

**The neurodevelopmental etiology of mental disorders among adolescents impacted by
physical abuse and neglect.**

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Abstract

There is an established connection between Adverse Childhood Experiences and the development of behavioral disorders, but the explanation of how these experiences affect neurodevelopment is relatively lacking. The objective of this project is to further understand the relationship between Childhood Abuse and the neurological development of the brain specifically citing neglect and physical abuse during the period of adolescence (12-17). In this manuscript the adverse effects of adolescent neglect and physical abuse is dissected, discussing the structural and biochemical changes of the brain as a result of potentially traumatic experiences (PTE). This review dissects how adolescent brains react to adverse experiences including physical abuse and neglect. This research begins with a background on the formal operational stage of development specifically connecting brain development as well as the development of social identity. Further the paper uses the previous description to explain the impact of stress response in the adolescent brain identifying possible preemptive measures for ACES and remedial treatments

The neurodevelopmental etiology of mental disorders among adolescents impacted by physical abuse and neglect.

Adolescence, the period from age ten to eighteen, is vital in human development. During this period, there is a transition from childhood to adulthood, so healthy, productive experiences serve as a foundation for successful adulthood. However, aversive or traumatic experiences during this time have the potential to have lasting adverse effects into adulthood. In fact, 1 in 6 adults experience four or more types of Adverse Childhood Experiences (CDC, 2021). ACE or Adverse Childhood Experiences are potentially traumatic events between the ages of 0 to 18. ACEs include but are not limited to experiencing violence, abuse, or neglect; witnessing violence in the home or community; and having a family member attempt or die by suicide or experience bereavement. Experiencing ACEs is directly linked to the development of maladaptive behaviors later in life and the development of certain Common Mental Disorders (Depression and Anxiety). The Center for Disease Control and Prevention (2021) has even linked ACEs to five out of the ten leading causes of death in the United States. Moreover, ACEs are a leading cause for concern when studying mental health in adolescence.

Furthermore, ACEs have proven to have lasting adverse effects into adulthood. ACEs have a direct correlation to the development of mental disorders in adulthood, increasing the likelihood of maladaptive and self-injurious behavior. However, proper treatment or prevention of ACEs could reduce the number of adults with depression by as much as 44% (CDC, 2021). Nevertheless, the treatment of ACEs can be quite difficult when other factors are taken into consideration. For instance, it is inappropriate to assume there is a definitive method to prevent adverse experiences for all adolescents. However, with awareness of what ACEs are, it is more

feasible to lower the occurrence of ACEs. Similarly, if there is availability to treat maladaptive behaviors due to ACEs, the effects can be negated before they can develop further. Further information into adolescent development, both physical and mental, demographic variation, and resilience can serve as steps towards improved treatment and awareness of ACEs.

The objective of this project is to further understand the relationship between childhood abuse and the neurological development of the brain specifically citing neglect and physical abuse during the period of adolescence (10-18). In this manuscript the adverse effects of adolescent neglect and physical abuse is dissected, discussing the structural and biochemical changes of the brain as a result of potentially traumatic experiences (PTE). Section one will provide a background on adolescent neurodevelopment and the factors that contribute to mental health disorders. Section two covers the dysregulation of the stress response system. Section three analyzes common mental disorders developed as a result of ACEs. Finally, section four discusses possible treatments for and prevention of ACEs.

Section One: Adolescent Neurodevelopment and Mental Health Disorders

During the period of adolescence, the brain develops significantly both in structure and function. For example, Dumontheil (2016) found critical changes in the brain's structure during adolescence. White matter, containing myelin-covered axons, develops rapidly during this period. This study shows that anomalies in this development serve as an explanation for the development of psychiatric disorders. Grey matter, containing neuronal cell bodies, also develops significantly during this period. Variability in gray matter impacts cortical thickness, which correlates with intelligence and environmental sensitivity. Concerning functionality, cognitive control (executive function) and social cognition both improve significantly. Less is

known regarding the function of the brain during this period, but studies have demonstrated that certain common genetic variants have led to abnormal development. During adolescence, the brain is in a state of fluctuation and is more sensitive to extremes.

Furthering the point of fluctuation, the ever-shifting and developing emotions during adolescence also play a role in abnormalities. McLaughlin, Garrad & Somerville (2022) report that certain emotional behaviors develop along a linear trajectory while others develop in a non-linear fashion. Their research has found that emotions attributed to progressive improvement in various activities follow the linear developmental trajectory, meaning these emotions develop gradually. On the contrary, emotions tied to spikes in day-to-day stressors or adverse events develop in a non-linear trajectory. This development is volatile and varies and has an increased connection to adolescent risk for psychopathology. Another point of this research is the acknowledgment that adolescents are still developing the ability to regulate emotions at this time. Furthermore, there is less motivation to regulate negative emotions in adolescence relative to adulthood.

Taking into account the sensitivity of adolescents at this period in life, the lasting impact of abuse and neglect becomes more apparent. Strathearn et al. (2020) examined an association between emotional abuse, physical abuse, neglect, and internalized and externalized behavioral issues. The study found that adolescents who had suffered from either abuse or neglect were strongly associated with the development of disorders, including depression, Post-Traumatic Stress Disorder (PTSD), and anxiety in their young adulthood. However, abuse and neglect are not standard across all situations, and varying demographics demonstrate different outcomes of neglect and abuse (i.e ACE). Research by Subramaniam et al. (2020) considered varying demographics when determining the outcome of ACEs. The study found that adolescents in

single-parent or divorced homes had a higher probability of experiencing emotional abuse and neglect. Females had a higher probability of physical abuse than males. Individuals who failed to complete high school or a GED equivalent were more likely to experience physical abuse and neglect. From these groups, it was deduced that individuals who experienced two or more aversive experiences were more likely to experience depression, suicidality, and substance abuse. In contrast, exposure to one ACE significantly increased the odds of developing depression and anxiety, but not suicidality and substance abuse. This study also attributed lower levels of education to ACEs. Adverse experiences during adolescence interfere with education and have been shown to reduce the information the individual retains. Varying demographics significantly impact the probability of an aversive experience occurring and how an individual might respond; this takes into account the concepts of resilience and susceptibility.

Furthermore, susceptibility and resilience result from a combination of genetic and environmental factors. As mentioned previously, varying demographics result in various outcomes of adverse experiences. This variation is partially attributed to an individual's susceptibility to a mental disorder, meaning how likely they would be to develop a disorder, and their resilience, meaning their ability to adapt to stressors aiding in the development of mental disorders (Gottschalk, Domschke, and Schiele, 2020). Specific individuals can withstand more significant amounts of stress without developing maladaptive behaviors, while others will develop them with exposure to similar stressors. Variation in neurodevelopment is a crucial aspect of this. However, there are other factors to be considered such as how the individual handles stress resulting from ACE.

Section Two: Mechanisms of Stress in Adolescence

To effectively discuss how stress induced by adverse experiences impairs mental development, we must first analyze the stress response system. The stress response system responds to stimuli in our environment and how we perceive said stimuli. The hypothalamus, an area of the brain that produces hormones, controls this system. If one perceives something in the environment as being stressful it sends signals to both the adrenal medulla and the pituitary gland. The pituitary gland begins producing adrenocorticotrophic hormone (ACTH) which stimulates the adrenal glands allowing for the production of the hormone corticosteroid. These glucocorticoid hormones regulate blood sugar levels to help cope with stressful stimuli. The adrenal medulla, when prompted by the hypothalamus, secretes adrenaline. Adrenaline elicits the fight or flight response, a physical reaction resulting in increased awareness and a faster heart rate (Cherry, 2019). When functioning correctly, the stress response system effectively prepares the body to deal with a stressful event. But, what are the parameters of a stress response system that is functioning properly, and what are the qualities of a dysregulated stress response system?

During adolescence (10-18 years of age), there is increased exposure to stressors (Roberts & Lopez-Duran, 2018) A stress response system that works properly is adaptive and changes to manage increased exposure to stressful stimuli. to manage the increased exposure to stressful stimuli. To account for the increased stress, the hypothalamus-pituitary-adrenal (HPA) axis creates an appropriate limit for stress in adolescents. According to Roberts and Lopez-Duran (2018), increased activation of the HPA axis results in “adaptive biological responses to stressors.” These responses include a short-term increase in muscle tone, mobilization of stored energy, and the inhibition of the parasympathetic nervous system to prepare for a threat. Roberts and Lopez-Duran also mentioned that HPA activity is most notable during adolescence,

specifically in pubertal maturation. The HPA axis activates due to numerous stressful stimuli, including but not limited to pain, exercise, and threats. As mentioned by Roberts and Lopez-Duran, the activation and recovery times of the HPA axis vary with age, however, with increased and consistent activation of the axis leading to slower activation time and longer recovery time. The HPA axis is activated as signals from cortical regions in the brain reach the nucleus of the hypothalamus resulting in the release of adrenaline and cortisol hormones, as previously mentioned. However, the recovery period for the rapid increase of these hormones significantly affects the basal levels of the stress response. Simply put, the more often someone has this rush of hormones to cope with stress, the less effective the hormones become leading to a dysregulated stress response system.

A dysregulated stress response system can be defined as a stress response system that maladaptively responds to environmental stressors. The dysregulation of the stress response system is thought to “be a central mechanism by which exposure to adverse early-life environments influence human development” (McLaughlin et al., 2015). However, further research has established a connection between dysregulation and environmental factors such as race, gender, and socioeconomic status among others. This demonstrates the importance of acknowledging adolescents' varying factors and upbringing. With this, it is important also to acknowledge the concept of stress diathesis. This model accounts for the development of psychological disorders, or in this case, dysregulation, as a result of an individual's susceptibility to the disorder and their capacity for stress. Broerman (2020) describes individuals who present specific vulnerabilities to disorders as having increased “environmental stressors.” However, he concludes that the intensity of stress that would elicit the development of a disorder in an individual is based on their vulnerability. Put simply, the more vulnerable an individual is to a

disorder, the less stress it will take for that disorder to develop. This diathesis can result in an inability to respond to stress appropriately. As an individual hits their stress threshold, the stress response system becomes less effective. With heterogeneous environmental and biological factors, it is difficult to establish a measurable threshold broadly. Tying it back to the overarching point, an adolescent experiencing the natural increase of stress may also experience adverse environmental factors and have a significantly increased chance of reaching their stress threshold, leading to an increased susceptibility to mental disorders.

Section Three: Common Mental Disorders

Understanding how the stress threshold is reached, it is now essential to discuss the types of mental disorders that manifest in adolescents. Most commonly, adolescents who experience high levels of stress develop depression and anxiety-related symptoms often referred to as Common Mental Disorders (CMD). These symptoms often lead to the diagnosis of generalized anxiety disorder or major depressive disorder (Silva et al., 2020). However, as previously mentioned, outside factors can impact the type of mental disorder developed by adolescents. For instance, Herpertz-Dahlman, Bühren, and Remschmidt (2013) reported a significant difference in types of mental disorders developed in adolescents based on gender. Their study demonstrated that female adolescents developed internalized disorders (e.g. eating disorders and social anxiety) at a prevalence of 23% globally. In comparison, male adolescents developed disruptive disorders (e.g. social behavior disorders) at a prevalence of 10% globally. In addition, females had a 25% prevalence of self-injurious behaviors, while males only had a 14% prevalence. Without even considering other factors, it is clear that there are many variables to consider in the adolescent development of mental disorders. However, the disorder's lasting impact is undeniable as mental disorders often continue into young adulthood.

The duration of mental disorder episodes in adolescence directly correlates to the continued development of mental disorders in young adulthood (20-29) (Patton et al., 2014). Research has shown that even brief episodes of mental disorders in adolescence have led to the remission of the disorder in young adulthood. However, more prolonged episodes of mental disorders have led to other disorders and increased morbidity in adults. Treatment of mental disorders during adolescence to shorten episodes dramatically increases the chance that the disorder will not persist into adulthood. As mental disorders continue, they can develop further, resulting in additional comorbidities and maladaptive behaviors.

Regarding CMDs, such as Major Depressive Disorder or Generalized Anxiety Disorder, research has shown that these disorders tend to worsen with age if left untreated and could lead to self-injurious behavior, substance abuse, and possibly suicide (Johnson et al., 2018). Additional research furthers this point by connecting the preexisting depressive symptoms with new stressors in young adulthood, saying that increased stress on top of disordered behavior increases vulnerability to drug abuse (Alves et al., 2020). Moreover, with a consistently disrupted emotional state caused by depression, the development of dependence to drugs becomes more common. Connecting the previous points, as increased stress causes mental disorders to develop in adolescence, and if the disorders are untreated, the disorder will more likely continue into adulthood, resulting in increased vulnerability to drug abuse and dependency as well as suicidal ideation or self-injurious behavior.

Although childhood development of psychotic disorders is more so attributed to genetics, increased stress during adolescence furthers the severity of these disorders in adulthood (Kasen et al., 2020). Research has shown that increased adolescent stress paired with the development of psychotic and personality disorders (e.g. Schizoid Personality Disorder and Antisocial

Personality Disorder) increases the risk of more significant social dysfunction and institutionalization in adulthood (Kasen et al., 2020). So, both the symptoms of mood disorders and psychotic or personality disorders are worsened by adverse experiences during adolescence. Without proper treatment, these symptoms could become far worse in adulthood.

Section Four: Treatment and Prevention

Considering both the long and short-term effects of ACEs on adolescents, the logical question is how we treat or even prevent the development of mental disorders. Although it is impossible to completely prevent the occurrence of ACE, there have been efforts to reduce domestic occurrences of abuse and neglect. Srivastav et al. (2020) demonstrated a feasible way to manage and prevent adolescent exposure to ACE. This was through a set of policies created by the state of South Carolina that created public health programs that educated communities about ACE as a form of prevention. One issue with this method was the state's apprehension to support these policies and fund programs. The authors discussed the difficulties and backlash regarding policies in public health. The researchers found that many people were apprehensive about seeking help or preventative education from public health programs because it felt like the government was intervening in their personal affairs. This is a common criticism of most preventative treatments or programs.

One perspective in addressing ACE focuses more on preparing a child for an adverse experience rather than preventing the event. This preventative treatment acknowledges the inability to prevent adverse experiences in totality and focuses on building a child's Emotional Intelligence (EI). Emotional intelligence, the ability to perceive, control, and use emotions to communicate with others effectively and constructively, carries much weight in developing

mental disorders (Cherry, 2022). Batool (2011) emphasized the importance of pre-adolescent education of culturally specific strategies and coping skills to prepare a child for adverse experiences that they may be subjected to in adolescence. If a child is never taught how to interpret and effectively communicate their emotions, they are more likely to develop maladaptive behaviors. Further Exposure to EI training for children and their parents dramatically reduces the child's susceptibility to mental disorders and increases their mental resilience. Llamas-Díaz et al. (2022) found a positive correlation between EI and subjective well-being in adolescents ages 10-19. EI training is a feasible and researched treatment for preventing and preparing children for adverse experiences.

One must also consider resilience when mentioning a child's preparedness to experience adverse situations. Martin-Soelch and Schnyder (2019) analyze the demographic factors regarding resilience. Generally speaking, people of different backgrounds have varying levels of resilience when it comes to stress. This resilience, paired with their level of EI, is a prominent force in determining whether an adverse experience could lead to them developing maladaptive behaviors such as what was previously discussed regarding the concept of the stress diathesis. In Martin-Soelch and Schnyder's research, there is an emphasis on demographic differences (Socio-economic status, race, sex, ethnicity, etc.) and the capacity for stress. When considering treatment, it is not so much trying to max out stats in terms of having high levels of emotional intelligence and being resilient to the development of disorders. Rather, it is acknowledging individual circumstances and seeking treatment accordingly.

Outside of preemptive treatments, many options exist for adolescents who have already begun to develop maladaptive behaviors. Tafet and Nemeroff (2020) explored forms of pharmacological treatment for common mental disorders among adolescents. Their research

focuses on managing hormones in the HPA axis with various "anti-anxiety agents." They worked on augmenting the corticotropin-releasing hormone (CRH) to provide therapeutic help when dealing with anxiety and depression-based mental illnesses. This treatment showed promising results but still has varying effectiveness; however, further manipulation of the CRH could become more effective.

Conclusion

Overall, with the variable nature of ACE in terms of occurrence and outcome, much research must be done before a more generalized treatment can be put into use. However, with the resources available now, there is much that can be accomplished. As mentioned, various forms of therapy have proven effective in treating individuals suffering from chronic mental disorders and/or exhibiting maladaptive behavior associated with ACE. Regarding the prevention of ACE, many states have passed legislation that identifies the impact of ACE and works to create programs that educate communities on behaviors to avoid to protect future generations. At this point, we know that ACE have a known connection to developing chronic mental disorders in adolescence and adulthood. ACE can dysregulate adolescent stress response systems, increasing susceptibility to mental disorders and making it harder to adapt to large amounts of stress. Furthermore, this development is contingent on individual variables such as susceptibility, resilience, socioeconomic status, race, and gender.

Despite the occurrence of ACE and their long term effects, there is still proven reason to continue research into preventive efforts and remedial treatments to better our society. Even when faced with the harsh reality of aversive experiences, adolescents have shown incredible

resilience to overcome trauma and heal in the face of adversity. With what we know, there is hope for new and improved treatments and more effective preventative measures.

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