

Protecting Brains, Not Simply Stimulating Minds

Jack P. Shonkoff

Curricular enhancements in early childhood education that are guided by the science of learning must be augmented by protective interventions informed by the biology of adversity. The same neuroplasticity that leaves emotional regulation, behavioral adaptation, and executive functioning skills vulnerable to early disruption by stressful environments also enables their successful development through focused interventions during sensitive periods in their maturation. The early childhood field should therefore combine cognitive-linguistic enrichment with greater attention to preventing, reducing, or mitigating the consequences of significant adversity on the developing brain. Guided by this enhanced theory of change, scientists, practitioners, and policy-makers must work together to design, implement, and evaluate innovative strategies to produce substantially greater impacts than those achieved by existing programs.

Advances in neuroscience, molecular biology, epigenetics, and the behavioral and social sciences indicate that the foundations of educational achievement, lifelong health, economic productivity, and responsible citizenship are formed early in life. Based on this knowledge, early childhood policy and practice are grounded in a growing understanding of the extent to which early experiences are incorporated into the developing brain, for better or for worse (1). An environment of stable, stimulating, and protective relationships builds a strong foundation for a lifetime of effective learning. In contrast, when young children are burdened by significant adversity, stress response systems are overactivated, maturing brain circuits can be impaired, metabolic regulatory systems and developing organs can be disrupted, and the probabilities increase for long-term problems in learning, behavior, and physical and mental health (2).

An Enhanced Theory of Change

Most programs for children in disadvantaged circumstances (typically defined by low family income and limited parent education) combine enriched learning experiences for the children and parenting education for mothers. Over four decades of evaluation research have generated ample evidence of the benefits of such interventions, but the magnitude of impact is typically modest (3). As promising new preschool curricula focus on teaching science (4), numeracy (5), and executive function skills (e.g., focused attention and impulse control) (6), advances in neurobiology suggest that socioeconomic disparities in educational achievement could be reduced more effectively by linking high-quality pedagogy to interventions that prevent, reduce, or mitigate the disruptive effects of toxic stress on the developing brain.

Center on the Developing Child at Harvard University, 50 Church Street, Cambridge, MA 02138, USA. E-mail: jack_shonkoff@harvard.edu

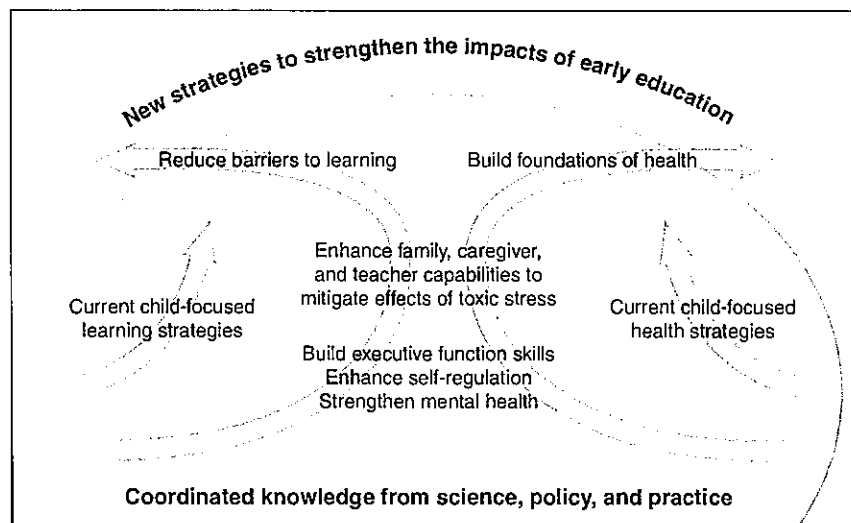
There is extensive evidence that significant adversity can lead to excessive activation of stress response systems (including persistently elevated stress hormones, such as cortisol) that can disrupt the developing brain (7). When children experience recurrent threat, fear conditioning affects developing circuits in the amygdala and hippocampus, which can lead to anxiety that impairs learning (8). This “fear learning” can begin early in infancy, whereas “fear unlearning” requires further development of the prefrontal cortex (PFC) later in childhood (9). In contrast to the relatively early maturation of the amygdala and hippocampus, the range of executive function and self-regulation skills mediated by the PFC develops well into adulthood. As the foundations of these skills emerge in the infant-toddler period, social class differences in the development and function of the PFC begin to appear (10). Because these higher-level neural circuits have extensive interconnections with deeper structures in the amygdala and hippocampus that control sim-

ple memory formation and responses to stress, executive function skills both influence and are affected by a young child’s management of strong emotions. Thus, early and repeated exposure to adversity can lead to emotional problems, as well as compromised working memory, cognitive flexibility, and inhibitory control.

Young children who experience the burdens of multiple economic and social stressors enter preschool with higher rates of emotional difficulties related to fear and anxiety, disruptive behaviors, impairments in executive function and self-regulation, and a range of difficulties categorized as behavior problems, learning disabilities, attention deficit hyperactivity disorder (ADHD), or mental health problems (11). Vulnerable children who do well in school often have well-developed capacities in executive function and emotional regulation, which help them manage adversity more effectively and provide a solid foundation for academic achievement and social competence (12). Evidence that executive function and self-regulation predict literacy and numeracy skills underscores the salience of these capacities for targeted intervention (13). Many teachers also contend that competence in these domains is more important at school entry than knowledge of letters and numbers (14). The same neuroplasticity that leaves these capacities vulnerable to early disruption also enables their facilitation during sensitive developmental periods (15). For example, responsive caregiving has been shown to be a potent buffer for primates with “vulnerability genes” that affect stress hormone regulation (16), as well as for human toddlers who are biologically predisposed to be more fearful or anxious than typically developing children (17).

A New Intervention Agenda

If early childhood policy and practice focused more explicit attention on buffering young children from the neurodevelopmental consequences



of toxic stress, then scientists, practitioners, and policy-makers could work together to design and test creative new interventions that combine both cognitive-linguistic stimulation with protective interactions that mitigate the harmful effects of significant adversity, beginning as early as possible and continuing throughout preschool. For this two-pronged approach to succeed, new strategies will be needed to strengthen the capacities of parents and providers of early care and education (beyond the provision of additional information and supports) to help young children cope with stress. To that end, three challenges are worthy of thoughtful exploration.

First, although pre-K programs for 4 year olds represent an important step forward in expanding learning opportunities before kindergarten, age 4 cannot be characterized as "early" with respect to brain development. For children in adverse environments, four years of inaction in the face of repeated threats to developing brain architecture are difficult to justify.

Second, although the influence of the home environment on school readiness and later academic achievement is well-documented (11), conventional parenting education and family support programs that simply provide information and advice have limited impact on the development of young children experiencing considerable stress (18). Alternatively, advances in neuroscience suggest that interventions that services that enhance the mental health, executive function skills, and self-regulation capacities of vulnerable mothers, beginning as early as pregnancy, suggest promising strategies to protect the developing brains of their children. Such services are likely to be particularly important for parents with histories of early adversity, later school difficulties, and minimal workforce experience, who have not had ample opportunities to develop the organizational skills needed to create a well-regulated caregiving environment that helps young children develop their own adaptive capacities. To this end, although interventions have been shown to improve executive function skills in college students with ADHD (19), efforts to build similar capabilities to enhance the parenting skills and stress-buffering capacities of mothers with limited education constitute unexplored, yet promising, territory.

Third, although the call for more effective strategies to build parenting capacities is broadly accepted, the unmet, skill-building needs of service providers in these domains are acknowledged less frequently. Although many preschools are staffed by highly trained professionals, a large

proportion of staff in early care and education programs have limited education, constrained work experience, and high rates of depression (20). Thus, large numbers of vulnerable children and highly stressed staff are engaged in dysregulated interactions on a daily basis that compromise early learning and undermine the ability to manage routine challenges and normative life stresses (12). Other indicators of unmet staff training needs include complaints about high rates of problematic child behaviors (14), increasing anti-psychotic drug prescriptions for children as young as age 3 (21), and large numbers of children being expelled from preschool programs (22). These signs of impending staff burnout underscore the need for expanded professional development activities to strengthen emotional health and executive function skills and self-regulation capacities of early childhood service providers.

The call for interventions that build adult capacities to prevent or reduce disruptions in developing brain circuitry in young children, above and beyond providing rich learning experiences, raises multiple questions for early childhood education. How does this new paradigm influence thinking about the developmental requirements for successful learning and our understanding of how to get a derailed process back on track? Which remote risk factors (e.g., toxic stress in infancy) and more proximal impediments (e.g., chaotic home or child care settings) are amenable to practical intervention? How much can we improve learning outcomes in young children by strengthening the mental health and executive function and self-regulatory skills of parents and program staff? How can responsibility for building a strong foundation for school success be better shared among education, health, and human services systems?

The call for greater attention to building the stress-buffering capacities of parents and providers of early care and education as a promising strategy to promote effective early learning is relatively new. The challenge of promoting collaboration across disciplines and service sectors is not. Neuroscientists who study the impact of adversity on the PFC have limited interaction with psychologists who study executive function in children or adults who live in disorganized environments. Neither group engages regularly with educators who work with children who exhibit problems in emotional stability or self-regulation nor with policy-makers who make decisions about allocating resources to education, health care, and human services that interact separately with the same children and families. A shared under-

standing of the common scientific foundations of learning, behavior, and both physical and mental health offers a compelling strategy for breaking down enduring barriers (2).

Persistent socioeconomic gaps in school readiness and academic achievement as well as the variable effectiveness of existing interventions, demand fresh thinking. The formulation of creative strategies to strengthen the organizational, self-regulatory, and mental health capacities of the adult caregivers and teachers who constitute the environment of relationships in which young brains develop could offer new pathways toward potentially greater impacts on early learning. The extent to which scientific advances offer new insights to guide innovative policies and practices has never been greater (23). The need for a more balanced and integrated approach to both enrichment and protection for the developing brain has never been more compelling.

References

1. S. E. Fox, P. Levitt, C. A. Nelson 3rd, *Child Dev.* **81**, 28 (2010).
2. J. P. Shonkoff, *Child Dev.* **81**, 357 (2010).
3. L. Karoly, M. Kilburn, J. Cannon, *Early Childhood Interventions: Proven Results, Future Promise* (RAND Corp., Santa Monica, CA, 2005).
4. R. Gelman, K. Brennenman, G. MacDonald, M. Roman, *Preschool Pathways to Science* (Brookes Publishing, Baltimore, 2009).
5. D. Clements, J. Sarama, *J. Res. Math. Educ.* **38**, 136 (2007).
6. A. Diamond, W. S. Barnett, J. Thomas, S. Munro, *Science* **318**, 1387 (2007).
7. S. J. Lupien, B. S. McEwen, M. R. Gunnar, C. Heim, *Nat. Rev. Neurosci.* **10**, 434 (2009).
8. D. S. Pine, *Biol. Psychiatry* **46**, 1555 (1999).
9. F. Sotres-Bayon, D. E. Bush, J. E. LeDoux, *Learn. Mem.* **11**, 525 (2004).
10. J. R. Best, P. H. Miller, *Child Dev.* **81**, 1641 (2010).
11. J. Shonkoff, D. Phillips, Eds., *From Neurons to Neighborhoods* (National Academy Press, Washington, DC, 2000).
12. C. C. Raver, *Child Dev.* **75**, 346 (2004).
13. C. C. Raver et al., *Child Dev.* **82**, 362 (2011).
14. S. Rimm-Kaufman, R. Pianta, M. Cox, *Early Child. Res. Q.* **15**, 147 (2000).
15. M. M. Loman, M. R. Gunnar, *Neurosci. Biobehav. Rev.* **34**, 867 (2010).
16. C. S. Barr et al., *Arch. Gen. Psychiatry* **61**, 1146 (2004).
17. M. Nachmias, M. Gunnar, S. Mangelsdorf, R. H. Parritz, K. Buss, *Child Dev.* **67**, 508 (1996).
18. J. Astuto, L. Allen, *Soc. Policy Rep.* **23**, 3 (2009).
19. D. Parker, K. Boutelle, *Learn. Disabil. Res. Pract.* **24**, 204 (2009).
20. B. Hamre, R. Pianta, *Early Child. Res. Q.* **19**, 297 (2004).
21. M. Olsson, S. Crystal, C. Huang, T. Gerhard, *J. Am. Acad. Child Adolesc. Psychiatry* **49**, 13 (2010).
22. W. Gilliam, G. Shahar, *Infants Young Child.* **19**, 228 (2006).
23. J. P. Shonkoff, P. Levitt, *Neuron* **67**, 689 (2010).

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