A Science-Based Framework for Early Childhood Policy

Using Evidence to Improve Outcomes in Learning, Behavior, and Health for Vulnerable Children




Center on the Developing Child HARVARD UNIVERSITY
NATIONAL FORUM ON EARLY CHILDHOOD PROGRAM EVALUATION
NATIONAL SCIENTIFIC COUNCIL ON THE DEVELOPING CHILD

National Forum on Early Childhood Program Evaluation

Greg J. Duncan, Ph.D., Co-Chair
Edwina S. Tarry Professor of
Human Development and Social Policy,
Faculty Fellow, Institute for Policy Research,
Northwestern University

Jack P. Shonkoff, M.D., Co-Chair
Julius B. Richmond FAMRI Professor of
Child Health and Development,
Director, Center on the Developing Child,
Harvard University

Katherine Magnuson, Ph.D.
Assistant Professor,
School of Social Work,
University of Wisconsin, Madison

Deborah Phillips, Ph.D.
Professor of Psychology and Associated
Faculty, Public Policy Institute,
Co-Director, Research Center on
Children in the U.S.,
Georgetown University

Helen Raikes, Ph.D.
Professor, Family and Consumer Sciences,
University of Nebraska-Lincoln

Hirokazu Yoshikawa, Ph.D.
Professor of Education,
Harvard Graduate School of Education

National Scientific Council on the Developing Child

Council Members

Jack P. Shonkoff, M.D., Chair
Julius B. Richmond FAMRI Professor of
Child Health and Development,
Director, Center on the Developing Child,
Harvard University

W. Thomas Boyce, M.D.
Sunny Hill Health Centre/BC Leadership
Chair in Child Development,
Professor, Graduate Studies and Medicine,
University of British Columbia, Vancouver

Judy Cameron, Ph.D.
Professor of Psychiatry, University of Pittsburgh
Senior Scientist, Oregon National
Primate Research Center,
Professor of Behavioral Neuroscience
and Obstetrics & Gynecology,
Oregon Health and Science University

Greg J. Duncan, Ph.D.
Edwina S. Tarry Professor of
Human Development and Social Policy,
Faculty Fellow, Institute for Policy Research,
Northwestern University

Nathan A. Fox, Ph.D.
Professor of Human Development,
University of Maryland College Park

William Greenough, Ph.D.
Swanlund Professor of Psychology, Psychiatry,
and Cell and Developmental Biology,
Director, Center for Advanced Study at
University of Illinois, Urbana-Champaign

Megan Gunnar, Ph.D.
Regents Professor and Distinguished
McKnight University Professor,
Institute of Child Development,
University of Minnesota

Eric Knudsen, Ph.D.
Edward C. and Amy H. Sewall
Professor of Neurobiology,
Stanford University School of Medicine

Pat Levitt, Ph.D.
Professor of Pharmacology,
Annette Schaffer Eskind Chair and
Director, Kennedy Center for Research
on Human Development,
Vanderbilt University

Betsy Lozoff, M.D.
Professor of Pediatrics, University of
Michigan Medical School,
Research Professor, Center for
Human Growth and Development,
University of Michigan

Charles A. Nelson, Ph.D.
Richard David Scott Chair in Pediatric
Developmental Medicine Research,
Children's Hospital Boston,
Professor of Pediatrics,
Harvard Medical School

Deborah Phillips, Ph.D.
Professor of Psychology and Associated
Faculty, Public Policy Institute,
Co-Director, Research Center
on Children in the U.S.,
Georgetown University

Ross Thompson, Ph.D.
Professor of Psychology,
University of California, Davis

Contributing Members

Susan Nall Bales
President, FrameWorks Institute

Bruce S. McEwen, Ph.D.
Alfred E. Mirsky Professor,
Head, Harold and Margaret Milliken Hatch
Laboratory of Neuroendocrinology,
The Rockefeller University

Arthur J. Rolnick, Ph.D.
Senior Vice President and Director of Research,
Federal Reserve Bank of Minneapolis

Table of Contents

Suggested citation: Center on the Developing Child at Harvard University (2007). *A Science-Based Framework for Early Childhood Policy: Using Evidence to Improve Outcomes in Learning, Behavior, and Health for Vulnerable Children.* http://www.developingchild.harvard.edu

Executive Summary

It is widely recognized that the path to our nation's future prosperity and security begins with the well-being of all our children. To this end, one of the most important tasks facing policymakers is to choose wisely among strategies that address the needs of our youngest children and their families. Until now, confusing messages about which strategies actually can improve children's life chances have presented enormous challenges to this decision-making process. As scientists, we believe that advances in the science of early childhood and early brain development, combined with the findings of four decades of rigorous program evaluation research, can now provide a strong foundation upon which policymakers and civic leaders with diverse political values can design a common, effective, and politically viable agenda. With this goal in mind, we describe in this report the process by which brain architecture is formed in very young children, with special attention to the important influence of early experiences on the production of a weak or sturdy foundation for future development, and integrate this scientific knowledge with the identification of those factors from the program evaluation literature that appear to offer the best course toward positive outcomes for children. We believe that this combination of neuroscience, child development research, and program evaluation data can provide an informed and pragmatic framework for those engaged in policy design and implementation.

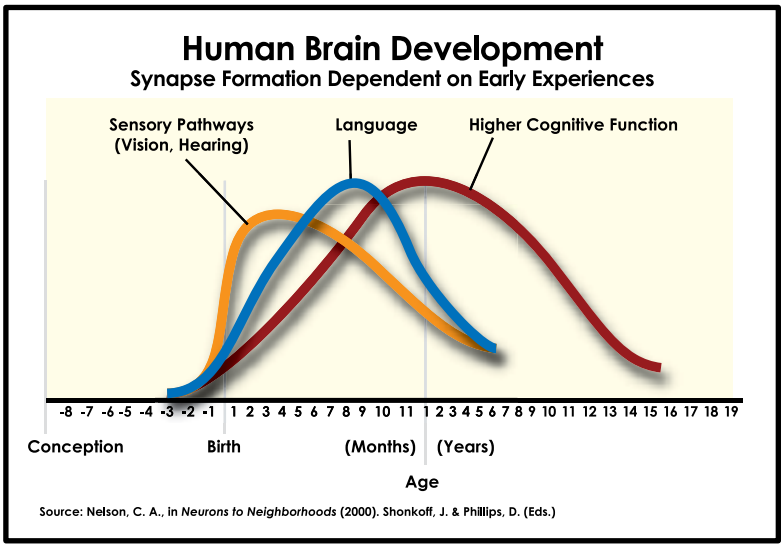
Early experiences determine whether a child's developing brain architecture provides a strong or weak foundation for all future learning, behavior, and health.

This paper builds on a process of systematic analysis that began with the publication in 2000 of a landmark report by the National Academy of Sciences entitled *From Neurons to Neighborhoods: The Science of Early Childhood Development*, followed by the ongoing work of the National Scientific Council on the Developing Child and the National Forum on Early Childhood Program Evaluation, both of which are based at the Center on the Developing Child at Harvard University. These groups of scientists and scholars engage in active debate about what the rapidly advancing biological and social sciences do and do not say about early childhood, brain development, and the impact of intervention programs. As agreement is reached on each issue, the groups integrate findings across disciplines and communicate this integrated information to policymakers and civic leaders to bring accurate knowledge to bear on public decision-making aimed at enhancing children's learning, behavior, and health.

Neuroscience and child development research address the *why* and *what* questions about investing in young children. The applied sciences of intervention and program evaluation attempt to answer questions about *when* and *how*. Four decades of data from a small number of intensive programs demonstrate that it is possible to improve a wide range of outcomes for vulnerable children well into the adult years, as well as generate benefits to society that far exceed program costs. But evaluations also have shown that many programs, particularly if they are designed or implemented poorly, have generated few to no

beneficial effects. Together, these findings provide an instructive and continuously growing body of knowledge about both successful and ineffective investments.

For the first time, researchers are now able to present a unified framework that can guide priorities for science-based early childhood policies and practices that are grounded in a combination of cutting-edge neuroscience, developmental-behavioral research, and program evaluation. Drawing on the best and most widely accepted evidence from all of these fields of study, we can confidently articulate the following findings.



Early experiences determine whether a child's developing brain architecture provides a strong or weak foundation for all future learning, behavior, and health. The brain is composed of billions of highly integrated sets of neural circuits (i.e., connections among brain cells) that are "wired" under the interactive influences of genetics, environment, and experience. Genes determine when circuits are formed, but a child's experiences shape how that formation unfolds. Children develop in an environment of relationships that begins within their family, extends into their community, and is affected by broader social and economic resources. From early infancy, they naturally reach out for interaction through such behaviors as babbling, making facial expressions, and uttering words, and they develop best when caring adults respond in warm, individualized, and stimulating ways. In contrast, when the environment is impoverished, neglectful, or abusive, the result can be a lifetime of increased risk for impairment in learning, behavior, and health.

Because brain architecture and skills are built continuously over time, policies that promote healthy development throughout the early years create a foundation for later school achievement, economic productivity, responsible citizenship, and successful parenting. For children at unusually high risk, neuroscience provides a compelling argument for beginning programs at birth, if not prenatally, since a substantial amount of brain circuitry is constructed very early in life. Developmental research shows that children master different skills at different ages, which suggests that opportunities for a variety of effective interventions are present throughout early childhood.

Four decades of program evaluation research point to a number of factors that can enhance positive development in the first five years of life. We have labeled these influences "effectiveness factors." The following principles draw on these findings and provide a framework for a variety of informed policy choices.

- **Access to basic medical care for pregnant women and children can help prevent threats to healthy development as well as provide early diagnosis and appropriate management when problems emerge.** Examples of well-documented benefits, among many others, include: the positive effects of adequate prenatal and early childhood nutrition on healthy brain development; improved outcomes for young children with developmental delays (or impairments in vision or hearing) when their difficulties are detected and early intervention is initiated; and the developmental benefits for very young children when parental problems such as maternal depression are identified and treated effectively.
- **For vulnerable families who are expecting a first child, early and intensive support by**

skilled home visitors can produce significant benefits for both the child and parents. One program model, which follows a detailed and effective curriculum provided by trained nurses beginning in the prenatal period and extending through the third year of life, has been studied extensively and shown to be highly effective. In contrast, few consistent impacts on child outcomes have been found in studies of low-intensity home visitation programs, services provided by poorly trained visitors, and programs with relatively low levels of family engagement.

- **For young children from low-income families, participation in very high-quality, center-based, early education programs has been demonstrated to enhance child cognitive and social development.** Effective center-based programs provide some combination of the following characteristics: (1) highly skilled teachers; (2) small class sizes and high adult-to-child ratios; (3) age-appropriate curricula and stimulating materials in a safe physical setting; (4) a language-rich environment; (5) warm, responsive interactions between staff and children; and (6) high and consistent levels of child participation. The most extensive evidence for the benefits of high-quality learning environments for children from low-income families comes from growing numbers of programs that serve three- and four-year-olds. Evaluations also have shown positive effects of some early care and education programs that began shortly after birth (e.g., the Abecedarian Program), but fewer long-term studies of these programs have been conducted.

A rich body of scientific knowledge is available to guide early childhood policies and practices.

- **For young children from families experiencing significant adversity, two-generation programs that simultaneously provide direct support for parents and high-quality, center-based care and education for the children can have positive impacts on both.** Some of the best-known early childhood evaluation research studied programs that provided a combination of services for children and parents. These include, among others, the Perry Preschool Project, the Infant Health and Development Program, Early Head Start, and Head Start itself. Although each of these programs has been associated with positive child outcomes, currently available knowledge does not tell us what mixture of program components best meets the needs of particular families and children.
- **For young children experiencing toxic stress from recurrent child abuse or neglect, severe maternal depression, parental substance abuse, or family violence, interventions that provide intensive services matched to the problems they are designed to address can prevent the disruption of brain architecture and promote better developmental outcomes.** Parents at high risk for child maltreatment, for example, have been found to benefit from model programs that provide individualized coaching aimed at increasing their awareness of specific child behaviors and encouraging them to use praise and nonviolent discipline strategies. Children of mothers with depression are also likely to benefit from interventions that treat the maternal symptoms and teach parents how to protect their children from the deleterious effects of their illness.
- **For families living under the poverty level, work-based income supplements for working parents have been demonstrated to boost the achievement of some young children.** Studies suggest that these benefits are most likely to occur in the later preschool years. Policy options available for those who wish to pursue this strategy include expanded income tax credits for low-income families, welfare reform policies that provide more money for low-income parents who are working, and employment support programs that reward full-time work with wage supplements for working parents with dependent children.
- **Environmental policies that reduce the level of neurotoxins in the environment will**

protect fetuses and young children from exposure to substances that are known to damage their developing brains. The reduction of lead in gasoline and paint is one example that has reduced a preventable cause of mental retardation, hyperactivity, and learning disabilities. In contrast, increasing levels of mercury in the food chain (particularly in certain types of fish) present a growing threat to the immature brains of fetuses and young children, despite the availability of technology to reduce emissions from coal-burning plants, which are the largest source of environmental methyl mercury.

- **No single program approach or mode of service delivery has been shown to be a magic bullet.** The diverse nature of the best practices described in this report demonstrates that there are a number of proven ways to promote the healthy development of young children. Moreover, the core concepts of neuroscience and child development remain equally valid, whatever the program category, administrative structure, or funding mechanism. This gives policymakers some latitude in choosing among program approaches to address specific objectives. The key is to select strategies that have documented effectiveness, assure that they are implemented well, and recognize the critical importance of a strong commitment to continuous program improvement.
- **"Scaling up" successful model interventions into effective, multi-site programs is a formidable challenge that can be addressed, at least in part, by establishing quality standards and monitoring service delivery on a routine basis.** Successful large-scale programs typically have organizations that provide rigorous assessment and periodic monitoring of the quality of individual implementation sites, as well as training and technical assistance for continuous quality improvement.
- **Return on investment is more important than up-front costs.** Without minimizing the reality of budget constraints, decisions regarding investments in young children and their families would be strengthened considerably by greater attention to long-term societal benefits relative to program costs. Cost-benefit studies demonstrate positive returns from some programs that target vulnerable children beginning as early as prenatally and as late as age four. However, research has not yet identified precisely how these returns differ by child age, level of risk, and program focus. In some cases, inexpensive services may generate sufficiently positive impacts to warrant their modest outlays. In other circumstances, expensive, comprehensive, multi-year programs may also provide long-term, positive returns. Model programs with proven benefits that are "scaled up" in low-cost, ineffective ways present a significant problem when short-term cost savings diminish their impact and reduce their ultimate investment value.

In summary, a rich body of scientific knowledge is available to guide informed early childhood policies and practices. This knowledge points to four key challenges that are worthy of sustained attention: (1) matching supports and services to the needs and strengths of the children and families to be served; (2) paying careful attention to the quality of implementation when effective model programs are taken to scale; (3) developing new intervention strategies for children and families for whom conventional approaches appear to have minimal impact; and (4) providing an environment that supports ongoing, constructive evaluation and continuous program improvement.

Building a Science-Based Framework for Early Childhood Policy

Introduction

A remarkable convergence of new knowledge about the developing brain, the human genome, molecular biology, and the interdependence of cognitive, social, and emotional development offers scientists and policymakers an exceptional opportunity that did not exist a decade ago. Now researchers are able to present a unified framework that can guide priorities for science-based early childhood policies built around common concepts (from neuroscience and developmental-behavioral research) and broadly accepted empirical findings (from four decades of program evaluation studies) that have been generated across these diverse fields of study.

In 2003, the Human Genome Project completed the task of identifying and sequencing the

The Continuum of Early Childhood Development

From the beginning of pregnancy to the first day of school, the ongoing construction of brain architecture and the emergence of increasingly complex behaviors and skills progress at a remarkable pace that is characterized by both continuity and change. Although there may be practical reasons for policymakers and program administrators to segment children by age ranges (e.g., birth to three versus three to five), neither developing brains nor emerging skills make such distinctions. Thus, the process of development is continuous and ongoing, but the maximal capacity of the immature brain to grow and change means that the early childhood years offer the ideal time to provide experiences that shape healthy brain circuits.[6]

• **Important prenatal influences on developing brain architecture** include the mother's health and nutritional status (such as adequate folic acid to prevent spina bifida), as well as potentially serious damage from certain prenatal infections (such as rubella, cytomegalovirus, and toxoplasmosis), environmental toxic exposures (such as mercury, lead, and organophosphate insecticides), and both legal and illegal drugs (such as alcohol, nicotine, and cocaine).[7] The threat of toxic exposures during pregnancy is particularly worrisome because widely available substances such as alcohol (which is the most common, known prenatal cause of mental retardation) and mercury (another potent cause of mental retardation, which is present at increasingly high levels in fish) are tolerated with minimal or no adverse effects in adults at doses that are highly damaging to the developing brains of embryos (during the first trimester of pregnancy), fetuses (during the second and third trimester), and young children (during the early childhood years).[8]

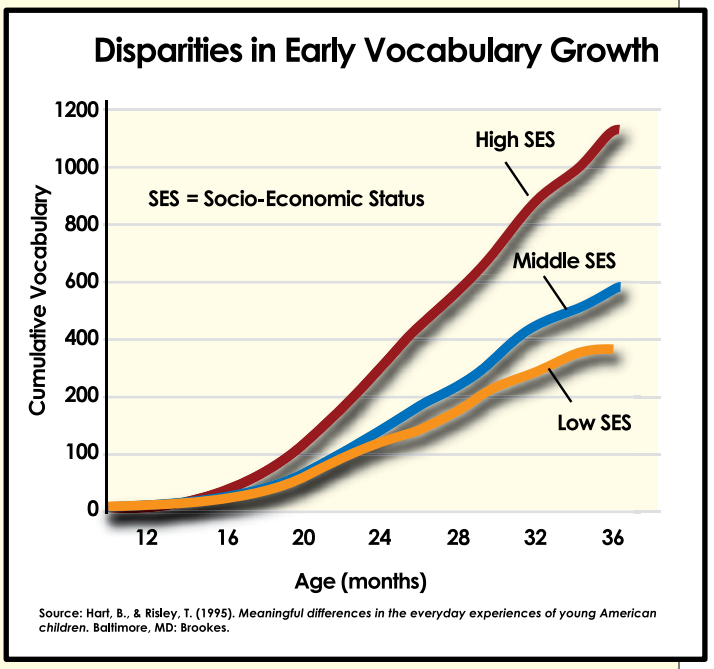
• **Adverse pre- and postnatal experiences** can have a profound effect on the course of health and development over a lifetime. The premise underlying this phenomenon, known as *developmental programming*, is that biological events that occur during fetal and postnatal life predispose the child to an elevated risk of subsequent problems in physical and mental health.[9] Babies with low birth weight, for example, have an increased lifetime risk for cardiovascular disease, diabetes, and learning difficulties.

• **The period between birth and three years** is a time of rapid cognitive, linguistic, social, emotional, and motor development. Explosive growth in vocabulary, for example, starts at around 15-18 months and continues into the preschool years. The ability to identify and regulate emotions in oneself and others is also well underway

three billion chemical base pairs that make up human DNA. This important scientific milestone followed shortly after the completion of the "Decade of the Brain," which was launched by the National Institute of Mental Health to promote an explosion of brain-focused scientific research and increase public interest in this fascinating organ. These extraordinary scientific efforts have produced a revolution in neuroscience and molecular biology that is already transforming our health care system. The challenge is to capitalize on this exciting, new science to build a strong foundation for improved learning and behavior that will produce better outcomes in academic achievement, economic productivity, responsible citizenship, and successful parenting of the next generation. Stated simply, we have an unprecedented opportunity to launch a new, science-driven era in early childhood policy and practice.

While this document does not detail how those policies might be implemented—we leave that challenge in the hands of those who work directly in the policy-making arena—we believe that the current state of knowledge is sufficiently strong to inspire a newly invigorated focus on policies and programs for young children and their families that are anchored to scientific evidence, truly bipartisan, and brought to scale most effectively through creative investments designed to benefit all of society.

by the second year. Language-rich, nurturing, and responsive caregiving fosters healthy development during this period, but not all children have such experiences. When inadequate stimulation is provided or barriers to opportunities for productive learning exist, these can lead to early disparities in capability that generally persist in the absence of effective intervention. Consequently, children who live in families with lower income and less parent education begin to score lower on standardized developmental tests as early as 18 months, and the differences typically increase into the school-age years.[10] Formal assessments of language development, for example, have shown that young children who grow up in homes with high incomes and high parent education levels have more than twice the expressive vocabulary at age three compared to children raised in homes characterized by low socioeconomic status.[11]



Source: Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experiences of young American children.* Baltimore, MD: Brookes.

• **Between three and five years of age**, there is an emergence of increasingly complex social behaviors, emotional capacities, problem-solving abilities, and pre-literacy skills that build on earlier developmental achievements and are essential building blocks for a successful life. By the ages of four and five, most children have learned the basics of the grammatical system in their language, can detect and identify simple emotions in themselves and others, begin to understand other people's points of view, experience emotions that are important to the development of conscience (e.g., shame and guilt), have learned the rudiments of how to negotiate with others to achieve common goals, and can sit quietly with a group of children and pay attention for at least brief periods of time. In the absence of intervention, early social class disparities in language and social-emotional development can become increasingly apparent during this period and grow with age.

The Science of Early Childhood Development

The basic science of development, including its underlying neurobiology, can be summarized in the following six core concepts. More detailed information on these concepts can be found in a companion document produced by the National Scientific Council on the Developing Child entitled *The Science of Early Childhood Development: Closing the Gap Between What We Know and What We Do*,[1] and in the Council's signature series of working papers.[2]

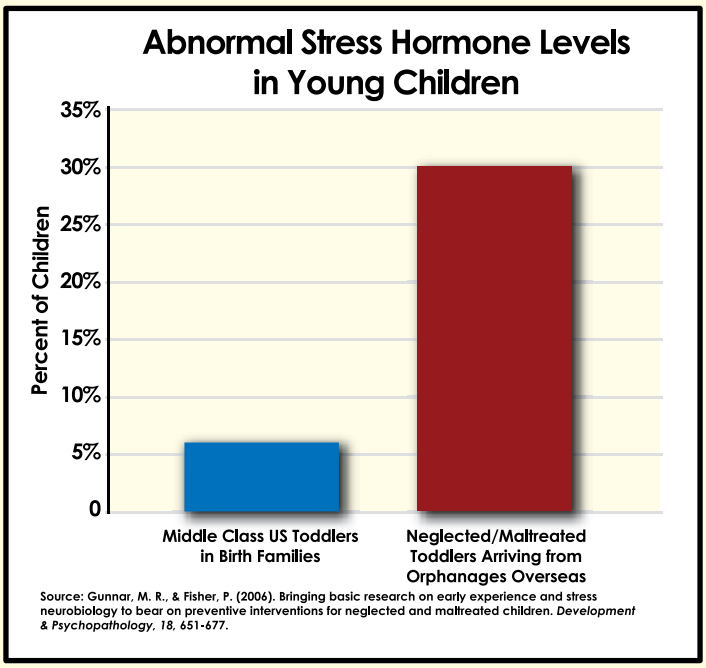
Brains are built over time and a substantial proportion is constructed during the early years of life. The basic architecture of the brain is constructed through an ongoing process, beginning before birth and continuing into early adulthood. Like the construction of a home, the building process begins with laying the foundation, framing the rooms, and wiring the electrical system in a predictable sequence, and it continues with the incorporation of distinctive features that reflect increasing individuality over time. A strong foundation in the early years increases the probability of positive outcomes, and a weak foundation increases the risk of later difficulties.[3]

The interactive influences of genes and experience shape the architecture of the developing brain, and the active ingredient in that process is the "serve and return" nature of children's relationships with their parents and other caregivers in their family and community. The architecture of the brain is composed of highly integrated sets of neural circuits (i.e., connections among brain cells) that are "wired" under the continuous and mutual influences of both genetics and environment. Genes determine when specific brain circuits are formed and experiences shape their formation. This developmental process is fueled by a self-initiated, inborn drive toward competence that depends on appropriate sensory input (e.g., through hearing and vision) and stable, responsive relationships to build healthy brain architecture. What scientists refer to as "mutuality and reciprocity" describes this "serve and return" process in which young children naturally reach out for interaction through such behaviors as babbling, facial expressions, and words, and adults respond with responsive vocalizing and gesturing back at them, as the process continues back and forth like a game of tennis or volleyball. Children's experiences with all of the people who are important to them have an influence on their brain's structure and function. These relationships begin in the family but often also involve other adults who play important roles in their lives.[4]

Both brain architecture and developing skills are built "from the bottom up," with simple circuits and skills providing the scaffolding for more advanced circuits and skills over time. The brain is built in an ordered sequence that is associated with the formation of specific circuits that influence particular abilities. Once a circuit is up and operating, it participates in the construction of later-developing circuits. Brain circuits that process basic information are wired earlier than those that process more complex information. Higher-level circuits build on lower-level circuits, and adaptation at higher levels is more difficult if lower-level circuits were not wired properly. Parallel to the construction of brain circuits, increasingly complex skills build on the more basic, foundational capabilities that precede them. Stated in simple terms, circuits build on circuits and skills beget skills.[5]

Stress and the Developing Brain

Stress in early childhood can be either growth-promoting or toxic to developing brain architecture and physical health. Different effects depend on the intensity and duration of the experience, differences among children in the magnitude of their body's stress reactions, and the extent to which a supportive adult is available to help the child cope with the adversity. These differences can be understood within the context of three types of stress experience that lead to different outcomes.[14]



• The first, called ***positive stress***, is associated with moderate, short-lived physiological responses, such as brief increases in heart rate and blood pressure or mild elevations in cortisol or cytokine levels. Positive stress (e.g., associated with meeting new people or dealing with frustration) is an important and necessary aspect of healthy development. It occurs in the context of stable and supportive relationships, which help to keep physiological stress responses small and manageable, and assist the child to develop increasing mastery and self-control.

• The second kind of stress experience, called ***tolerable stress***, is associated with events that could trigger physiological responses large enough to disrupt brain architecture, but are relieved by supportive relationships that facilitate adaptive coping and thereby restore heart rate and stress hormone levels to their baseline. These kinds of experiences (e.g., death of a loved one, divorce of one's parents, a natural disaster such as Hurricane Katrina, or an act of terrorism such as 9-11) could have long-term consequences, including the development of clinically significant post-traumatic stress disorder. What makes them tolerable rather than invariably harmful is the presence of trusted and supportive adults whose actions protect the child by reducing the sense of being overwhelmed and whose availability literally turns down the child's stress response system (i.e., heart rate, blood pressure, and stress hormones). Most often this support is provided by parents and their informal support system. When a stressful experience overwhelms the family's capacity to cope, professional assistance can make a substantial difference. The resulting return of stress hormones to baseline levels gives the brain an opportunity to recover from the potentially damaging effects of an overactive stress management system, and thus prevents permanent harm.

• The third and most threatening kind of stress experience, called ***toxic stress***, is associated with strong and prolonged activation of the body's stress response systems in the absence of the buffering protection of adult support. Stressors include recurrent child abuse or neglect, severe maternal depression, parental substance abuse, or family violence. Under such circumstances, persistent elevations of stress hormones and altered levels of key brain chemicals produce an internal physiological state that disrupts the architecture and chemistry of the developing brain. Although individuals differ in their physiological responsiveness and adaptive capacities, these bodily reactions can lead to difficulties in learning and memory, as well as health-damaging behaviors and later adult lifestyles that undermine well-being over time.[15] Continuous activation of the stress response system also can produce disruptions of the immune system and metabolic regulatory functions. In fact, science has shown that toxic stress in early childhood can result in a lifetime of greater susceptibility to physical illnesses (such as cardiovascular disease, hypertension, obesity, diabetes, and stroke) as well as mental health problems (such as depression, anxiety disorders, and substance abuse).[16]

Cognitive, emotional, and social capabilities are inextricably intertwined throughout the life course, and their interactive relationship develops in a continuous process over time. The brain is a highly integrated organ, and its multiple functions operate in a richly coordinated fashion. All of our human capabilities develop through a process that is both simultaneous and deeply inter-connected. Thus, emotional well-being, social competence, and emerging cognitive abilities are highly inter-related, and together they are the bricks and mortar that comprise the foundation for human development.[12]

Toxic stress in early childhood is associated with disruptive effects on the nervous system and stress hormone regulatory systems that can damage developing brain architecture and chemistry and lead to lifelong problems in learning, behavior, and both physical and mental health. Activation of the body's stress management systems produces a variety of physiological reactions. These include an increase in heart rate, a rise in blood pressure, and elevated blood levels of stress hormones (e.g., cortisol) and proteins associated with inflammation (e.g., cytokines). Such responses prepare the body to deal with threat and are essential to survival. Healthy development depends on the capacity of these systems to ramp up rapidly in the face of stress, as well as their ability to ramp back down and return to baseline when they have done their job. When these physiological responses remain activated at high levels over a long period of time, they can have adverse effects on developing brain architecture, which weakens the foundation upon which future learning, behavior, and health are built.[13]

It is possible to improve a wide range of outcomes for vulnerable children well into the adult years, as well as generate benefits to society far in excess of program costs.

The basic principles of neuroscience tell us that providing the right conditions for healthy development in early childhood is likely to be more effective than treating problems at a later age. As the maturing brain becomes more specialized to assume more complex functions, it becomes less capable of reorganizing and adapting to new or unexpected challenges. Once a circuit is "wired," it stabilizes with age, making it increasingly more difficult to alter over time. Scientists use the term "plasticity" to refer to the capacity of brain architecture and function to change. Plasticity is maximal in childhood and decreases with age. Although "windows of opportunity" for skill development and behavioral adaptation remain open for many years, trying to change behavior or build new skills on a foundation of brain circuits that were not wired properly when they were first formed requires more work and is more expensive. For the brain, the notion of "more expensive" means that greater amounts of metabolic energy are needed to compensate for circuits that do not perform in an expected fashion.[17]

The Science of Program Evaluation:

Effectiveness Factors for Early Childhood Policies and Programs

The basic science of early childhood and early brain development answers the *why* and *what* questions about investing in young children. The applied science of intervention and program evaluation is essential to answer the *when* and *how* questions. Over the past four decades, a compelling body of empirical data from a relatively small number of successful programs has begun to answer these latter questions for young children who are at risk for poor life outcomes. The analysis of these data by child development researchers, education specialists, and economists has

shown that it is possible to improve a wide range of outcomes for vulnerable children well into the adult years, as well as generate benefits to society far in excess of program costs. Over this same 40-year period, however, evaluations also have shown that many interventions, particularly those that are poorly planned or implemented, have generated few to no beneficial effects. Together, these positive and negative findings have contributed to a growing body of knowledge about both successful and ineffective programs and/or practices.

Because the selection of outcome variables has varied across studies, the question of what constitutes a successful early childhood program impact does not have a single answer. Within this context, evaluation research has included various combinations of standardized developmental assessments in the preschool years; measures of academic achievement, grade retention, and need for special education during the school-age years; and long-term data on high school graduation rates, unintended pregnancy, employment status, income, dependence on public assistance, home ownership, and incarceration in the late adolescent and adult years.[18]

An important challenge confronting policymakers who are trying to design and implement effective policies for all young children and their families, and particularly for those who are most vulnerable, is to understand what is possible from successful models and then to replicate the essential elements of effective interventions in scaled-up programs. Central to meeting this challenge is the need to differentiate rigorous evaluation research from inappropriately designed or poorly conducted studies that do not meet conventional scientific standards. The most powerful data on program effectiveness come from experimental studies in which participants are randomly assigned to either an intervention or control group. Additional information of value can be gleaned from non-experimental research, but such studies cannot definitively answer questions about cause and effect. This document provides an overview of what has been learned from high-quality evaluation research that meets rigorous scientific standards. The scope of the report includes programs that delivered services between the prenatal period and age five years.

Effect Sizes

Evaluation studies often express program impacts in terms of "effect sizes." These are differences between parents or children who receive program services and parents or children in the control (comparison) group, expressed as a fraction of the variation (standard deviation) of the outcome. For example, in the case of the SAT college entrance test scores, the standard deviation is 100. An early education program with sufficiently enduring impacts that led program children to score 30 more points on their SAT tests than control-group children would have an effect size of 0.30. Effect sizes are useful because they offer researchers the ability to compare program effects across a range of different tests and assessments using a common metric.

Conventional guidelines consider effect sizes as "large" if the program versus control difference is at least 0.80 standard deviations; "moderate" if the impact is 0.30 to 0.80 standard deviations; and "small" if the impact is 0.30 or less.[112] We use these adjectives throughout our report to characterize impacts from program evaluations.

It is tempting to conclude that "large" effects make for better policy than "small" effects. Unfortunately, effect sizes can provide incomplete and at times, misleading guidance to policymakers. It is important to recognize that sometimes small effects may translate into meaningful differences in children's lives. In addition, it is possible that small effects across a range of domains taken together may also lead to important improvements. A cost-benefit approach may be more useful because it quantifies the value of a program's effects *relative to the costs incurred in achieving them*. Thus, an inexpensive program that produces small but economically valuable outcomes may make for good policy, while a very expensive program that produces larger, but not proportionately larger, effects may not.

The following sections focus on the multiple environments within which children develop and summarize what evaluation science has to say about maximizing the contribution of these environments to the production of healthy outcomes. To this end, we identify five "contexts" for which sufficient data exist to provide important lessons for policy consideration: (1) the nuclear family; (2) out-of-home settings; (3) multi-generational programs; (4) family economics and maternal employment; and (5) environmental contamination. In each context we identify, to the degree possible, the effectiveness factors that emerge from the scientific literature about successful interventions.

Helping Children by Strengthening their Family Environment

Improving Health and Nutrition. Given the multitude of preventable threats to brain architecture early in life, high-quality health care and adequate nutrition before birth (for pregnant women) and after birth (for both the primary caregiver and baby) are fundamental to the promotion of healthy child development. Providing access to affordable health services (including mental health care, when needed) is, therefore, one of the most effective policies available for reducing perinatal and early childhood health impairments.[19]

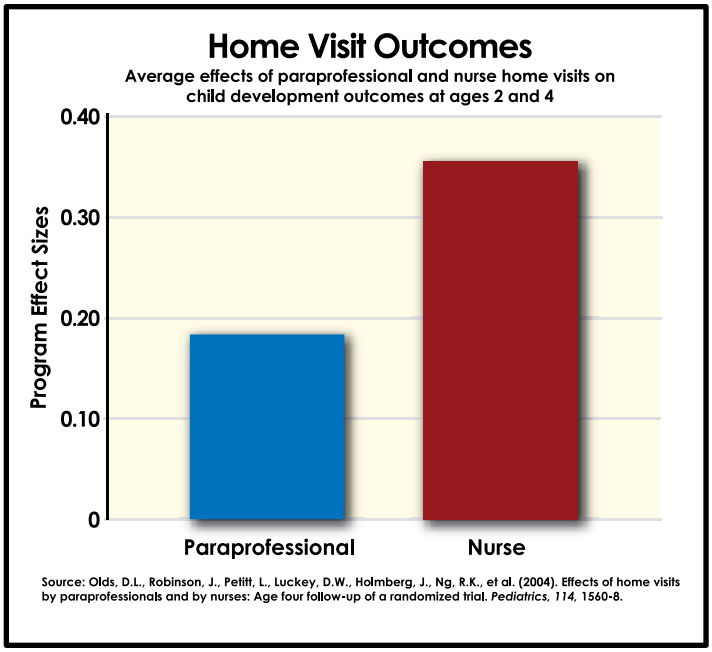
Before birth, the developing brain architecture of a fetus can be disrupted by poor maternal nutrition, exposure to a variety of hazardous substances (including recreational substances, such as alcohol and cocaine, and environmental toxins, such as organophosphate pesticides, mercury, and lead), and the adverse physiological effects of a pregnant woman's chronic stress. Access to prenatal health care can help identify such high-risk circumstances and provide a vehicle for addressing hazards to healthy brain development in a preventive fashion. After birth, a regular source of primary health care for children can be an important vehicle for identifying and initiating early intervention for concerns that could lead to more serious problems later in learning, behavior, and both physical and mental health.[20] In addition to its traditional focus on health supervision, pediatric care also has been shown to be capable of improving the chances that mothers will read to their children.[21]

Beyond the extent to which investments in prenatal care have generated favorable benefit-cost returns[22], mothers who participate in the Supplemental Food Program for Women, Infants, and Children (WIC) are less likely to bear low birth-weight or pre-term infants, both of which are associated with lower educational achievement, lower probability of employment, and lower earnings as an adult.[23] Research also shows that the WIC program is especially effective for families who are at greatest risk for poor nutrition.[24] Although not all studies point to such positive conclusions,[25] the preponderance of the evidence supports these findings.[26]

Effectiveness Factors for Home Visiting Programs. Most families adapt successfully to the challenges of preparing for a newborn's birth and caring for a young baby. Nevertheless, this transition can be a difficult time, particularly for first-time parents who may be socially isolated or experiencing severe adversity (which can result in the experience of toxic stress by their babies). Under such circumstances, home visiting services can provide critical support and have positive impacts on a variety of outcomes. Not every home visiting program, however, has proven equally effective.

A study reviewing the characteristics of home visiting programs that were most likely to be effective found that those serving targeted populations (i.e., narrower selection criteria than all families in poverty) were more likely to have measurable benefits. Home visitation was also found more likely to be successful if it is provided by well-trained and adequately supervised professional staff who implement a range of services guided by clear goals, and who are successful in engaging families for the duration of the program.[27]

The home visiting program with the strongest evidence of success, which has been replicated in multiple settings across the country, is the model introduced by the Nurse Family Partnership. This program provides home visits by trained nurses, starting in the second trimester before birth, although some families begin services later in the prenatal period. The relative high intensity of this service model (roughly 50 visits from the prenatal period to age two years, with weekly visits at the beginning of the program and immediately after birth) differentiates it from other predominantly home-based services. Visits focus on improving pregnancy outcomes, enhancing child health and development through improvements in parenting and access to health care, and enhancing the mother's life course by facilitating goals in education, employment, and partner/family involvement.



In a series of rigorous experimental evaluations, the Nurse Family Partnership has produced multiple, positive impacts on families and children, including fewer subsequent pregnancies, increased maternal employment, higher cognitive performance, and better social behavior by children in the preschool years, as well as (in the study with the longest-term follow-up) fewer arrests in adolescence.[28] Moreover, an experiment comparing program impacts when home visits were provided by paraprofessionals (versus skilled nurses) found positive effects roughly twice as large for the nurse-delivered intervention. This program appears to be effective for young, first-time mothers living in poverty, perhaps because they may be more likely to perceive the need for information and formal support, and be more open to accept visitors into their homes.[29] Its results have not been replicated for other target groups.

Evaluations of other home visiting models have shown less consistent positive impacts.[30] One example is Healthy Families America (HFA), a program to prevent child maltreatment that was modeled after the Hawaii Healthy Start Program, which was developed in the early 1990s and implemented state-wide in several states. The core of this program involved identifying parents at high risk of abusing or neglecting their children through broad-based screening and then offering voluntary home visiting services delivered by paraprofessionals for a period of three to five years.[31] Home visitors were expected to provide a range of services including service referrals, modeling problem-solving skills, and parent education. Randomized trials have yielded mixed findings. One study conducted in Hawaii yielded disappointing results, with as many negative impacts as positive effects on key family process outcomes.[32] In contrast, a study in New York showed promising reductions in harsh parenting during the first year of the program, although fewer effects on other dimensions.[33]

Several explanations for the lack of results in the Hawaii study were offered by the evaluators.[34] First,

the program may have been poorly implemented, as 51 percent of the parents dropped out within the first year and participating families received fewer home visits than intended. Second, evaluators questioned whether the paraprofessional staff had sufficient skills to identify high-risk situations and engage parents in the process of reducing risks associated with abusive parenting. Finally, to accommodate funding requirements, the program shifted away from an emphasis on recognizing and addressing risks for abusive parenting and moved toward an early intervention philosophy of parent-driven goal-setting, which may have compromised its effectiveness.

A recent evaluation of an augmented Healthy Families America program, with a sharper focus on using a specific intervention (i.e., cognitive appraisal theory) to reduce risks for abuse and neglect, as well as better implementation practices, yielded considerably more favorable results compared with both the unenhanced HFA program and a control group that did not receive any home visiting services.[35] These positive findings were particularly evident for medically vulnerable infants, such as those born prematurely or those with low Apgar scores at birth. Although the study was small, and thus in need of replication, the lessons learned (i.e., the importance of engaging families, providing high-quality training and ongoing supervision of staff, and ensuring consistent and well-implemented service delivery) illustrate the value of evaluating and refining program improvements rather than terminating potentially effective services that produce initially disappointing results.[36]

Focusing Supports on Sources of Toxic Stress. Finally, families in greatest need of support (e.g., parents with mental health or substance abuse problems, parents experiencing high levels of conflict or violence, or parents at risk for child maltreatment) may benefit from more focused services targeted to the particular sources of their stress. For example, parents at high risk for child abuse have been found to benefit from individualized coaching to increase their awareness of specific child behaviors and to use praise and nonviolent discipline strategies.[37] Similarly, young children of mothers with depression are likely to benefit from interventions that treat maternal symptoms and teach parents how to protect their children from the deleterious effects of their illness.[38] The targeting of services to particular needs requires a family-focused screening process for sources of excessive stress before, at, or soon after birth. Although some monitoring strategies have been implemented in pediatric care systems (e.g., for postpartum depression), screening for other kinds of risk factors and comparisons of different approaches to monitoring and follow-up are scarce .[39]

Policy Implications

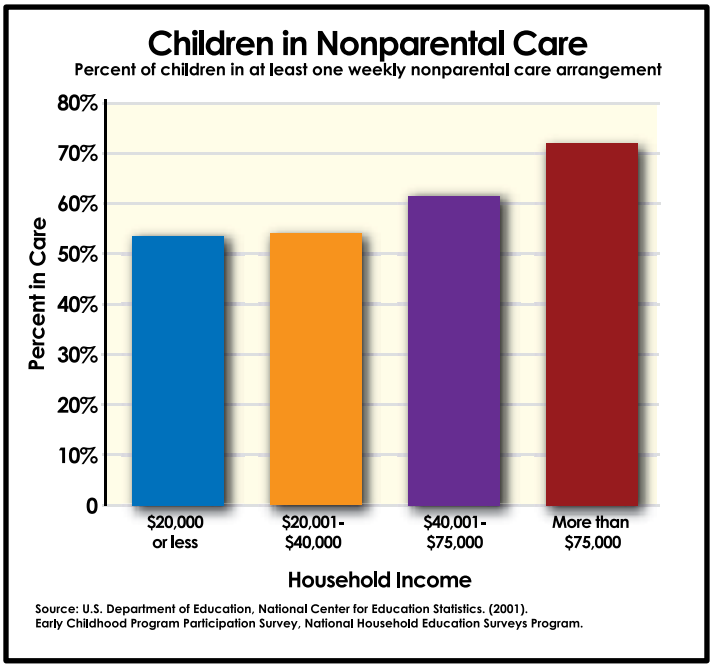
Access to basic medical care for pregnant women and children can help prevent threats to healthy development, as well as provide early detection and intervention for problems that emerge. The unique nature of the U.S. health care system depends on a complex mix of federal, state, work-related, and personal finance mechanisms. While the science of early childhood development and intervention has nothing to say about health care financing or the formulation of optimal health insurance policies, it clearly points to the benefits of consistent, uninterrupted

access to health care for all pregnant women and children. Well-documented benefits include, among many others, the positive effects of adequate prenatal and early childhood nutrition on healthy brain development; improved outcomes for young children with developmental delays (or impairments in vision or hearing) when their difficulties are detected and early intervention is initiated; and the developmental benefits for very young children when parental problems, such as maternal depression, are identified and treated effectively.

Intensive family support through home visiting by skilled personnel can produce benefits for children and parents, especially when it is targeted to families at particular risk. The best studied and most effective example of this model to date provides nurse home visitation targeted to first-time parents who are living in poverty. Programs of low intensity (for example, fewer than 10 visits) and services that are provided on a universal basis appear unlikely to produce significant benefits. In addition, effective services are designed to address identified risks and stresses, dependent on the qualifications and skills of the staff, and associated with the quality of the home visitors' engagement with parents.

Serving Children in Out-of-Home Environments: Early Care and Education

The science of child development tells us that significant variations in the quality of early care and education programs have the potential to produce lasting repercussions for both children and society as a whole.[40] Evidence points to the beneficial impacts at the highest end of the quality spectrum and to detrimental impacts at the lowest end. For children whose life circumstances lead to greater vulnerability, the nature of their out-of-home experiences is particularly important and the potential impacts are greater.



Transitions into and among out-of-home child care arrangements vary greatly in the first years of life. These variations include differences in timing (early vs. later), setting (center-based, relative, or nonrelative family care arrangements), auspices (public vs. private funding sources, secular vs. faith-based programs, for-profit vs. not-for-profit centers), and quality as measured by both structural indicators (e.g., the physical environment, materials, group size, child-adult ratio) and process indicators (e.g., caregiver stimulation, warmth, and discipline). Given the large number of children in the United States who experience some form of non-parental care of highly variable quality, the application of science-based effectiveness factors to policy and program design offers important benefits.

Effectiveness Factors for Center-Based Programs. A number of intensive programs providing early care and education experiences for infants and toddlers at risk for problems have successfully boosted cognitive performance, with effects in some cases lasting for years after the termination of services.[41] Several random-assignment studies suggest that programs beginning in infancy have the potential to affect key outcomes for vulnerable children during the period from birth to three years. The best known is the Abecedarian Program, which provided a full-day, center-based, educational program for children who were at high risk for school failure, starting

in early infancy and continuing until school entry. Despite its $18,000 annual cost, this program is estimated to have returned roughly $3 for every $1 invested.[42] What isn't known is how much each individual program component contributed to these long-term program effects.

Very high-quality early care and education programs for vulnerable preschoolers can produce short-term gains on standardized cognitive and social-emotional measures and longer-run reductions in grade retentions, suspensions, and referrals for special education services.[43] Evaluations of such programs have shown that, as a group, this form of intervention can produce benefits that outweigh costs when provided to three- and four-year-olds from low-income families.[44]

Beyond the documented impacts of intensive model programs, it is important to assess the benefits of scaled-up, center-based programs that are actually in operation. In this regard, a number of recent studies have examined the short-term effects of state-initiated pre-K programs on children's test scores.[45] One investigation of pre-K programs implemented in five states found small effects on receptive vocabulary and math and moderate to large effects on print awareness.[46] A study of Oklahoma's universal pre-K program conducted in Tulsa (which has the largest school system in the state) found large effects on pre-reading and pre-writing skills and moderate effects on early math scores for children from all racial-ethnic and income groups.[47]

Although early care and education programs vary greatly and some of the evidence for their effectiveness is mixed, the principal elements that have consistently produced positive impacts include: (1) highly skilled teachers;[48] (2) small class sizes and high adult-to-child ratios;[49] (3) age-appropriate curricula and stimulating materials in a safe physical setting;[50] (4) a language-rich environment;[51] (5) warm, responsive interactions between staff and children;[52] and (6) high and consistent levels of child participation.[53]

Most successful programs have included nearly all of these elements. The question that the available data do not answer, however, is whether any of these program features are more important than others or whether the full combination is essential to achieve the strongest impacts. For example, although it is possible that improvements in particular dimensions of program quality, such as a stronger curriculum, may be more influential than others, current knowledge does not give us the information needed to differentiate among multiple, positive program characteristics.

Questions also remain about the threshold of quality that must be crossed in order to see consistent and enduring developmental benefits from out-of-home care and education programs. Previous efforts to address this important question have been inconclusive with respect to whether modest increments in community-based child care quality are correlated with children's later cognitive ability, school achievement, or social behaviors. However, studies of children from low-income families that have reported associations between variations in quality among typical child care settings and developmental outcomes for children underscore the need for greater policy attention to this concern.[54]

Standards for Child Care

Recommended by the American Academy of Pediatrics and the American Public Health Association

Child Age Range	Child-to-Adult Ratios	Maximum Group Sizes
Birth – 12 months	3:1	6
13 – 30 months	4:1	8
31 – 35 months	5:1	10
3 years	7:1	14
4 – 5 years	8:1	16

Source: American Academy of Pediatrics, American Public Health Association, and National Resource Center for Health and Safety in Child Care and Early Education (2002). *Caring for Our Children: National Health and Safety Performance Standards: Guidelines for Out-of-Home Child Care Programs, 2nd edition.* Elk Grove Village, IL: American Academy of Pediatrics and Washington, DC: American Public Health Association. http://nrc.uchsc.edu.

The Problem of Unsafe and Poor Quality Programs. Numerous studies of early care and education settings in the United States have documented that extremely wide variation in quality is the norm. Of greatest concern, the largest, multi-state, observational study to date—the NICHD Study of Early Child Care and Youth Development—found that 26 percent of infant care settings were characterized by moderately or highly insensitive care-giving, and 75 percent were minimally or not at all stimulating.[55] For preschool-age children, positive care-giving (defined as sensitive and stimulating adult-child interactions) was uncharacteristic or not at all characteristic in over half of all child care settings.[56] Overall ratings of quality revealed that 12 percent of observed centers and 11 percent of home-based arrangements provided poor quality care for both toddlers and preschoolers.

The principal elements that have consistently produced positive impacts include:

- **highly skilled teachers;**
- **small class sizes and high adult-to-child ratios;**
- **age-appropriate curricula and stimulating materials in a safe physical setting;**
- **a language-rich environment;**
- **warm, responsive interactions between staff and children; and**
- **high and consistent levels of child participation.**

At this lower end of the quality spectrum, basic safety and protection are significant concerns for all young children, poor and non-poor alike. For example, a 1998 study of 220 licensed child care facilities by the Consumer Product Safety Commission found at least one safety hazard in two-thirds of the settings they visited. These included cribs with soft bedding that posed suffocation risks, no safety gates on stairs, unsafe (or no) playground surfacing, and use of recalled products.[57] The magnitude of this problem is underscored by data from the multi-site, NICHD Study of Early Child Care and Youth Development, which found that 20 percent of child care centers failed to meet any of the basic standards for six- and 15-month olds established by the American Public Health Association and American Academy of Pediatrics.[58]

Current federal policy provides funding for states to improve the quality of child care through the Child Development Fund. Nevertheless, there is a paucity of national and state-level data about whether these investments actually have succeeded in raising the quality of care, particularly for children from low income families, or whether they have produced better developmental outcomes for children.[59]

The fact that all young children in the U.S. military's exemplary child care system enjoy access to either center-based or family settings that provide rich learning experiences in a safe and health-promoting environment demonstrates what can be accomplished if quality standards are established and enforced.[60] According to a 2006 Annual Report, 97 percent of the military's child development centers meet the professional standards of quality required to be accredited by the National Association for the Education of Young Children.[61] For comparison purposes, it is noteworthy that the average rate of accredited centers across the 50 states is eight percent, and the highest state figure is 40 percent in Massachusetts.[62]

Effects on Young Children Who Spend Extensive Time in Out-of-Home Care. Persistent concerns have been raised about whether long hours in non-parental care—especially center-based care with its exposure to large peer groups—have negative effects on children's long-term social behavior. Although studies have shown statistically significant differences in behavioral ratings of aggressive or assertive behaviors, the magnitude of the differences is small, a minority of children is affected, and the children's behavior is within the range of normal variability for the age groups involved.[63]

Policy Implications

The participation of children from low-income families in very high-quality early education centers can enhance their developmental outcomes. Evidence from program evaluation research supports efforts to enroll children who are living in poverty in high-quality early care and education programs, beginning at age three, and, in some cases, earlier. Well-implemented, effective programs can increase the odds that children will have the kinds of experiences and interactions that produce long-term, positive benefits in academic achievement, social and emotional adjustment, economic productivity, and responsible citizenship. The basic concepts of neuroscience and child development research indicate that early environments that do not provide such growth-promoting experiences, beginning in early infancy, miss out on key windows of opportunity for building healthy brain architecture and mastering important foundational skills that are building blocks for increasingly complex brain circuits and capacities over time.

The well-being of all young children requires greater public attention to early care and education settings that fail to meet minimal standards for health and safety. National health and safety performance standards for out-of-home child care programs have been formulated by a joint effort of the American Public Health Association and American Academy of Pediatrics. Despite the existence of these standards, many child care settings in the United States, particularly those for infants and toddlers, operate outside the protective net of basic safety provisions and monitoring.

Multi-Generational Programs: Combining Support for Vulnerable Families with Direct Services for Children

Since the original design of the Head Start program in 1965, the concept of providing support for low-income parents in conjunction with high-quality, center-based care and education experiences for their young children has been implemented in many program models. The rationale for this blended approach is to focus broadly on the environment of relationships within which young children develop and to strengthen those aspects that are associated with improved cognitive, linguistic, social, emotional, and health outcomes for children who are at risk for problems.[64] In practice, these programs vary greatly in their intensity, duration, and component services, as well as in their effectiveness.

Small-Scale Demonstrations: What We Have Learned. Perhaps the best known single-site demonstration test of a two-generation model is the Perry Preschool Project. This program provided not only a high-quality preschool program for three- and four-year olds at a single site beginning in the late 1960s, but it also included weekly home visits to families by trained teachers. These visits reinforced the curriculum implemented at the center by providing support for parents to engage with their children in cognitively and socially enriching activities. Although the evaluation could not establish the unique contribution of the parent component, this flagship program has demonstrated long-term benefits in stronger school performance, reduced special education placements, higher rates of high school graduation, reduced teen pregnancy, higher rates of employment, higher earnings, and lower rates of juvenile crime and adult arrests.[65]

Some two-generation programs have been successful in focusing their interventions on very specific child outcomes. One example, the Incredible Years Program, has demonstrated effectiveness in reducing rates of aggressive behaviors in young children by providing a behavior management curriculum with professional support for teachers, as well as a videotape-based behavior management program for parents.[66]

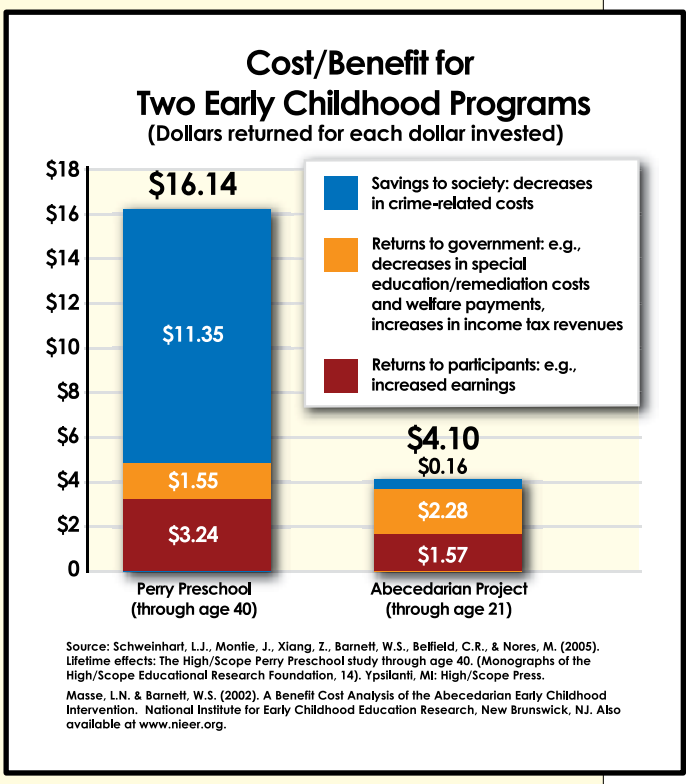
Multi-Site Programs: The Challenge of Scale. Several large-scale, two-generation models

have been evaluated rigorously using experimental designs. These include a mixture of programs that have demonstrated strong and even long-term benefits for children, as well as those with less conclusive findings.

Head Start includes elements that focus on parent involvement, social services, physical health, mental health, and community engagement in addition to its early education component. In its first national experimental evaluation, this multi-dimensional program produced small effects on more than half of its targeted outcomes across cognitive, social, emotional, health, and parenting domains after one year of services, but found no effects on other measured outcomes.[67] After taking into account the complicating presence of "crossovers" (i.e., children and families assigned to the experimental group who did not end up receiving Head Start services, and those assigned to

Cost-Benefit Calculations

From an economic perspective, a program constitutes a worthy social "investment" if the total benefits it generates exceed its costs.[113] Cost-benefit accounting typically distinguishes costs borne by and benefits accruing to taxpayers versus participants and their families. Summing across these two groups provides estimates of total social costs and benefits. Although policymakers sometimes choose to focus only on the taxpayers' costs and benefits, economic logic stresses the need to compare total resource costs, regardless of the degree to which they are borne by taxpayers or the participants, and total benefits, regardless of whether they are enjoyed by taxpayers or only by participants. If total benefits exceed total costs, then the program constitutes a worthy social investment.



The available evidence on early childhood interventions is largely restricted to model programs, which have generated benefit-cost ratios ranging from 2:1 to 17:1, depending on the program.[114] The most successful intervention with the longest longitudinal data base, the Perry Preschool Project, generated an estimated annual internal rate of return of 16 percent projected to age 65 years, with a 4 percent return realized by program participants and 12 percent realized by society at large.[115] For individuals, economists estimate that each additional year of schooling increases lifetime labor-markets earnings by about 10 percent.[116] For society, most of the documented returns from Perry Preschool to society accrued from decreased expenditures in the juvenile and criminal justice systems, decreased special education costs, increased tax revenues from higher incomes, and decreased reliance on government assistance. Benefit-cost analyses conducted on a few demonstration programs begun prenatally or soon after birth (e.g., the Nurse Family Partnership) also have shown positive returns.[117] As with the Perry Preschool study, cost-savings from reductions in crime are the primary saving mechanisms. Unfortunately, large-scale programs, which are of particular interest to policymakers, generally have failed to track their costs and to invest in studies that quantify their benefits, particularly in the years after children leave the programs.[118]

the control group who did), the effects of Head Start on children and families who actually participate are larger, falling in the moderate range.[68]

The Early Head Start national evaluation also tested a two-generation model that provided relatively more intensive family support services (including assistance with parenting, health promotion for the children, and guidance in formulating parents' own life goals) with services provided directly to children (in center-based child care or during child-focused home visits) from the prenatal period to age three years. This study was conducted in the context of a program model that was being taken to national scale quickly, which suggests that its federally-mandated evaluation may have been conducted before all the programs were operating as planned and, therefore, measured the effects of varied levels of implementation. Age of entry ranged from the prenatal period to the first year of life, services were provided until 36 months, and implementation was guided by Early Head Start performance standards.

A 17-site experimental evaluation reported small effects of Early Head Start when the children were 36 months of age.[69] Across children and program models, these effects included multiple domains of cognitive, social, and emotional development, as well as several areas of parenting and economic self-sufficiency.[70] The strongest positive effects on parents and children at age three were found in programs that mixed center- and home-based services, those that implemented the Head Start Performance Standards earlier rather than later, those that enrolled parents during pregnancy, and those serving children in families at medium levels of risk as defined by demographic characteristics. The national infrastructure provided by Early Head Start offers a promising network for ongoing experimentation, careful evaluation, and continuous program refinement for infants and toddlers in low-income families.

Although most two-generation models focus on families in poverty, some programs have targeted groups experiencing other risks. The Infant Health and Development Program, for example, combined home visits beginning at birth for parents with low-birth weight, premature infants across the socioeconomic spectrum, along with high-quality, center-based care for the children between one and three years of age.[71] Evaluation results showed positive effects on cognitive ability at ages two and three for all children except those born to college-educated mothers. For the heavier-weight infants (ranging between 3.3 and 5.8 pounds at birth), there were positive impacts on receptive language, vocabulary, and standardized math scores at age eight, as well as positive effects on receptive language, math, and some youth-reported risk behavior at age 18.

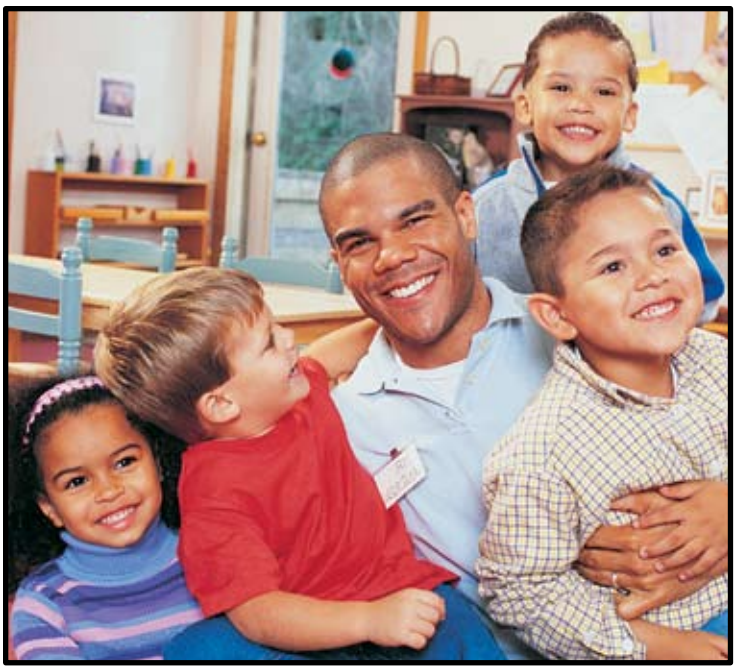
Finally, in contrast to Head Start, Early Head Start, and the Perry Preschool Project, in which services were designed and provided directly by local program sites, the Comprehensive Child Development Program utilized a parent education and case management model to integrate pre-existing services for families with children from birth to five years of

Thinking Beyond Economic Benefits

Despite the obvious value of economic impact data, it is also important to recognize that ensuring the health and well-being of young children is an important objective in its own right, regardless of whether financial benefits can be documented in the future. Policies for children with significant developmental disabilities or complex medical problems may be viewed most appropriately through this lens. The same can be said about certain public expenditures for adults, such as the rapidly escalating costs of custodial care that are projected for the growing frail, elderly population that will make up an increasing part of our nation's population and not be expected to generate positive financial returns in the future. Some might even suggest that policies related to subsidized child care should be evaluated primarily for their role in supporting working families rather than for their potential impact on child outcomes. These issues, among many others, raise important challenges for policymaking, particularly when they speak more to society's moral values than to its economic interests.

age. Results of a 23-site experimental evaluation of this large-scale federal initiative revealed no overall impacts on parent or child outcomes at age five.[72]

Explanations for why the program may not have had significant effects include both program design and implementation issues. First, it may be that direct child development services were weak and both the content and delivery of the parenting education was inappropriate or simply ineffective.[73] In addition, many families received extremely modest levels of service because of implementation difficulties, and many control-group members received similar kinds of services as their experimental-group counterparts. It also has been postulated that simply coordinating existing services, even within an intensive case management model, may not be beneficial to families if the services to which they have access are not high quality.[74]



Policy Implications

Two-generation programs can have positive impacts on both children and parents who are experiencing adversity, but further evaluation is needed to match the mix of service components to the circumstances of the participants. Positive impacts have been documented in model programs like the Perry Preschool Project, as well as scaled-up, multi-site programs, such as Head Start and Early Head Start. The considerable variability in costs associated with different combinations of service formats and locations provides compelling motivation to identify the "active ingredients" that contribute the most to successful outcomes. Yet one of the most difficult challenges facing those who seek to convert evaluation findings into sound policy recommendations has been the inability to disentangle the relative contributions of different program components. In fact, the hypothesis that a combined focus on parenting skills/self-sufficiency and high-quality educational experiences for children will produce greater impacts than providing either alone, although highly suggestive, has not been proven conclusively.

The "unpacking" of services that are provided through large, multi-site programs would help us learn more about the relative effectiveness of interventions for a diversity of target populations. Evaluations of the Infant Health and Development Program and Early Head Start indicate that these programs have had greater impacts on some groups compared with others. However, far less is known about the differential effects of specific program models for young children in non-English speaking or immigrant families in comparison to what is known about program impacts on low-income, African-American families in the United States. Thus, evidence from existing, multi-site interventions are best viewed not as a final answer but as an important starting point for continuous program improvement through the ongoing design, implementation, evaluation, and refinement of alternative service approaches over time.[75]

Effectiveness Factors That Cut Across All Program Models

Four decades of evaluation research have made it abundantly clear that effective policies and programs in the first five years of life require attention to the specific needs of children and families in a variety of circumstances. Positive results have been achieved in a diverse array of programs,

including child-focused, parent-focused, and two-generation models, and in a variety of service settings, including families' own homes and community-based centers. Program evaluation research indicates that several strategies can be effective for young children and families experiencing significant adversity. Depending on the specific circumstances, these might include intensive home visiting by specialized nurses or highly trained practitioners, skilled counseling for mental health problems, or a mixture of intensive home visiting for parents and high-quality center-based services for children, among others.[76]

Programs that cost less because they employ less skilled staff are a waste of money if they do not have the expertise needed to produce measurable impacts.

The core scientific concepts of early childhood and early brain development remain equally valid, whatever the program category, administrative structure, or funding mechanism. This gives policymakers some latitude in choosing among program approaches to address specific objectives. The key is to select strategies that have documented effectiveness, to assure that they are implemented well, and to be specific and clear about how their impact will be measured.

Screening Services and Staff Skills. In order to provide appropriate services in a timely manner, it is important to have effective screening and referral mechanisms in place in a variety of settings in which young children and their families are seen regularly. These can include doctors' offices, child care facilities, and preschools, among others. Once specific needs are identified, it is essential that prescribed services are sufficiently prepared to address them, particularly for those families facing the greatest challenges. For example, home visiting programs staffed by non-professional staff would be grossly inadequate for mothers coping with serious depression, substance abuse, or family violence. Stated simply, programs that cost less because they employ less skilled staff are a waste of money if they do not have the expertise needed to produce measurable impacts. Similarly, it is essential that all screening, assessment, and intervention efforts are matched appropriately to the language and cultural characteristics of the children and families they are asked to serve. This latter requirement is increasingly important as the early childhood population in the United States is becoming more diverse racially, ethnically, and linguistically.[77]

Program Targeting. Successful programs that are more broadly targeted (e.g., to families in poverty) have generally provided more broadly defined services (e.g., high-quality early education, child development information, support for parenting and parent self-sufficiency) than those targeted to families at risk due to specific factors such as parental depression or likelihood for child maltreatment. This suggests the potential benefits of both broadly targeted programs and screening for specific problems in the first years of life. To this end, screening systems should be broad-based so that a high proportion of families at specific risk can be identified. However, very little evidence exists regarding the effective implementation of such screening systems, with follow-up referral to programs targeted to particular risks.

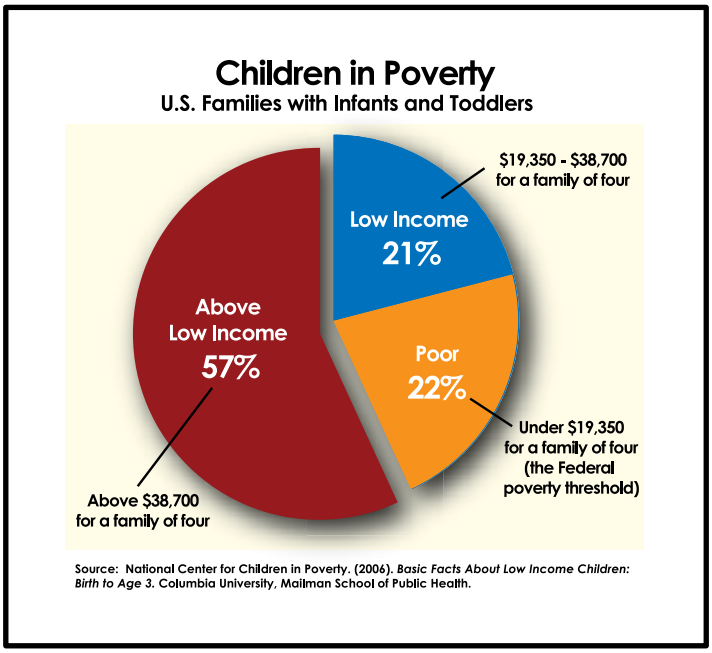
Mental Health Services. Finally, the striking shortage of well-trained professionals with expertise in mental health services for families with young children also needs to be addressed. The particular importance of greater attention to early childhood mental health concerns is underscored by recent reports of expulsions of disruptive children from early childhood programs;[78] rising rates of off-label drug treatment for young children with emotional or behavioral problems (i.e., use of medications that have been tested for efficacy and safety in adults but not for children, although they can be prescribed legally at the discretion

of a physician);[79] and the comparatively high prevalence of depression in mothers of very young children, particularly in low-income families.[80] In this context, it is important to note that the original federal legislation mandating early intervention for children from birth to age three (now provided through Part C of the Individuals With Disabilities Education Act) included services to address emotional and social difficulties, as well as problems in cognition, language, and motor development. Thus, the need for professional staff development in this area is not a new directive but simply a delayed implementation of the original provisions of the Education for All Handicapped Children Act Amendments of 1986.[81]

Family Economics and Maternal Employment

Approximately 4.1 million infants, toddlers, and preschoolers lived in poverty in the United States in 2005. For a family of three, this means a total income of less than $15,577, which actually falls well above the income level of many poor families.[82] Extensive research shows that children who grow up under conditions of poverty are more likely (relative to non-poor children) to be less successful in school, less productive as adults in the labor market, have lifelong health problems, and commit crimes and engage in other forms of problematic behavior.[83]

There are many reasons why low family income may be detrimental for young children. Early development can be compromised when parents cannot afford to provide nutritious meals, are unable to assure access to age-appropriate learning experiences both in the home and in early care and education settings outside the home, and cannot guarantee safe and growth-promoting neighborhood environments.[84] Poverty and economic insecurity also can take a toll on parents' mental health, with depression and other forms of psychological distress profoundly affecting their interactions with their children.[85]



Despite the strong and consistent correlations between poverty and diminished child well-being, relatively few studies have focused on isolating the adverse child impacts of low income itself in contrast to the effects of a host of associated conditions, such as decreased parent education and high levels of family stress. Nevertheless, many of the most sophisticated studies point to the early childhood period as the stage in which children are most vulnerable to economic deprivation.[86] This might be expected, given the greater malleability of early development and the overwhelming importance of the immediate environment of relationships (i.e., within the family, in contrast to school or peer contexts) for infants, toddlers, and preschoolers.[87]

Income Support. Two well-designed sets of studies have shown that employment-based boosts in family income can produce achievement gains in young children. One, using data from random-assignment program evaluations of welfare-to-work initiatives, found that earnings supplements that increased family income by $1,000 to $1,500 per year were consistently associated with small, positive impacts on the achievement of preschool-aged

children, although the same policies had negative effects on children entering adolescence.[88] A recent study estimating the impacts of the Earned Income Tax Credit also found small benefits for younger children's achievement but did not test for impacts on adolescents.[89]

These findings suggest that the transition from preschool into middle childhood (i.e., age four to five) may be a period during which financial supports for families can have a positive influence on their children's development. These financial supports have been successfully implemented in a variety of policy and service settings, including tax policy (the EITC), the welfare system, and community-based work support organizations that are outside the welfare system.

Effectiveness Factors for Supporting Working Parents. Beyond the special problems faced by families who live in poverty, the challenges of balancing work and parenting are substantial across all income groups. This issue is particularly problematic in early infancy, as the United States is one of the few western, industrialized nations that does not offer the option of paid parental leave following the birth of a baby. Although the Family and Medical Leave Act (FMLA) does provide for *unpaid* leave for up to three months, this provision covers only about half of employed parents, and evidence strongly suggests that many parents, particularly those with low incomes, cannot afford financially to take time out of the labor market to stay home with their infants.[90] Consequently, current FMLA leave provisions have very small effects on whether mothers take maternity leave, and appear to have no effect on fathers' leave-taking behavior. In contrast, evidence from other countries suggests that policies that provide wage replacement have considerably stronger effects on leave-taking.[91]

Research on leave policies in countries that support new mothers to stay home beyond the first few weeks and months of life has documented improved health outcomes for both children and their mothers.[92] Research in the United States has found that women who return to work later in the first year experience less depression.[93] Comparative studies have found that when paid leave periods are longer, infant mortality rates are lower.[94] Unpaid leave—the parental leave policy in the United States—does not have the same protective effect, presumably because parents are less likely to take it.[95] There also is evidence that children whose mothers stay home longer in the first year of life are more likely to receive well-baby care and to be fully immunized.[96] While some evidence suggests that paid parental leave may enable parents to better balance work and caregiving demands, more research is needed to better understand how leave policies will affect work patterns and the quality of caregiving, and which families will benefit from such policies.[97]

Extensive behavioral and developmental research evidence supports the importance of sensitive caregiving in the early months of life.[98] Whether child well-being would be facilitated by a paid parental leave policy in the United States has not been quantified, primarily because research in this country has not been able to evaluate the direct effects of such policies on child outcomes. Instead, studies have linked variation in the timing of mothers' return to work after the birth of their children with variation in their children's development. Although most studies of maternal employment show no links with adverse child outcomes for pre-adolescent children, questions continue to be raised about the special vulnerability of

infants. Some recent reports, for example, indicate that full-time maternal employment in the first year of life may be linked to lower levels of cognitive development and higher levels of problem behavior later in childhood.[99]

An overarching problem with this literature, however, is that few of these studies have been able to explain the possible mechanisms for the negative effects that have been found for children in more advantaged families.[100] For example, adverse outcomes may arise from the *conditions*—rather than the mere *fact*—of early maternal employment (e.g., an unemployed father, shift work, etc). It also is possible that mothers who return to work early may experience elevated levels of stress or depression and thus may be less sensitive caregivers or may not engage in such health-promoting behaviors as breastfeeding and immunization.[101] In addition, because of the substantial cost and scarcity of high-quality care for infants in the United States, children whose mothers work full-time during the first year may experience lower quality out-of-home care than children of mothers who work only part-time.[102]

Finally, it is important to note that negative impacts of maternal employment are less likely to be found among disadvantaged, single-parent families. In fact, some evidence suggests that maternal employment may be beneficial for disadvantaged children, especially if it leads to higher family income.[103]

Policy Implications

Income supplements for low-income parents that are tied to employment offer a potential strategy for supporting the development of young children. Research suggests that two policy directions are worthy of consideration. The first would be to design state welfare reform policies and employment support programs to reward full-time work with wage supplements for employees with dependent children. A second is to expand the Earned Income Tax Credit (EITC), which would provide more money, contingent on work effort, for low-income parents whose financial resources are limited. Nearly half of all states have implemented their own EITC and, thus, could consider this option. States without these tax credits should be aware of their potential positive effects on child and family outcomes. In both cases, focusing expanded financial support on families with young children would help contain the total cost and concentrate resources where they appear to generate the highest returns.

Studies in other countries indicate that parental leave with wage replacement is associated with positive health benefits for children and mothers, but research focused explicitly on how paid parental leave affects child outcomes is not sufficiently developed in the United States to inform the policymaking debate. Considerable public discussion has been generated about the potential tradeoffs of various durations of parental leave with or without wage replacement. Unfortunately, the paucity of systematic research about the specific impacts of alternative leave policies on either parent well-being or child development in this country limits the extent to which empirical evidence can inform this policy question.

Environmental Contamination: Recognizing the Vulnerability of the Young Brain

There is no question that exposure to certain chemical substances during the period from conception through the early years of life can interfere with the normal function of genes, proteins, and other small molecules that influence brain development. There is also no question that exposures at levels that appear to be harmless for adults can cause significant and

irreversible damage to the developing architecture of the brain of a fetus or infant. Despite this well-established scientific fact, the importance of determining which substances are safe and specifying thresholds of exposure for those that are dangerous is not generally incorporated into public policy. Moreover, when safe levels of exposure to known environmental neurotoxins (i.e., substances that have a poisonous effect on brain cells and circuits) are established, they are determined primarily through a process that is guided by research findings from studies of mature animals and adult humans.

Legal and Illegal Substances. The fact that some legally available substances (such as alcohol and certain prescription drugs) are far more toxic to the developing brain of an embryo or fetus than many illegal drugs (such as cocaine or marijuana) is not known by most people. This underscores the need for expanded access to health care, education, and monitoring for women in the child-bearing years, both before and immediately after they become pregnant.[104] Although a great deal remains to be learned about the full breadth of risk during pregnancy and early childhood, there is much that can be done based solely on what we know now about how to reduce the number of children whose brains are seriously harmed by environmental toxins.[105]

Environmental Toxins. Reductions in the levels of well-documented neurotoxins in the environment have been proven to lower the risk of preventable damage to the brains of fetuses and young children. For example, the U.S. Environmental Protection Agency (EPA) imposed new regulations on the use of organophosphate pesticides, largely because of concerns about the potential exposure of young children. Follow-up studies found that the percentage of food samples with detectable residues of these pesticides dropped from 29 percent in 1996 to 19 percent in 2001.[106]

Exposure to certain chemical substances during the period from conception through the early years of life can interfere with the normal function of genes, proteins, and other small molecules that influence brain development.

The problem of mercury and its increasing presence in our nation's food supply shows that there is more work to do. Resistance to the imposition of restrictions on the sources of environmental mercury is particularly problematic, given the results of a recent EPA study that reported: (1) there is no safe blood level of methyl mercury; (2) 50 percent of women of childbearing age in the U.S. have blood levels that reach or exceed one part per billion; (3) an estimated eight percent of women of childbearing age have dangerously high blood levels; and (4) mercury levels in the food chain are increasing (particularly in swordfish and tuna). Perhaps the most troubling aspect of this serious cause of brain damage in fetuses and young babies is the fact that the largest production of environmental mercury comes from the emissions of coal-burning power plants and incinerators, despite the fact that technology is available to reduce its atmospheric release.[107]

The costs of ignoring the devastating impacts of neurotoxins are high. Cognitive impairments caused by lead poisoning alone have been estimated to result in societal costs of approximately $43 billion annually. The emotional costs of severe disabilities that could have been prevented are exceedingly high.[108]

Policy Implications

The determination of safe levels of exposure to toxic substances should be based on rigorous studies that focus on the critical link between relative vulnerability and age. There

is no question that the brain of a young child can be seriously damaged by exposure to certain chemicals (such as mercury, lead, and alcohol) at levels that would have essentially no harmful effects on the brain of an adult. Moreover, levels of exposure that are relatively safe for a young infant can be harmful to a fetus, and what is relatively less dangerous for a fetus can have serious and permanent consequences for the brain of an embryo at the beginning of pregnancy. Given this basic scientific principle, policies designed to protect the public from harm should be focused on establishing thresholds of safety based on the best data available for the youngest children, as well as for pregnant women.

Expanding public awareness with more extensive dissemination of accurate scientific information through warning labels and proactive controls on toxic exposures could lead to significant benefits. Information on the toxic effects of organophosphates, for example, could be disseminated more effectively by requiring clearer content and warning labels on the packaging of commonly used insecticides. This would enable pregnant women and families with young children to make more informed choices about the products they use around their home. In an effort to move beyond policies that rely solely on individual monitoring by parents alone, Michigan enacted legislation in 2004 that prohibits the use of any pesticides at a school or child care center unless it has adopted an integrated pest management program that focuses on non-pesticide alternatives to chemical compounds. Both the Michigan law and legislation in Rhode Island and Illinois, among others, require schools and child care centers to notify parents in advance before pesticides are used on school grounds.[109]

Concluding Thoughts

Decreasing risk and improving life-long outcomes for vulnerable, young children do not require the full implementation of all the policy alternatives described in this document. The task for policymakers is to choose wisely among politically viable options and to maximize the return on their investments through effective interventions that target well-defined needs with proven, well-implemented programs. Recent advances in the science of early childhood and early brain development, combined with the findings of increasingly sophisticated program evaluation research, provide a strong knowledge base upon which people with diverse political values can design a common agenda.

It also is essential to underscore the critical need to strengthen program quality. To this end, honest accountability practices would be facilitated by a governing environment that supports stable funding for needed services in the context of ongoing research and continuous program enhancement. Persistent discrepancies in effectiveness between model programs and many scaled-up service systems call for greater attention to the importance of quality control and the need for ongoing investigation of impacts in the implementation of large scale programs. When all is said and done, interventions should be evaluated to strengthen

their impact, not to erect barriers to participation.

Can these principles be enacted in ways that take into account very different cultures, geographies, populations, and political environments across states? The answer is yes. Although much work still remains to be done, recent efforts in places as varied as Nebraska, South Carolina, Oklahoma, Connecticut, Washington, and Illinois, among others, provide impressive examples of the many ways that different states can design and implement alternative strategies for investing in the needs of young children.

Are some investments more strategic than others? Absolutely. While good programs can enhance the performance of all children, current knowledge about brain and child development, as well as empirical data from cost-benefit studies, presents a compelling case for early, public investments targeted preferentially toward those children who are at greatest risk for later failure in school, in the workplace, and in society at large.

Current knowledge about brain and child development, as well as empirical data from cost-benefit studies, presents a compelling case for early public investments targeted toward children who are at greatest risk for failure in school, in the workplace, and in society at large.

Can or should government do it all? The answer is no. The magnitude of the challenges and the considerable up-front costs of doing things right suggest that shared responsibility through public-private sector partnerships offers greater promise than either government or voluntary action alone—and both will benefit greatly in the long term.

Seven years ago, the introductory chapter of *From Neurons to Neighborhoods* proposed two complementary agendas:

The first is focused on the future and asks: How can society use knowledge about early childhood development to maximize the development of the nation's human capital and ensure the ongoing vitality of its democratic institutions? The second is focused on the present and asks: How can the nation use knowledge to nurture, protect, and ensure the health and well-being of all young children as an important objective in its own right, regardless of whether measurable returns can be documented in the future? The first agenda speaks to society's economic, political, and social interests. The second speaks to its ethical and moral values. The committee is clear in our responsibility to speak to both.[110]

In the final chapter, the report concluded:

Finally, there is a compelling need for more constructive dialogue between those who support massive public investments in early childhood services and those who question their cost and ask whether they really make a difference. Both perspectives have merit. Advocates of earlier and more intervention have an obligation to measure their impacts and costs. Skeptics, in turn, must acknowledge the massive scientific evidence that early childhood development is influenced by the environments in which children live.[111]

This paper is designed to further inform sound policy decisions guided by state-of-the-art knowledge. Its objective is to create a science-based framework within which a broad range of thoughtful people from both the public and private sectors can come together and find common ground on behalf of our nation's young children and their families in order to improve both the quality of their lives today and the future of our nation tomorrow. We recognize that, for some, this is a critical moral responsibility. For others, this is a wise economic investment. As scientists, we believe that rapidly growing scientific knowledge about early childhood and early brain development provides a compelling framework for both.

References

1 National Scientific Council on the Developing Child (2007). *The science of early childhood development: Closing the gap between what we know and what we do.* http://www.developingchild.net/pubs/persp/pdf/Science_Early_Childhood_Development.pdf

2 National Scientific Council on the Developing Child (2004a). *Young children develop in an environment of relationships. Working Paper No.1.* http://www.developingchild.net/pubs/wp.html

National Scientific Council on the Developing Child (2004b). *Children's emotional development is built into the architecture of their brain. Working Paper No. 2.* http://www.developingchild.net/pubs/wp.html

National Scientific Council on the Developing Child (2005). *Excessive stress disrupts the architecture of the developing brain. Working Paper No. 3.* http://www.developingchild.net/pubs/wp.html

National Scientific Council on the Developing Child (2006). *Early exposure to toxic substances damages brain architecture. Working Paper No. 4.* http://www.developingchild.net/pubs/wp.html

3 Dawson, G., & Fischer, K. (Eds.). (1994). *Human behavior and the developing brain*. New York: Guilford.

Nelson, C. (2000). The neurobiological bases of early intervention. In J. Shonkoff & S. Meisels, (Eds.), *Handbook of early childhood intervention* (2nd ed.). New York: Cambridge University Press.

Nelson C., & Bloom, F. (1997). Child development and neuroscience. *Child Development, 68,* 970-987.

Shonkoff, J., & Phillips, D. (Eds.). (2000). *From neurons to neighborhoods: The science of early childhood development*. Committee on Integrating the Science of Early Childhood Development, Board on Children, Youth, and Families, Commission on Behavioral and Social Sciences and Education, National Research Council and Institute of Medicine. Washington, DC: National Academy Press.

4 Champagne, F., Francis, D., Mar, A., & Meaney, M. (2003). Variations in maternal care in the rat as a mediating influence for the effects of environment on development. *Physiology and Behavior, 79*, 359-371.

Greenough, W., & Black, J. (1992). Induction of brain structure by experience: Substrates for cognitive development. In M. Gunnar & C. Nelson (Eds.), *Developmental Behavior Neuroscience.* Volume 24 (pp. 155-200). Hillsdale, NJ: Erlbaum.

Liu, D., Diorio, J., Day, J., Francis, D., & Meaney, M. (2000). Maternal care, hippocampal synaptogenesis and cognitive development in rats. *Nature Neuroscience, 3*(8), 799-806.

Meaney, M. (2001). Maternal care, gene expression, and the transmission of individual differences in stress reactivity across generations. *Annual Review of Neuroscience, 24,* 1161-1192.

Pianta, R., Nimetz, S., & Bennett, E. (1997). Mother-child relationships, teacher-child relationships, and school outcomes in preschool and kindergarten. *Early Childhood Research Quarterly, 12,* 263-280.

Reis, H., Collins, W., & Berscheid, E. (2000). Relationships in human behavior and development. *Psychological Bulletin, 126,* 844-872.

Shonkoff, J., & Phillips, D. (Eds.). (2000).

Thompson, R. (1999). Early attachment and later development. In J. Cassidy & P. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications* (pp. 265-286). New York: Guilford.

5 Cunha, F., Heckman, J., Lochner, L., & Masterov, D. (2005). *Interpreting the evidence on life skill formation.* Cambridge, MA: National Bureau of Economic Research Working Paper #10091.

Knudsen, E. (2004). Sensitive periods in the development of the brain and behavior. *Journal of Cognitive Neuroscience, 16,* 1412-1425.

Knudsen, E., Heckman, J., Cameron, J., & Shonkoff, J. (2006). Economic, neurobiological and behavioral perspectives on building America's future workforce. *Proceedings of the National Academy of Sciences, 103*, 10155-10162.

6 Levitt, P. (2003). Structural and functional maturation of the developing primate brain. *Journal of Pediatrics, 143*(Supplement 1), 35-45.

Monk, C.S., Webb, S.J. & Nelson, C.A. (2001). Prenatal neurobiological development: molecular mechanisms and anatomical changes. *Developmental Neuropsychology, 19,* 211-236.

Webb, S.J., Monk, C.S. & Nelson, C.A. (2001). Mechanisms of postnatal neurobiological development: implications for human development. *Developmental Neuropsychology, 19,* 147-71.

7 National Scientific Council on the Developing Child (2006).

8 Rice, D., & Barone, S. (2000). Critical periods of vulnerability for the developing nervous system: Evidence from humans and animal models. *Environmental Health Perspectives, 108*(Supplement 3), 511-533.

Weiss, B. (2000). Vulnerability of children and the developing brain to neurotoxic hazards. *Environmental Health Perspectives, 108*(Supplement 3), 375-381.

9 Barker, D.J. (1989). Rise and fall of Western diseases. *Nature, 338*(6214), 371-372.

Barker, D.J., Osmond, G., Golding, J., Kuh, D., & Wadsworth, M.E. (1989). Growth in utero, blood pressure in childhood and adult life and mortality from cardiovascular disease. *British Medical Journal, 298*(6673), 564-567.

Barker, D.J.P., Osmond, C., Forsén, T.J., Kajantie, E., & Eriksson, J. (2005). Trajectories of growth among children who have coronary events as adults. *New England Journal of Medicine, 353,* 1802-1809.

10 Sirin, S. (2005). Socio-economic status and achievement: A meta-analytic review of research. *Review of Educational Research, 75*, 413-453.

11 Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experiences of young American children*. Baltimore, MD: Brookes.

12 Emde, R., & Robinson, J. (2000). Guiding principles for a theory of early intervention: A developmental-psychoanalytic perspective. In J. Shonkoff & S. Meisels (Eds.), *Handbook of early childhood intervention* (2nd ed.) (pp. 160-178). New York: Cambridge University Press.

McCartney, K., & Phillips, D. (Eds.). (2006). *The handbook of early childhood development.* Oxford, UK: Blackwell.

Shonkoff, J., & Phillips, D. (Eds.). (2000).

13 Caldji, C., Tannenbaum, B., Sharma, S., Francis, D., Plotsky, P., & Meaney, M. (1998). Maternal care during infancy regulates the development of neural systems mediating the expression of fearfulness in the rat. *Proceedings of the National Academy of Sciences, 95*(9), 5335-5340.

Gunnar M., & Donzella, B. (2002). Social regulation of the cortisol levels in early human development. *Pschoneuroendocrinology, 27,* 199-220.

McEwen, B., & Sapolsky, R. (1995). Stress and cognitive function. *Current Opinion in Neurobiology, 5*(2), 205-216.

14 National Scientific Council on the Developing Child (2005).

15 Carrion, V., Weems, C., Ray, R., Glaser, B., Hessl, D., & Reiss, A. (2002). Diurnal salivary cortisol in pediatric post-traumatic stress disorder. *Biological Psychiatry, 51*, 575-582.

DeBellis, M., Baum, A., Birmaher, B., Keshavan, M., Eccard, C., Boring, A., et al. (1999). Developmental traumatology, Part 1: Biological stress systems. *Biological Psychiatry, 9*, 1259-1270.

DeBellis, M., Keshavan, M., Clark, D., Casey, B.J., Giedd, J., Boring, A., et al. (1999). Developmental traumatology, Part 2: Brain development. *Biological Psychiatry, 45,* 1271-1284.

Farah, M., Shera, D., Savage, J., Betancourt, L., Giannetta, J., Brodsky, N., et al. (2006). Childhood poverty: Specific associations with neurocognitive development. *Brain Research, 1110*, 166-174.

Gunnar, M. (2003). Integrating neuroscience and psychosocial approaches in the study of early experiences. In J. King, C. Ferris, & I. Lederhendler (Eds.), *Roots of Mental Illness in Children, 1008,* 238-247. New York: New York Academy of Sciences.

Gunnar, M., Morrison, S., Chisholm, K., & Schuder, M. (2001). Salivary cortisol levels in children adopted from Romanian orphanages. *Development and Psychopathology, 13,* 611-628.

16 Anda, R., Felitti, V., Bremner, J.D., Walker, J., Whitfield, C., Perry, B., et al. (2006). The enduring effects of abuse and related adverse experiences in childhood. *European Archives of Psychiatry and Clinical Neuroscience, 256*, 174-186.

McEwen, B. (1998). Protective and damaging effects of stress mediators. *New England Journal of Medicine, 338*, 171-179.

McEwen, B., & Seeman, T. (1999). Protective and damaging effects of mediators of stress: Elaborating and testing the concepts of allostasis and allostatic load. In N. Adler, M. Marmot, B. McEwen, & J. Stewart (Eds.), *Socioeconomic status and health in industrial nations: Social, psychological, and biological pathways. Annals of the New York Academy of Sciences, 896,* 30-47.

17 Hensch, T. (2005). Critical period plasticity in local cortical circuits. *Nature Reviews, Neuroscience, 6*, 877–888.

Knudsen, E. (2004).

Knudsen, E., Heckman, J., Cameron, J., & Shonkoff, J. (2006).

Luscher, C., Nicoll, R., Malenka, R., & Muller, D. (2000). Synaptic plasticity and dynamic modulation of the postsynaptic membrane. *Nature Neuroscience, 3*, 545-550.

Malenka, R., & Nicoll, R. (1999). Long-term potentiation: A decade of progress. *Science, 285*, 1870-1874.

Martin, S., Grimwood, P., & Morris, R. (2000). Synaptic plasticity and memory: An evaluation of the hypothesis. *Annual Review of Neuroscience, 23*, 649-711.

18 Shonkoff, J., & Phillips, D. (Eds.). (2000).

19 Carroli, G., Villar, J., Piaggio, G., Khan-Neelofur, D., Gülmezoglu, M. Mugford, M., et al. (2001). WHO systematic review of randomised controlled trials of routine antenatal care. *The Lancet, 357*(9268), 1565-1570.

20 Dworkin, P. (2000). Preventive health care and anticipatory guidance. In J. Shonkoff & S. Meisels (Eds.), *Handbook of early childhood intervention* (2nd ed.). New York: Cambridge University Press.

Green, M. (Ed.). (1994). *Bright Futures. Guidelines for health supervision of infants, children, and adolescents.* Arlington, VA: National Center for Education in Maternal and Child Health.

Green, M., & Kessel, S. (1993). Diagnosing and treating health: Bright Futures. *Pediatrics, 91*, 998-1000.

21 High, P., LaGasse, L., Becker, S., Ahlgren, I., & Gardner, A. (2000). Literacy promotion in primary care pediatrics: Can we make a difference. *Pediatrics, 105,* 927-934.

22 Sackett, K., Pope, R.K., & Erdley, W.S. (2004). Demonstrating a positive return on investment for a prenatal program at a managed care organization: An economic analysis. *Journal of Perinatal and Neonatal Nursing, 18*(2), 117-127.

23 Bitler, M., & Currie, J. (2005). Does WIC work? The effects of WIC on pregnancy and birth outcomes. *Journal of Policy Analysis and Management, 24*, 73-91.

Devaney, B., Bilherman, L., & Schre, J. (1990). *The savings in Medicaid costs for newborns and their mothers from perinatal participation in the WIC program*. Washington, DC: Mathematical Policy Research.

24 Institute of Medicine. (1996). *WIC nutrition risk criteria: A scientific assessment*. Washington, DC: National Academy Press.

25 Joyce, T., Gibson, D., & Colman, S. (2005). The changing association between prenatal participation in WIC and birth outcomes in New York City: What does it mean? *Journal of Policy Analysis and Management, 24*, 661-685.

26 Ludwig, J., & Miller, M. (2005). Interpreting the WIC debate. *Journal of Policy Analysis and Management, 24*, 691-701.

27 Margie, N.G., & Phillips, D. (Eds.). (2000). *Revisiting home visiting: Summary of a workshop*. Washington, DC: National Academy Press.

Sweet, M.A., & Appelbaum, M.I. (2004). Is home visiting an effective strategy? A meta-analytic review of home visiting programs for families with young children. *Child Development, 75*, 1435-1456.

28 Olds, D. (2006). The Nurse-Family Partnership. In N.F. Watt, C. Ayoub, R.H. Bradley, J.E. Puma, & W.A. LeBoeuf (Eds.), *The crisis in youth mental health: Early intervention programs and policies* (pp. 147-180). Westport, CT: Praeger.

29 Dumont, K., Mitchell-Herzfeld, S., Greene, R., Lee, E., Lowenfels, A., & Rodriguez, M. (2006). *Healthy Families New York randomized trial: Impacts on parenting after the first two years.* Office of Children and Family Services, Working Paper 1. http://www.ocfs.state.ny.us/main/prevention/assets/HFNYRandomizedTrialWorkingPaper.pdf

30 Gomby, D.S., Culross, P.L., Behrman, R.E. (1999). Home visiting: Recent program evaluations: Analysis and recommendations. *The Future of Children, 9*(1), 4-26.

Olds, D.L., Sadler, L., & Kitzman, H. (2007). Programs for infants and toddlers: Recent evidence from randomized trials. *Journal of Child Psychology and Psychiatry*, *48*, 355-391.

31 Duggan, A., McFarlane, E., Fuddy, L., Burrell, L., Higman, S.M., Windham, A., et al. (2004). Randomized trial of a statewide home visiting program: Impact in preventing child abuse and neglect. *Child Abuse & Neglect, 28*, 597-622.

32 Duggan, A., et al. (2004).

33 Dumont, K., et al. (2006).

Olds, D.L., Sadler, L., & Kitzman, H. (2007).

34 Duggan, A., et al. (2004).

35 Bugental, D.P., Ellerson, P.C., Lin, E.K., Rainey, B., Kokotovic, A., & O'Hara, N. (2002). A cognitive approach to child abuse prevention. *Journal of Family Psychology, 3*, 243-258.

36 Olds, D.L., Sadler, L., & Kitzman, H. (2007).

37 Chaffin, M., Silovsky, J.F., Funderburk, B., Valle, L.A, Brestan, E.V., Balachova, T., et al. (2004). Parent-child interaction therapy for physically abusive parents: Efficacy for reducing future abuse reports. *Journal of Consulting and Clinical Psychology, 72*, 500-510.

38 Beardslee, W.R., Gladstone, T.R.G., Wright, E.J., & Cooper, A.B. (2003). A family-based approach to the prevention of depressive symptoms in children at risk: Evidence of parental and child change. *Pediatrics, 112,* 119-131.

Weissman, M.M., Pilowsky, D.J., Wickramaratne, P.J., Talati, A., Wisniewski, S.R., Fava, M., et al. (2006). Remissions in maternal depression and child psychopathology: A STAR*D-Child report. *Journal of the American Medical Association, 295*(12), 1389-1398.

39 Chaudron, L.H., Szilagyi, P.G., Campbell, A.T., Mounts, K.O., & McInerny, T.K. (2007). Legal and ethical considerations: Risks and benefits of postpartum depression screening at well-baby visits. *Pediatrics, 119,* 123-128.

40 Shonkoff, J., & Phillips, D. (Eds.). (2000).

41 Barnett, W.S. (1995). Long-term effects of early childhood programs on cognitive and school outcomes. *The Future of Children, 5*(3), 25-50.

Brooks-Gunn, J., McCarton, C.C., Casey, P.H., McCormick, M.C., Bauer, C.R., Bernbaum, J.C., et al. (1994). Early intervention in low-birthweight premature infants: Results through age 5 years from the Infant Health and Development Program. *Journal of the American Medical Association, 272*, 1257-1262.

Campbell, F.A., & Ramey, C.T. (1994). Effects of early intervention on intellectual and academic achievement: A follow-up study of children from low-income families. *Child Development, 65*, 684-698.

Love, J.M., Kisker, E.E., Ross, C.M., Raikes, H., Constantine, J., Boller, K., et al. (2005). The effectiveness of Early Head Start for 3 year old children and their parents: Lessons for policy and programs. *Developmental Psychology, 42*(6), 885-901.

42 Karoly, L.A., Kilburn, M.R., & Cannon, J.S. (2005). *Early childhood interventions: Proven results, future promise*. Santa Monica, CA: RAND Corporation.

Masse, D.N., & Barnett, W.S. (2002). *A benefit cost analysis of the Abecedarian Project*. New Brunswick, NJ: NIEER.

43 Aos, S., Lieb, R., Mayfield, J., Miller, M., & Pennucci, A. (2004). *Benefits and costs of prevention and early intervention programs for youth*. Olympia, WA: Washington State Institute for Public Policy.

Karoly, L.A., Kilburn, M.R., & Cannon, J.S. (2005).

44 Aos, S., et al. (2004).

Barnett, S., Belfield, C.R., & Nores, M. (2005). Lifetime cost-benefit analysis. In L.J. Schweinhart, J. Montie, Z. Xiang, W.S. Barnett, C.R. Belfield, & M. Nores (Eds.). *Lifetime effects: The High/Scope Perry Preschool study through age 40 (Monographs of the High/Scope Educational Research Foundation, 14)*. Ypsilanti, MI: High/Scope Educational Research Foundation.

Karoly, L.A., Kilburn, M.R., & Cannon, J.S. (2005).

45 Barnett, W.S., Lamy, C., & Jung, K. (2005). *The effects of state prekindergarten program on young children's school readiness in five states.* Rutgers University: National Institute for Early Education Research.

Gormley, W.T., & Gayer, T. (2005) Promoting School Readiness in Oklahoma: An Evaluation of Tulsa's Pre-K Program, *Journal of Human Resources, 40*(3), 533-538.

Gormley, W.T., Gayer, T., Phillips, D., & Dawson, B. (2005). The effects of universal pre-k on cognitive development. *Developmental Psychology, 41*(6), 872-874.

46 Barnett, W.S., Lamy, C., & Jung, K. (2005).

47 Gormley, W.T, & Gayer, T. (2005).

Gormley, W.T., Gayer, T, Phillips, D., & Dawson, B. (2005).

48 Barnett, W. S., Lamy, C., & Jung, K. (2005).

Gormley, W.T., Gayer, T, Phillips, D., & Dawson, B. (2005).

Early, D.M., Maxwell, K.L., Burchinal, M., Alva, S., Bender, R.H., Bryant, D., et al. (2007). Teachers' education, classroom quality, and young children's academic skills: Results from seven studies of preschool programs. *Child Development, 78*(2), 558-580.

49 NICHD Early Child Care Research Network (1999). Child outcomes when child care center classes meet recommended standards for quality. *American Journal of Public Health, 89*, 1072-1077.

50 Zill, N., Resnick, G., Sorongon, A., Kim, K., O'Donnell, K., McKey, R.H., et al. (2003). *Head Start FACES 2000: A whole-child perspective on program performance.* Fourth Progress Report. Prepared for the Administration for Children and Families.

51 McCartney, K., & Phillips, D. (Eds.). (2006).

NICHD Early Child Care Research Network (2000a). The relation of child care to cognitive and language development. *Child Development, 71*, 960-980.

Snow, C.E., Burns, M.B., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy Press.

52 NICHD Early Child Care Research Network. (1996). Characteristics of infant child care: Factors contributing to positive caregiving. *Early Childhood Research Quarterly, 11,* 269-306.

NICHD Early Child Care Research Network. (2000b). Characteristics and quality of child care for toddlers and preschoolers. *Applied Developmental Science, 4*, 116-135.

53 Hill, J.L., Brooks-Gunn, J., & Waldfogel, J. (2003). Sustained effects of high participation in an early intervention for low-birthweight premature infants. *Developmental Psychology, 39*(4), 730-744.

54 McCartney, K., Dearing, E., Taylor, B., & Bub, K. (in press). Quality child care supports the achievement of low-income children: direct and indirect pathways through caregiving and the home environment. *Applied Developmental Science.*

Votruba-Drzal, E., Coley, R.L., & Chase-Lansdale, P.L (2004). Child care and low-income children's development: Direct and moderated effects. *Child Development, 751,* 296-312.

55 NICHD Early Child Care Research Network. (1996).

56 NICHD Early Child Care Research Network. (2000b).

57 Consumer Product Safety Commission. (1999). *Safety hazards in child care settings.* Washington, DC: U.S. Consumer Product Safety Commission.

58 NICHD Early Child Care Research Network. (1999).

American Academy of Pediatrics, American Public Health Association, and National Resource Center for Health and Safety in Child Care and Early Education. (2002). *Caring for our children: National health and safety performance standards: Guidelines for out-of-home child care programs* (2nd ed.). Elk Grove Village, IL: American Academy of Pediatrics and Washington, DC: American Public Health Association.

59 U.S. General Accounting Agency (2002). *Child care: States have undertaken a variety of quality improvement initiatives, but more evaluations of effectiveness are needed.* Washington: Government Printing Office. (GAO-02-897).

60 Campbell, N., Appelbaum, J, Martinson, K., & Martin, E. (2000). *Be all that we can be: Lessons from the military for improving our nation's child care system.* Washington, DC: National Women's Law Center.

61 Department of Defense Child Development Program Annual Report. (2006).

62 National Association for the Education of Young Children. (2007). *Summary of NAEYC-accredited programs for young children.* Retrieved June 26, 2007 from http://www.naeyc.org/academy/web_ready/summary/center_summary.asp.

63 NICHD Early Child Care Research Network. (2003). Does amount of time spent in child care predict socioemotional adjustment during the transition to kindergarten? *Child Development, 74*(4), 976-1005.

64 St. Pierre, R.G., Layzer, J.I., & Barnes, H.V. (1995). Two-generation program: Design, cost, and short-term effectiveness. *The Future of Children, 5*(3), 76-93.

Yoshikawa, H. (1994). Prevention as cumulative protection: Effects of early family support and education on chronic delinquency and its risks. *Psychological Bulletin, 115*, 28-54.

65 Schweinhart, L.J., Montie, J., Xiang, Z., Barnett, W.S., Belfield, C.R., & Nores, M. (2005). *Lifetime effects: The High/Scope Perry Preschool study through age 40*. Ypsilanti, MI: High/Scope Press.

Karoly, L.A., Kilburn, M.R., & Cannon, J.S. (2005).

66 Webster-Stratton, C., Reid, J., & Hammond, M. (2001). Preventing conduct problems in Head Start children: A parent and teacher training partnership in Head Start. *Journal of Clinical Child Psychology, 30*, 283-302.

67 U.S. Department of Health and Human Services, Administration for Children and Families. (2005). *Head Start impact study: First year findings*. Washington, DC: U.S. Administration for Children and Families.

68 Ludwig, J., & Phillips, D.A. (2007). *The benefits and costs of Head Start.* Manuscript under review.

69 Love, J. M., et al. (2005).

70 Administration for Children and Families. (2002). Making a difference in the lives of infants and toddlers and their families: The impacts of Early Head Start. Washington, DC: U.S. Department of Health and Human Services.

71 Brooks-Gunn, et al. (1994).

72 St. Pierre, R.G., Layzer, J.I., Goodson, B., & Bernstein, L. (1997). *National impact evaluation of the Comprehensive Child Development Program: Final report*. Cambridge, MA: Abt Associates.

73 St. Pierre, R.G., & Layzer, J.I. (1999). Using home visits for multiple purposes: The Comprehensive Child Development Program. The Future of Children, 9-1, 134-151.

74 Gilliam, W.S., Ripple, C.H., Zigler, E.F., & Leiter, V. (2000). Evaluating child and family demonstration initiatives: Lessons from the Comprehensive Child Development Program. *Early Childhood Research Quarterly, 15*, 41-45.

75 Olds, D. (2007). Programs for parents of infants and toddlers: Recent evidence from randomized trials. *Journal of Child Psychology and Psychiatry, 48*(3/4), 355-391.

76 Ialongo, N.S., Rogosch, F.A., Cicchetti, D., Toth, S.L., Buckley, J., Petras, H., et al. (2006). A developmental psychopathology approach to the prevention of mental disorders. In D. Cicchetti & D. Cohen (Eds.), *Handbook of developmental psychopathology* (2nd ed.) (pp. 9068-1018). New York: Wiley.

Sweet, M.A., & Appelbaum, M.I. (2004).

77 Hernandez, D.J., Denton, N.A., & Macartney S.E. (2007). Demographic trends and the transition years. In R.C. Pianta, M.J. Cox, & K.L. Snow (Eds.), *School readiness and the transition to kindergarten in the era of accountability* (pp. 217-281). Baltimore: Brookes.

78 Gilliam, W., & Shahar, G. (2004). Prekindergarten expulsion and suspension: Rates and predictors in one state. *Infants and Young Children, 19*, 228-245.

79 Zito, J.M., Safer, D.J., dosReis, S., Gardner, J.F., Boles, M., & Lynch, F. (2000). Trends in the prescribing of psychotropic medications to preschoolers. *Journal of the American Medical Association, 283*(8), 1025-1030.

80 Mian, A. I. (2005). Depression in pregnancy and the postpartum period: Balancing adverse effects of untreated illness with treatment risks. *Journal of Psychiatric Practice, 11*(6), 389-396.

O'Hara, M., & Swain, A. (1996). Rates and risk of postpartum depression: A meta-analysis. *International Review of Psychiatry, 8*, 37-54.

81 Shonkoff, J., & Meisels, S. (Eds.). (2000). *Handbook of early childhood intervention* (2nd ed.). New York: Cambridge University Press.

82 U.S. Census Bureau. (2006). *Poverty thresholds 2005.* Retreived July 18, 2007, from http://www.census.gov/hhes/www/poverty/threshld/thresh05.html

83 Holzer, H., Whitmore-Schanzenbach, D., Duncan, G., & Ludwig, J. (2007). *The economic costs of poverty in the United States: Subsequent effects of children growing up poor.* Center for American Progress, Washington, DC.

84 Becker, G.S. (1981). *A treatise on the family,* Cambridge MA: Harvard University Press.

85 Zahn-Waxler, C., Duggal, S., & Gruber, R. (2002). Parental psychopathology in M.H. Bornstein (Ed.), *Handbook of parenting (*2nd ed.). New Jersey: Erlbaum.

86 Duncan, G., & Brooks-Gunn, J. (Eds.). (1997). *Consequences of growing up poor*. New York: Russell Sage Foundation.

Mayer, S.E. (1997). *What money can't buy: Family income and children's life chances.* Cambridge, MA: Harvard University Press.

87 Bronfenbrenner, U., & Morris, P. (1998). The ecology of developmental processes in R.M. Lerner (Ed.), *Theoretical Models of Human Development, Handbook of Child Psychology* (5th Ed., Vol. 1) (pp. 993-1028). New York: Wiley.

Duncan, G., & Brooks-Gunn, J. (Eds.). (1997).

88 Morris. P., Duncan G., & Clark-Kauffman, E. (2006). Child well-being in an era of welfare reform: The sensitivity of transition in development to policy change. *Developmental Psychology*, *41*(6), 919-932.

89 Dahl, G., & Lochner, L. (2005). *The impact of family income on child achievement*. NBER Working paper No. 11279. Cambridge, MA, National Bureau of Economic Research.

90 Han, W., & Waldfogel, J. (2003). Parental leave: The impact of recent legislation on parents' leave taking. *Demography, 40*, 191-200.

Ruhm, C.J. (1997). Policy watch: The Family and Medical Leave Act. *Journal of Economic Perspectives*, *11*, 175-186.

91 Galtry, J., & Callister, P. (2005). Assessing the optimal length of parental leave for child and parental well-being: How can research inform policy? *Journal of Family Issues*, 26, 219-246.

92 Waldfogel, J. (2006). Early childhood policy: A comparative perspective. In K. McCartney & D. Phillips (Eds.), *The handbook of early childhood development* (pp. 576-594). Malden, MA: Blackwell Publishers.

93 Chatterji, P., & Markowitz, S. (2004). *Does the length of maternity leave affect maternal health? NBER Working Paper No. 10206.* Cambridge, MA: National Bureau of Economic Research.

94 Ruhm, C. (2000). Parental leave and child health. *Journal of Health Economics, 19*(6), 931-960.

Tanaka, S. (2005). Parental leave and child health across OECD countries. *Economic Journal, 115*, F7-F28.

95 Ruhm, 2000.

Tanaka, 2005.

96 Berger, L., Hill, J., & Waldfogel, J. (2005). Maternity leave, early maternal employment, and child outcomes in the US. *The Economic Journal, 115*, F29-F47.

97 Smolensky, E., & Gootman, J.A. (Eds.). (2003). *Working families and growing kids: Caring for children and adolescents.* Washington, DC: National Academies Press.

98 Shonkoff, J., & Phillips, D. (Eds.). (2000).

99 Currie, J. (2005). When do we know what we think we know? Determining causality. In M. Bianchi, L. Casper, & R.S. King (Eds.), *Work, family, health and wellbeing* (pp. 279-296). New Jersey: Erlbaum.

Baum, C.L. (2003). Does early maternal employment harm child development? An analysis of the potential benefits of leave-taking. *Journal of Labor Economics, 21*, 409-448.

Hill, J., Waldfogel, J., Brooks-Gunn, J., & Han, W. (2005). Maternal employment and child development: A fresh look using newer methods. *Developmental Psychology*, *41*, 833-850.

Ruhm, C. (2004). Parental employment and child cognitive development. *Journal of Human Resources*, *39*, 155-192.

Brooks-Gunn, J. Han, W., & Waldfogel, J. (2002). Maternal employment and child cognitive outcomes in the first three years of life: The NICHD Study of Early Child Care. *Child Development*, *73*, 1052-1072.

100 Brooks-Gunn, J., Han, W., & Waldfogel, J. (2002).

101 Clark, R., Hyde, J.S., Essex, M., & Klein, M.H. (1997). Length of maternity leave and quality of mother-infant interactions. *Child Development*, *68*, 364-383.

Berger, L., Hill, J., & Waldfogel, J. (2005).

Galtry, J., & Callister, P. (2005).

102 Brooks-Gunn, J., Han, W., & Waldfogel, J. (2002).

103 Currie, J. (2005).

Baum, C. L. (2003).

Ruhm, C. (2004).

104 Burbacher, T., & Grant, K. (2006). Neurodevelopmental effects of alcohol. In P. Davidson, G. Myers, & B. Weiss (Eds.), *Neurotoxicity and developmental disabilities.* San Diego, CA: Elsevier Academic Press.

Costa, L.G., Aschner. M., Vitalone, A., Syversen, T., & Soldin O.P. (2004). Developmental neuropathology of environmental agents. *Annual Review of Pharmacology and Toxicology, 44*, 87-110.

Welch-Carre, E. (2005). The neurodevelopmental consequences of prenatal alcohol exposure. *Advances in Neonatal Care, 5*(4), 217-229.

105 National Scientific Council on the Developing Child. (2006).

106 U.S. Environmental Protection Agency (2003). *America's children and the environment: Measures of contaminants, body burdens, and illnesses.* Washington, DC: National Service Center for Environmental Publications.

107 Rice, G., & Hammit, J. K. (2005). *Economic valuation of human health benefits of controlling mercury emissions from U.S.* Prepared by Harvard Center for Risk Analysis for NESCAUM, USA, February 2005.

U.S. Environmental Protection Agency (1997). *Mercury study report to Congress.* Washington, DC: EPA/600/P-94/002Aa.

U.S. Environmental Protection Agency. (2003).

108 Landrigan, P., Schecter, C.B., Lipton, J.M., Fahs, M.C., & Schwartz, J. (2002) Environmental pollutants and disease in American children: estimates of morbidity, mortality, and costs for lead poisoning, asthma, cancer, and developmental disabilities. *Environmental Health Perspectives, 110*(7), 721-728.

109 National Conference of State Legislatures. (2004). *Children's health and environmental fact sheet: Developmental disabilities.* Denver, CO.

110 Shonkoff, J., & Phillips, D., (Eds.). (2000).

111 Shonkoff, J., & Phillips, D., (Eds.). (2000).

112 Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). New Jersey: Lawrence Erlbaum.

113 Gramlich, E. (1990). *A guide to cost-benefit analysis.* Englewood Cliffs, NJ: Prentice-Hall.

Levin, H. (1983). *Cost effectiveness: A primer.* Beverly Hills, CA: Sage.

114 Karoly, L.A., Kilburn, M.R., & Cannon, J.S. (2005).

Aos, S., et al. (2004).

115 Rolnick, A., & Grunewald, R. (2003). Early childhood development: Economic development with a high public return. *The Region, 17*(Supplement 9), 6-12.

116 Card, D. (1999). The causal effect of education on earnings. In O. Ashenfelter & D. Card (Eds.), *Handbook of Labor Economics* (1st ed.). (pp. 1801-1863). New York: Elsevier.

117 Aos, S., et al. (2004).

118 Aos, S., et al. (2004).

About the Authors

The work for this paper began in 1998 with the establishment of a blue ribbon committee by the Board on Children, Youth, and Families at the Institute of Medicine and National Research Council, which produced a report in 2000 entitled *From Neurons to Neighborhoods: The Science of Early Childhood Development.* Subsequent to the publication of this widely acclaimed volume, a working group of distinguished scientists and scholars was convened under the auspices of the MacArthur Research Network on Early Experience and Brain Development to explore strategies for educating the public about this growing knowledge base. In 2003, individuals from these two groups merged their commitment to the application of rigorous science to social policy and established the National Scientific Council on the Developing Child. More recently, the National Forum on Early Childhood Program Evaluation was created to expand the Council's focus beyond neuroscience and basic child development research to include evidence from evaluation studies of intervention effectiveness. In 2006, both the Council and Forum were incorporated within the newly established Center on the Developing Child at Harvard University, which has sponsored the development of this document. The final product combines the neuroscience expertise of the Council, the program evaluation expertise of the Forum, and their shared knowledge of research in child development and economics.

Acknowledgments

On April 19, 2007, a group of distinguished researchers and policy analysts was convened to provide peer review of an earlier draft of this paper, focusing on the accuracy and rigor of its scientific content. Comments were received from Steven Barnett, Jeanne Brooks-Gunn, Ron Haskins, Jerome Kagan, Lynn Karoly, Joan Lombardi, John Love, Bruce McEwen, David Olds, Craig Ramey, Isabel Sawhill, Ruby Takanishi, Nicholas Zill, and Martha Zaslow. On April 20, 2007, a diverse group of policymakers, advocates, and civic leaders was convened to assess the utility of the document for non-scientists who make decisions about investments in young children. Comments were received from Bernest Cain, Shannon Christian, Steffanie Clothier, Sarah Daily, Susan DeVenny, Steven Dow, Ruth Friedman, Naomi Goldstein, Laura Beth Hebbler, Graciela Italiano-Thomas, Charles Kolb, Anna Lovejoy, Tammy Mann, Matthew Melmed, Harriet Meyer, Ed Olson, Dan Pedersen, Elliot Regenstein, Roberto Rodriguez, Ann Segal, Albert Wat, Sarah Watson, and Dan Wuori. Both groups provided constructive feedback and helpful suggestions that have resulted in a strengthened final document. Finally, we gratefully acknowledge comments provided by the Legislative Working Group, a partnership of the National Conference of State Legislatures and the National Scientific Council on the Developing Child, particularly Rep. Elizabeth Coulson (IL), Sen. Wes Hayes (SC), Rep. Ruth Kagi (WA), and Rep. Steven Kestell (WI).

Funding Support for the Council and Forum

The Buffett Early Childhood Fund
The Pierre and Pamela Omidyar Fund
The John D. and Catherine T. MacArthur Foundation
The McCormick Tribune Foundation
The Johnson & Johnson Pediatric Institute
An Anonymous Donor

Please note: The content of this paper is the sole responsibility of the authors and does not necessarily represent the opinions of the reviewers or the funders.

Selected Background Readings

From the National Academy of Sciences

National Research Council and Institute of Medicine: *From Neurons to Neighborhoods: The Science of Early Childhood Development*. Committee on Integrating the Science of Early Childhood Development, Shonkoff J., Phillips D. (eds.). Board on Children, Youth, and Families, Commission on Behavioral and Social Sciences and Education. Washington, DC, National Academy Press. 2000.

From the National Scientific Council on the Developing Child

The Science of Early Childhood Development. (2007) National Scientific Council on the Developing Child. http://developingchild.net/pubs/persp/pdf/Science_Early_Childhood_Development.pdf

Knudsen, E., Heckman, J., Cameron, J., Shonkoff, J.: "Economic, Neurobiological and Behavioral Perspectives on Building America's Future Workforce." Proceedings of the National Academy of Sciences 2006; 103: 10155-10162.

Young Children Develop in an Environment of Relationships. (2004)
National Scientific Council on the Developing Child, Working Paper No.1
http://developingchild.net/pubs/wp-abstracts/wp1.html

Children's Emotional Development is Built into the Architecture of their Brain. (2004)
National Scientific Council on the Developing Child, Working Paper No. 2
http://developingchild.net/pubs/wp-abstracts/wp2.html

Excessive Stress Disrupts the Architecture of the Developing Brain. (2005)
National Scientific Council on the Developing Child, Working Paper No. 3
http://developingchild.net/pubs/wp-abstracts/wp3.html

Early Exposure to Toxic Substances Damages Brain Architecture. (2006)
National Scientific Council on the Developing Child, Working Paper No. 4
http://developingchild.net/pubs/wp-abstracts/wp4.html

Center on the Developing Child HARVARD UNIVERSITY
NATIONAL FORUM ON EARLY CHILDHOOD PROGRAM EVALUATION
NATIONAL SCIENTIFIC COUNCIL ON THE DEVELOPING CHILD

50 Church St., 4th Floor, Cambridge, MA 02138 • 617-496-2070 • www.developingchild.harvard.edu