSD in men versus women who were sexually abused but not raped. Women who experience sexual assault other than rape are more than twice as likely as men to develop PTSD, though men who are raped are more likely than women to develop PTSD. But because many more women than men are raped, the incidence of PTSD as a consequence of rape is still higher in women. Differences in trauma type and severity of experience may partially account for the high incidence of PTSD in women who have been sexually victimized but these relationships are not necessarily categorical or linear (Tolin and Foa, 2006). Aside from type and severity of trauma, psychological changes that occur within an individual during and after assault are meaningful and can differ between the sexes. For example, victims of sexual or physical assault often report negative thoughts about the self, including self-blame and shame, while viewing the world as bleak and from a negative perspective (Beck et al., 2015; Foa et al., 1999b). Believing that the world is "*completely dangerous*" or that one is "*entirely incompetent*" undoubtedly influences the likelihood that the individual will go on to develop symptomatology consistent with PTSD (Foa et al., 1999b). In addition, victims of trauma frequently overgeneralize, associating the horror and fear from the precipitating event with similar events in the past, as well as projecting that fear into the present and future context (Rubin, 2014).

Many studies of trauma focus on "positive" responses to trauma, meaning those responses that increase in magnitude as a result of the experience, such as startle, blood pressure, heart rate and emotional volatility. However, in many cases, the individual finds him or herself incapacitated in a state referred to as "tonic immobility," which is an involuntary response to inescapable threat. This response occurs in response to many types of threat (Fiszman et al., 2008), but it is common in women who are victims of sexual assault (Kalaf et al., 2015). This state can persist for days and weeks after the event and may be considered part of a larger set of symptoms reflected by disorganization, during which the person may be unable or unwilling to discuss or reveal the details of the traumatic event. It is presumed that some of the immobility and confusion arises because the victim cannot or has yet to incorporate the memory of the traumatic event into her existing autobiographical representations (i.e. her life story). These mental disruptions in everyday lived experience can be further exacerbated by the emergence of ruminations, whereby an individual spends an inordinate amount of time rehearsing the memory of the event and the conditions associated with it, even blaming herself for its occurrence (e.g., Frazier et al., 2005).

1.3. Memory for sexual trauma in women

It is often assumed that the memory for a traumatic event becomes distorted or degraded through psychological disassociation at the time of trauma or generally repressed and therefore resistant to retrieval. Such distortions would suggest that the central and peripheral nervous systems failed to process the experience as a whole at the time of the trauma (van der Kolk, 2000). However, much of the data with respect to trauma indicates that memories during the experience are encoded well and not necessarily via different mechanisms than other types of memory (McNally, 2005). Nonetheless, negative cognitions that arise later in women who experienced a traumatic event are often influenced by memories of the trauma, which then become integrated into her present life. These cognitions in turn influence memories related to the self in the recent and distant past, though this happens to varying degrees within trauma-exposed individuals (Boals and Rubin, 2011; Brewin, 2011). Moreover, the trauma memory can contain a high degree of sensory detail, which contributes to a fragmented and disjointed story upon recall. This constellation of memories continues to impact the person, oftentimes contributing to the maintenance of PTSD-related symptoms (Brewin, 2011). Some studies indicate that memories with negative content are stronger than positive ones (Kensinger and Corkin, 2003; Mickley and Kensinger, 2008), which are further influenced by changes in attentional processes and arousal levels during encoding (Boals and Rubin, 2011; Everaert and Koster, 2015; Kensinger and Corkin, 2004). The relationship between arousal and memory, although well established in principle, is complex because it depends on the interactions among degrees of arousal and stimulus properties surrounding the learning experience at the time of trauma, not to