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The brain science of poverty and its policy implications

TAKEAWAYS

Children in poverty are often exposed to negative influences on brain activity and development, whereas higher-income children benefit not only from fewer negative exposures but also from more language and cognitive enrichment.

Aspects of poverty that impede brain development go beyond limited financial resources to include neighborhood violence, low-quality schools, environmental toxins, and unstable family life.

Infants whose families are poor and nonpoor have similarly sized brains at birth, but around age 2 brain scans of poor versus nonpoor children start to show differences in the rate of brain growth.

Measures of brain growth do not appear to be permanent. Researchers see evidence that the effects of poverty on the brain can be reversed/corrected by identifying and offsetting negative environmental influences.

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Research has documented a strong association between growing up in poverty and diminished school achievement compared to growing up in prosperity, resulting in what is known as "the income achievement gap."[1] More recently, neuroscientists and poverty scholars are collaborating to better understand *how* childhood poverty may inhibit brain development in ways that lead to lower scores on achievement tests, poorer grades, and less educational achievement.[2] Identifying key causes and mechanisms for these links and their relative influences is paramount to developing effective policy interventions.

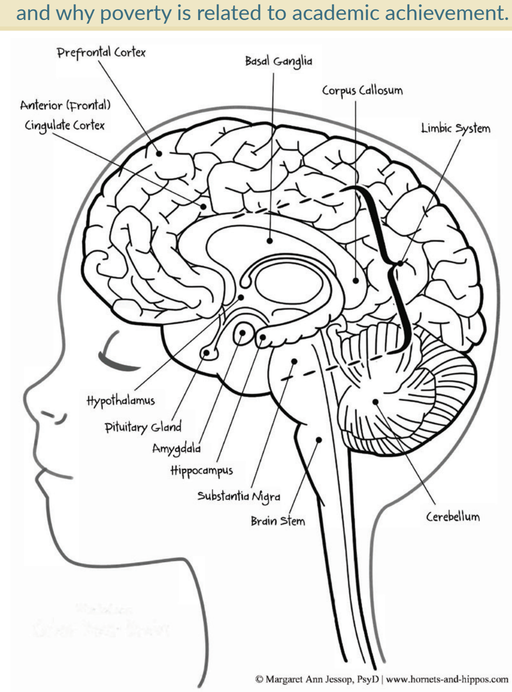
Differences in brain development associated with poverty appear around age 2.

Poverty and circumstances that often accompany poverty such as eviction, exposure to violence, and low-quality schools (see Figure 1) help explain the wide and growing achievement gap between poor and nonpoor children.[3] Researchers are now confident that a child's poverty affects their cognitive development such that, without intervention, many poor children will have less academic success than their more advantaged peers. The fallout may be lasting as academic deficits can persist into adulthood.[4]

Figure 1. Family poverty increases children's risk for a wide range of exposures that adversely influence brain development.

Source: Allyson P. Mackey.

Figure 2. Examining areas of the brain in childhood using MRI scans help researchers document how and why poverty is related to academic achievement.



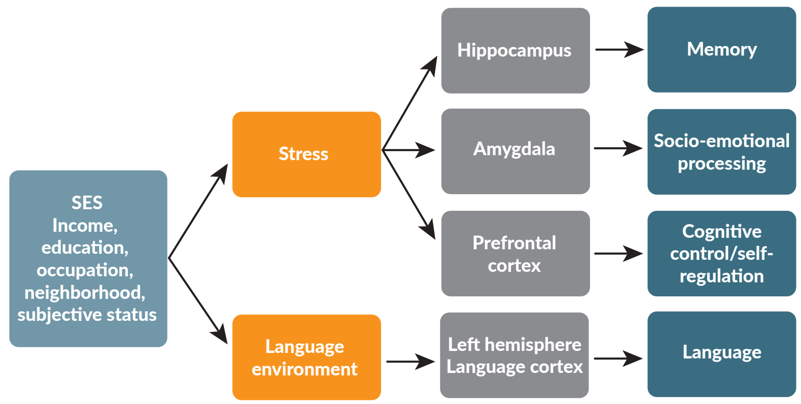
Source: Margaret Jessop at https://margaretjessoppsyd.com. Used with permission.

However, numerous brain imaging studies establish that poor and nonpoor infants have similarly sized brains at birth.[5] Differences in the rate of brain growth associated with poverty begin to appear in the brain scans of children around age 2.[6] Neuroscientists call these differences evidence of the neuroplasticity or flexibility of the brain. For policymakers, this means that interventions that modify exposures to specific aspects of poverty hold potential to reduce, or even reverse, its negative effects (thanks to neuroplasticity) and put children on more even ground with their more advantaged schoolmates.

Researchers are identifying how poverty affects learning and achievement.

By examining areas of the brain among children ranging in age from early childhood to early adolescence (see Figure 2), recent studies are moving beyond identifying correlations or associations between poverty and achievement, and into documenting the biophysical processes that may explain how and why these effects occur.[7] It is known that children in higher-income households benefit from less stress, greater language exposure, and more cognitive stimulation than their peers in poor households. A study of seventh and eighth graders observed large differences in the thickness of the cortex—which connects different parts of the brain and affects academic achievement—between poor and nonpoor students, suggesting differential brain development in areas associated with cognitive tasks.[8] Other research has documented that stress is associated with less efficient connections and communication between parts of the brain, which may result in increased internalizing and depression and higher aggression[9] as well as difficulty paying attention.[10] Figure 3 is a theoretical model that illustrates one way in which the differential experiences between moderate-to-high- and low-SES homes are likely to have downstream effects on certain brain structures. For example, disparities in linguistic stimulation in the home have been associated with developmental differences in areas of the brain's left hemisphere.[11] In addition, experiencing stress has been shown in brain imaging studies to affect the hippocampus, amygdala, and the prefrontal cortex, which are associated with memory, socio-emotional processing, and self-regulation.[12]

Figure 3. Neuroscientists created this model to hypothesize a way that leads socioeconomic status (SES) to influence brain development and cognitive functioning, and downstream, academic achievement.



Source: N. H. Brito and K. G. Noble, "Socioeconomic Status and Structural Brain Development," *Frontiers in Neuroscience* 8 (2014).

Research on poverty's effects on children's brain using both biological and social sciences is complementary.

Neural processes can reveal things that social science cannot, including more specificity about poverty's effects on the brain that complement general measures of functioning used in social science. The reverse is also true, with social science providing important information that biological science cannot. As such, the two approaches are complementary. For example, neural effects are visible as they are occurring, whereas behavioral effects (such as adult earnings and high school graduation) require decades to see. In addition, research suggests that evidence of biological harm is particularly persuasive to policymakers and the general public. For example, brain scan evidence showing lead poisoning caused brain damage motivated swift policy action to reduce children's exposure, despite decades of social science research suggesting lead exposure resulted in poor developmental outcomes. Although there is no one "brain signature of poverty," given the complexity of poverty and its effects, the combined findings from the social and biological sciences provide an opportunity for researchers and policymakers to design particularly innovative interventions.[13]

The Baby's First Years study has the potential to uncover the effects of unconditional cash payments on a range of factors related to poverty.

Baby's First Years, a large study launched in May 2018 by a team of neuroscientists, economists, social welfare experts, and developmental psychologists, is assessing whether unconditional cash payments have a causal effect on the cognitive, socio-emotional, and brain development of infants and toddlers in poor U.S. families.[14] The randomized controlled trial (the gold standard in social science research) is the first clinical trial of poverty reduction in early childhood. The study is based on the premise that if, as previous studies have found, low income, poverty, and the associated environment children experience affects their developing brains, then increasing family income may improve outcomes.

The study is recruiting a thousand poor mothers in the hospital shortly after giving birth, who are being randomly assigned into either the treatment or control group. All participants will receive an unconditional cash transfer for 40 months: the treatment group will receive $333 per month ($4,000 per year), and the control group will receive $20 per month ($240 per year). The money—which will not reduce a family's other benefits—will be reloaded monthly via a debit card. Researchers will assess whether there is a causal impact of the increased income for the treatment group on children's cognitive, emotional, and brain development, after establishing a baseline at birth. The children and their families will be followed for three years.

For sources and more information, go to https://www.irp.wisc.edu/resource/the-brain-science-of-poverty-and-its-policy-implications/

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ENDNOTES

[1]See, for example: G. J. Duncan and K. Magnuson, "Socioeconomic Status and Cognitive Functioning: Moving from Correlation to Causation," *WIREs Cognitive Science* 3 (2012): 377–386; N. L. Hair, J. L. Hanson, B. L. Wolfe, and S. D. Pollak, "Association of Child Poverty, Brain Development, and Academic Achievement," *Pediatrics* 169, No. 9 (2015): 822–829; A. P. Mackey, A. S. Finn, J. A. Leonard, D. S. Jacoby Senghor, M. R. West, C. F. O. Gabrieli et al., "Neuroanatomical Correlates of the Income Achievement Gap," *Psychological Science* 26, No. 6 (2015): 925–933.

[2]Special thanks to Barbara Wolfe and Seth Pollak for their assistance on this brief, which is based on the Institute for Research on Poverty workshop they organized, "Poverty and Brain Development in Children," held in Madison, Wisconsin, on September 27, 2018. The workshop brought neuroscientists, social scientists, and policymakers together to discuss current understanding and policy applications thereof. (See the workshop agenda here.)

[3]Mackey and colleagues, "Neuroanatomical Correlates of the Income Achievement Gap."

[4]Hair and colleagues, "Association of Child Poverty, Brain Development, and Academic Achievement."

[5]N. H. Brito, W. P. Fifer, M. M. Myers, A. J. Elliott, and K. G. Noble, "Associations Among Family Socioeconomic Status, EEG Power at Birth, and Cognitive Skills During Infancy," *Developmental Cognitive Neuroscience* 19 (2016, June): 144–151.

[6]J. L. Hanson, N. Hair, D. G. Shen, F. Shi, J. H. Gilmore, B. L. Wolfe, and S. D. Pollak, "Family Poverty Affects the Rate of Human Infant Brain Growth," *PLoS ONE* 8, No. 12 (2013): e80954. doi:10.1371/journal.pone.0080954

[7]Mackey and colleagues, "Neuroanatomical Correlates of the Income Achievement Gap."

[8]The brain areas affected were in the temporal lobe and back of the brain. Mackey and colleagues, "Neuroanatomical Correlates of the Income Achievement Gap."

[9]A. T. Park, J. A. Leonard, P. Saxler, A. B. Cyr, J. Gabrieli, J., and A. P. Mackey, "Amygdala-Medial Prefrontal Connectivity Relates to Stress and Mental Health in Early Childhood," *Social Cognitive and Affective Neuroscience* 13, No. 4 (2018): 430–439. Advance online publication. doi:10.1093/scan/nsy017

[10]N. H. Brito and K. G. Noble, "Socioeconomic Status and Structural Brain Development," *Frontiers in Neuroscience* 8 (2014): 276. doi:10.3389/fnins.2014.00276

[11]P. K. Kuhl, F.-M. Tsao, and H.-M. Liu, "Foreign-Language Experience in Infancy: Effects of Short-Term Exposure and Social Interaction on Phonetic Learning," *Proceedings of the National Academy of Sciences* 100 (2003): 9096–9101. doi: 10.1073/pnas.1532872100

[12]B. S. McEwan and P. J. Gianaros, "Central Role of the Brain in Stress and Adaptation: Links to Socioeconomic Status, Health, and Disease," *Annals of the New York Academy of Sciences* 1186 (2010): 190–222. doi: 10.1111/j.1749-6632.2009.05331.x

[13]Psychologist Seth Pollak coined the term "brain signature of poverty," and notes the complementarity of neuroscience and social science findings about poverty's effects on the developing brain.

[14]For further description of Baby's First Years see the following: National Institutes of Health, ClinicalTrials.gov, Baby's First Years, https://clinicaltrials.gov/ct2/show/NCT03593356; "Lisa Gennetian on New Baby's First Years Study to Test Causal Impact of Income in the First 3 Years of Life," press release, July 10, 2018, Madison, Wisconsin: Institute for Research on Poverty, University of Wisconsin–Madison. https://www.irp.wisc.edu/lisa-gennetian-on-new-babys-first-years-study-to-test-causal-impact-of-income-in-the-first-3-years-of-life/