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Review

Neurological changes in brain structure and functions among individuals with a history of childhood sexual abuse: A review

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A R T I C L E I N F O

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A B S T R A C T

Objective: Review literature focused on neurological associations in brain structure among individuals with a history of childhood sexual abuse (CSA).
Methodology: A review of literature examining physiological irregularities in brain structures of individuals with a history of CSA was conducted.
Results: Results revealed that a history of CSA was associated with irregularities in the cortical and subcortical regions of the brain. These irregularities have been recognized to contribute to various cognitive, behavioral, and psychological health outcomes later in life. Age of CSA onset was associated with differential neurological brain structures.
Conclusion: Mental and behavioral health problems such as anxiety, depression, substance abuse, dissociative disorders, and sexual dysfunction are associated with CSA and may persist into adulthood. Research depicting the associations of CSA on neurological outcomes emphasizes the need to examine the biological and subsequent psychological outcomes associated with CSA. Early intervention is imperative for CSA survivors.

Contents

1. Introduction

While research has demonstrated the brain's resiliency to many factors, particular stressors have been linked to modifying its development. Various factors such as malnutrition (Uauy and Dangour,

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2006; Prado and Dewey, 2014), maternal stress (King and Laplante, 2005; Talge et al., 2007), violence (Fonzo et al., 2010; Perry et al., 1995), and other stress-inducing experiences during childhood development can negatively impact and alter neuroplasticity and structural composition of the brain (Teicher et al., 2004). A history childhood sexual abuse (CSA) has been associated with a host of adverse health issues, including but not limited to cognitive impairments (Bohn and Holz, 1996; De Bellis et al., 2011; Leserman, 2005; Moeller et al., 1993; Murray et al., 2014).

CSA is defined as coercive or unwanted sexual acts occurring between a child and a perpetrator (Wyatt, 1985; Wyatt and Newcomb, 1990; Wyatt and Peters, 1986; Zwickl and Merriman, 2011). Rates of CSA are surprisingly high with 33% of women (Finkelhor, 1994; Wyatt et al., 2004) and 16% of men (Finkelhor, 1994) reporting a history of CSA. Recent finding suggest approximately 20–26% (The National Center for Victims of Crime, 2012) of young girls experience CSA (Finkelhor et al., 2014). Prevalence rates of sexual abuse often differ due to non-disclosure by survivors (Sciolla et al., 2011). Reluctance to discuss abuse may occur due to a fear of repercussions from the abuser, victim blaming, self-blame, and fear of re-living the experience (Bohn and Holz, 1996; Sciolla et al., 2011).

Innovative research has investigated the neurological and neurocognitive differences associated with women who have experienced CSA compared to those who have not (De Bellis et al., 2011; Minzenberg et al., 2008). Neuro-analytical techniques support the finding that differences in brain structure and plasticity is associated with a significant number of women who experienced early CSA. Such areas include, but are not limited to, sections of cerebral cortex, prefrontal cortex, hippocampus, amygdala, corpus callosum, cerebellum, limbic system as well as the endocrinal Hypothalamic-Pituitary-Adrenal axis (HPA; De Bellis et al., 1999; Hart and Rubia, 2012; Heim et al., 2008; Shin et al., 1999; Teicher et al., 2003). This review includes neurologic structural and functional associations with CSA (see Table 1) and addresses cognitive deficits of CSA survivors.

1.1. Cortical regions

1.1.1. Cerebral cortex

The cerebral cortex is responsible for higher cognitive functions such as language and information processing. It is composed of four lobes: (a) the frontal lobe which is associated with reasoning, higher level cognition, language expression, and motor movements; (b) the parietal lobe, which includes the somatosensory cortex, and is involved with processing sensory information; (c) the temporal lobe, which includes the hippocampus and is tied with memory and serves as an auditory interpreting center; and finally, (d) the occipital lobe, which is involved with interpretation of visual stimuli (Sherwood, 2012, p. 144). The lobes divide into structures that have shed light on neuronal differences associated with experiencing CSA.

1.1.1.1. Frontal lobe. The prefrontal cortex, a major part of the frontal lobe, is involved in understanding emotions, planning complex cognitive behaviors, and expressing social and personality characteristics (Dubin, 2001). The orbitofrontal cortex of the prefrontal cortex is responsible for sensory integration, automatic reactions, learning, prediction, and decision-making for emotional and reward-related behaviors (Kringelbach, 2005). Bremner and colleagues (1999) observed increased cerebral blood flow in the orbitofrontal cortex among CSA survivors with and without post-traumatic stress disorder (PTSD). Using positron emission tomography (PET) imaging, Bremner and colleagues (1999) presented neutral and personalized accounts of abuse to previously abused women with and without a diagnosis of PTSD. Survivors with PTSD who were read CSA scripts experienced decreased blood flow in the medial and dorsolateral prefrontal cortex (Bremner et al., 1999). As blood flow in an area of the brain is linearly correlated with activity (Lee et al., 2005), decreased blood flow may disrupt optimal functioning of a structure. A decrease in blood flow within this neural region could lead to difficulty in executing frontal lobe processes such as complex decision-making tasks (Dubin, 2001). Bremner and colleagues (1999) suggest that impairment within the medial prefrontal cortex may lead to decreased ability to minimize or eliminate fear responses and pathological emotions among individuals diagnosed with PTSD. Furthermore, decreased blood flow in the bilateral anterior front regions and left inferior frontal gyrus (Shin et al., 1999) may lead to difficulty in the structures' functions such as decision-making, weighing alternatives, and interpreting emotional meanings (Wilson, 2003).

1.1.1.2. Temporal lobe. The temporal lobe processes auditory, olfactory, and taste information. It provides information about the form of objects that make up visual images and decodes images of the human face (Dubin, 2001). Using PET, Shin and colleagues (1999) examined differences in activation of the anterior limbic and para-limbic regions of the brain when presented with personalized traumatic and neutral scripts among women with and without PTSD. Shin and colleagues (1999) observed regional differences in the women across three conditions: a neutral event, a neutral event with teeth clenched, and a traumatic event. After hearing scripts of CSA experiences, CSA survivors with and without PTSD showed increased cerebral blood flow and increased activity in the anterior temporal poles, although increases were greater among those with PTSD (Shin et al., 1999). The differences may indicate that CSA survivors, especially those with PTSD, experience heightened perceptions of their surroundings. In this study, Shin et al. (1999) also observed increased activity in the anterior cingulate gyrus, a structure implicated in various functions of the frontal lobe and limbic system. Increased cerebral blood flow in this region may indicate that experiencing CSA is associated with sensitivity to emotions involving situations that evoke sadness, anxiety, and phobias (Dubin, 2001).

1.1.1.3. Occipital lobe. The visual cortex of the occipital lobe receives and processes visual information (Dubin, 2001; Wilson, 2003). Gray matter, a major component of the central nervous system, is comprised of primarily neuronal cell bodies that work together to relay motor or sensory stimuli to interneurons and eventually elicit an appropriate response to the stimuli (Sherwood, 2012, p. 143). The visual cortex is composed of gray matter and processes visual stimuli, thus suggesting people with less gray matter volume may be less capable of optimally processing and comprehending visual stimuli. Significant differences in gray matter volume for female CSA survivors and non-survivors were observed in a structural magnetic resonance imaging (MRI) study (Tomoda et al., 2009). In this study, CSA survivors were found to have 18.1% less gray matter volume in the left visual cortex and 12.6% less volume in the right visual cortex compared to women without a history of abuse. Further, changes in gray matter volume in the left and right visual cortex were associated with the duration of CSA occurring before the age of 12 (Tomoda et al., 2009). Tomoda and colleagues (2009) suggest that the duration of abuse occurring prior to 12 years of age may have a greater impact on the development of brain structure and concomitant function. This study was focused solely on women with a history of CSA versus CSA and other forms of abuse, therefore, findings provide support only for neurological differences associated with CSA.