Early experiences of physical and sexual abuse are well-documented correlates of suicidal behavior in adolescence and adulthood. Childhood abuse and neglect have also been reported as etiological factors in the development of suicidal and self-harm behaviors. There is strong evidence for a robust relationship between adverse childhood experiences and suicide even when controlling for other environmental variables of familial dysfunction. (Dube et al., 2001; Molnar et al., 2001; Enns et al., 2006; Yates et al., 2008).

Methodological limitations have included inconsistencies in the definition and measure of childhood abuse, self-injury and suicidal behavior across studies. However, measurements of childhood physical and sexual abuse and parental neglect are becoming more standardized (Bernstein et al., 1994), as are the classifications of suicidal behavior (Posner et al., 2007; Silverman et al., 2007; Linehan, 2004). Recently developed measures also more clearly distinguish between suicidal behavior and non-suicidal self-injurious behavior (NSSI) (Nock et al., 2007; Gratz et al., 2001).

There is evidence that adverse childhood experiences are related to the development of certain personality traits that increase the risk for suicidal behavior. Genetic and neurobiological studies have identified possible biological mediators between environmental factors and personality traits related to suicidal behavior. In this article we revisit and update our 2008 review of what is known regarding the relationship and mediators between childhood abuse/neglect and suicidal behavior, and give emphasis to the most recent findings. We integrate past and present findings into a theoretical model that illustrates current state of understanding as to how childhood adversity and genetic/biological factors interact to affect neurobiological changes, which then lead to the development of personality traits correlated with suicidal behavior.

Definitions and Measurement of Early Adverse Experiences

Sources for obtaining information regarding childhood abuse and neglect consist of chart reviews, self-reports, semi-structured interviews and independently verified reports. Some define objective criteria for physical and sexual abuse (Santa Mina & Gallop, 1998; Chaffin et al., 1999; Wagner & Linehan, 1994), others rely on more subjective reports. The Childhood Trauma Questionnaire has become one of the most widely used measures to determine presence or absence of physical and sexual abuse and/or emotional or physical neglect, or emotional abuse (Bernstein et al., 1994). It is a 28-item self-report form that asks the subject to rate how often various feelings or experiences were true for them when they were growing up. As investigators reach consensus, and the assessment of adverse childhood experiences narrows to a smaller number of validated measures, the field is moving toward increased consistency in the definition of childhood abuse/neglect across studies.
Definitions and Measures of Suicidal Behavior

Measures of suicidal behavior have widely adopted the following definition of suicide attempt: “a non-fatal self-directed potentially injurious behavior with at least some intent to die as a result of the behavior.” Non-suicidal self-injury (NSSI) is defined as: “behavior that is self-directed and deliberately results in injury or the potential for injury to oneself, with no evidence, whether implicit or explicit, of suicidal intent (The Center for Disease Control and Prevention [CDC], 2011).”

A number of semi-structured interviews have emerged as valid and reliable measures, increasing standardization in measurement of suicidal behavior as well as the ability to systematically distinguish between suicidal behavior and NSSI. The Columbia Suicide Severity Rating Scale (C-SSRS) (Posner et al., 2011), the Suicide Attempt Self-injury Interview (SASII) (Linehan et al., 2006), and the Self-Injurious Thoughts and Behaviors Interview (SITBI) (Nock et al., 2007) quantify the severity of suicidal ideation, suicide attempts and NSSI, in clinical and research settings. The Deliberate Self-Harm Inventory (DSHI), is a behavior-based 17-item self-report that measures the frequency, severity, duration and type of NSSI (Gratz, 2001).

Dimensions of Abuse and Suicidal Behavior

The various dimensions of childhood abuse that have been studied in relationship to the risk for developing suicidal and/or NSSI behaviors later in life include the type, severity, and age of onset of the abuse.

Type of Abuse

Recently, more emphasis has been given to studying the role of neglect and psychological abuse. Although not a standardized definition, Glaser (2002) describes neglect as patterns of harmful interactions within a caregiver-child relationship that require no physical contact with the child, and where motivation to harm the child is not necessarily present. In a prospective, longitudinal study of childhood adversities and risk for suicidal ideation and attempts, Enns et al., (2006) report that childhood neglect, psychological abuse and physical abuse were strongly associated with new onset of suicidal ideation and suicide attempts in an adult population-based sample. Emotional neglect was described to participants as: “people at home didn’t listen to you, your problems were ignored, or you had the feeling of not being able to find any attention or support from people in your home.” Psychological abuse was described as: “you were cursed, unjustly punished, your brothers or sisters were favored – but no bodily harm was done.”

The majority of studies find a greater correlation of suicidal behavior with a history of sexual, rather than physical abuse, (Molnar et al., 2001; Ogata et al., 1990; McHolm et al., 2003). Some find a greater risk for suicide attempts in those reporting more than one type of abuse (Anderson et al., 2002). Sexual abuse perpetrated by a parental figure (incest) as opposed to a non-parent, is related to the likelihood of multiple suicide attempts among women outpatients (Cankaya et al., 2012). Santa Mina et al., (1998) summarized that when trauma is sexual in nature and invasive; it is more likely to be correlated with suicidal behavior. Ystgaard et al., (2004) found that both physical and sexual abuse are significantly and independently associated with repeated suicidal behavior.

Several studies found a differential effect. For example, sexual abuse in childhood is related to suicidal behavior in adulthood, while childhood physical abuse is related to aggression and interpersonal violence (Brodsky et al., 2008; McHolm et al., 2003). In a prospective study (Yates et al. 2008) physical abuse increased the probability of intermittent suicidal behavior (one to two events), whereas sexual abuse contributed to recurrent suicidal behavior (three or more events). The authors speculate that physical abuse may lead to disruptions in impulse control related to intermittent injury whereas emotional dysregulation may be more related to sexual abuse, leading to recurrent suicidal behavior as a form of affect regulation.

Sexual abuse may be more specifically related to suicidal behavior because it is closely associated with feelings of shame (Feiring et al., 1996, Feiring & Taska 2005) or internal attributions of blame (Feiring et al., 2002; Quas et al., 2003; Barker-Collo, 2001).
For instance, female survivors of sexual abuse by an immediate family member recalled making internal attributions of blame, which was predictive of a history of suicide attempts (Valle & Silovsky, 2002).

**Severity and Age of Onset**

Adult suicide attempters who report a history of either physical or sexual abuse in childhood make their first attempt at an earlier age than attempters who do not report abuse (Boudewyn & Liem, 1995; Ferguson et al., 2000, Brodsky, 2001).

In a study of 55,299 respondents from samples of 21 countries worldwide, Bruffaerts et al. (2010) found that intrusive (either sexual or physical) traumatic events experienced during childhood were more likely to lead to suicide attempts across the lifespan, and that physical and sexual abuse in childhood were predictive of earlier onset of suicidal attempts.

**Personality traits**

There is substantial evidence that childhood adversity impacts directly on neurobiological systems related to impulsivity and suicidal behavior (Braquehais et al., 2010). Generational studies show that transmission of suicidal behavior is part genetic, and may be mediated by the transmission of intermediate phenotypes, such as impulsivity and aggression (Brent, 2008, Brodsky et al., 2008). Childhood abuse also seems to contribute to emotional dysregulation and poor attachment patterns, which can also increase the likelihood of engaging in suicidal and NSSI behaviors (Gratz, 2001; Briere & Jordan 2009).

**Protective Factors**

The presence of a caring adult, less affiliation with delinquent peer groups, involvement in sports throughout childhood/adolescence (Fergusson et al., 2000, Beauvais & Horwood, 2003) mitigate the association between abuse history and adult psychopathology. Perceived parental care, and a positive response upon disclosure to a maternal parent, are also associated with decreased likelihood of suicidal ideation and behavior in sexually abused adolescent boys (Chandy, 1996) and women (Broman-Fulkes, 2007).

**Neurobiological Correlates**

Certain genetic and neurobiological systems are affected by childhood adversity and might play a mediating role in the development of personality traits associated with suicidal and NSSI behaviors. In addition to serotonergic and HPA Axis functioning, new research includes more specific knowledge regarding: 1) the interaction of genes and the environment 2) the role of oxytocin in maternal attachment and 3) the opioid system.

**Serotonin**

Low serotonergic functioning has been consistently associated with increased impulsivity and self-destructive as well as aggressive behavior in adults (Stanley & Mann, 1983; Mann et al. 2001). Non-human primate studies demonstrate that genetic transmission as well as environmental factors such as maternal deprivation, contribute to the presence of lower serotonergic levels and biological correlates of impulsivity. (Higley et al., 1992).

Similarly, the relationship between maternal separation, decreased expression of serotonin, and depressive symptomatology has been found in rodents (Lee et al., 2007, Bhansali et al., 2007, Vicentic et al., 2006).

Human genetic studies provide evidence that certain gene polymorphisms related to serotonergic functioning moderate the relationship between childhood trauma and depression and suicidal behavior. In a prospective longitudinal study, Caspi et al. (2003) found that a polymorphism in the promoter region of the 5-HT T serotonin transporter mediated the association between life stressors and depression, suicidal ideation and suicide attempts. Childhood trauma has also been found to interact with low expressing 5-HTTLPR genotypes to increase the risk of suicide attempts among patients with substance dependence (Roy et al., 2007). Gibb et al., (2006) found that 5-HTTLPR genotype moderated the link between childhood physical and sexual, but not emotional abuse and suicide attempts in adult inpatients.

**HPA Axis**

Recent studies have further examined the relationship between childhood abuse, the hypothalamic-pituitary-adrenal (HPA) axis (which regulates the stress response), and risk of suicide attempts and completed suicide. A study comparing first degree relatives of suicide completers with matched controls, (McGirr et al., 2010) found that relatives of suicide completers exhibited a blunted cortisol response. Thus, an abated stress response was associated with suicide risk. Roy et al., (2010) found that the interaction between the FKBP5 haplotypes (genes related to the HPA Axis) and exposure to childhood trauma significantly increased the risk of attempting suicide. These results suggest that genetic and developmental risk factors interact to impair the stress response, and thereby increase an individual’s vulnerability for attempting suicide.

**Genetics**

Exciting new research (Szyf 2012) has demonstrated that DNA methylation can serve as a genome adaptation mechanism, adapting genome function to changing environmental contexts including social environments. A critical time point for this process is in early life when cues from the social and physical environments define lifelong trajectories of physical and mental health. Roth et al., (2009) assessed DNA methylation patterns and gene expression throughout the life span of infant rats exposed to stressed, abused caretakers during their first postnatal week, as well as in the next generation of infants. Early maltreatment engendered persistent changes in methylation of hippocampal DNA that caused altered gene expression in the adult prefrontal cortex in both the infant rats and their offspring. In humans, a postmortem study (McGowan et al., 2009) of hippocampal samples from suicide completers with a history of childhood abuse found increased methylation of the exon 1F NR3C1 promoter in comparison with controls.

Thus, it is possible that childhood adversity can give rise to epigenetic changes within the individual that might affect neurobiological systems related to stress and suicidal behavior in the same individual, as well as in biological offspring.
Oxytocin and Attachment

Disrupted attachment behaviors related to parental neglect may also have biological underpinnings. Researchers speculate that the hormone oxytocin supports affiliation through its role in stress reduction (Bartz & Hollander, 2006). Adverse experiences in early childhood can alter brain development through its effects on the oxytocin-vasopressin stress response system (Pierrehumbert et al., 2010). Low CSF oxytocin levels have been found in suicide attempters with high suicide intent (Jokinen et al., 2012). Neuropeptides, including the opioids, oxytocin, and vasopressin, serve a crucial role in the regulation of affiliative behaviors, and are disrupted in individuals with borderline personality disorder (BPD), who are at high risk for making suicide attempts and engaging in NSSI behavior. (Stanley & Siever, 2010).

The opioid system and non-suicidal self-injury

Opioid receptors are involved in the pathogenesis of NSSI, and opioid deficiency is prevalent among those who engage in NSSI. Individuals with BPD who self-injure have lower CSF levels of endogenous opioids compared to those who do not engage in NSSI. In addition, opioid antagonist treatment has been shown effective in reducing NSSI. It is possible that childhood adversity could lead to a deficiency in opioid receptors, which might increase the likelihood of engaging in NSSI for the purpose of opioid release (Sher & Stanley, 2008, Stanley et al., 2010).

Models of Adverse Experience and Suicidal Behavior

In the diathesis-stress model of suicidal behavior (Mann et al 1999), early childhood abuse constitutes an environmental factor that might contribute both to the diathesis (the vulnerability to act on suicidal ideation) possibly by altering stress responsivity, as well as the stressor, which might be events that trigger memories of the abuse. The association between suicide attempts and intrusive childhood adversities observed by Bruffaerts et al., (2010) is consonant with the stress-diathesis model. Critical levels of early-life stress may create particular vulnerable conditions for enhanced sensitivity of the hypothalamic-pituitary-adrenal axis, with both biological and emotional consequences.

Joiner’s interpersonal theory of suicide (Joiner et al., 2007; 2009) postulates that the following three factors increase the capacity for making suicide attempts: the experience of thwarted belongingness, perceived burdensomeness, and an acquired capability for suicide, which occurs when an individual acclimates to physical pain and the fear of death. This habituation takes place through repeated exposure to painful experiences (Van Orden, et al. 2010). Timmons et al (2011) found that actual separation from the parent or a profound disruption in the parental relationship, leads to diminished feelings of belonging and an increased desire for death. More research is needed to examine whether adverse childhood experiences contribute to these three factors.

Nock (2010) proposes a model suggesting that NSSI behaviors serve two primary functions: an intrapersonal (i.e. decreases aversive affective/cognitive states or increases desired states of mind) and an interpersonal function (i.e. increases social support or removes undesired social demands). He maintains that childhood abuse leads to physiological hyperarousal in response to stressful situations and social learning. This reduces the ability to regulate affective, cognitive, or social experiences, and increases the likelihood of engaging in NSSI for intrapersonal functions.

Our Proposed Model

We present a schematic model that integrates some of these latest findings to illustrate our understanding to date regarding the relationship between adverse experiences in childhood and suicidal behavior later in life. Early childhood adversity not only influences neurobiological and psychological phenotype, but also may impact on genotype, resulting in biological changes during the lifetime that might mediate the development of personality traits and suicidal behavior. In our model, childhood adversity and genetic/biological factors interact to affect neurobiological changes, which then lead to the development of personality traits that are correlated with suicidal behavior (Fig. 1).

Although we lack sufficient data to support a more specific model, we propose that future research investigate whether certain types of adverse experiences might result in specific genetic and/or neurobiological changes which lead to particular types of traits correlated with suicidal or NSSI behaviors. For example, physical or sexual abuse might reduce serotonergic functioning, leading to increased impulsive aggression and subsequent suicidal behavior. Or, childhood neglect might decrease oxytocin,
disrupt the propensity for attachment, and lead to increased emotional dysregulation and suicidal behavior. Or, sexual abuse might adversely affect the HPA Axis and cortisol levels (and blunt the stress response), which might contribute to emotional dysregulation that leads to suicidal behavior. Physical, or sexual abuse might decrease opioid functioning, thereby increasing propensity for engaging in NSSI (Fig. 2).

**Conclusion**

Recent advances in the study of the relationship between adverse childhood experiences and suicidal behavior later in life have built upon the “first wave” of cross-sectional and retrospective correlational studies. The field continues to move toward increased standardization in the definition and measurement of childhood adversity and suicidal and NSSI behavior. Prospective and familial transmission studies, and laboratory investigations, examine the interaction of environmental adversity with genetic and biological systems related to psychological risk factors for these behaviors. Our proposed theoretical model illustrates how childhood adversity and genetic/biological factors interact to affect neurobiological changes, which then lead to the development of personality traits correlated with suicidal behavior. Our model provides a framework for further investigation into the mediating roles of specific neurobiological factors related to both childhood adversity and suicidal and self-harm behavior.

**References**


