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Rethinking evidence-based practice and two-generation programs to create the future of early childhood policy

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Abstract

Half a century of research and program evaluation has fueled a diverse landscape of early childhood policies and practices that produce a range of positive effects on the life prospects of children who face the burdens of significant adversity. Drawing on advances in neurobiology, developmental psychology, developmental psychopathology, and prevention science, this paper presents a framework for elucidating underlying causal mechanisms that explain differences in outcomes, formulating enhanced theories of change about how to shift developmental trajectories, designing creative interventions and rethinking the concept of a two-generation strategy to produce breakthrough impacts, and launching a new era of investment in young children and their families that will achieve greater reductions in intergenerational disparities in learning, behavior, and health than those produced by current best practices. Particular attention is focused on the hypothesis that substantially better outcomes for vulnerable, young children could be achieved by greater attention to strengthening the resources and capabilities of the adults who care for them rather than by continuing to focus primarily on the provision of child-focused enrichment, parenting education, and informal support. Central to achieving this goal is the need to establish an innovation-friendly environment that embraces fast-cycle sharing, supports risk taking, and celebrates learning from failure.

Over the past several decades, early childhood policies and programs for young children experiencing significant adversity have been influenced by converging theoretical models and extensive empirical research. The most influential of these developmental frameworks highlight the critical importance of nurturing relationships and mutually responsive interactions between adults and young children (Cicchetti, 1990; Cicchetti & Toth, 1997; Sameroff & Chandler, 1975; Sameroff & Fiese, 2000) and underscore the extent to which life outcomes are influenced by a dynamic interplay between the cumulative burden of risk factors and the buffering effects of protective factors within the individual, family, community, and broader socioeconomic and cultural context (Bronfenbrenner, 1979; Garmezy & Rutter, 1983; Rutter, 2000; Werner & Smith, 1982).

Parallel to the production of an increasingly sophisticated knowledge base about early childhood development, almost half a century of program evaluation research has demonstrated the ability of a variety of interventions to produce favorable impacts on a range of long-term outcomes for young children who face the burdens of significant economic and social disadvantage (Heckman, 2006; Karoly, Kilburn, & Cannon, 2005; Shonkoff & Phillips, 2000). These impacts have been well documented in multiple domains with high policy salience, including higher educational attainment, fewer unplanned pregnancies, increased economic productivity, and reduced criminal behavior. Despite the value of these intervention effects and their favorable benefit–cost ratios, the quality of implementation has been highly variable, and the magnitude of measured impacts has remained fairly stable over the past several decades, consistently falling within the small to moderate effect size range.

Although the basic concepts of developmental psychology that inform early childhood programs have stood up well over time, recent advances in the biological sciences offer an unprecedented opportunity to stimulate fresh thinking by illuminating some of the underlying causal mechanisms that explain differences in the developmental trajectories of young children. Extensive and growing evidence from neuroscience, molecular biology, genomics, and epigenetics indicates that genes provide the basic blueprint for brain architecture, environmental influences affect how neural circuits are built in a bottom-up sequence over time, ongoing reciprocal interactions among genetic predispositions and early experiences affect developmental trajectories, and significant adversity can disrupt neural circuits and other maturing biological systems in ways that undermine lifelong learning, behavior, and physical and mental health. (Fox, Levitt, & Nelson, 2010; Meaney, 2010; Shonkoff, 2012). Moreover, growing evidence from neuroscience suggests that the longer we wait to intervene with children at high risk for problems, the more difficult it

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will be to achieve positive outcomes later, particularly for children who experience the physiological disruptions of *toxic stress* (i.e., excessive, prolonged activation of stress response systems) during the earliest years (Knudsen, Heckman, Cameron, & Shonkoff, 2006; Lupien, McEwen, Gunnar, & Heim, 2009; National Scientific Council on the Developing Child, 2005; Shonkoff, Boyce, & McEwen, 2009).

Capitalizing on growing public support for investment in young children and recognizing the highly variable content and quality of implementation that characterize the full landscape of contemporary early childhood programs, many policymakers are endorsing the establishment of quality rating and improvement systems, enhanced data management practices, and stronger systems to coordinate services and expand access. Although the importance of these activities is clear, the moderate magnitude of effects achieved by the most successful programs studied to date indicates that quality improvement and system-building alone are unlikely to produce breakthrough impacts on the life prospects of young children who face the cumulative burdens of low family income, limited parent education, and social exclusion.

The call for fresh thinking grounded in science that is presented in this paper requires a serious reexamination of the current environment for early childhood policy and practice. The fundamental challenge facing the field today is not just the inability to produce larger impacts but also the absence of an R&D (research and development) dimension to encourage the design and testing of new ideas. In a policy context that is increasingly focused on evidence-based programs, the ability to stimulate innovation requires an expanded definition of evidence to include broadly accepted scientific principles as well as the results of experimental evaluations and benefit–cost studies (Shonkoff, 2010). Guidelines that restrict funding to services with documented effectiveness will significantly limit opportunities to try new things.

The achievement of substantially larger intervention impacts requires a more dynamic environment that invites experimentation, supports responsible risk taking, and learns from failure. Decades of research in developmental psychology, developmental psychopathology, neurobiology, and prevention science provide a rich knowledge base to catalyze such creativity. For example, the consistently replicated finding that parent characteristics typically explain a greater proportion of the variance in child outcomes than the measured impacts of program variables highlights the need for new intervention strategies that focus more explicitly on strengthening the capabilities of parents and other caregivers. The concept of a *two-generation* approach to children and families experiencing significant adversity is thus particularly ripe for creative rethinking that moves beyond a simple call for enhanced coordination among the "silos" that separate child-focused and adult-focused services. In short, the need for innovation is compelling and the potential generativity of an expanded definition of evidence that includes advances in the developmental sciences is enormous.

A Historical Perspective on Half a Century of Research, Policy, and Practice

Most current policies and programs that focus on the needs of socioeconomically disadvantaged children and adults in the United States were initiated under the banner of the "War on Poverty" launched by President Lyndon B. Johnson in 1964. Created half a century ago by a confluence of cutting-edge social science and broad-based political activism, these pioneering initiatives were fueled by the conviction that intergenerational poverty could be eliminated by investments on multiple fronts, including such disparate domains as early education for preschoolers, job training for young adults, and grassroots empowerment efforts for communities. Organized within the newly established Office of Economic Opportunity, these initiatives included Head Start, Community Action Programs, Job Corps, Volunteers in Service to America, and a number of other community-based efforts, such as neighborhood health centers for children and adults. Over the ensuing five decades, the evolution of these independent programs has been shaped by systematic evaluation, on-the-ground experience, targeted advocacy, and changes in the political environment.

Over this same time period, successive generations of academically based investigators have advanced our understanding of the complex interactions among genetics, experiences, and environmental influences that explain persistent disparities in human health and development that are associated with differences in income, education, minority group status, and the cumulative burden of significant adversity. However, the limited extent to which these advances in scientific knowledge have catalyzed breakthrough thinking or new intervention strategies in early childhood programs or services focused on adults living in poverty highlights the fundamental challenge this paper is designed to address.

Flagship Models, Benefit–Cost Analyses, and the Enduring Challenges of Scaling Up

Systematic approaches to intervening in the lives of young children experiencing significant adversity have existed for many decades (Brooks-Gunn et al., 2000; Farran, 2000). The most widely cited of these interventions is the High/Scope Perry Preschool Project, a 1960s model demonstration project designed for low-income children at very high risk for academic failure upon entry into primary school (Berrueta-Clement, Schweinhart, Barnett, Epstein, & Weikart. 1984). The initial Perry Preschool experience consisted of 1 or 2 years of intervention for 3- and 4-year-old children, including half-day classes, 5 days per week, with a high teacher–student ratio and 1- to 2-hr weekly home visits. Services were provided by well-trained staff members who followed a standardized curriculum that emphasized child-directed activities and a strong focus on building problem-solving and decision-making skills.

The Perry Preschool intervention was originally evaluated through a randomized trial involving 128 children and their

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families. Numerous short-term, intermediate, and long-term positive intervention effects have been reported, including impacts on IQ, homework completion, academic achievement, high school graduation, income, and arrest rates (Barnett, 1996; Schweinhart, Barnes, & Weikart, 1993; Schweinhart & Weikart, 2002). In addition, a number of economic evaluations have reported robust benefit–cost data with significant returns on the initial investment (Barnett 1985, 1993, 1996; Belfield, Nores, Barnett, & Schweinhart, 2006; Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010; Karoly et al., 2005; Nores, Belfield, Barnett, & Schweinhart, 2005; Schweinhart, 2005).

Although the Perry Preschool Project was initiated five decades ago with a small sample size, it remains the most frequently referenced example of an effective, evidence-based program for improving outcomes for young children living in poverty. Its 40-year follow-up data demonstrate impressive impacts of higher rates of high school graduation (66% in the intervention group vs. 45% in the controls), lower rates of arrest for violent crime (32% vs. 48%), and a calculated benefit–cost ratio of 9.2:1 (Heckman et al, 2010; Schweinhart, 2005). However, the recognition that a third of the intervention group had at least one arrest for an alleged violent offense and that the effects on high school completion rates were statistically significant only for girls demonstrates the need for more effective strategies to produce larger effects.

Another frequently cited flagship program for young children living in poverty is the Abecedarian Project (Campbell, Helms, Sparling, & Ramey, 1998). This 1970s center-based program delivered year-round, full-time services by highly trained staff members in child care settings with high adult–child ratios from early infancy until age 5. Activities in the center followed a structured curriculum with an emphasis on language, cognitive, social, and emotional development. As with the Perry Preschool Project, the Abecedarian intervention was evaluated via a randomized clinical trial design. The sample was also relatively small, consisting of 111 infants assigned to intervention or control groups, and it included African American children almost exclusively. Numerous positive outcomes were reported from infancy through adulthood, including measures of academic performance and behavior (Campbell et al., 1998; Campbell & Ramey, 2010; Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Campbell et al., 2012; Muennig et al., 2011; Ramey & Campbell, 1984). Economic evaluations demonstrated that the program benefits far outweighed the costs (Barnett & Masse, 2007).

The positive effects of the Perry Preschool Project, the Abecedarian Project, and others that followed provide a robust and enduring foundation of support for the value of public investment in early intervention for young children living in poverty (Karoly et al., 2005; Shonkoff & Phillips, 2000; Yoshikawa, 1995). However, over many decades of evaluation reports, not all of the commentary has been positive (Beatty, 2012). Beginning with the "Great Society" programs in the 1960s, some critics have charged that early childhood interventions targeted toward low-income families, particularly in communities of color, represent hegemonic intrusions on family autonomy by imposing White, middle-class values on ethnic minority families. Other critics have raised concerns about the so-called "fade-out" of early childhood program effects (Fuller, 2009), although there is evidence that such findings are not universal across populations of children or domains of functioning (Zigler, 2011; Zigler & Seitz, 1980). Finally, persistent questions have been raised about the variable and inconsistent patterns of differential program impacts on subgroups defined by race, ethnicity, gender, and level of socioeconomic adversity.

As debates over the meaning of early childhood intervention outcome data have continued among researchers, policymakers, and practitioners, dichotomous win–lose arguments about whether or not programs produce enduring change have had diminishing value. In contrast, more constructive discussion from both a research and investment perspective focuses greater attention on understanding why some programs have been effective in some ways but not in others or have had significant impacts for some individuals but not for all. It would be more productive to view these early flagship programs primarily through a historical lens and appreciate their seminal contributions as proof of concept for the potential benefits of early childhood intervention rather than continue to tout their impacts as evidence for the value of current investments.

Over the past few decades, there has been a significant proliferation of early childhood programs and empirical evaluations. Many of these have been supported by funding from a wide range of federal agencies, including (but not limited to) the National Institutes of Health, Administration on Children and Families, Maternal and Child Health Bureau, Substance Abuse and Mental Health Services Administration, Indian Health Service, and Institute of Education Sciences. These public investments have documented the extent to which interventions can improve cognitive, behavioral, and educational outcomes for vulnerable young children while continuing to illustrate massive shortcomings in the more nuanced knowledge needed to achieve specific outcomes for different subgroups of children.

Building on this extensive yet limited evidence base, current best practices vary along a number of important dimensions. These include the content of the intervention, the location(s) in which services are delivered, the level of training of the staff, the characteristics and needs of the children and families served, and the timing, intensity, and duration of program involvement (Shonkoff & Phillips, 2000). Interventions range from prenatal and infant home-visitation programs to child care, preschool, and family-based parenting programs. Services have been developed to address the overall developmental burdens of poverty as well as the impacts of specific adversities, such as maternal depression (Cicchetti, Rogosch, & Toth, 2000; Nylen, Moran, Franklin, & O'Hara, 2006) and involvement in the child welfare system as a result of child maltreatment (Pears, Fisher, & Bronz, 2007; Pears, Kim, &

Fisher, 2012). Programs targeting the distinctive strengths and needs of different racial and ethnic groups have also been developed, with a particular focus on the importance of addressing issues of cross-cultural competence and the damaging effects of discrimination on human development (Klingner et al., 2005; Sims et al., 2008). Detailed descriptions of these diverse categories of program models and intervention strategies are beyond the scope of this paper. Interested readers are referred to many excellent reviews and other sources of information (Elliott, Huai, & Roach, 2007; Haager, Klingner, & Vaughn, 2007; Halpern, 2000; Justice & Pullen, 2003; Maag & Katsiyannis, 2010).

Finally, it is noteworthy to reflect upon the relatively modest pace of replication and scaling-up of evidence-based interventions in community-based settings (especially for infants and toddlers) as well as the persistence of programs that have been subjected to independent evaluation and not found to produce significant impacts. Despite the limited empirical data available to explain the remarkably slow pace of building, strengthening, and pruning the landscape of early childhood investments, a number of hypotheses are worthy of investigation.

First, many of the best-documented program models were first developed and evaluated in research settings under the rubric of an efficacy trial. Unlike assessments of effectiveness that test a program's impact in a variety of settings, measurements of efficacy represent best-case scenarios of implementation and are often conducted in highly controlled settings that are somewhat removed from real-world contexts. The subsequent task of transporting programs that have been developed and evaluated in this manner into community-based education, human services, or health settings, while maintaining the quality of implementation necessary to replicate their effectiveness, can present a host of challenges (Glasgow, Lichtenstein, & Marcus, 2003; Greenberg, 2004; Marchand, Stice, Rohde, & Becker, 2011).

Second, many of the most effective evidence-based programs are time intensive and require highly trained staff, making them relatively expensive to operate. This dilemma is the legacy of an approach to demonstration projects that typically assigns greater priority to maximizing impacts over controlling costs. Although credible economic evaluations have demonstrated that the benefits of these programs outweigh their costs, the funding required for high-quality replication of the original intervention often precludes the ability to scale up and still reproduce the impacts achieved in more resource-rich settings. This challenge is particularly formidable in locations where the reallocation of funds toward more effective interventions competes with continuing support for well-established programs that have failed to document significant impacts yet have built a strong and loyal local constituency.

Third, another reason for the slow pace of scaling up evidence-based programs and phasing out those that appear to be ineffective might be related to the complex relationship between science and politics. For example, when significant disagreements arise over the interpretation of program evaluation findings among experts with apparently comparable credentials, it is very difficult for even the most conscientious policymakers to apply research evidence to their work. Moreover, although compelling anecdotes and organized advocacy have little influence in the scientific community, they can overpower complex empirical data and generate enormous leverage in public policy.

In summary, 50 years of child development research and program evaluation data have produced a rich knowledge base that informs a varied menu of early childhood initiatives that improve the life prospects of vulnerable children. However, it is also clear that the inconsistent magnitude of impact achieved by many current programs underscores the need for more effective and efficient investments in the future. This paper is driven by the conviction that ongoing advances in neuroscience, molecular biology, genomics, and epigenetics, linked to continuing progress in the behavioral and social sciences, are producing a wealth of new insights about the developmental process that ought to be stimulating breakthrough thinking in the search for more effective strategies to reduce the intergenerational cycle of economic and social disadvantage (Cicchetti & Posner, 2005). Stated simply, we believe the time has come to explore the possibilities of a new role for biology in early childhood policy and practice.

Contributions of developmental neuroscience to early childhood intervention

Since the 1990s, when most preschool curricula emphasized basic cognitive competencies essential to reading and arithmetic, with a particularly strong emphasis on language stimulation supported by the widely cited work of Hart and Risley (1995), a growing number of intervention scientists have been exploring the value of greater attention to foundational skills in social development, emotional well-being, executive functioning, and self-regulatory capacities as key success factors for school readiness and subsequent academic achievement (Blair 1999, 2002; Raver, Blackburn, Bancroft, & Torp, 1999). Increasing support for this broader direction has been driven by the documentation of relative deficits in these domains among socioeconomically disadvantaged individuals (Raver, 2012) as well as growing evidence that these skills can be improved through targeted interventions (Diamond, Barnett, Thomas, & Munro, 2007; Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Tang, Yang, Leve, & Harold, 2012; Verkerk et al., 2012). Over the past decade, these emerging findings have led to the formulation, implementation, and evaluation of several evidence-based interventions, including the Chicago School Readiness Project (Raver et al., 2008, 2009, 2011) and the PATHS Curriculum (Bierman et al., 2010; Hamre, Pianta, Mashburn, & Downer, 2012), each of which contains important program elements designed to improve children's self-regulatory capacities.

Most recently, several prevention researchers have proposed that the impacts of these interventions could be augmented further by targeting the specific neurobiological

systems underlying individual executive functions of interest (Fishbein 2000; Fishbein, Hyde, Coe, & Paschall, 2004). To this end, focused intervention strategies have been developed to promote skill-building in such domains as working memory (Elliott, Gathercole, Alloway, Holmes, & Kirkwood, 2010; Röthlisberger, Neuenschwander, Cimeli, Michel, & Roebers, 2012; Söderqvist, Nutley, Ottersen, Grill, & Klingberg, 2012; Tachibana et al., 2012), inhibitory control (Ford, McDougall, & Evans, 2009), and cognitive flexibility (Diamond & Lee, 2011; Lewis-Morrarty et al., 2012; Röthlisberger et al., 2012).

Broadly speaking, two general approaches are being employed to target these neurobiological systems (Bryck & Fisher 2012). One strategy (commonly referred to as "brain training") employs computer tasks or other methods through which a very specific behavior is practiced intensively for a set amount of time each day. The other approach is more implicit in nature and involves intervention strategies that facilitate the development of a specific neurobiological system by promoting the practice of associated behaviors or discrete skills in real-world settings, such as classrooms and child care centers. A burgeoning interest in both approaches is being fueled by growing evidence that the development of these neural systems is disrupted by excessive activation of stress response systems in the face of significant adversity (Lupien et al, 2009), as well as by advances in prevention research that suggest promising directions for more effective interventions (Dozier, Albus, Fisher, & Sepulveda, 2002; Fishbein, 2000; Gunnar & Fisher, 2006).

Brain training approaches present the advantage of employing tasks that are based on sound principles and methods of cognitive neuroscience, thereby achieving a high degree of precision in isolating and activating targeted, underlying systems. For example, whereas the cognitive domain of working memory in clinical neuropsychology has often been assessed by digit span tests, a cognitive neuroscience framework recognizes that the successful repetition of a digit span might engage other systems such that individuals who are able to group numbers into clusters might perform well independent of their working memory capacity. Alternatively, researchers in cognitive neuroscience have developed tasks that isolate working memory from other capacities and further differentiate between its visual and auditory components. For example, one group of investigators has developed a computerized change-detection paradigm to measure the number of objects an individual can hold in visual working memory and identify through a briefly presented array of shapes on a screen, after which the subject is asked to identify a subsequent presentation of the array in which the shapes have changed color (Anderson, Vogel, & Awh, 2011; Awh & Vogel, 2008; Fukuda, Awh, & Vogel, 2010). This line of research and others like it are producing more exact and efficient training tools as well as better measures of intervention effects (Ester, Serences, & Awh, 2009; Roth, Serences, & Courtney, 2006).

Despite these potential benefits, brain training approaches also have a number of limitations. First, they typically require extensive and repetitive practice on relatively mundane computer tasks on a daily basis for many weeks. Under such circumstances, maintaining participant interest (especially among young children) might be quite challenging. Second, although some studies of children are beginning to emerge (Hardy, Willard, & Bonner, 2011; Wass, Scerif, & Johnson, 2012), the existing evidence base on effectiveness is largely confined to adults, and the protracted course of significant brain changes from birth through early adulthood limits the ability to apply knowledge from research on adults to studies of children. Third, inasmuch as these approaches are often conducted in laboratory settings and completed on a computer, the training experience itself might lack ecological validity. Fourth, there is relatively limited evidence at this time to confirm that domain-focused training will generalize to *near transfer* and *far transfer* effects. Near transfer refers to observed effects on measures of the same neurocognitive domain (e.g., working memory) that involve a different task from the one that was employed in the training exercise. Far transfer refers to observed effects on related but more complex behaviors (e.g., improved reasoning or fluid intelligence following a training program on working memory). In the limited number of studies conducted to date, some near transfer effects of training have been reported, but the results have been equivocal (e.g., Bastian, Langer, Jäncke, & Oberauer. 2012; Brehmer, Westerberg, & Bäckman, 2012; Karbach & Kray, 2009). In a recent meta-analysis of working memory training, for example, little evidence of far transfer effects was found (Melby-Lervåg & Hulme, 2012). Thus, although this appears to be a promising area of emerging research, a great deal more work will have to be done before these approaches are ready for broader application.

In contrast to the explicit brain system focus of laboratory-based training, the neurobiological context of community-based interventions is more implicit. This approach requires the development of ecologically valid intervention strategies that promote the practice of specific behavioral skills that are known (or hypothesized) to be manifestations of the underlying neural systems of interest in real-world settings (e.g., homes, classrooms, and early care and education centers). One of the most widely cited examples, *Tools of the Mind* (Bodrova & Leong 2009), is designed to promote positive effects on underlying neural mechanisms of self-regulation as well as measurable improvements in behavioral and cognitive outcomes (Barnett et al., 2008; Diamond et al., 2007). Programs that use these kinds of strategies have employed a range of biologically based outcome measures, including electroencephalography (Almas et al., 2012), event-related potentials (Bruce, McDermott, Fisher, & Fox, 2009), neuroendocrine functioning (Fisher, Stoolmiller, Mannering, & Chamberlain, 2011), and neuroimaging (Tang et al., 2012). A major advantage of these contextual approaches is the greater likelihood of generalization because of the naturalistic setting in which the intervention is delivered. One relative limitation is its considerably lower degree of specificity regarding targeted domains of interest in comparison to laboratory-based training approaches (Bryck & Fisher, 2012).

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The examples cited above are illustrative of an emerging field in its infancy. The convergence of rapidly moving advances in neuroscience, the public's fascination with the developing brain, and the need for new strategies to promote early learning in vulnerable young children suggest that the pace of investigation in this area will be brisk. Responsible custodianship of this promising resource by the scientific community will require thoughtful application, ongoing assessment in educational settings, and the avoidance of false or premature proclamations of teaching breakthroughs that are driven by entrepreneurial zeal rather than rigorous scientific evaluation.

Evolving concepts of parent involvement and two-generation programs

The broadly accepted assertion that the development of young children unfolds in the context of their relationships with the important adults in their lives leads to a natural conclusion that effective interventions for disadvantaged infants, toddlers, and preschoolers ought to include significant engagement with parents and other caregivers. That said, the design and implementation of strategies for meaningful parent involvement in early childhood programs face a range of complex challenges, and success in this area remains elusive for much of the field.

It is important to acknowledge that the conceptual model guiding Head Start from its inception included an explicit mandate to promote maximum feasible parent participation. However, it is worth noting that the meanings of *maximum, feasible,* and *participation* have varied among stakeholder groups, and the battles over definition have often been fierce (Zigler & Muenchow, 1992). In the beginning, there was a lack of clarity over the extent to which parent participation meant direct involvement in classroom activities, employment opportunities at the centers, or control over program governance. At some sites, Head Start offered participating parents access to jobs as maintenance staff, cooks, and teacher aides. At others, parent participation was defined as the power to hire and fire program directors and teachers. In some circles, Head Start was viewed as a delivery system for teaching parents about child development and providing advice on child-rearing practices. In others, it provided a venue for strengthening the capacity of low-income parents to become effective advocates for political, economic, and social change in their communities. Over time, when continuing support for Head Start was threatened by policymakers who viewed its political activism with disdain, parenting education and employment opportunities in the centers became the most prominent manifestations of parent participation.

Over the past 50 years, the range of responses to the continuing call for greater parent involvement across multiple early childhood program models has varied widely. These have included many variations and combinations of parenting education and social support provided through individualized home visitation services and within the context of center-based activities (e.g., parenting classes, evening programs, and volunteer opportunities). Extensive variations on the home visitation model have also emerged over time, reflecting important differences in timing (prenatal vs. infancy), frequency (weekly to monthly), and various levels of staff capabilities (from peer support and paraprofessional assistance to highly skilled clinical expertise).

The Perry Preschool Project included weekly home visits by highly trained professionals who taught mothers how to reinforce their children's school-based learning experiences. The Abecedarian Project, in contrast, offered relatively little direct parent instruction. The Nurse Family Partnership provides regular home visits by registered nurses guided by a highly standardized protocol (focused on prenatal health, infant care, and maternal support toward economic self-sufficiency) for low-income, first-time pregnant women that begins no later than the 28th week of pregnancy and continues to age 2 years. This intervention model has generated the most rigorous outcome data on home visitation to date from a series of randomized controlled trials that produced significant impacts on both short- and long-term outcomes (Olds et al., 2009; Olds, Hill, O'Brien, Racine, & Moritz, 2003). In contrast, evaluations of home visiting programs staffed by local volunteers or personnel with limited professional training have generated many anecdotal reports of success but produced limited experimental evidence of comparable impacts (Astuto & Allen, 2009; Center on the Developing Child at Harvard University, 2007; Howard & Brooks-Gunn, 2009).

The various conceptual frameworks guiding the inclusion of parents in early childhood programs have been influenced to variable degrees by social learning theory (Dishion, Patterson, & Kavanagh, 1992; Patterson, 2002), attachment theory (Dozier, 2003), and developmental–psychoanalytic perspectives (Emde & Robinson, 2000). Although some investigators have viewed these frameworks as distinct or incompatible, others have articulated a shared conceptual core that views children's life outcomes as dependent on the availability of responsive and supportive relationships that are predictable, contingent, warm, and positive (Dozier et al., 2002; Patterson & Fisher, 2002; Scott & Dadds, 2009). Interventions for mothers of young children whose experience with significant trauma during their own early childhood years seriously impairs their parenting capacities also draw on elements of these three models in the context of providing child-parent psychotherapy or other intensive, therapeutic services (Cicchetti, Rogosch, & Toth, 2006; Cicchetti, Rogosch, Toth, & Sturge-Apple, 2011; Ghosh Ippen, Harris, Van Horn, & Lieberman, 2011; Lieberman, Ghosh Ippen, & Van Horn, 2006).

Beyond the general importance of strengthening caregiver responsiveness and addressing the specialized needs of parents who are coping with serious emotional traumas, several other objectives have been the focus of attention in the parent components of many early childhood programs. Some provide coaching on the use of effective techniques to manage problematic behavior and reinforce desirable behavior in young children (Reid & Webster-Stratton, 2001; Reid,

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Webster-Stratton, & Hammond, 2003; Webster-Stratton, 2005). Some programs help parents respond appropriately to their child's signals and be aware of their own responses to those signals (Dozier, 2003). Others provide didactic information on developmental milestones to help promote appropriate expectations regarding children's evolving capabilities and skills. One promising new development that has been prompted by the search for more effective strategies to reach parents who are difficult to engage (particularly for those whose children exhibit poorly regulated behavior) is increased attention to the motivational aspects of parental involvement to reduce resistance to intervention protocols and increase the likelihood of more meaningful, proactive engagement on the parents' terms through the use of a "Family Check-Up" (Connell, Dishion, Yasui, & Kavanagh, 2007; Shaw, Dishion, Supplee, Gardner, & Arnds, 2006).

In addition to assistance with child development information and behavior management, many programs offer targeted instruction for inexperienced parents about ways to enhance early learning by reading to and/or playing with their child, supplemented by the provision of books and games (Pears et al., 2007, 2012). This approach is guided by the belief that enriching a young child's daily experiences can offset the lost opportunities caused by the absence of an appropriately stimulating home environment. Recent advances in neuroscience (as discussed later in this paper) suggest that the provision of environmental enrichment can be helpful but might have a relatively limited impact on improving outcomes for children whose exposure to significant adversity might be producing neurobiological disruptions that make it more difficult to benefit fully from enhanced learning opportunities (Shonkoff, 2011).

Despite its face validity and broad-based political popularity, parent involvement in early childhood programs has eluded clear definition for decades, making its independent contribution to program impacts extremely difficult to measure. The complexity of this challenge is even greater in a pluralistic and increasingly diverse society in which professional perspectives on child-rearing are often viewed as paternalistic, disrespectful, or undermining by those whose cultural values are grounded in different beliefs and practices. When variations in child-rearing associated with race, ethnicity, and culture are confounded by the developmental burdens of poverty and discrimination, the threshold for difficulties is particularly low, and the paucity of empirical data to inform constructive policy and practice is a serious problem that must be addressed (Garcia Coll et al., 1996). The absence of sufficient information on the specific characteristics of the parenting intervention in most program evaluation studies has made it particularly difficult to understand the relative influence of the parent component on child outcomes. Much more refined research is clearly needed to deconstruct multidimensional interventions to determine which aspects of parent involvement lead to improved outcomes for children over the long term.

The challenge of developing early childhood services that address both child- and adult-focused outcomes has been formidable. Programs that fall within this category are based on the understanding that all families with young children share a common set of responsibilities but that parents with limited education and low income face barriers that can impair their ability to provide growth-promoting environments for their children and that require explicit attention (Ramey, Ramey, Gaines, & Blair, 1995; Smith & Zaslow, 1995). Some of the most common of these challenges include difficulties finding or maintaining employment, intermittent or chronic financial crises, unstable housing or homelessness, mental health problems related to the posttraumatic effects of a parent's own difficult childhood experiences, substance abuse problems, and domestic violence and related problems with spousal or partner relationships (Grossman & Hollis, 1995; Herr, Halpern, & Majeske, 1995; Smith, 1995; Smith & Zaslow, 1995).

In many of these circumstances, high levels of stress, unpredictability, and overall chaos in the home environment can compromise the health and development of young children and undermine or even negate the potential benefits that could otherwise be achieved by evidence-based early childhood programs (Evans & Kim, 2013). Consequently, programs that provide services for the most vulnerable families must have the expertise and capacity required to address the needs of the parents to achieve significant impacts on the development and well-being of their children.

Notwithstanding the magnitude of the challenge, a number of two-generation models have been developed within the early childhood arena (Benzies et al., 2011; Goodson, Layzer, St. Pierre, Bernstein, & Lopez, 2000). These interventions include various combinations of home visitation, active parent participation in the classroom, enrollment in parenting classes, or supportive services directed toward family needs. At a minimal level, many programs that feature any amount of parent involvement (passive or active; sporadic or regularized) have classified themselves as meeting the baseline criterion for two-generation status. Others have raised the bar and defined themselves as two-generational based on more concrete evidence of meaningful and consistent adult engagement. One of the most widely implemented examples of this latter group can be found in Early Head Start (Raikes & Emde, 2006). However, in almost all of these cases the ultimate program effectiveness has been measured in terms of child outcomes, and impacts on adults have been viewed primarily in terms of their value as mediators of child change rather than as desired objectives in their own right.

As the leading edge of early childhood intervention moves toward a more expansive view of parent engagement, innovative two-generation approaches that focus on reducing the transmission of socioeconomic disadvantage from parents to children could play an important role. In this context, considerable attention in some settings is being directed toward enhanced coordination between early childhood intervention and adult-focused, antipoverty initiatives. Examples of this approach include the development of integrated data systems and the colocation of early care and education programs for

children with workforce development programs for their mothers. Without dismissing the importance of this movement toward enhanced coordination, it is also important to note that most of these efforts are additive rather than transformational. That is, although many program developers are broadening the scope of conventional, child-focused programs to include greater attention to the needs of parents and other caregivers, the most common practice has been to add selected intervention elements from existing adult services. The bigger challenge is to move beyond an emphasis on improved coordination across independent service systems and to create a truly innovative, fully hybridized model that is explicitly focused on transforming the lives of both children and adults. How advances in the biological, behavioral, and social sciences might be mobilized to catalyze the design and implementation of creative, new strategies to achieve such transformational change will be addressed in the remaining sections of this paper.

A New Frontier for Evidence-Based Practice: Innovation at the Intersection of Neurobiology, Developmental Psychology, Developmental Psychopathology, and Prevention Science

The current landscape of early childhood policy and practice has been shaped by decades of research in developmental processes and empirical program evaluation studies. Over this same period, extraordinary advances in neurobiology have deepened our understanding of the impact of early experiences on the developing brain and other maturing organ systems, yet the influence of biology on early childhood practice has been limited. In recent years, these diverse streams of knowledge have converged in the articulation of a core story about early childhood and brain development that has galvanized public will and transformed the policy environment for early childhood investment (Shonkoff, 2010; Shonkoff, Garner, & Committee on Psychosocial Aspects of Child and Family Health, 2012). This new public readiness makes it all the more urgent to leverage the full depth and breadth of this multidisciplinary knowledge base and begin to ask, "What's next?"

The incorporation of developmental biology into an expanded evidence base for early childhood intervention introduces two breakthrough possibilities. The first is the opportunity to build on what has been learned from the massive quantitative data that have been generated by decades of rigorous program evaluation and to mine the rapidly growing research literature in neuroscience, molecular biology, genomics, and epigenetics that is helping to elucidate underlying causal mechanisms that might explain why some interventions work and others do not. The second opportunity is to leverage this rich knowledge base in the service of formulating enhanced theories of change that will stimulate the design, testing, implementation, replication, and scaling up of a new generation of intervention strategies, the impacts of which will far exceed the magnitude of those achieved by current best practices (Shonkoff & Levitt, 2010).

Perhaps most important, the intersection of neurobiology, developmental psychology, developmental psychopathology, and prevention science provides a compelling new framework for a conceptually integrated approach to the highly interrelated needs of both young children and their caregivers. Stated simply, this expanded knowledge base offers a remarkable opportunity to launch a new era in two-generation policies and programs. To this end, a unified model for practice that is grounded in a common science that extends from conception to adulthood (and is not distracted by artificial boundaries that divide human development into arbitrary stages) could move us beyond the simple coordination of separate programs to focus on the transactional impacts of risk and protective factors on the developmental trajectories of both children and their parents over time.

To cite one example, the identification of a shared phenotype in a mother and child characterized by difficulties with inhibitory control and other self-regulatory capacities associated with substance abuse could serve as a promising framework for innovative, joint intervention strategies (Fisher, Lester, et al., 2011; Lester et al., 2012; Willoughby, Greenberg, Blair, & Stifter, 2007). The potential opportunity to design new screening protocols informed by a deeper understanding of dyadic causal pathways and to target innovative interventions on a range of underlying neurocognitive functions and associated behavioral competencies in children, parents, family systems, and other caregivers in the child's life (such as child care providers) offers one small glimpse of what two-generation programs might look like in the next era of early childhood intervention.

Another promising parameter for creative program development, as discussed earlier, is the extent to which hypothesized neurocognitive systems in parents and children could be addressed in a coordinated fashion, either explicitly or implicitly. It is not clear at this point whether direct training approaches that specifically target common core competencies in parents and children (along with their associated, underlying neurobiological systems) will be the best way to influence outcomes. One approach that could conceivably be more effective is to employ methods that do not directly target specific domains of functioning but for which indirect or implicit impacts might be achieved. The Multidimensional Treatment Foster Care Program for Preschoolers provides an example of such an approach. This intervention is based in social learning theory and emphasizes both behavioral parent training (Leve, Fisher, & Chamberlain, 2009) and reducing caregiver stress levels (Fisher & Stoolmiller, 2008). Outcome studies have found significant effects on attachment-related behavior (Fisher & Kim, 2007) and diurnal cortisol levels in the children (Fisher, Stoolmiller, Gunnar, & Burraston, 2007), although neither attachment behavior nor stress regulatory systems were targeted directly.

As these kinds of approaches evolve, some investigators might consider explicit and implicit strategies as mutually exclusive while awaiting the results of empirical evaluation to

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find out which is superior. However, it is equally plausible that interventions directly targeting basic competencies in parents and children through training approaches will be just as effective as more implicit and ecologically valid approaches for addressing the common set of phenotypic challenges in executive functioning and self-regulation that have been identified in prior research. In the final analysis, interventions that hybridize implicit and explicit components might very well prove to be most efficacious. These are all researchable questions whose answers lie on the horizon.

One other parameter along which programs might vary involves the sequencing of specific intervention components. For example, given the growing interest in executive function skills and their underlying neural systems as foundational capacities necessary for effective adult and child functioning, it is reasonable to hypothesize that these core competencies ought to be strengthened before traditional skill-based approaches to parenting and employability are introduced. Although this is a plausible working model, it is also reasonable to speculate that simultaneously strengthening executive function capacities while focusing on the development of specific skills in parents and children could be more effective. Alternatively, many parents might benefit from specific, skill-based coaching and not require any remedial work on basic executive function and self-regulation capacities. With these uncertainties in mind, reliable and valid assessment techniques that predict whether or not attention to underlying neurocognitive processes is a necessary prerequisite to specific skill-building interventions would be most helpful. The extent to which these hypothesized approaches will result in more effective interventions that have the capacity to prevent (in young children) or repair (in both children and adults) the physiological disruptions caused by excessive activation of stress response systems under conditions of significant adversity (i.e., toxic stress) illustrates the possibilities of a new era in two-generation programs guided by the incorporation of biology into an expanded definition of evidence-based practice.

Finally, although the proposed approach to address child and caregiver capabilities in an integrated way is highly promising, considerable work will be needed to transform existing interventions into programs that will produce breakthrough impacts. The following sections present illustrative examples of testable hypotheses and a preliminary roadmap to illustrate how an expanded scientific framework could be used to make that happen. How different researchers, practitioners, and policymakers will use the advancing frontiers of knowledge in all four domains (psychology, neurobiology, developmental psychopathology, and prevention science) will be a major determinant of how fast and how far that leading edge of innovation will move.

Recognizing that the boundary of science is a perpetually moving target and that the most creative innovation is always highly speculative, no single approach can be identified at present as more likely to produce breakthrough impacts than other strategies that are also grounded in credible theories of change. The question is not whether risk taking is needed. It is a fundamental prerequisite for progress. The question is how early childhood policymakers and practitioners can collaborate with researchers to create an open and inquiring environment in which scientific knowledge can be a catalyst for fresh thinking and potentially high-impact innovation.

Formulating enhanced theories of change to transform early childhood intervention

Science tells us that the causal chains of gene–environment interaction that affect developmental trajectories begin with the health of a woman before she becomes pregnant and that the *active ingredient* of environmental influence after birth is the cumulative impact of children's interactions and relationships with the important people in their lives. When a child grows up in adverse circumstances associated with any combination of the three most frequently documented risk factors associated with poor life outcomes (significant economic hardship, limited parent education, and racial or ethnic minority group status), the burdens on the caregiving environment can be substantial. When these threats are magnified by abuse or neglect, excessive or prolonged activation of stress response systems early in life can lead to disruptions in developing brain architecture that create barriers to learning and impairments in other maturing organs and metabolic regulatory functions that can lead to lifelong problems in physical and mental health (Blair, 2010; Blair & Raver, 2012; Gunnar, 2000; Gunnar & Vazquez, 2006; Miller & Chen, 2013; Shonkoff et al., 2009, 2012).

When significant adversity in the lives of young children overwhelms the capacity of service providers to respond effectively, the impacts of interventions are understandably limited. In such circumstances, the biology of adversity supports the hypothesis that the magnitude and sustainability of program impacts on those who are the most vulnerable could be increased by balancing the provision of enriched learning opportunities with increased investment in strategies to provide greater protective buffering from the biological consequences of toxic stress (Shonkoff, 2012). To that end, there is a critical need for creative new interventions that strengthen the capacity of parents and other caregivers to reduce sources of excessive adversity and to help build effective coping skills in children who experience high levels of stress. This scaffolding support is particularly critical for children who exhibit increased biological sensitivity to context, which renders them more vulnerable in the face of adversity and more able to benefit from positive experiences (Ellis & Boyce, 2011; Obradovic, Bush, Stamperdahl, Adler, & Boyce, 2010).

In short, although our understanding of precise causal mechanisms will continue to grow, advances in biology to date suggest that children who experience toxic stress are less able to benefit from early childhood programs because of impairments in their developing brain circuitry. Therefore, the development of science-informed interventions that

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reduce or mitigate the biological disruptions associated with significant adversity must be a compelling priority for early childhood policy and practice. A few examples in this emerging area illustrate the promising new frontier ahead.

Two interventions focused on maltreated foster children, one for infants and toddlers (Dozier et al., 2009; Dozier, Higley, Albus, & Nutter, 2002; Dozier, Lindhiem, & Ackerman, 2005) and one for preschoolers (Fisher et al., 2007; Fisher & Stoolmiller, 2008; Fisher, Van Ryzin, & Gunnar, 2011), have been found to affect child behavioral outcomes and neuroendocrine functioning. Similar effects were found in a program for low-income, inner-city preschoolers (Brotman et al., 2007) and a program for the children of divorced parents (Luecken et al., 2010). These findings have been augmented by an extensive longitudinal database from an experimental evaluation of the impacts of a foster care intervention for institutionalized young children living in Romanian orphanages, which documents positive effects on a wide range of developmental and biobehavioral outcomes (Almas et al., 2012; Smyke, Zeanah, Fox, Nelson, & Guthrie, 2010). Each of these programs represents a promising approach yet none of them is being replicated widely in community settings. The failure of most early childhood programs to address the serious threat resulting from children's experience of toxic stress is likely to result in continuing, large numbers of children who develop maladaptive physiological and behavioral responses to adversity (increasing their risk for problems in learning and behavior) and higher rates of hypertension, cardiovascular disease, diabetes, depression, and other chronic health impairments in adulthood.

In 2010, the National Forum on Early Childhood Policy and Programs and the National Scientific Council on the Developing Child coauthored *The Foundations of Lifelong Health Are Built in Early Childhood*, which included a logic model (see Figure 1) to address this challenge (Center on the Developing Child at Harvard University, 2010). In 2012, the American Academy of Pediatrics endorsed this framework in a policy statement that called for a leadership role for the pediatric community to "catalyze fundamental change" in early childhood policy and services focused on the need for creative new strategies to reduce the precipitants of toxic stress and to mitigate their negative effects on health and development (Garner, Shonkoff, & Committee on Psychosocial Aspects of Child and Family Health, 2012).

As depicted in Figure 1 (from left to right), this theory of change views policies and programs as levers for innovation to strengthen the capacities of caregivers and communities to, in turn, build strong foundations for healthy development in young children, so that those children experience a favorable balance of biological adaptations over disruptions that leads to positive outcomes in health and development across the life span. As we describe below, the first two components of that framework constitute a rich landscape within which a vibrant research and development agenda could be crafted to launch a new, more effective era in early childhood intervention.

Improving Child Outcomes Through Greater Attention to the Capabilities and Needs of Their Caregivers

Leveraging science to drive successful innovation will require a highly disciplined commitment to the formulation of precise strategies that target specific causal mechanisms to produce breakthrough gains on key outcomes. Guided by the

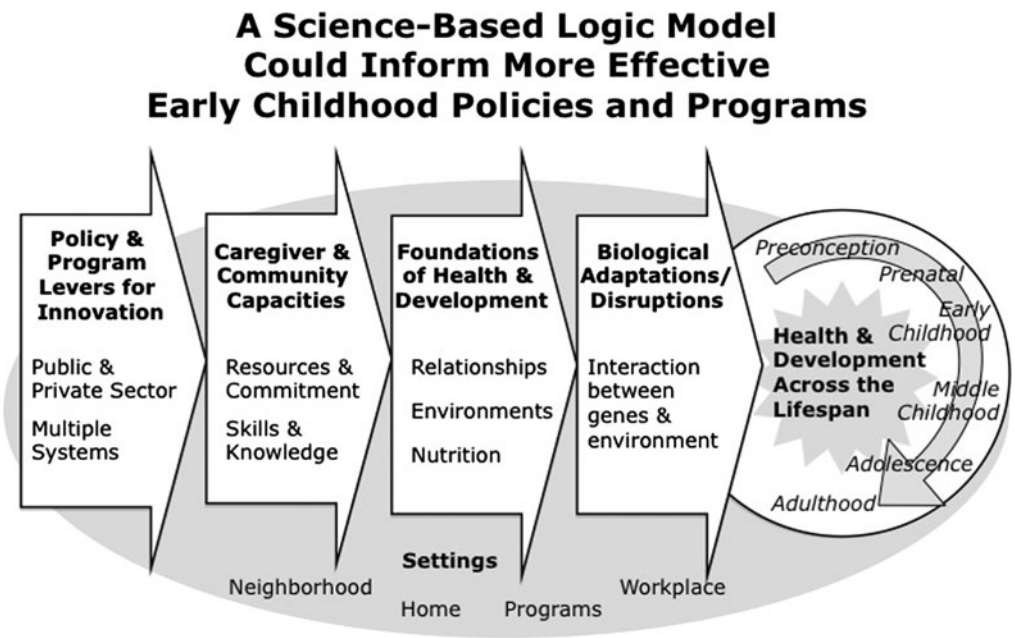

Figure 1. How policies, programs, and capacities affect the foundations of lifelong health and development: a logic model (Center on the Developing Child, 2010).

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framework presented in the previous section, there is a compelling need to identify a short list of caregiver and community capacities and resources that have important influences on the foundations of healthy development in young children and are amenable to change through focused intervention. Among many potential domains for consideration, the following three stand out as particularly ripe candidates for ground-breaking intervention strategies.

Building the executive function and self-regulation skills of parents and providers of early care and education

The development of core capacities in working memory, inhibitory control, and cognitive flexibility or shifting begins in early childhood and continues into the early adult years (Best & Miller, 2010). The full spectrum of these evolving competencies includes the ability to focus and sustain attention, set goals and make plans, follow rules, solve problems, monitor actions, shift course, defer gratification, and control impulses. These cognitive and social skills enable adults across the socioeconomic spectrum to care for themselves and their children, run households, seek and maintain jobs, and achieve financial and social stability. Executive function skills are built over time within the context of close relationships with individuals who have well-developed abilities of their own in these areas. The critical nature of these capacities and the location of their neural circuitry in the prefrontal cortex (which remains relatively plastic well into young adulthood) provide a promising focus for designing a fully integrated model of intervention for vulnerable children and families and for informing the content of professional development programs for early childhood personnel in community-based programs.

Strengthening caregiver mental health

Beyond the need for well-developed organizational and problem-solving skills, successful parenting and effective staff performance in early childhood programs cannot be separated from the importance of adult mental health. The emotional well-being of mothers has been studied extensively, and a spectrum of difficulties (particularly those associated with depression and anxiety) are correlated with a range of poor child outcomes in cognitive, behavioral, and psychological development (Brand & Brennan, 2009). Studies of the mental health of personnel in early care and education programs are less voluminous but equally worrisome, particularly in the reported high rates of depression (Steinhardt, Jaggars, Faulk, & Gloria, 2011). These findings underscore the need for a seamlessly integrated approach to mental health support as an essential, currently under-addressed dimension of effective services for mothers and professional development for program staff.

Enhancing family economic stability

Beyond the importance of parenting skills, there is extensive evidence about the extent to which economic security plays a significant role in an adult's capacity to provide a stable, consistent, and appropriately stimulating environment in which a young child will thrive. When families are burdened by significant financial stress, they typically operate in a crisis-oriented mode that is often associated with poor self-regulatory behaviors and diminished impulse control in contrast to the more future-oriented mindset associated with financial security that offers the relative "luxury" of reflective planning and delayed gratification. Although a comprehensive review of this literature is beyond the scope of this paper, there is also growing empirical evidence that family poverty is particularly threatening to healthy development in the early childhood years (Duncan, Morris, & Rodrigues, 2011; Magnuson & Shager, 2010). Two explanatory theories have been postulated to clarify these findings. The first presents the straightforward argument that parents who have a stable source of adequate income are better able to provide sound nutrition, age-appropriate toys, higher quality child care, and other material benefits to their children (Bradley & Corwyn, 2002). The second explanation focuses on a wide range of stressors that make it difficult for economically insecure caregivers to provide and/or maintain the kind of well-regulated environment in which healthy development can happen. These may include the cumulative burden of such diverse threats as unpredictable or chaotic daily routines, residential crowding and exposure to excessive noise, and victimization from direct or passive witnessing of violence, among many other factors associated with poverty that can undermine a parent's ability to engage in more positive interactions with his or her young child on a more consistent basis (Evans & Kim, 2013).

Building on the foundational importance of these three domains, the following hypotheses suggest promising strategies for innovation in early childhood policy and practice that are worthy of exploration:

Hypothesis 1: Protecting children from the impacts of toxic stress requires capacity building, not simply the provision of information and support, for their caregivers.

Promoting resilience in young children who experience high levels of adversity depends upon the availability of adults who can help them develop effective coping skills that bring their overly activated stress response systems back to baseline. Caregivers who are able to provide that buffering protection have sound mental health and well-developed executive function skills in problem solving, planning, monitoring, and self-regulation. The synergistic effects of poor executive functioning and depression in low-income mothers and the resulting impacts on their daily interactions with their young children make these domains critically important targets for focused intervention, particularly given evidence that social class differences in self-regulation begin to appear in infancy. Parents and staff members in early childhood programs who have limited education levels, low socioeconomic status, and reduced exposure to circumstances that help build strong executive function skills are typically constrained in their ability

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to promote these capacities in their children. The low likelihood that difficulties in these areas will be overcome by the simple provision of information and advice about child development might explain why the impacts of such interventions are typically modest, particularly for those who are the most disadvantaged (Karoly et al., 2005). The fact that these skills can be strengthened through focused coaching, training, and practice suggests promising new intervention approaches to assist parents and early childhood program staff members whose needs are not addressed sufficiently by existing supports (Jolles, van Buchem, Rombouts, & Crone, 2012; Shonkoff, 2011).

Hypothesis 2: Interventions that improve the caregiving environment by strengthening executive function skills and promoting mental health in vulnerable parents will also enhance their employability, thereby providing a synergistic strategy for augmenting child outcomes by strengthening the economic and social stability of the family.

The disconnect between services focused on the developmental needs of vulnerable young children and programs focused on remedial education, workforce preparation, financial literacy, and asset building for adults living in poverty has been decried for decades. Rather than continuing heroic efforts to build bridges across systems in which the diversity of professional cultures and theories of change resist meaningful collaboration, advances in the developmental sciences offer a more promising, alternative strategy: to construct a single, conceptually unified framework for reducing the intergenerational transmission of poverty by focusing on a core set of adult capabilities that are essential prerequisites for success in the home and the workplace. Without minimizing the importance of sensitive periods in brain development during early childhood, the extended plasticity of the prefrontal cortex provides a strong rationale for targeted skill-building into the adult years (Lupien et al., 2009). Stated simply, the varied impacts of a wide range of interventions focused on such disparate outcomes as improved parenting or enhanced workforce skills all rest on a common foundation of core competencies that can be strengthened through focused training, coaching, and practice during any stage of development from infancy through the young adult years (Diamond et al., 2007; Jolles et al., 2012; Olesen, Westerberg, & Klingberg, 2004; Rabiner, Murray, Skinner, & Malone, 2010; Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005; Stevens, Fanning, Coch, Sanders, & Neville, 2008).

Hypothesis 3: Community-based initiatives and broad-based systems approaches are likely to be more effective in promoting healthy child development if they include an explicit focus on strengthening neighborhood-level resources and capacities that can prevent, reduce, or mitigate the adverse impacts of toxic stress on families.

Decades of place-based initiatives have been fueled by broad concepts such as building social capital, eliminating structural inequities, and promoting a sense of empowerment and collective self-efficacy (Brooks-Gunn, Duncan, & Aber, 1997; Sampson, Raudenbush, & Earls, 1997; Wilson, 1990, 1997). Further support for these actions has been provided by the emergence of ecological theories that emphasize the impact of socioeconomic and cultural influences on human development (Bronfenbrenner, 1979) and evolving policies and programs that focus on the broader context in which families raise children (Sameroff, 2010). Advances in the science of early childhood development and its underlying biology offer the opportunity to augment the impacts of current community-based efforts through theories of change targeting the causal mechanisms that link specific neighborhood-level interventions to explicit child outcomes (Radner & Shonkoff, 2012). The biology of adversity provides one example by supplying a compelling rationale for selectively targeting community-level precipitants of toxic stress in young children (e.g., endemic neighborhood violence or the absence of safe places for parents to congregate and build social capital).

In summary, science suggests that significantly greater impacts on the healthy development and life prospects of vulnerable young children could be achieved by focusing greater attention on strengthening the capabilities of their caregivers, improving the economic stability of their families, and building stress-buffering resources in their communities rather than by continuing to focus primarily on the provision of child-focused enrichment, parenting education, and informal support. With this objective in mind, the challenge for policymakers and practitioners is to move beyond the simple coordination of separate child- and adult-focused programs and to combine the best of both domains within a fully integrated, intergenerational strategy that is grounded in developmental science, aligned at the program, community, and policy levels, and committed to the pursuit of breakthrough outcomes in lifelong learning, behavior, and health.

Creating Environments That Drive Innovation

Beyond the development and implementation of new ideas, breakthrough impacts on the lives of children and their parents will demand a significant cultural shift in the way research, policy, and practice interact in the fields of child health and learning as well as in adult-focused poverty alleviation. This required change is reflected in the following five dimensions.

The first dimension (as noted earlier) is the critical need to *expand the definition of evidence* to include broadly accepted scientific principles from the biological and social sciences rather than restrict the definition to results of experimental evaluations and benefit–cost studies. Within these broader parameters, evidence-based innovation could include promising, untested strategies informed by research on developmental processes and their underlying neurobiology and by field-based studies that generate intriguing hypotheses derived from high-quality quantitative and/or qualitative data. The proposition that the physiological consequences of

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excessive adversity warrant interventions that reduce or mitigate the consequences of toxic stress is one such example of an evidence-based approach to program development. Randomized controlled trials that generate data on the effectiveness of existing programs produce an important part of the evidence base, but they are rarely a source of creative new ideas. However, when experimental studies of new interventions are used to illuminate causal pathways and test variable effects across contexts, segments, doses, and changes in key parameters, they can be a vital part of the innovation engine. The most important question is not whether randomized trials are important, but rather, how can we strengthen the evidence base for policy and practice by including other sources of knowledge?

The second dimension is the need to broaden our understanding of what we should be looking for in order to *designate a promising idea as worthy of testing*. Experience in a range of fields in which innovation is commonplace indicates that breakthrough strategies for young children and their families could include a creative combination of existing interventions, a new application or adaptation of a currently available policy or program, or the introduction of something entirely novel. Promising ideas should be supported by credible theories of change and positioned at the leading edge of their field, a place where high-risk, high-gain strategies are welcomed and where further refinements and new applications are expected to follow.

The third dimension is the need to *define breakthrough outcomes*. These could include (but should not be limited to) substantially larger effect sizes on particular measures for an existing target group, the extension of benefits to a more diverse population of children (particularly subgroups that are not reached by existing policies or services), and gains in cost-effectiveness that enable both improved application of a proven strategy and redeployment of cost savings to other effective programs, thereby leading to much larger impacts. Because no one innovation will result in improved health and development for all vulnerable children, the need for specificity will require that breakthrough outcomes be defined for each target group in a practical way that fits its needs and goals. The population of children and adults achieving those outcomes must then be measured as precisely as possible within a given program, community, or state context.

The fourth dimension is the need to *implement the notion of short-cycle sharing*. This requires a flexible approach to planning, funding, and action that promotes quick turnaround time for information exchange, encourages rapid discovery in the context of continuous change, and embraces the value of learning from failure. The contrast between this approach to innovation and conventional academic research is dramatic. The former typically involves multiple shifts in course within a single year. The latter requires strict adherence to a fixed protocol once a grant is approved (which can take as much as two years or more of proposal writing, submitting, and revising before funding begins) followed by several years of prescribed data collection and analysis. The short-cycle nature of the innovation process feeds on the continuous sharing of findings along the way while traditional academics delay dissemination until peer-reviewed results have been published (which often occurs about six or seven years after the original idea was formulated). The magnitude of the challenge facing academically based investigators who attempt this culture shift must not be underestimated.

The fifth dimension, which is critical to the implementation of an action plan involving short-cycle design, testing, evaluation, and sharing, is the need to *secure entrepreneurial funding support*. This bedrock requirement requires a special breed of investors who understand that the achievement of breakthrough impacts requires intellectual venture capital that accepts risk and fuels the interrelated capacities to seize opportunities, adjust quickly to short-cycle feedback, and engage leaders from multiple fields in a fast-changing process of co-creation that produces a stepwise process toward breakthrough outcomes (see Figure 2).

Crafting a Roadmap to a New Era in Science-Based Policy and Practice

The time has come to build on the best of our current efforts, mobilize advances in science to catalyze fresh thinking, and launch a new era in early childhood policy and practice that sets a higher bar for success by demanding significantly greater impacts on the lives of vulnerable children and their parents. Continuing to document relatively small effect sizes that meet the criteria for statistical significance must be viewed as an urgent call for new ideas, not as a reason to restrict funding solely to narrowly defined, evidence-based programs defined by rigorous experimental methods. Constructive dissatisfaction with the magnitude of current program effects and the call for innovative thinking are most likely to lead to breakthrough impacts if they are grounded in rigorous science, not driven by personal belief or unconditional loyalty to a specific program or intervention model.

As described throughout this paper, developmental science indicates that the search for more effective strategies to improve the lives of vulnerable young children ought to include greater attention to strengthening the capabilities of their caregivers and addressing the material needs of their families in order to assure a more appropriate balance between providing enriched experiences and facilitating protection from adversity. However, the translation of this proposition into a general call for two-generation approaches to poverty alleviation is neither a new nor a simple undertaking. The logic of a unified strategy to address the needs of disadvantaged children and their parents is supported by science and common sense, but the effective integration of adult- and child-focused policies is a complex challenge.

Few interventions that target adults with limited education and low income include explicit attention to the developmental needs of their clients' children. Similarly, programs for young children living in poverty rarely incorporate sufficient efforts to

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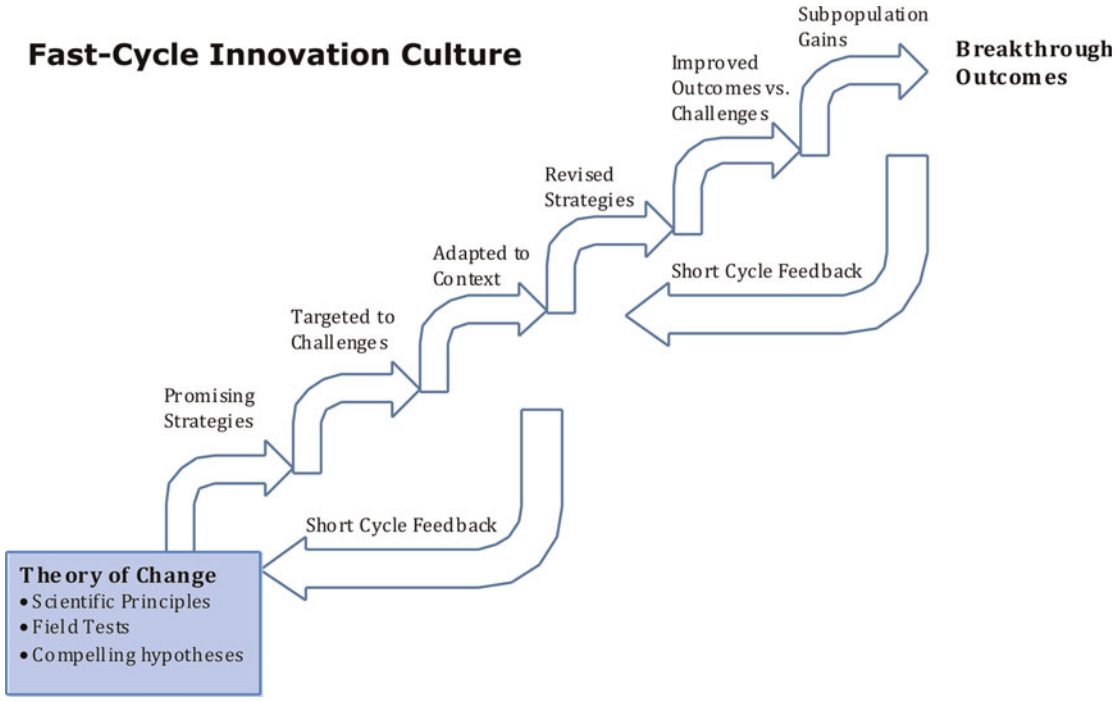

Figure 2. (Color online) How fast-cycle innovation leads to breakthrough outcomes.

materially influence the economic circumstances of their caregivers. Although experts from both areas agree that evidence-based approaches to child and parent needs together would be likely to generate greater and more enduring impacts, the variable magnitude of program effectiveness in both areas and the absence of an historical trend of increasingly stronger impacts in either domain suggest the hypothesis that achieving breakthrough outcomes for both children and their parents will require far more than simple colocation or enhanced coordination of efforts.

With that caveat as a backdrop and guided by widely accepted concepts of human development and its underlying biology, we envision a multistage process for achieving breakthrough impacts in both policy and practice. With much collaborative planning remaining to be done, such a process would be designed to catalyze the design, testing, refinement, and scaling of new models of intergenerational programming that focus on building the common core of foundational, adult capabilities that are necessary to be an effective parent, a productive worker, and a contributing member of society.

The early stages of this process are driven by the hypothesis that the impacts produced by separate program streams (i.e., early care and education for young children on the one hand and services focused on workforce development, financial literacy, and asset building for adults living in poverty on the other) will be increased by the synergistic effects of their enhanced coordination. Adding a shared commitment to innovation in program design will then move beyond the integration of existing services to the cocreation and cotesting of new interventions based on promising strategies, such as strengthening aspects of executive functioning, self-regulation, and mental health in low-income parents.

The most successful products of these early stages will create a foundation upon which to build. The next step will be to generate a new breed of service models that are no longer identifiable as the product of better coordination between separate programs but that represent fully hybridized strategies that strengthen child and adult outcomes together. The leading edge of these programs will then be tested, replicated, and adapted in a diversity of community settings. The final stage will be marked by widespread scaling up of successful strategies for a broad range of target groups and a complete transformation of poverty alleviation policies and early childhood practices across populations. At that point in the future, growing networks of highly effective programs within receptive, community-based systems will be fully aligned with coordinated policies and funding streams.

Although innovation can and should start anywhere, groups of innovators within specific geographic areas could join together around a medium-term goal of coordinating their efforts at multiple levels (i.e., from program to community to policy) toward a common outcome. Those "vertical alignment" approaches that are most likely to succeed will be built on a shared commitment to a conceptually unified, two-generation strategy and will coordinate the diverse components of that strategy to achieve specific outcomes for a defined population. This type of approach will help navigate between the futile search for "magic bullets" and the dysfunctional overload of multiple, "piled-on" services by coordinating a diversity of innovative program strategies within a variety of community contexts, all supported by locally aligned public systems and

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focused on applying an integrated, science-informed theory of change to achieve shared, population-level objectives.

In the final phase, the impacts of these aligned interventions will be substantially greater than those achieved by current investments. Building on their demonstrated success, the replication and broad dissemination of these new strategies will be facilitated by the favorable climate of an increasingly supportive political and philanthropic environment. The crowning feature of this multistage approach will be the documentation of significantly greater impacts on reducing disparities in learning, behavior, and health at a population level and the creation of an enduring commitment to the culture of innovation within the early childhood field.

Conclusions

Science tells us that children develop in an environment of relationships and that early childhood is a time of great opportunity and considerable risk. Building on these two fundamental concepts, almost half a century of early childhood policy and practice has generated a variety of strategies for providing enriched learning opportunities for vulnerable young children and parenting education and support for parents whose life circumstances are burdened by significant economic and social adversity. Over this same period, considerable investments have been made in a number of adult-focused initiatives designed to alleviate family poverty, including workforce development programs, cash-transfer policies, asset-building, and community-based interventions. Although positive effects have been demonstrated in all of these domains, the magnitude of their impacts has been relatively modest and variable, and limited social mobility remains a serious problem for increasing numbers of children growing up in the United States.

This paper is guided by the conclusion that the time has come to move beyond quality improvement alone and to invest greater energy in developing new ideas. The time has come to move beyond efforts to simply strengthen the linkages between child-focused and adult-focused services and to catalyze the creation of fully integrated, two-generational programs that produce large impacts that significantly exceed the sum of their parts. The time has come to create an environment that drives fresh thinking and facilitates creative experimentation by encouraging risk taking and making it safe to fail.

The time has come to leverage advances in the biological and social sciences to further elucidate causal mechanisms that explain disparities in learning, behavior, and health. The time has come to catalyze the formulation of enhanced theories of change to guide the design and testing of new strategies that will produce breakthrough impacts in reducing persistent, intergenerational disadvantage. The time has come for the scientific community to advance this compelling agenda by increasing the publication of intervention studies that did not achieve positive impacts yet generated new insights or lessons learned that can stimulate fresh thinking to fuel the innovation process.

The field of early childhood intervention can no longer tolerate a generic statement that more research is needed, nor can it continue to view neuroscience solely as a vehicle for building public support for investment in existing programs. The current revolution in the life sciences, particularly in the domains of neurobiology, molecular biology, genomics, and epigenetics, presents tremendous potential to catalyze transformational thinking about how to bend the trajectories of human health and development. The ongoing synthesis, translation, and application of knowledge at the frontiers of scientific discovery can and must drive a creative process of continuous experimentation in the quest for breakthrough impacts for children and adults experiencing significant adversity. The possibility for substantial change in our ability to address seemingly intractable problems is real. The price for not aiming high will be scientifically indefensible, economically exorbitant, and morally prohibitive.

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