Toxic Stress: Implications for Policy & Practice

An Interview with Developmental Psychologist Megan R. Gunnar

NATIONAL SCIENTIFIC COUNCIL ON THE DEVELOPING CHILD is a multi-disciplinary collaboration of leading scholars in neuroscience, early childhood development, pediatrics, and economics. Housed at the Center on the Developing Child at Harvard University, the Council works to bring sound and accurate science to bear on public decision-making affecting the lives of young children.

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Abstract: A growing body of science shows the critical effects of an extreme and sustained stressful environment for children on their developing brain architecture and the expression of genes in later life. Toxic stress can shift the brain into surviving in a way that's more rigid and less adaptive. For example, as a result of biologically altered brain processing, children who have suffered physical abuse may be predisposed to imagine anger in otherwise ambiguous faces. The implications of the science for public-policy decisions are far-reaching. Science reinforces the urgent need to focus on early childhood development, and not to shortchange it, thinking we can compensate later.

Council Member **Megan R. Gunnar** is the Distinguished McKnight University Professor in the Institute of Child Development at the University of Minnesota. Her research focuses on the emotional and social processes that regulate physiological responses to stressful events early in childhood. She serves on numerous editorial boards, and sits on the advisory board to the Director of the National Institute of Mental Health as well as ZERO TO THREE: The National Center for Infants, Toddlers, and Families. In addition, she was a member of the Committee on Integrating the Science of Early Childhood Development for the Institute of Medicine and the National Research Council of the National Academy of Sciences, and is the recipient of a National Institute of Mental Health Research Scientist Career Award. She earned a Ph.D. in developmental psychology from Stanford University.

What does "brain architecture" mean and how does it work?

Brain architecture, to me, is the basis for everything we're talking about in connection with the National Scientific Council on the Developing Child. The developing brain organizes itself through the interaction of genes responding to the local environment, and it's influenced by many things from the outside. So the architecture is about far more than just the "wiring," or how our brain forms its synaptic connections. It's about nerve myelination (formation of the fatty insulation around the brain's nerve cells that promotes speedy transfer of signals). It's about chemical receptors. It's about how finely tuned we are to receiving different kinds of information and stimulation.

Let's remember: The process by which the brain builds itself is tangible, it's physical. And that's appropriate, since virtually every human function—all our thoughts, all our feelings—has to operate through this physical thing called our brain.

How does stress affect the developing brain and its architecture?

To begin with, the relationship between stress and the brain is a function of both nature and nurture. All of this is a dance between genes and experience. The genes we are born with can be thought of as our "genetic library." The experiences we have influence which books in that library we take out and read at different points in brain development, and this intertwining of genes and experience determines how the brain develops. Scientists are just beginning to understand how particular genes in our library affect how we react to stress early in life, and what affect this has on how our brains develop and respond to stress later. We know that some children are much more adversely affected by stress than are others and we strongly suspect that this is partly due to the genes they have in their genetic libraries.

Children who have been physically maltreated at very young ages experience actual biological changes in the brain.

Are there critical or sensitive periods during which stress can be especially damaging to the brain?

We're not quite sure we know the answer to that question. The animal literature strongly suggests there are sensitive periods—stages of development when the brain is particularly vulnerable to toxic stress. We know very little about what's happening in humans, although we strongly suspect that serious or prolonged forms of stress—which can take many forms, ranging from chronic and untreated childhood illness to physical or emotional abuse—will have the greatest impact during periods of rapid development. These sensitive periods include the fetal period (when the basic structures of the brain are being organized); infancy and early childhood (when the brain is doing much of its basic wiring); and adolescence (when changes in sex hormones are shaping and altering the way the brain processes chemical messages).

Think, for example, about a child who is just learning to walk. When she moved from point A to B by crawling, she could get there even if there were bumps in the road. Once she is a good walker, getting from point A to B even over a bumpy road won't be a problem. But at the transition between crawling and walking, if we think of that as a metaphor for rapid brain development, even small bumps in the road may send her careening off in another direction. There may be something similar at work regarding adaptation to stress in the young child—periods of rapid change when this deflection point is unusually sensitive, and when early development can be more dramatically affected by stressful events. That is, set off course, slowed down, or otherwise altered from its normal, healthy trajectory.

And there's another danger of chronic or severe stress. Toxic stress, we think, can shift the brain into surviving in a way that's more rigid and less adaptive—indeed, maladaptive. There's a really powerful illustration of this in current research of maltreated children by Seth Pollak at the University of Wisconsin. He's showing how children who have been physically maltreated at very young ages experience actual biological changes in the brain—changes which alter the way their brain processes social threat messages, such as those conveyed by anger expressed in the face and voice of others, even years later. He uses a push-button simulation game, which asks kids to identify pictures of three different facial expressions—happy, fearful and angry—and painlessly monitors the electrical response in their brain. Some of the pictures show full-blown expressions of each emotion. But using a morphing program, he also degrades the expressions so some are blurred or ambiguous. Compared with other children, those who'd suffered severe physical abuse "see" the anger face when other children still aren't sure what expression they are looking at in the blurred image.

The findings suggest that their "neural category" for anger—the way their brain processes things like facial expressions and voices—has been biologically altered. Now, that might serve as an important adaptive response—alerting vulnerable kids to a threatening situation and helping them avoid getting walloped. But it can also serve the opposite purpose—predisposing kids to imagine anger and creating possible conflict when they get bumped in the hallway, for example, and perceive threat when there is none.

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How are youngsters most affected by early stress?
The effects are varied and quite broad. The fact is that we've focused so much of our attention on the cognitive effects of early stressors—from exposure to cocaine, from malnutrition, just go down the list—that we've been really focused on the cognitive outcomes. But what we're beginning to see is that things like emotion processing and social behavior are also fundamentally affected by these early toxic stresses. (See the Pollak research, for example, above.)

Can you identify a few ways in which the science of brain development—and your research specifically—should have an impact on public policies in this country?
It's very clear that our research findings reinforce at a biological level much of what we've been saying about environments for young children for a long, long time. The policy implications are far-reaching. The science tells us, for example, that we really need high-quality care for young children. We really need sensitive, responsive, individualized and continuous relationships with the most important people in our children's lives, whether parents or professional caregivers. And we really need good child nutrition. So these findings have implications for all sorts of public policy decisions—everything from the way we structure our nation's child-care system and invest in high-quality programs, to the way we treat vulnerable youngsters in foster care.

What we're demonstrating with science is that these influences really do have the capacity to affect brain architecture. It's not just some ephemeral, abstract notion about what's good for the growing child. In recent years, everything we've seen through the science only reinforces the urgent need to focus on early childhood development—and to not shortchange it thinking we can somehow compensate later.

What do we know now that we didn't just a few years ago to make these scientific observations more compelling?
So many things. There's tremendously new and exciting knowledge about the brain's "plasticity," its ability to be shaped or sculpted, for example, and about the complexity of the frontal cortex.

There's a new frontier regarding how genes are regulated, and exciting work about the processes early in development that can permanently "silence" genes. And we're learning more about how, on a molecular level, social experience can enter the picture and really alter gene expression [by] turning "on" and "off" the genes we're each carrying. We've seen all this in animals, and we know it's extremely unlikely that it's happening in one species and not in our own.

The interviewer: Dorian Friedman is the policy editor at *The American Prospect*, a monthly political magazine, and a former associate editor at *U.S. News & World Report*. She has worked to advance beneficial social policies and effective communication strategies with the FrameWorks Institute, the Welfare to Work Partnership, and other nonprofit organizations. She is based in Washington, D.C.