

BUILDING A FOUNDATION *for Prosperity* **ON THE SCIENCE OF** **EARLY CHILDHOOD DEVELOPMENT**

BY JACK P. SHONKOFF, M.D.


Science tells us that early childhood is a time of both great opportunity and considerable risk. For better or worse, its influence can extend over a lifetime. A strong foundation in early childhood lays the groundwork for responsible citizenship, economic prosperity, healthy communities, and successful parenting of the next generation. A weak foundation can seriously undermine the social and economic vitality of the nation.

Dramatic advances in neuroscience, molecular biology, genomics, and the behavioral and social sciences are deepening our understanding of how healthy development happens, how it can be derailed, and what societies can do to keep it on track. We now know, for example, that:

- Genes provide the initial blueprint for building brain architecture
- Environmental influences affect how the neural circuitry actually gets wired
- Reciprocal interactions among genetic predispositions and early experiences affect the extent to which the foundations of learning, behavior, and both physical and mental health will be strong or weak



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These and other striking discoveries offer provocative insights about the far-reaching influences of early developmental processes that were not appreciated as recently as a decade ago. The challenge for policymakers and civic leaders is to capitalize on this scientific revolution through creative new thinking about a broad range of societal concerns, including education reform, workforce development, health promotion, prevention of disease and disability, child protection, crime reduction, and poverty alleviation.

The foundations of healthy development and the origins of many physical and cognitive impairments are increasingly likely to be found in the biological “memories” that are created by gene-environment interactions in the early years of life, in some cases as early as during the prenatal period. The science explaining these phenomena is grounded in the basic biological principle that the immature organism “reads” salient environmental characteristics in the service of developing its capacity to adapt to the environment in which it “expects” it will live. For example, inadequate maternal nutrition during pregnancy prepares biological systems for a life of scarcity after birth—a life in which the baby must make the most of limited nutrients. This healthy adaptation becomes a liability when the post-natal environment in fact offers plenty of high-caloric nutrition. Hence the result of poor prenatal nutrition can be increased likelihood of obesity in childhood and adulthood, as well as later hypertension and heart disease.

Similarly, when early experiences are nurturing, contingent, stable, and predictable, healthy brain development is promoted and other organ regulatory systems are facilitated. When early experiences are fraught with threat, uncertainty, neglect, or abuse, stress management systems are over-activated. The consequences can include disruptions of developing brain circuitry, as well as the establishment of a short fuse for subsequent stress response activation, which leads to greater vulnerability to a host of physical diseases. As a result of these biological adaptations, stable, responsive, nurturing caregiving early in life is associated with better physical and mental health, fewer behavioral problems, higher educational achievement, more productive employment, and less involvement with social services in adulthood. For the one in seven U.S. children who experience some form of maltreatment, such as chronic neglect or physical, sexual, or emotional abuse, biological adaptations can lead to increased risk of a compromised immune system, hypertension and heart disease, obesity, substance abuse, and mental illness.

Viewing this scientific evidence within a biodevelopmental framework (see Figure 1) points to the particular importance of addressing the needs of our most disadvantaged children at the earliest ages. The domains that comprise this framework provide a roadmap for a new, science-driven era in early childhood policy, starting with three promising targets for innovative intervention strategies, beginning as early as the prenatal period. These three targets determine whether the early years establish the foundations of healthy development or are sources of adversity with lifelong detrimental consequences.

Target #1: Healthy, stable relationships. The first target area—the environment of relationships in which a young child develops—requires attention to a continuum from providing more nurturing, responsive caregiving to protecting children from neglectful or abusive interactions. These relationships include those with family and non-family members, as both are important sources of stable and growth-promoting experiences. Moreover, these relationships can provide critical buffers against potential threats to healthy development.

Target #2: Physical environments. The second target area—the physical, chemical, and built environments in which the child and family live—requires protection from neurotoxic exposures such as lead, mercury, and organophosphate insecticides; safeguards against injury such as the use of infant seat restraints in automobiles and safe play spaces; and the availability of safe neighborhoods and their associated social capital,

both of which improve the prospects of families with young children. When communities provide children with safer and less toxic environments, the architecture of their brains and bodies is more likely to develop in healthy ways, leading to more success and productivity further on down the road.

Target #3: Appropriate nutrition. The third target area for intervention—appropriate versus poor nutrition—requires attention to the availability and affordability of nutritious food; parent knowledge about age-appropriate meal planning for young children; and effective controls against the growing problem of excess caloric consumption and early obesity. As noted earlier, this is not just about providing healthy meal options in school cafeterias. The foundation for healthy nutrition starts as early as the prenatal period, when scarcity and proper maternal nutrition literally lay the groundwork for later health and nutritional status throughout the life course.

Together, experiences in each of these target areas trigger a variety of physiological responses. In some cases, specific adverse events or experiences that occur during sensitive periods in the development of the brain or other organ systems may leave physiological “markers” whose effects are seen later. Lifelong cognitive deficits and physical impairments associated with first-trimester rubella infection or significant prenatal alcohol exposure are two prominent examples. In other circumstances, physiological changes may reflect the cumulative damage or biological “wear and tear” caused by recurrent abuse or chronic neglect over time. This breakdown of the physiological “steady state” is believed to be due to chronic activation of the stress response system. And this breakdown, in turn, gives a much greater sense of urgency to the disproportionate exposure of low-income children to ongoing environmental stressors, traumatic experiences, and family chaos. When early influences are positive, physiological systems are typically healthy and adaptive. When

HOW STRESS AFFECTS BRAIN DEVELOPMENT

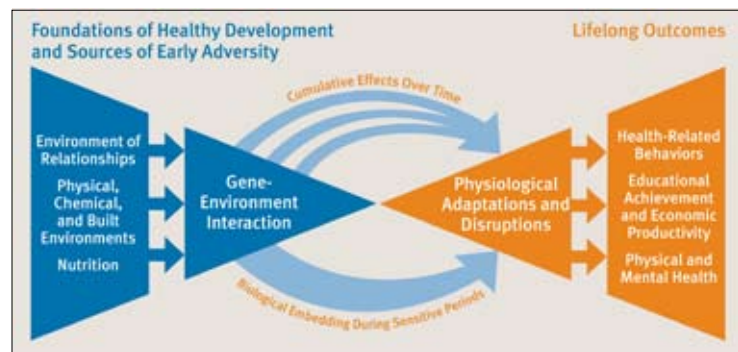
Learning how to cope with adversity is an important part of healthy child development. When we are threatened, our bodies activate a variety of physiological responses to stress. Scientists now know that chronic, unrelenting stress in early childhood, in the absence of supportive relationships with adults, can be toxic to the developing brain.

Positive stress is characterized by moderate, short-lived increases in heart rate, blood pressure, serum glucose, and circulating levels of stress hormones. Precipitants include the challenges of dealing with frustration, adjusting to a new child care setting, and other normative experiences. Positive stress is an important aspect of healthy development that is experienced in the context of stable and supportive relationships that facilitate adaptive responses that restore the stress response system to baseline.

Tolerable stress refers to a physiological state that could potentially disrupt brain architecture but is buffered by supportive relationships that facilitate adaptive coping. Precipitants include the death or serious illness of a family member, parental divorce, homelessness, a natural disaster, or community violence. The defining characteristic of tolerable stress is the support provided by invested adults that helps restore the body’s stress-response systems to baseline, thereby preventing disruptions in brain circuits that could lead to long-term consequences.

Toxic stress refers to strong, frequent, and/or prolonged activation of the body’s stress-response systems in the absence of the buffering protection of stable adult support. Major risk factors include recurrent physical and/or emotional abuse, chronic neglect, severe maternal depression, parental substance abuse, and family violence, with or without the additional burdens of deep poverty. Toxic stress disrupts brain architecture, adversely affects other organs, and leads to stress-management systems that establish relatively lower thresholds for responsiveness that persist throughout life, thereby increasing the risk of stress-related disease or disorder as well as cognitive impairment well into the adult years.

FIGURE 1 How Early Experiences Get into the Body: A Biodevelopmental Framework



Source: Shonkoff, J.P., “Building a New Biodevelopmental Framework to Guide the Future of Early Childhood Policy.” *Child Development*, January/February 2010, Volume 81, Number 1, pp. 357–367.

influences are negative, systems may become dysfunctional. In both cases, genetic predisposition affects whether a child is more or less sensitive to environmental influences. The identification and measurement of both types of physiological “footprints” offer considerable promise for understanding both resilience and vulnerability in the face of adversity.

Physiological responses to early experiences affect adult outcomes such as educational achievement and economic productivity; health-related behaviors like diet, exercise, smoking, alcohol and substance abuse, antisocial behavior, and violent crime; and both the preservation of physical health and the avoidance of disease and disorder. In other words, children who experience positive early environments and experiences tend to go on to complete more school years and have higher-paying jobs, demonstrate more health-promoting lifestyles, and live longer, healthier lives. Children who, early in life, experience adverse conditions such as deep, sustained poverty, profound neglect or abuse, exposure to violence, and parental mental illness or substance abuse tend to drop out of school earlier, earn less, depend more on social supports, adopt a range of unhealthy behaviors, and die at a younger age. And this winds up costing us all more in the end than if we had addressed these problems early on.

From Science to Policy

The proposed biodevelopmental framework presents an integrated approach for addressing the early childhood roots of disparities in learning, behavior, and health. We know more now than ever before about how young children learn and about how to facilitate the development of their competencies in a wide variety of areas. We also have greater insights into how early adversity can produce disruptive physiological effects on the developing brain, cardiovascular system, and immune system, all of which can have lifelong impacts on both educational achievement and health. These rapidly moving scientific frontiers offer unprecedented opportunities to catalyze a new era in early childhood policy and practice guided by science. This science-based future must be driven by leadership that combines a strong sense of civic responsibility, an informed understanding of the positive returns that can be generated by wise investment, and a willingness to explore new ideas.

There is sufficient evidence right now to make the scientific and economic case for investing in innovative, relationship-based interventions for young children burdened by the stresses of child maltreatment, parental mental health impairments, or family violence. Another candidate for intervention is the disruptive impact of emotional and behavioral problems on early learning. The simple provision of rich, center-based learning experiences for young children is not in itself sufficient for preventing developmental lags if their brain circuits are burdened by anxieties and fears that result from adverse life circumstances. These disruptive experiences must be addressed directly. Similarly, it is not sufficient to simply provide information on child development and advice on parenting to mothers and fathers

with low income and limited education if these parents themselves are having considerable difficulty coping with the stresses of poverty, depression, substance abuse, food insecurity, homelessness, and/or neighborhood violence. Only by addressing these problems head-on can we reduce the intergenerational cycle of disadvantage associated with growing up in such environments.

Complementing our knowledge base in the biological and developmental sciences, program evaluation data tell us that we can improve the life trajectories of children who face the burdens of poverty and social disadvantage, but the quality of program implementation and the magnitude of measured impacts are highly variable. This evidence base is amplified by reports from early childhood program staff who see the positive impacts of their efforts on a daily basis, yet are often overwhelmed by the emotional, behavioral, and social problems of many of the children and families they serve. All available information points to the same conclusion—intervention in the early years can make an important difference, but the *magnitude* of policy and program impacts must be increased.

The field of early childhood intervention currently stands at an important crossroads. One path leads toward the vital task of closing the gap between what we know and what we do right now. This road’s directions are clear—it requires enhanced staff development, increased quality improvement, appropriate measures of accountability, and expanded funding to serve more children and families. The second path heads into less charted territory, yet its purpose is deeply compelling—to create the building blocks for a new mindset that promotes innovation, invites experimentation, and leverages the frontiers of both the biological and social sciences into transformational changes in policy and practice. The first path will bring state-of-the-art services to greater numbers of children and families. The second views current best practices as a promising starting point, not a final destination. Both are essential, but taking the first steps down the path toward a new era begins with several key challenges.

Challenge #1: Thinking across silos. The fragmented world of early childhood policy, practice, and research must be guided by a single underlying science of early childhood development. As our understanding of that unified science base has deepened, persistent disconnections among the multiple policy streams that affect young children have become increasingly untenable. Improved outcomes for children facing significant adversity are most likely to be achieved through the coordinated application of an integrated, science-based framework across agencies and sectors, not through continuing attempts to foster improved inter-agency cooperation among disparate systems that are guided by divergent, historical traditions rather than convergent, contemporary knowledge.

Challenge #2: Understanding cultural context. The increasing racial and ethnic diversity of the early childhood population in the United States demands a deep commitment to the critical


task of developing, testing, and continually refining approaches that speak to a broad range of child-rearing beliefs and practices. Acknowledgment of the importance of cultural competence in early childhood policy and programs is common, but scientific investigation of the impact of different child-rearing beliefs and practices on early brain development is nonexistent. Greater understanding of the impact of a diversity of parenting practices on the development of the brain will significantly enhance our capacity to design policies and services that meet the needs of all young children and their families in an increasingly pluralistic society.

Challenge #3: Innovating as well as improving. The growing demand for evidence-based policies and programs is an increasingly powerful force in the early childhood policy arena. The question is not whether decisions about the allocation of resources should be informed by evidence, but whether the current definition of evidence that guides early childhood investments may be too narrow. Randomized experiments remain the gold standard for comparing the efficacy and effectiveness of alternative interventions. Cost-effectiveness and cost-benefit assessments for calculating the monetary returns achieved from interventions also provide useful information about existing services. Neither, however, offers significant guidance for the compelling task of innovation. The challenge is to look beyond the program evaluation literature alone and to leverage well-established and broadly accepted scientific concepts to drive innovation.

Challenge #4: Formulating and testing new theories of change. Early childhood policies and practices are likely to advance best within an open environment that engages a broad diversity of values and expertise, promotes intellectual flexibility and creativity, and encourages a willingness to take risks and learn from failure. This is not meant to minimize the continuing importance of efforts that focus on incremental improvements in the quality of existing programs. It is simply intended to underscore the need for simultaneous investment in new ideas in the search for more effective intervention strategies.

The challenge for informed policymaking is to focus less attention on competing interpretations of program evaluation data that demonstrate statistically significant but relatively modest impacts and to direct more investment toward generating and testing new ideas about how to achieve more dramatic improvements in life outcomes, particularly for those whose needs are not being met. The complementary challenge for the research community is to focus less on fine-tuned measurement of what we already know about children's development and more on the formulation, testing, and continuous refinement of new theories of change about how to reduce significant threats in the early years of life. An exciting new era in early childhood policy, practice, and research lies at the convergence of these two agendas—an era driven by science, creativity, and pragmatic problem-solving in the service of building a more humane present and more promising future for all young children and their families.

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