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Neurodevelopment and Early Childhood Education for Low-Income Students: An Analytical Literature Review

Abstract

A child's experiences shape his development and never is that more true than in his earliest years. The early childhood years are a time when student's brain is rapidly maturing. Educators must make every effort to ensure that at school, the experiences to which children are exposed and the resources to which they have access are positive. Considering both the importance of brain development in children's early years and the disadvantages faced by our at-risk populations of children, it is imperative that educators consider what the study of neuroscience can contribute to the field of early childhood education. This review examines the overlap of neurology and early childhood experiences especially as it pertains to students of lower socioeconomic status. Three significant external factors that influence children's neurodevelopment are discussed. These three influential factors are adult engagement, the home environment, and the school environment. Additionally, suggestions for future research will be proposed.

Keywords:
Early childhood education, low-income, brain science, neurology

Introduction

A focus on early childhood schooling has recently come to the forefront of the education debate worldwide as well as in the United States. In 2015, UNESCO published its *Investing against evidence: The global state of early childhood care and education*, exemplifying the international focus on the topic. In 2013, President Obama announced his "Preschool for All" initiative which "calls for dramatic increases in the number of 4 year olds in public preschool programs and in the quality of these programs nationwide" (Cascio & Schanzenbach, 2013, p. 2). This new push towards early childhood education is, in part, due to increased research in the field. Scientific studies continually show that, "the most rapid period of brain development occurs in the first few years of life" (Lipkowitz & Poppe, 2014, p. 24). Thus, the experiences in the early years of a child's life can have meaningful effects on his later achievement. This is especially true for those children who come from low socioeconomic families in that they fall in the low-performing end of the income-achievement gap. The income achievement gap refers to the achievement difference that exists between students of lower and higher socioeconomic status and has "grown significantly in the last three decades" (Reardon, 2013, p. 11). Today, students from low-income households score, on average, 1.3 standard deviations lower in literacy and math than their higher-socioeconomic status peers when they enter kindergarten and even lower in executive functioning skills (Duncan & Sojourner, 2013).

With what we know about the importance of brain development in the early years and the disadvantages faced by our at-risk populations of children, it is important that educators focus on what the study of neuroscience can contribute to the field of early childhood education. In fact, there is an increasing support for this approach in the education community (Rushton & Juola-Rushton, 2011).

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This paper will examine the issue of neurology and early childhood experiences especially as it pertains to students of lower socioeconomic status. The review of related literature that follows will first briefly introduce the relationship between neuroscience and education. Next, three significant external factors which influence a child's neurodevelopment in his early years will be discussed. These three influential factors are adult engagement, the home environment, and the school environment. Finally, suggestions for future research will be proposed.

Review of Related Literature

The Neuroscience-Education Connection

An exhaustive explanation of the neuroscience of learning is a complex, complicated matter and is beyond the scope of this paper. However, it is important to understand that when a child learns, his brain is physically and chemically altered. In fact, each experience a child has affects the brain, creating new neural connections. In the early stages of life, an individual's brain creates an astonishing, (sometimes up to 40,000) new neural connections each second (Wolfe, 2010). This process of creating new circuits in the brain is at its peak during the early childhood ages (Twardosz, 2012) and amazingly, by the time a child enters kindergarten, his brain with weigh nearly 90% of what it will when he is full grown (Woolfolk, 2010). As a child ages, his brain selectively retains and abandons certain of these connections, based on their importance and use frequency. Those connections that are deemed important and used more often are strengthened while those that go unused are "pruned" (Calder, 2014; Frey & Fisher, 2010; Wolfe, 2010). Understanding how the brain makes these new connections is an important component of understanding students' learning. As Frey and Fisher (2010) explain, "cognitive neurosciences can serve the useful purpose of informing biologically what we understand behaviorally" (p. 104). Thus, when we speak about learning and cognitive domains of academics, we are very much talking about the development of a student's brain.

External Influences on Neurodevelopment

As was previously stated, a child's early experiences and external influences play a significant role in his cognitive development. The three external influences this paper will consider are adult engagements, the home environment, and the school environment. Research suggests that these three factors greatly contribute to a child's achievement. (Burchinal, McCartney, Steinberg, Crosnoe, Friedman, McLoyd, & Pianta, 2011).

Adult Engagement

Young children typically spend the majority of their day either with parents, caregivers, or teachers. Thus, for the purpose of this paper, the term *adult engagement* comprises two important components: parents and supporting adults with whom the child spends a great deal of time. Both of these components play important roles in the cognitive and emotional development of young children.

The focus on parent involvement as a means of increasing student achievement and well-being has been growing in recent decades and its importance was noted in two seminal international texts: *The Salamanca Statement and Framework for Action on Special Needs Education* (1994) and the Convention of the Rights of the Child (1989). More recently, *The No Child Left Behind Act of 2001*, a federally mandated education law in the United States, identified increasing parent educational involvement as one of the six targeted areas of reform. The Obama Administration furthered this agenda by supporting the National Coalition for Parent Involvement in Education, among other federally funded initiatives (Crowe, 2013). This increased focus stems from research that suggests that parent involvement is positively related to increased achievement levels (Cheung & Pomerantz, 2012; Crowe, 2013). On a macro level, Holcomb-McCoy (2007) even goes so far as to argue that parental involvement could be the driving factor in closing the achievement gap.

The research on this subject suggests that parents are an important external factor in children's cognitive development. For example, parental involvement has been shown to have a positive association with both math and literacy achievement, especially in low income families (Crowe, 2013). Parent interaction in the form of reading with children and facilitating conversation for the purpose of increased comprehension has been shown to have a strong positive relationship with a child's receptive language development (Dexter & Stacks, 2014).

Not all adult interaction, however, have positive impacts on a child's neurodevelopment. A mother's temperament has been shown to be closely correlated with both the cognitive and behavioral development of a child. In particular, Razza, Martin, and Brooks-Gunn (2010) assert that a mother's hostility or lack of hostility towards her child is strongly correlated with his receptive vocabulary and her mental well being may also influence her child's behavioral patterns. Similarly, there is literature to

suggest that "interpersonal relationships between children and the important adults in their lives can be leveraged to support young children's self-regulation" (Raver, 2012, p. 687). This suggests that a parent has considerable influence on her child's brain development in the prefrontal cortex, the part of the brain responsible for executive functioning. Executive functioning is a process of the frontal cortex and refers to the performance of activities such as "planning, organizing, strategizing, paying attention to and remembering details, and managing time and space," (NCLD, 2014) as well as " the ability to focus, filter distractions, self-regulate, plan ahead, adjust to changes, control impulsivity, resist temptation, delay gratification, and remember, organize and use information" (Lipkowitz, & Poppe, 2014, p. 25).

Home Environment

Just as the adults in a child's life can have an impact on his development, so too can his home environment. One's home environment is greatly influenced by family income. In fact, Dearing and Taylor (2007) found a strong relationship between the two factors explaining, "for both physical and psychosocial qualities of children's homes, changes in family income were significantly and positively associated with changes in the home environment such that gains in income predicted improvements in the quality of the home environment" (p. 440). The subsequent effect of the home setting on the child can influence both cognitive development and development of the prefrontal cortex. In the realm of cognitive development, a student's home environment has been shown to affect his receptive vocabulary (Razza, et al., 2010) as well as his math scores (Johnson, Martin, & Brooks-Gunn, 2013). The combination of low income and low quality home environment has also been shown to predict difficulties with executive functioning (Raver, McCoy, Lowenstein, & Pess, 2013). The development of executive functioning and control is important in that it can be a strong predictor of the child's later ability to control impulses, maintain attention, and perform other activities necessary for success in the classroom (Raver, et al., 2013).

Early childhood is a time of peak brain development and thus sleep in particularly important at that stage. Interestingly, a child's sleep patterns and exposure to stressful conditions have been found to be contributing factors to cognitive development. Kurth, Achermann, Rusterholz, and LeBourgeois (2013), suggests that sleeping may play an important role in the forming of network connection in the brain. Thus, if a child experiences sleep disturbances at home, due to housing instability, crowded sleeping conditions, or a number of other reasons, it is possible for this to affect his ability to form strong network connections in his brain. There is also clinical evidence to support the idea that sleep is an important factor for increased motor development (Al-Sharman, A., & Siengsukon, C. F., 2013). Additionally, there is research to suggest that early stressors cause "structural and functional changes in the stress-related regions of the amygdala, hippocampus and insula" (Baker, Heaps, Paul, Williams, Korgaonkar, & Cohen, 2013, p200). According to Twardosz (2012) stress, "affects brain development and functioning throughout the lifespan through the action of cortisol, a glucocorticoid that is released as part of the human stress response" (p. 103). Twardosz goes on to explain that exposure to long-term stress can cause later emotional problems such as anxiety disorders. This research is especially important in light of the common stress related to low-income family life including housing and food instability and other financial challenges.

School Environment

For students who attend early childhood centers, the school environment can prove to influence their neurodevelopment and has been shown to be correlated with later achievement (Crowe, 2013; Missal, Reschly, Betts, McConnel, Heistad, Pickart & Marston, 2007). Quality early education offers a learning environment that has the potential to create a strong foundation of learning for its students prior to entering elementary school. In particular, math skills may benefit from a rich early childhood education, especially for at-risk populations. Manfra, Dinehart, and Sembiante (2014) found that "low-income children who have mastered the more advanced counting skills at the beginning of the preschool year are more likely to have higher math performance in early elementary school" (p.112).

Much research has been done which supports the idea that a quality early education can have tremendous impacts on students' cognitive development in the area of literacy. Hemphill and Tivnan (2008) suggest that a child's early vocabulary is strongly correlated with his later reading comprehension skills. This idea is supported by a study by Missal et al. (2007) who found that "any attempt to increase a student's early literacy skills with respect to language, rhyming, and alliteration should result in positive shifts in that student's later reading skills (p. 446). Additionally, early work with phonemic awareness can act as a developmental building block on which students can build later reading

proficiency (Kim, Petscher, Foorman, & Zhou, 2010; Ziolkowski & Goldstein, 2008). It is important to note that reading is not simply a matter of recall or memory. In fact, reading and writing uses multiple regions of the brain, working in conjunction, including those necessary for language, vision, and motor coordination, in the case of writing (Carter, 2010).

The brain development necessary to learn and process math skills as well as to learn to read requires a conducive physical environment as well. Research has shown that components in the school environment impact the way one develops and functions, neurologically. For students, everything from temperature, lighting, and seating (Jensen, 2005), to adequate access to space for playtime (Wolfe, 2010) play a role in a child's learning.

The teacher is also an important component of the educational environment. The teacher can play an important role in cognitive development of literacy skills. A teacher's proactive use of interactive conversation with her students can help foster a child's knowledge about how books work (Cabell, Justice, Piasta, Curenton, Wiggins, Turnbull, & Petscher, 2011). A classroom environment that combines both skilled teachers and rich educational materials and resources best support literacy growth in students (Guo, Justice, Kaderavek, & McGinty, 2012; Girard, Girolametto, Weitzman, & Greenberg, 2013). Teachers are also an important part of creating a safe environment for the students. Such a protective environment has been shown to be closely related to a child's ability to develop executive control and functioning (Raver et al., 2013).

This research demonstrates the strong external influence a child's early school environment can have on his cognitive development. Without a strong educational basis, students may lag behind later in their academic careers (Hemphill & Tivnan, 2008). As the research shows, however, providing a rigorous early educational setting for students is especially beneficial for low-income students. Duncan and Sojourner (2013) examined the effect of income-based and universal early childhood programs and report that at age three–at the end of the program– income- based gaps would be essentially eliminated with either a universal or income-based targeted program. Income- based gaps in age five IQ were also substantially reduced (in the case of a targeted program) or completely eliminated (for a universal program). Our increasingly imprecise estimates suggest that one- third to three- quarters of the gaps in age eight IQ and achievement would be eliminated (p. 962).

These findings suggest that the recent focus on early childhood education could have significant impact on helping bridge the income-achievement gap.

Discussion

The Neuroscience-Education Connection

As educators, it is important to remember that learning is a neurological process, and because of this, an understanding of brain processes is important if we are to teach. A child's early experiences undeniably shape his cognitive development. During his early childhood years, a student's brain is rapidly maturing and as educators, we must make every effort to ensure that at school, the experiences he is exposed to and the resources to which he has access are those that will benefit him and allow him to succeed to his greatest potential.

Adult Engagement

While the entirety of our students' adult engagements is not fully in the control of educators, as they are exposed to parents, caregivers, and other family members, schools can make every effort to provide students with strong, healthy relationships with adults in the educational setting. For many low-income students, their time spent at school is the most stable and predictable part of their lives and thus, teachers must foster a safe, encouraging environment.

The parent component of adult engagement can be cultivated through encouragement, and providing resources to parents that will help them understand their child's development. It is important for parents to be knowledgeable about their child's individual learning. When a parent understands their child's needs, she is better able to foster growth at home.

Home Environment

One of the most difficult factors for schools to influence is the home environment. However, knowing the importance of the child's home for student achievement, it is important for educators and school leaders to consider the role community partnerships may play. Social services such as health, mental health, and housing organizations in the community can be a useful resource for parents to create more stable, quality environments. If it is within the means of a school, community partnerships should be forged to help build the bridge between the services families need and the families themselves.

School Environment

The school environment depends on many factors including school leaders, skilled teachers, and rich material resources. Recruiting quality leaders, teachers and affording resources are common challenges in schools that serve students of low socioeconomic status. However, as the field of early childhood education gains greater attention, more federal and private funding may become available. The research shows that it is through a combination of material resources and skilled educators that students develop cognitively. It is also important to consider the curriculum and practices used in early childhood environments. An understanding of the neuroscience related to education, can better help educators create meaningful learning experiences and secure, nurturing environments for their most vulnerable students (Diamond & Whitington, 2015).

Suggestions for Future Research & Conclusion

Continued research is needed with a focus on how external factors such as adult engagement, the home environment, and the school environment affect a student's neurodevelopment, particularly for those students who come from low socioeconomic families. Additionally, it would be beneficial to research ways in which professionals in the fields of neuroscience and education may collaborate to inform educational policy and best practices.

This paper set out to examine the issue of neurology and early childhood experiences, especially as it pertains to students of lower socio-economic status. The review of related literature briefly introduced the relationship between neuroscience and education. Next, three significant external factors which influence a child's neurodevelopment in his early years were discussed. These three influential factors are adult engagement, the home environment, and the school environment. Finally, suggestions for future research were proposed.

With the focus on the importance of early childhood schooling now at the forefront of the education dialogue worldwide, researchers and educators are in the position to study how to improve teaching for our youngest learners. We know that the early childhood years are likely the most critical stage for learning and thus it is imperative we have the most comprehensive understanding of this period including a knowledge of the related neuroscience. With the income achievement gap, wider than ever, early childhood education may be most vital to those children who are of low socioeconomic status. With continued research on the subject, it is possible that future educators in early childhood will be able to best serve even our most as-risk popilations.

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