ACEs are Wild: How Educators Can Positively Influence the "Hand" Students are dealt

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Abstract: Failing test scores in reading proficiency have been a blemish on our nation's report card for decades as scores have remained static despite the readily-available information on language and literacy attainment, and the employment of research-based strategies in classrooms. While we continue our quest to efficiently bolster reading skills, a less obvious solution may have little to do with literacy and everything to do with neuroscience. Over 60% of youths have suffered from one or more adverse childhood experiences (ACEs), and children who experience adversity are more likely to struggle in school. Cortisol, a hormone released under stress, limits brain function and negatively impacts one's working memory, decision-making skills, and attention, all of which are required for reading proficiency. Researchers have proven that oxytocin, the "love hormone", reverses the effects of cortisol and is easily triggered in classroom settings via physical contact. By reversing the effects of cortisol, students will have the "mental real estate" to learn and retain the skills and knowledge necessary to become proficient readers.

Keywords: adverse childhood experiences, literacy, neurophysiology

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Introduction

National concerns regarding poor academic achievement in K-12 schools have been sweeping headlines for decades, and while Covid-19 has become a convenient scapegoat for various problems in American schools, the current status of our educational shortcomings has longstanding roots. Forty years ago, a landmark report highlighted problems in our educational system and encouraged discussions to resolve the identified problems (United States National Commission on Excellence in Education, 1983). This report spurred numerous studies that advanced our knowledge of best teaching practices; however, national scores have remained predominantly static (Hussar et al., 2020), thus failing to narrow the achievement gap. Results from the Programme of International Student Assessment (PISA) reported that the United States ranked 13th in reading and has maintained a flat curvilinear trajectory from 2000-2018 (OECD, 2018), indicating stagnant literacy rates spanning nearly two decades. Prior to Covid-19, the National Association of Educational Progress (NAEP, 2019) reported that only 35% of fourth graders and 34% of eighth graders nationwide scored at or above

proficiency in reading. The most recent report from NAEP (2022) indicated that fourth graders in 21 states have made no significant progress, while students in 29 states plus Washington, D.C. have shown a decrease since 2019.

These abysmal scores prompted leading researchers to investigate and draw connections between neuroscience and literacy. The term 'Science of Reading' emerged in literacy journals a few years ago and has quickly gained attention among education researchers, school district leaders, and state legislators. The Reading League (2022) defined the Science of Reading (SoR) as "a vast, interdisciplinary body of scientifically-based research about reading and issues related to reading and writing" (p. 6). SoR advances what is known about literacy development to include psychology and neuroscience in order to create a more comprehensive framework. This has spurred hope within the literacy community because the science behind literacy acquisition is brain-based and foundational. One vital area of neuroscience has been given limited attention, though – the biology and physiology of the reading brain.

The purpose of this article is to expand upon the current research on literacy acquisition as it pertains to neuroscience and to offer an alternative method to narrowing the achievement gap, specifically focused on improving the literacy skills of children who have experienced traumatic events.

Adverse Childhood Experiences

Adverse childhood experiences, or ACEs, is the term used for children under 18 who experience traumatic events that initiate feelings of unsafe, unstable, and unsupported environments as a result of abuse, neglect, and household dysfunction (Division of Violence Prevention, 2019). As seen in Figure 1, a more detailed list of specific types of ACEs is provided below each category.

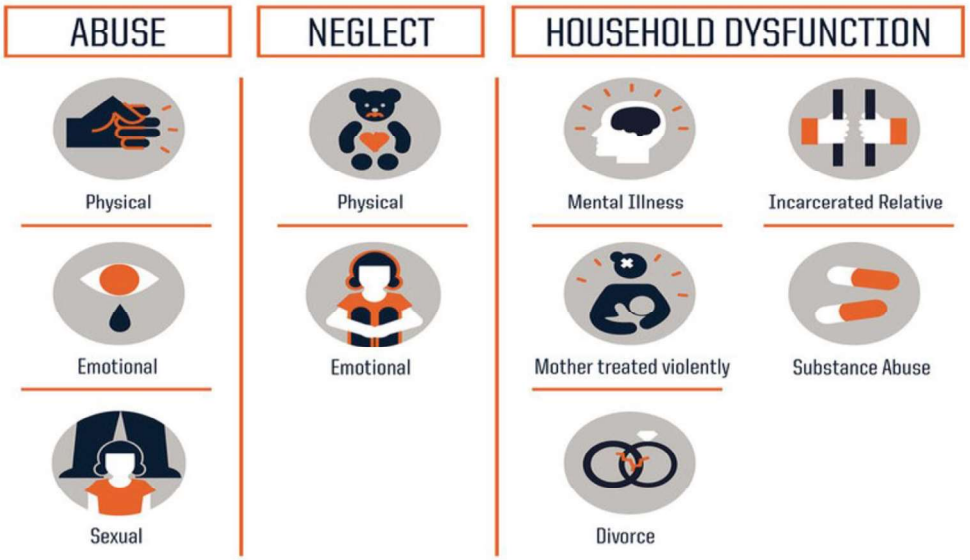

Figure 1. Three Types of Adversity

The former president of the American Academy of Pediatrics stated, "Adverse childhood experiences are the single greatest unaddressed public health threat facing our nation today" (Council on Accreditation, 2018, para. 1), as there are myriad lifelong physical and psychological effects resulting from such experiences. The effects of ACEs, depending on the number of experiences and severity of each, could extend into adulthood, as employment, income potential, mental health, and overall quality of life may be impacted (Division of Violence Prevention, 2019; Jimenez et al., 2016), as indicated in Figure 2.

Figure 2. Lifelong Effects of Adverse Childhood Experiences

Children who have been repeatedly exposed to the same ACE or experienced different types of ACEs should be considered at-risk. With every exposure, associations between ACEs and school readiness, low achievement, social problems, and aggression become increasingly prevalent, thus, congruently widening the achievement gap (Blair, 2002; Jimenez et al., 2016). The CDC's most recent report states that 61% of surveyed participants have experienced one type of ACE, and approximately 17% have experienced four or more types of ACEs (2022). It is important to remember that these numbers only reflect what was reported and percentages could be higher.

It is impossible for educators to know the history of every student every year; however, researchers have found that children from low-SES homes are at greater risk for ACEs. Due to the cascading effects of adult stress on children, obstacles of parenting under pressure, financial hardships, and/or living in unsafe, unstable, or overcrowded environments disturb the quality of caregiving (Blair & Raver, 2012).

The Reading Brain and ACEs

The effects of ACEs may significantly alter a child's brain and affect their ability to learn, regardless of the quality of instruction. It is imperative that teachers and educational leaders understand that the best teaching strategies and resources will not narrow classroom achievement gaps if a student has a cognitive impairment from current or past traumas. In the subsequent sections, cognitive processes and the effects of ACEs are explained and connected to achievement outcomes.

Executive Function

Hormones can alter brain function, and children's brains are more susceptible since the brain is not fully developed until age 25 (Massachusetts Institute of Technology, 2018). One particular function necessary for learning and accomplishing tasks is called executive function (EF). EF refers to a set of cognitive processes that are crucial to learning and accomplishing tasks in school (Korucu et al., 2020), e.g., paying attention, communicating effectively, prioritizing, following multistep directions, and requires strong functioning in the area of the brain called the prefrontal cortex (PFC) (National Scientific Council on the Developing Child, 2011). Between early childhood and adolescence, the PFC remains highly "plastic" and is shaped by both negative and positive experiences.

Three functions comprise EF skills: (a) working memory, (b) inhibition, and (c) cognitive flexibility. EF skills work in concert with one another, and they must be fully operational to complete a multitude of tasks in both school and work environments (Hudson, et al., 2016; Lubin et al., 2016). Working memory allows an individual to hold a piece of information for a short time while new information is received. Inhibition allows one to control their impulses and focus their attention on tasks. Cognitive or mental flexibility allows one to successfully switch from one activity to another or apply a new set of rules to different contexts (Developing Child, 2011). Researchers have been able to predict EF capabilities in older children from events experienced in early childhood (Raver et al., 2013).

Executive function is heavily influenced by the brain's neural physiological signals communicated between the adrenal glands and various regions in the PFC, and proper functioning of each EF skill may be compromised when an individual feels threatened or stressed. Compromised functions are a result of cortisol production, a hormone created and released by the adrenal glands during times of stress to initiate a primal fight, flight, or freeze response (Thau & Sharma, 2019). Frequent states of chronic stress may alter the brain's architecture and, with long-term exposure, may result in atrophy in some regions (Shonkoff & Garner, 2012).

It is important to note that not all stress is equal. The Center on the Developing Child (2014) described three different types of stress: (1) positive stress e.g., attending a new school, having a toy taken away; (2) tolerable stress e.g., experiencing a natural disaster, losing a loved one; and (3) toxic stress e.g., physical/emotional abuse/neglect, extreme poverty. When a child's basic physiological and psychological needs are not met, toxic stress is probable and will likely impair function of the PFC, thereby affecting students' learning capabilities (National Scientific Council on the Developing Child, 2010). Throughout the rest of this article, any reference to stress should be assumed as toxic stress.

Executive Function and Literacy

Life experiences as early as infancy can have lasting impacts on relationships, cognitive functioning, and overall well-being throughout childhood and into adulthood (Bethel et al., 2019; Blair, 2010; Blair & Raver, 2012;

National Scientific Council on the Developing Child, 2010; Suor et al., 2015). These experiences, both positive and negative, create neural changes and are more pronounced in young children and adolescents because the brain is still developing (Blair, 2002; Blair, 2010; Nelson, 1999). In turn, learning would be impacted tremendously.

A longitudinal study measured cortisol levels in children ages 2-4 at yearly intervals who suffered from living in poverty, witnessed domestic violence in their homes, or whose caregivers were emotionally unavailable (Suor et al., 2015). The cortisol samples indicated that children either had elevated, moderate, or unusually low levels. When participants turned 4, a standardized assessment was administered to measure their cognitive functioning. In instances of both elevated and low levels of cortisol, researchers discovered a reduction in cognitive functioning. Cortisol levels deemed too low may be a consequence of prolonged exposure to trauma. Children who showed only a moderate level of cortisol did not exhibit the same reduction in cognitive functioning the other two groups exhibited. Suor and colleagues explained that the reduction may have been from neurotoxic effects on the prefrontal cortex and hippocampus, which are two areas of the brain that are still developing in children and support cognitive functioning.

More specifically, ACEs have deleterious effects on children's literacy development, as cortisol interferes with specific EF skills, including working memory, inhibition, and cognitive flexibility (DeDreu, 2016; Vogel & Schwabe, 2016). To read accurately and fluently, working memory is necessary for phonemic awareness, phoneme-grapheme correspondence, sight word recognition, and word analogy skills (Ehri et al., 2014). Additionally, it is required for readers to make sense of and retain new information and apply it to preexisting knowledge. Inhibition requires readers to maintain focus on the topic as they identify necessary information and ignore irrelevant information (Hudson et al., 2016). Cognitive flexibility is required for background knowledge activation, mental representations, and inferring (Kendeou et al., 2014). It is also required for self-monitoring and shifting attention to make connections between preexisting knowledge and new information (Westby, 2014).

Over the last decade, researchers have been able to predict the causes of poor EF skills, as well as connect the development of EF skills to later reading trajectories and achievement gaps (Finders et al., 2020; Liu et al., 2018; Montoya et al., 2019; Nayfeld et al., 2013; Patael et al., 2018; Raver et al., 2013). Low SES has been found to be a robust predictor of poor EF skills in children (Jimenez et al., 2016; Raver et al., 2013). EF skills have also predicted comprehension skills in young children, while, conversely, comprehension skills predicted EF skills in older students (Meixner et al., 2018).

It is imperative for educators and researchers to understand not only how reading proficiency is dependent on EF skills but also why EF skills are so low in children. This information can be used to better understand the root causes for EF deficiencies so that at-risk students are correctly and expeditiously identified, and opportunities for teachers to narrow the achievement gaps through effective interventions may be implemented.

Reversing the Damage

Progress toward improving students' literacy scores has been stagnant over the last several decades, and the achievement gap has not been narrowed. With an increased focus on EF skills and neuroscience, researchers' and educators' attention has been redirected; however, there is one element missing from much of the research. Teachers' roles in rewiring students' prefrontal cortex have not garnered much attention, and it may be a simpler and more effective approach to narrowing the achievement gap.

Oxytocin

Similar to cortisol, oxytocin is a hormone released by the nervous system that affects the PFC. Unlike cortisol, these effects are positive. Otherwise known as the "love hormone", oxytocin triggers a state of calmness by slowing the heart rate and lowering blood pressure (Uvnas-Moberg et al., 2015). It also stimulates feelings of trust, bonding, and cooperation toward others and improves pro-social behaviors (Barraza & Zak, 2009; Kosfeld et al., 2005; Zak et al., 2007). If the nervous system is in a heightened state, oxytocin stymies the effects of cortisol and works to slow down the neurophysiological response to stress. This anxiolytic effect allows executive functioning to be restored, thereby reenabling the brain to take in and retain information (DeDreu, 2016).

Researchers viewed fMRI scans to understand the effects of oxytocin on various regions of the brain and learned that "a prolonged priming effect of OT (oxytocin) can elicit functional rewiring of neuronal networks" (Bethlehem et al., 2013, p. 969). Each time oxytocin is released, the benefits can last up to 30 minutes (Zak, 2017), which may sound insignificant; however, fMRI images proved that neurological repairs to the prefrontal cortex are possible when oxytocin is present over long periods.

This information could have tremendous implications for narrowing the achievement gap because adults, specifically classroom teachers, have the ability to trigger oxytocin throughout the day every day in students via physical touch.

Interpersonal Touch

For over 50 years, a single touch between humans has been studied in a multitude of contexts with participants from various dyads: (a) adult strangers (Crusco & Wetzel, 1984; Fisher et al., 1976; Guéguen & Jacob, 2005; Hertenstein et al., 2009); (b) adult friends, family, and caregivers to children and adults (Harrison et al., 2019; Jones & Glover, 2014; Kraus et al., 2010; Spitz, 1947); (c) educators to college students (Guéguen, 2004; Steward & Lupfer, 1987); and (d) educators to K-12 students (Gutshall, 2008; Wheldall et al., 1986). Researchers learned that touch between two people, known as interpersonal (IP) touch, triggers a release of oxytocin and counteracts the effects of cortisol (Barraza & Zak, 2009; Kosfeld et al., 2005; Unvas-Moberg et al., 2015; Zak et al., 2007).

Numerous studies have centered on the effects of IP touch, neuroscience, and academic achievement; however, research that focuses on all three variables is lacking in scholarly literature. Butler's (2021) research resulted in an unintended but significant finding. A five-year-old boy had experienced several ACEs, and strong evidence suggested he was living in an unsafe situation at the time of this study. He had not met any of the literacy or math benchmarks by mid-year and was volatile toward peers and teachers. After receiving a side-by-side interactive read-aloud intervention designed to simulate a lap reading environment, he eventually became non-combative with his peers and teachers, and he met or exceeded all benchmark assessments. The student continued to thrive through fourth grade but then moved out of state and could no longer be tracked.

Another study highlighted the success found with fourth-grade struggling readers and their "reading buddies" (Gutshall, 2009). The reading buddies were a group of college students majoring in education. During the first seven weeks of this 21-week study, students' only instructions were to "accompany their buddies to the library, pick a cozy spot, and snuggle up and read" (p. 436). After the first seven weeks, students' average oral reading fluency (ORF) rate increased by 20 words, and their attitude and motivation improved.

During the next seven weeks, the reading buddies were replaced with a computer-based reading intervention and then re-assessed. Gutshall found that student growth stalled; however, the positive ORF growth students made with their reading buddies remained. The reading buddies returned to their struggling readers for another seven weeks, and students were re-assessed once more. The post-assessment indicated that students' average reading rate increased by another 20 words, thereby totaling an average increase of 40 words. Since there was no control group, it is unclear whether the "snuggling" made a difference; however, it is evident that the relationship between the participants made a substantial difference.

The number of studies on the effects of touch between professors and students in higher education is also limited, though it does offer a more complete understanding of how IP touch during classroom instruction affects students' behaviors, attitudes, and opinions. Guéguen's research (2004) focused on how IP touch of student participants shaped their level of in-class participation. At random, the professor employed a slight tap to students' upper-arm area for one second when assisting with math problems and offering encouragement. Then, volunteers were invited to solve a statistical problem on the board in front of the class. Both male and female students who received the one-second touch volunteered more than those who volunteered without being touched. These findings indicated that touching students while offering encouragement has an increased effect on affective behaviors, such as participation.

Other studies have focused on how a handshake or a brief touch on the arm affects students' attitudes and opinions about their teachers (Steward & Lupfer, 1987; Wilson et al, 2009) and their compliance with on-task behavior (Wheldall, 1986). While interpersonal touch and student achievement are not directly correlated in these studies, affective factors, i.e., improved participation, motivation, engagement, and cooperation, are directly correlated to academic achievement (Deng, et al, 2016; Kuo, 2015; Lai et al, 2015).

An Alternative Approach to Narrowing the Achievement Gap

Neurophysiology combines neuroscience and physiology to study nervous systems (Luhman, 2013), and it is imperative to consider this component when researching the role of the PFC and EF skills in academic achievement. Advances in neurocognitive science have proven that oxytocin promotes feelings of cooperation and trust toward others, improves motivation and attitude, and is released via interpersonal touch (Barraza & Zak, 2009; Kosfeld et al., 2005; Unvas-Moberg et al., 2015; Zak et al., 2007). Psychology and brain-based studies are becoming increasingly integrated into the education field to better understand literacy acquisition; however, the neurophysiology underpinning is absent from the frameworks despite the wealth of research highlighting its significance in literacy acquisition and general academic achievement. The achievement path of those who suffer from ACEs and toxic stress is markedly disparate compared to students with moderate or no stress. As shown in Figure 3, toxic stress triggers the release of cortisol and impairs the PFC, thereby interrupting executive function and impeding the learning process. This response creates a physiological barrier that has a debilitating effect on brain function and cognition, thereby affecting achievement outcomes. Over time, IP touch is powerful enough to mitigate the effects of cortisol and carve a new path for student achievement. IP touch can occur in a split second and does not require a grandiose gesture. To trigger oxytocin throughout the day, teachers can give students a high-five, fist bump, elbow/forearm bump, or a pat on the upper back or arm. Teachers of young children can simulate an interactive read-aloud setting similar to the aforementioned studies. IP touch will look different across grade levels; nonetheless, as Figure 3 shows, the effects will be the same.

A Framework Model of Differentiated Learning Capabilities and Academic Outcomes According to Students' Stress Levels and Interpersonal Touch Opportunities

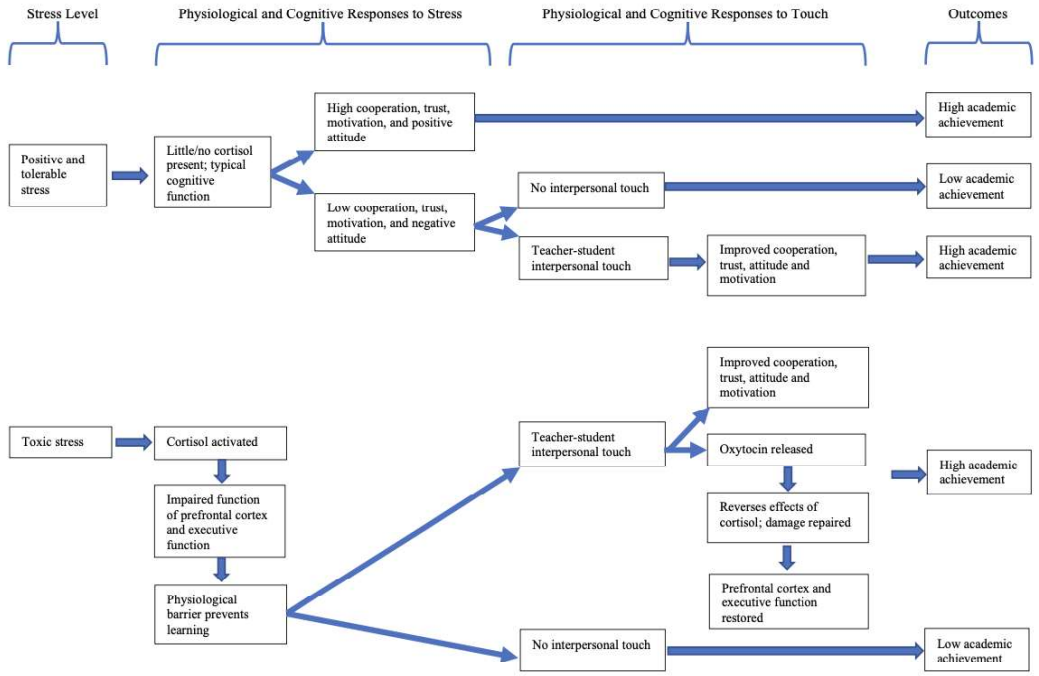

Figure 3. Projected Academic Outcomes by Stress Levels

Conclusion

The landscape of K-12 education continues to shift as innovative research emerges and historic seminal works inspire new theories and research. Neuroscience is embedded in the Science of Reading, and the effects of childhood trauma are well-documented, but a confluence of ACEs, neuroscience, and IP touch is minimal in educational literature. The viral videos of teachers greeting students at the door with various handshakes and hugs were praised, shared, and replicated, but what most likely do not know is that these practices ignite a flurry of oxytocin in both the students and the teacher, and every child, irrespective of their stress level, reap cognitive benefits. Teachers use these strategies because they have seen them transform their relationships with students, but the effects of IP touch run much deeper.

Narrowing the achievement gap will require a concerted effort within schools and districts to address the neural impacts of ACEs and to become knowledgeable about how EF skills affect aptitude. Most importantly, educators at every level must understand the effects of stress on children's PFC and be strategic in applying IP touch daily to calm students' nervous systems. When working with struggling readers who have experienced trauma, teachers should not rush to add another strategy or intervention into the curriculum because, if a child's brain is not primed for learning, no amount of highly effective teaching will be sufficient on its own. This was the case with the previously discussed kindergartner. The interventions this child received throughout the year did not generate adequate progress; however, once he received an intervention that included IP touch, the achievement gap between this child and his peers no longer existed. A first-things-first approach is necessary for successful teaching, and for students who have suffered from toxic stress due to ACEs, restoration of the PFC must be a teacher's top priority.

Recommendations

It is imperative that educators and district leaders take a first-things-first approach and invest in understanding why some students struggle, specifically those who have experienced adversity and continue to underperform.

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