

A Neuroscientific Approach to Childhood Poverty: Hope for New Beginnings

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ABSTRACT

Socioeconomic status (SES) affects brain development. As the brain is one of the most important parts of the body, it is crucial to investigate factors that can influence its function and how those changes carry on to different aspects of life. The impact of SES on brain function is broad, and it ranges from affecting emotional responses to life achievements in adulthood. The negative results of SES start in early childhood and continue onto adult life, causing many issues along the way. This review highlights the studies that have already examined SES. Many studies have already examined SES and its influence on cognitive function and in this work, different research will also be presented on each aspect of the brain region. Knowing the long-term consequences of lower SES, scientists have theorized using biomarkers to prevent and/or resolve these detriments. This report highlights the need for further research into intervention. These biomarkers will identify the people that are affected the most by low SES and certain actions can then be taken to alleviate the issues. Using the data from biomarkers, new policy can be proposed to counter the issues of SES and bring about positive results. By understanding the negative effects of SES, awareness is brought to the need for mediation of these impacts.

Introduction

“The rich become richer, and the poor become poorer is a cry heard throughout the whole civilized world” - Friedrich Schiller. Centuries later, this still holds true in our modern world. Socioeconomic status (SES) and income disparities lead to pressing issues in society, leaving children who grow up in poverty disadvantaged. SES is a measure of a person’s economic and social standing with parental income and educational level considered. This status plays a role in a child’s mental health and impacts many brain-related functions. Researchers have demonstrated that children of low SES have home environments associated with poor parental nurturing and elevated stress. Lower SES causes physical and mental health issues and impacts later life achievements. Those later life consequences include lower educational attainment and long-term occupational achievements. The recent COVID pandemic exacerbated these effects by widening the learning gap among children of different SES levels. This has accelerated the need for a call to action to reduce the impact of SES disparities in society.

The Brains of Children from Low SES

SES and its impact on the brain have been the subject of research, attracting the interest of international institutions such as UNICEF and the World Bank. The brain has many different regions, each of which controls specific functions with overlap between them. In a study by Pollak et al. (2007) there were structural differences in several areas of the brain as determined by magnetic resonance imaging (MRI) scans in children from the poorest households. In terms of neuroscientific study, the main regions of interest for the neuroscience of SES are the prefrontal cortex and temporal

lobe. The prefrontal cortex is situated in the front of our brain. It controls executive function, logic, inhibition, emotional regulation, and complex reasoning. The temporal lobe is the seat of language comprehension such as identifying words, relating heard sounds with letters of the alphabet, and attaching meaning to words. Within the temporal lobe, lie the hippocampus and amygdala. The hippocampus is the location where memory is processed, and the amygdala is the emotional center of the brain.

The Changes in Brain Structure due to SES

When looking at the MRIs of school-age children who were below the poverty level, their brain volumes as related to the mentioned regions of interest, were significantly less than children from higher SES households even after accounting for controls such as age. For example, neuroimaging studies have found that the frontal lobe and temporal lobe, seats for executive function and language respectively, are smaller in volume for children and adolescents living in poverty. These differences are reflected in standardized tests. For instance, lower SES students scored four to seven points less than higher SES students. Other studies have demonstrated similar findings in the hippocampus, where long-term memory is stored. A study by Luby et al (2013) showed that children from families of lower income had smaller amygdala volume. Other studies have shown that children born to families with lower income have less gray matter volume as well as frontal lobe volume compared to children from families of higher income as evident on MRI scans. These developmental differences in the brain can account for as much as 20% of achievement deficits in low-income children and according to Pollak et al, these brain structural differences also affect brain function. A review by Noble et al (2014) concluded that children growing up in poverty have a less developed prefrontal cortex due to less access to education and opportunities for the cortex to grow. Children growing up in lower SES households are also often exposed to violence, generating strong emotional reactions. The fight or flight response and emotions such as rage and anger are generated in the amygdala. It is the prefrontal cortex, the seat of reasoning and cognition, which modulates and inhibits the amygdala's response in stressful situations. With a less developed prefrontal cortex, children born into poverty often demonstrate irrational anger and rage disproportionate to stressful situations. The underdeveloped prefrontal cortex and overactive amygdala result in these children having a more difficult time regulating their emotions, affecting their daily lives and their social interactions.

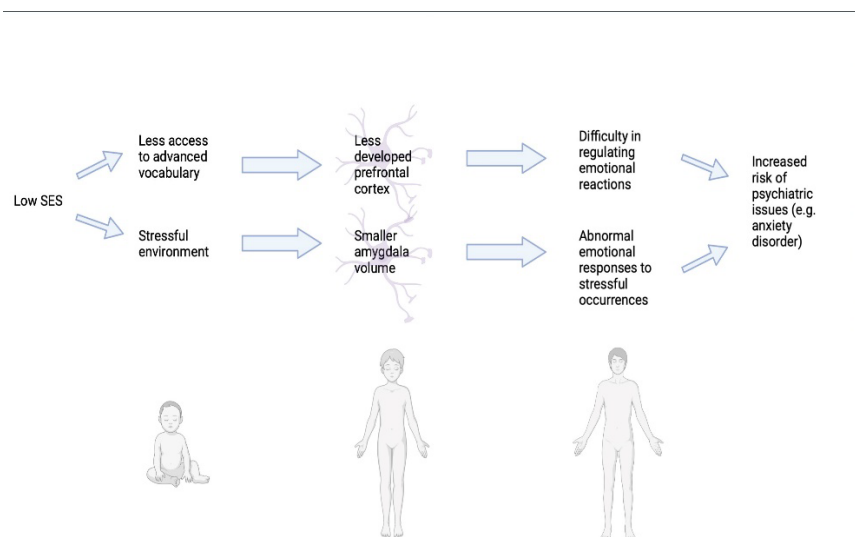


Figure 1. Effects of Low SES on different stages of life.

Table 1. SES in Correlation to Brain Structure

Brain Region	Function	Effect on Brain Structure for lower SES children (in comparison to higher SES)	Effects on Life Outcomes
<u>Frontal lobe</u>	Controls movement, language, and higher cognitive functions	Smaller in volume	Lower scores on standardized tests Less access to education and strong vocabulary
<u>Temporal Lobe</u>	The seat of language comprehension	Smaller in volume	Lower scores on standardized tests Less access to education and strong vocabulary
<u>Hippocampus</u>	The location where memory is processed and stored	Smaller in volume	Lower scores on standardized tests Greater exposure to stressful situations
<u>Prefrontal cortex</u>	Controls executive function, logic, inhibition, emotional regulation, and complex reasoning.	Less developed	Harder to regulate emotional responses to stressful situations Greater exposure to stressful situations
<u>Amygdala</u>	Activates the fight or flight response and emotions such as rage and anger	Smaller in volume	Irrational response to stressful situations in later life and emotional issues Greater exposure to stressful situations

Differences in Scores on Standardized Tests

Children from a lower SES status regularly perform lower than their higher SES peers in language benchmarks which leads to long-term gaps in learning and eventually an academic achievement gap. In terms of the effects of SES on language development, child characteristics, interactions with parents, and access to learning materials play major roles. According to seminal research done by Hart and Risley's (1995), children growing up in poverty are exposed to 30 million fewer words than their more well-off peers. In a study done by Annie E. Casey et al (2013), it was shown that 80 % of children from low-income families could not read adequately. These impairments of language ability in lower SES students lead to less comprehension in the classroom and these effects carry on to their adult life. In another study, it was shown that children of higher and lower SES have different ways of doing mathematics, in which the lower SES students' comprehension of the problems was less than higher SES students. Together, they help paint that picture of how exactly these children are falling behind in school.

Academic Impacts of Low SES

Since these brain structural and functional changes occur in early childhood and continue through adolescence, low SES children have long-term difficulties. It is shown that only 14% of adults who grew up in a lower SES bracket obtained a bachelor's degree, compared to 60% of adults from a higher SES background getting the degree. Furthermore, 7% of students from lower SES as opposed to only 1 % of children with higher SES did not graduate high school. During the recent pandemic, many schools shifted to distance learning. This had a negative impact on children from lower SES households in terms of education. These children are more likely to experience a lack of internet access and academic support from their parents, and this affects their learning. These educational barriers were also exacerbated by food insecurity, as they no longer had access to free school lunches and a stable source of nutrition. Overall, children of low SES achieve lower academic success in younger years which translates into less occupational success in adulthood.

Mental Health Problems that Arise.

In the German BELLA cohort-study by Franziska Reiss et al (2019), it was shown that children and adolescents, ages 7 to 17, from lower socioeconomic status have more mental health problems than their counterparts from higher SES backgrounds. This study considered many factors of low SES such as parental education and occupation status as well as income per capita. All these factors had a direct correlation to a greater number of mental health issues. The study illustrated that children of lower SES are two to three times more likely to have mental health problems later compared to children of higher SES. The study also associated the number of stressful life situations with increased mental health issues later in life. Children and adolescents from lower SES backgrounds went through significantly more stressful situations compared to children from higher SES status. Therefore, mental health issues are another significant effect of low SES.

Biomarkers as a Promising Solution

With the effects of socioeconomic disparities increasing, especially accelerated by the recent pandemic, a policy change based on neuroscientific studies is necessary. The most promising solution is using biomarkers to determine who is at risk for the negative effects of socioeconomic disparities and to tease apart vulnerable and resilient children from low SES households. Biomarkers are tools that are helpful objective markers in a research study. In this case, as relating to the brain, different neurological instruments such as electroencephalography (EEG) based devices can be used. EEG comprises many electrodes that an individual can wear as a cap, and it can measure brain electrical activity. By doing so, it provides more insight into what is changing in terms of brain function rather than relying on behavioral data which is unreliable. The results of these biomarkers can determine what groups need to be targeted for interventions, which can help ameliorate the situation. Furthermore, the biomarkers can be used to follow SES children longitudinally over time to determine if the interventions are working. By continuing studies like these using biomarkers, scientists can direct policymakers in understanding who needs to be helped and which intervention would work best for them. With the implementation of a new policy using this data, we can break this cycle of poverty. Children who grew up in low SES would have an increased opportunity for education and success, and in turn, provide the next generation with a stable environment to flourish. All in all, these are exciting new times where neuroscience-based policies can mitigate the growing academic and achievement gap due to SES.

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