How Poverty Affects the Brain

By Erika Hayasaki On 8/25/16 at 7:10 AM

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The video tells the story of Malala Yousafzai, the Nobel Peace Prize winner from Pakistan who at 15 survived being shot in the head by the Taliban while riding a bus in 2012. “I want to get my education, and I want to become a doctor,” she says, adding that the Taliban throw acid on some people’s faces and kill others, but “they cannot stop me.”

A 15-year-old boy watching the clip on a laptop inside the University of Southern California’s Brain and Creativity Institute seems unmoved by Yousafzai’s story—his face is blank, his shoulders slumped. An interviewer asks how it makes him feel.

He shrugs: “I don’t know.” Nothing. The researcher moves on, asking what kind of person he hopes to be when he grows up.

“Nice,” he says.

“Do you want to go to college?”

“Yeah.”

“Do you have plans after college?”

“I haven’t thought about it.”

“What kind of job do you want?”

“I haven’t thought about it.”

He is one of the 73 low-income teens USC neuroscientist Mary Helen Immordino-Yang has been tracking in a five-year study designed to understand how culture, family relationships, exposure to violence and other factors shape the human mind. Test subjects from throughout Southern California watch 40 video clips, each depicting a different true story told by the person who lived it. Some stories—like Yousafzai’s—were chosen because they are heart-tugging and inspirational. The teenagers watch parts of the clips again while inside an MRI machine, and their brain responses are recorded. Two years later, they are called back to the Brain and Creativity Lab, a hybrid learning center and campus innovation hub with an MRI-scanning lab, meeting offices, modern art and photography galleries, as well as a performance hall that offers literary readings, scientific presentations and cello concerts featuring Yo-Yo Ma. The testing process is repeated to track changes over time.

Early results show a troubling trend: Kids who grow up with higher levels of violence as a backdrop in their lives, based on MRI scans, have weaker real-time neural connections and interaction in parts of the brain involved in awareness, judgment, and ethical and emotional processing.

Immordino-Yang’s work is contributing to a growing field called the neuroscience of poverty. Though it’s still largely based on correlations between brain patterns and particular environments, the research points to a disturbing conclusion: Poverty and the conditions that often accompany it—violence, excessive noise, chaos at home, pollution, malnutrition, abuse and parents without jobs—can affect the interactions, formation and pruning of connections in the young brain.

Two recent influential reports cracked open a public conversation on the matter. In one, researchers found that impoverished children had less gray matter—brain tissue that supports information processing and executive behavior—in their hippocampus (involved in memory), frontal lobe (involved in decision making, problem solving, impulse control, judgment, and social and emotional behavior) and temporal lobe (involved in language, visual and auditory processing and self-awareness). Working together, these brain areas are crucial for following instructions, paying attention and overall learning—some of the keys to academic success.

The study, published in JAMA Pediatrics in 2015, examined 389 people between 4 and 22 years old. A quarter of the participants came from homes well below the federal poverty level ($24,230 annual income for a family of four in 2016). Children from the poorest backgrounds showed greater diminishment of gray matter and scored lower on standardized tests.

The second key study, published in Nature Neuroscience , also in 2015 , looked at 1,099 people between ages 3 and 20, and found that children with parents who had lower incomes had reduced brain surface areas in comparison to children from families bringing home $150,000 or more a year.

“We have [long] known about the social class differences in health and learning outcomes,” says Dr. Jack Shonkoff, director of the Center on the Developing Child at Harvard University. But neuroscience has now linked the environment, behavior and brain activity—and that could lead to a stunning overhaul of both educational and social policies, like rethinking Head Start–style programs that have traditionally emphasized early literacy. New approaches, he says, could focus on social and emotional development as well, since science now tells us that relationships and interactions with the environment sculpt the areas of the brain that control behavior (like the ability to concentrate), which also can affect academic achievement (like learning to read). “We are living in a revolution in biology now,” Shonkoff says, one in which new findings are finally giving us a real understanding of the interaction between nature and nurture.

A Constant State of Fight-or-Flight

When she thinks back to her South Los Angeles middle school, 19-year-old Stephanie Vergara sees metal detectors, police dogs and riots. Her school was once in lockdown for a week—kids couldn’t leave campus or move freely in the hallways because campus officials were worried about gang activity outside of its gates.

Vergara’s sister, Vanessa, 16, remembers worse scares, like walking onto her physical education field with a friend and getting jumped by five girls. They beat Vanessa’s friend until she bled because they thought she was trying to “act tough,” Vanessa says. Neither sister ever really felt safe at that school. Strangers, both kids and adults, would force their way onto the campus through broken bars over windows. Gang members would show up after school and linger. “They were always strapped,” Vanessa says, “and they would wait for kids to come out.”

High school was better but not always. Vanessa remembers one code-red lockdown following a shooting near the campus. All students were directed to the gym as one of the shooters ran across the campus, still carrying his gun.

Vanessa and Stephanie grew up in a 950-square-foot home, along with an older sister and brother. Their parents were immigrants who met while working in a sewing factory; they bought their house in 1999 after years of scrimping and saving to get the cash for a down payment. At least four rival gangs control their block and the surrounding ones, but, the family says, at least their house is within walking distance of several schools.

In 2013, Vergara joined Immordino-Yang’s study as a test subject, watching the series of videos and undergoing MRI scans. (She remembers the story of a girl with terminal cancer who tried to raise money for her treatment with a lemonade stand.) The experience piqued her interest, and when she learned that Immordino-Yang was offering internships, Vergara put her name in. She got the job and helped recruit test subjects from her neighborhood, where 43 percent of families live below the poverty line ($24,230 a year for a family of four in 2016, according to U.S. census data).

Even before she started working at the lab, Vergara knew how people in more affluent neighborhoods viewed her life and why researchers were interested in studying her and her classmates. But then Vergara started to see the MRI scans of classmates and understood that something profoundly unsettling was happening: “Our brains don’t really develop the same as people who live in other communities.”

Vergara did not yet know that there is a direct connection between the body’s stress-response system and brain development. And being poor is inherently stressful. The sisters always knew when their area was in “a heat,” which meant gang violence was surging. They knew which blocks belonged to the Bloods, or Back Street Crips, PJ Watts Crips, Main Street Crips or Hoover Criminals. They knew which men on their block were lifelong gangsters and which kids from their elementary school were new recruits. Vergara never saw anyone get shot, but she heard bullets flying outside her bedroom more than a few times.

You don’t need to see anyone take a bullet to the chest to be affected by violence, according to Immordino-Yang. When all of this turmoil is in the background, “it tells your biology you are in a scary social world,” she says. “It’s a dangerous, mean place where anything can happen. You can’t trust that other people are good.” In such a stressful state, brain structures shift. Neural synapses are altered, and your neurons fire differently. The stress hormones that permeate your brain go into overdrive.

For most people, being held up at gunpoint kicks in a fight-or-flight response, releasing hormones, including cortisol and epinephrine, that shoot energy and vigor to muscles. Neurotransmitters like norepinephrine, adrenaline and dopamine are released into the amygdala, which stimulate the brain to tell the heart and lungs to beat and breathe faster. Emotions and acuity are on high alert, and the body gears up to run or fight for its life. It’s beyond stressful—a study out of King’s College London analyzed 106 mugging victims and found that 33 percent ended up with post-traumatic stress disorder, while 80 percent reported feeling excessively fearful of people.

Now imagine seeing dozens of violent criminals every day. Imagine they are likely to pop out of the shadows at any moment to beat you, rob you, rape you, shoot you. Your stress hormones would be constantly amped up, and after a while your body wouldn’t be able to turn down the volume. Your brain would get stuck in a constant state of fight-or-flight—the kind of chronic stress that impedes the development of stem cells, brain connections and neurons. Immordino-Yang’s lab is running analyses to see whether exposure to violence interferes with teens’ development of abilities to effectively plan, set goals, make moral decisions and maintain emotional stability. “Their brain activity is less organized,” it appears, “less well developed and less systematic,” Immordino-Yang says.

Similar harm is seen in response to family chaos, neglect and abuse. This biological-neural effect grips teenagers and children, but it is also seen in toddlers and newborns. One study of 77 children by University of Wisconsin-Madison researchers found that children as young as 5 months old from low-income families had reduced regions of gray matter in their frontal and parietal regions compared with babies and toddlers from wealthier families. This and other research on baby brain activity indicates that such early effects of poverty may lead to slower brain growth.

And when it comes to brain development, if you start behind, you might never catch up.

**The New Eugenics?**

The headlines around this emerging neurological research are startling and troubling—“How Poverty Stunts Kids’ Brain Development.” “Poverty Shrinks Brains From Birth.” “Why Poor People Seem to Make Bad Decisions.”

Shonkoff says this type of language is a “dangerous, slippery slope. It’s one thing to say, ‘We on average see less gray matter, less surface area.’ It’s another for people to conclude, ‘Oh, you’re brain damaged.…’ This unfairly stigmatizes people.” Without context, poverty-brain research could fuel misguided beliefs involving racial disparities in intelligence or the inherent inferiority of the poor. It could also be used to justify racism.

“We run the risk of these findings becoming fodder for a nouveau eugenics movement,” says Matthew Hughey, associate professor of sociology at the University of Connecticut. “The easily dispensed adage that ‘the poor’s brains are different’ is an all-too-easy, scary and simply wrong-headed approach.”

It’s true that some minority groups living in poverty “greatly exceed” the U.S. average, according to the National Poverty Center at the University of Michigan. As of 2014, the national poverty rate was at 14.8 percent, according to U.S. census figures: 26.2 percent of African-Americans and 23.6 percent of Latinos are poor, compared with 10.1 percent of whites and 12 percent Asian-Americans, proving that poverty is not equally distributed among ethnic groups.

Young minorities who are more likely to experience poverty—and in turn more likely to face the cognitive development challenges laid out by science—could end up shouldering another burden, says W. Carson Byrd, assistant professor of Pan-African Studies at the University of Louisville: the assumption, based on these studies and headlines, that minority children “are less capable than their white peers.” Growing up as a poor minority in America alone does not make someone inherently more prone to brain development impacts—but the manifestations of poverty, along with how society treats poor minorities, can have an effect.

Housing discrimination against minorities living in unsafe, dilapidated buildings, implicit racial bias by teachers, malnutrition, and underfunded schools in poor communities can hamper normal brain development. All of these factors combined can make learning nearly impossible and influence why African-Americans, for example, are more likely than whites to be entrapped by poverty. It's easy to see how a sound bite about smaller brains “can end up as fuel for narrow views of social inequalities and the people that endure them in society,” Byrd says. It begins to dangerously echo racist arguments from past generations by so-called scientists who claimed that black people had smaller brain sizes and were therefore less intelligent than Europeans.

The scientists behind these brain studies agree their work tends to be oversimplified in mass media articles and even research abstracts. “For example, they imply causality when we really only have correlational evidence at this point,” says Columbia University neuroscientist Kimberly Noble, who led the Nature Neuroscience study. “Portraying the findings this way often misrepresents the science. The brain is not destiny. I can't predict with any accuracy what a particular child's brain size will be based on their family income.”

How much money a child’s parents make is just one piece of the puzzle: Shonkoff points out, “You have kids living in poverty whose brains are perfectly fine.” That’s because poverty is on the one hand just a measure of income. It alone does not equate to a neurobiological life crippled by the stress of violence or abuse. Certain kids in impoverished neighborhoods ruled by gangs can still grow up feeling safe, because their parents shielded them and emotionally prepared them to handle adversity.

Through relationships with parents, teachers and other adults who make them feel secure and teach them coping mechanisms so their fight-or-flight systems are not constantly keyed up, these children are able to develop resilience “buffers” that protect their brains from adversity. “It’s about getting that stress system down to baseline and building a capacity to deal with burdens of violence or poverty,” Shonkoff says.

These subtleties, in fact, are what hint at a potential solution: We need to teach kids who grow up poor to deal with stress from an early age. Even if your neural foundation is weak because of adversity early on, “it’s never too late,” Shonkoff says. “The brain continues to develop.” Neural circuits are open to being shaped by environmental influence. The brain’s neuroplasticity—its ability to modify its own structure—is highest around birth and early childhood, and it decreases over time but never to zero. And between the ages of 15 and 30, the brain undergoes a second spurt of increased plasticity, which means that adolescents and young adults, with coaching and practice, are primed to adapt.

To help that happen, child behavioral experts agree that we need to rethink the social programs and policies in poor communities, investing in programs that reduce crime, pollution, overcrowding and abuse, and focus on helping parents during the first five years of a child’s life. New programs would focus not just on the children but also on the mother who grew up in poverty and as a result hasn’t developed coping skills and is therefore highly unlikely to be passing them on to her children.

Schools could add social and emotional learning courses to their elementary through high school curricula, designed to help children recognize and pay attention to their feelings, especially while coping with trauma and stress. Such courses could become requirements, like reading and math. That would require a massive re-evaluation of the priorities of our educational and development institutions—and some way of funding any new programs and tools deemed necessary.

Getting that to happen could take the kind of power wielded by Congress, local governments, school boards or the U.S. legal system. In 2013, Clancy Blair of the New York University Neuroscience and Education Lab, led a study that found the time a child spent in poverty, and in a household filled with chaos, was significantly related to higher levels of the stress hormone cortisol. Blair says similar findings could be leveraged the way research in the past linked detrimental health outcomes to tobacco, sugar-filled drinks and junk food, and ultimately changed policies and regulation of those industries. Similarly, findings like those in Blair’s study could be used support legislation or even a landmark lawsuit targeting overcrowded living conditions, or unaffordable housing and child care.

Other systems that reinforce the cycle of poverty—inferior schools and community infrastructure; poorly protected neighborhoods and unchecked child abuse; environmental pollution; or lack of health care, public transportation and green space—could face legal challenges or new laws.