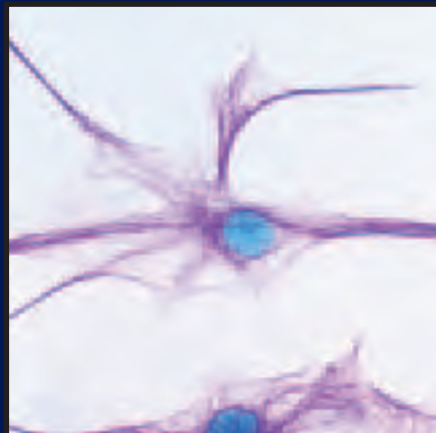


# The Science of Early Childhood Development

Closing the Gap Between  
What We Know and What We Do



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# Executive Summary

**T**he future of any society depends on its ability to foster the health and well-being of the next generation. Stated simply, today's children will become tomorrow's citizens, workers, and parents. When we invest wisely in children and families, the next generation will pay that back through a lifetime of productivity and responsible citizenship. When we fail to provide children with what they need to build a strong foundation for healthy and productive lives, we put our future prosperity and security at risk.

Two recent developments have stimulated growing public discussion about the right balance between individual and shared responsibility for that strong foundation. The first is the explosion of research in neurobiology that clarifies the extent to which the interaction between genetics and early experience literally shapes brain architecture. The second is the increasingly recognized need for a highly skilled workforce and healthy adult population to confront the growing challenges of global economic competition and the rising costs of Social Security, Medicare, and Medicaid for the aging baby boomers.

In an effort to identify those aspects of development that are accepted broadly by the scientific community, the National Scientific Council, based at the Center on the Developing Child at Harvard University, brought together several of the nation's leading neuroscientists, developmental psychologists, pediatricians, and economists. This document presents their critical review of the existing literatures in their fields and a consensus about what we now know about development in the early childhood years. The objective of the Council is to move beyond the public's fascination with "the latest study" and focus on the cumulative knowledge of decades of research that has been subjected to rigorous and continuous peer review. The goal of this document is to help the public and its policy makers understand the core principles of that body of work that are now sufficiently accepted across the scientific community to warrant public action.

It is our hope and belief that better public understanding of the rapidly growing science of early childhood and early brain development can provide a powerful impetus for the design and implementation of policies and programs that could make a significant difference in the lives of all children. Without that understanding, investments that could generate significant returns for all of society stand the risk of being rejected or undermined. Thus, there is a compelling need for scientists to share with the public and its representatives an objective basis for choosing wisely among competing demands on limited resources.

This paper is designed to provide a framework within which this complex challenge can be addressed most effectively. Its goal is to promote an understanding of the basic science of early childhood development, including its underlying neurobiology, to inform both public and private sector investment in young children and their families. To this end, the paper presents a set of core developmental concepts that have emerged from decades of rigorous research in neurobiology, developmental psychology, and the economics of human capital formation, and considers their implications for a range of issues in policy and practice.

## Core Concepts of Development

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- Child development is a foundation for community development and economic development, as capable children become the foundation of a prosperous and sustainable society.
- Brains are built over time.
- The interactive influences of genes and experience literally shape the architecture of the developing brain, and the active ingredient is the "serve and return" nature of children's engagement in relationships with their parents and other caregivers in their family or community.



- Both brain architecture and developing abilities are built “from the bottom up,” with simple circuits and skills providing the scaffolding for more advanced circuits and skills over time.
- Toxic stress in early childhood is associated with persistent effects on the nervous system and stress hormone systems that can damage developing brain architecture and lead to lifelong problems in learning, behavior, and both physical and mental health.
- Creating the right conditions for early childhood development is likely to be more effective and less costly than addressing problems at a later age.



## Implications for Policy and Practice

- Policy initiatives that promote supportive relationships and rich learning opportunities for young children create a strong foundation for higher school achievement followed by greater productivity in the workplace and solid citizenship in the community.
  - Substantial progress toward this goal can be achieved by assuring growth-promoting experiences both at home and in community-based settings, through a range of parent education, family support, early care and education, preschool, and intervention services.
  - When parents, informal community programs, and professionally staffed early childhood services pay attention to young children’s emotional and social needs, as well as to their mastery of literacy and cognitive skills, they have maximum impact on the development of sturdy brain architecture and preparation for success in school.
  - When basic health and early childhood programs monitor the development of all children, problems that require attention can be identified in a timely fashion and intervention can be provided.
  - The basic principles of neuroscience and the technology of human skill formation indicate that later remediation for highly vulnerable children will produce less favorable outcomes and cost more than appropriate intervention at a younger age.
- The essence of quality in early childhood services is embodied in the expertise and skills of the staff and in their capacity to build positive relationships with young children. The striking shortage of well-trained personnel in the field today indicates that substantial investments in training, recruiting, compensating, and retaining a high quality workforce must be a top priority.
  - Responsible investments in services for young children and their families focus on benefits relative to cost. Inexpensive services that do not meet quality standards are a waste of money. Stated simply, sound policies seek maximum value rather than minimal cost.

The need to address significant inequalities in opportunity, beginning in the earliest years of life, is both a fundamental moral responsibility and a critical investment in our nation’s social and economic future. Thus, the time has come to close the gap between what we know (from systematic scientific inquiry across a broad range of disciplines) and what we do (through both public and private sector policies and practices) to promote the healthy development of all young children. The science of early childhood development can provide a powerful framework for informing sound choices among alternative priorities and for building consensus around a shared plan of action. The well-being of our nation’s children and the security of its future would be well-served by such wise choices and concerted commitment.



# The Science of Early Childhood Development

**T**he future of any society depends on its ability to foster the health and well-being of the next generation. Stated simply, today's children will become tomorrow's citizens, workers, and parents. When we fail to provide children with what they need to build a strong foundation for healthy and productive lives, we put our future prosperity and security at risk.

Science has a lot to offer about how we as a community can use our collective resources most effectively and efficiently to build that strong foundation. When we invest wisely in children and families, the next generation will pay that back through a lifetime of productivity and responsible citizenship. When we do not make wise investments in the earliest years, we will all pay the considerable costs of greater numbers of school-aged children who need special education and more adults who are under-employable, unemployable, or incarcerated.

Two recent developments have stimulated growing public discussion about the right balance between individual and shared responsibility for child well-being. The first is the explosion of research in neuroscience and other developmental sciences that highlights the extent to which the interaction between genetics and early experience creates either a sturdy or weak foundation for all the learning, behavior, and health that follow. The second is the increasingly recognized need for a highly skilled workforce and healthy adult population to confront the growing challenges of global economic competition and the rising costs of Social Security, Medicare, and Medicaid for the aging baby boomers.

Most policy makers who face decisions among competing actions lack both the time and means to secure sound scientific advice about which investments offer the greatest potential value and what program elements are critical to their effectiveness. Those same policy makers must explain their decisions to business executives and civic leaders who hold a wide range of beliefs about child-rearing and developmental influences. Without better public understanding of the science of early childhood and brain development, policies and programs that could make a significant difference in the lives of children and all of society stand the risk of being rejected or undermined. Thus, there is a compelling need to educate the public and its representatives about how to choose wisely among competing demands.

For some, the most important decisions focus on the allocation of resources among alternative approaches defined by need (e.g., universal versus targeted investments) or age (e.g., pre-K for four-year-olds versus parent support programs beginning at birth). Others move quickly to questions about the relative merits of different program models. Some are interested primarily in the results of benefit-cost analyses. Others view the reduction of inequalities in opportunity



**When we invest wisely in children and families, the next generation will pay that back through a lifetime of productivity and responsible citizenship.**



as a moral imperative. All are united in the responsibility to assure that limited resources are invested wisely.

Regardless of the questions, it is essential that the answers be grounded in accurate scientific knowledge where it is available and sound professional judgment when it is needed. This is particularly important in the face of inevitable debates over alternative interpretations of the mountains of program evaluation data generated in a policy environment characterized by ideological differences about the means and ends of raising young children.

In October 2000, the Institute of Medicine and National Research Council of the National Academy of Sciences released a report entitled *From Neurons to Neighborhoods: The Science of Early Childhood Development*. The final paragraph of that 588-page report presented a compelling challenge:

*The charge to this committee was to blend the knowledge and insights of a broad range of disciplines to generate an integrated science of early childhood development. The charge to society is to blend the skepticism of a scientist, the passion of an advocate, the pragmatism of a policy maker, the creativity of a practitioner, and the devotion of a parent—and to use existing knowledge to ensure both a decent quality of life for all of our children and a promising future for the nation.*

This paper is designed to provide a framework within which this complex charge can be addressed most effectively. Its goal is to promote an understanding of the basic science of early childhood development, including its underlying neurobiology, to inform both public and private sector investment in young children and their families. To this end, the paper presents a set of core developmental concepts that have emerged from decades of rigorous research in neuroscience, developmental psychology, and the economics of human capital formation—and that have survived a rigorous process of debate among the members of the National Scientific Council on the Developing Child about what science can tell us about brain architecture and the foundations of learning, behavior, and health.

## Core Concepts of Development

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**Concept 1: Child development is a foundation for community development and economic development, as capable children become the foundation of a prosperous and sustainable society.**

The early development of cognitive skills, emotional well-being, social competence, and sound physical and mental health builds a strong foundation for success well into the adult years. Beyond their short-term importance for positive school achievement, these abilities are critical prerequisites for economic productivity and responsible citizenship throughout life. All aspects of adult human capital, from work force skills to cooperative and lawful behavior, build on capacities that are developed during childhood, beginning at birth.

### Implications for Policy and Practice

- Policy initiatives that promote supportive relationships and rich learning opportunities for young children create a strong foundation for higher school achievement followed by greater productivity in the workplace and solid citizenship in the community throughout the adult years. Thus, current calls for greater emphasis on early literacy must not diminish the importance of attention to other essential capacities,

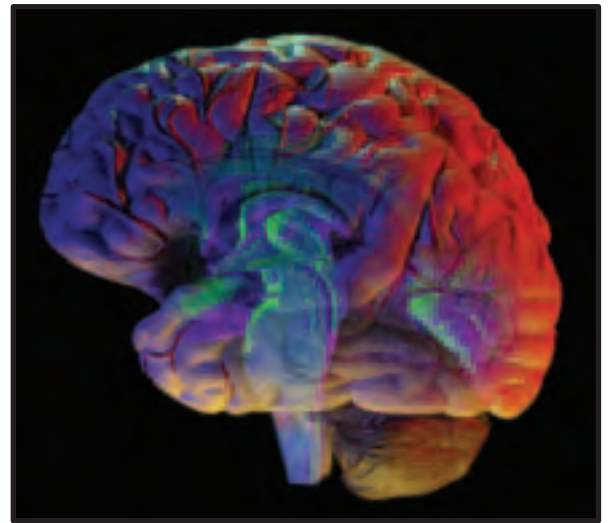
such as initiative, self-confidence, and persistence in learning, as well as the ability to work cooperatively and resolve conflict with peers—all of which are core characteristics of students in a successful school, citizens in a healthy community, and the workforce of a prosperous nation.

- All of society would benefit from a coordinated effort to reduce significant inequalities in the skills of young children at school entry. Substantial progress toward this goal can be achieved by assuring high quality early learning experiences both at home and in community-based settings, through a range of parent education, family support, early care and education, preschool, and intervention services.
- This calls for a long-term investment by all segments of society—including the business community, private philanthropy, both faith-based and secular voluntary organizations, professional associations, and government at all levels—to work together to strengthen families, educate mothers and fathers, and provide professional assistance for those young children and their parents who need help. In fact, the future vitality of the institutions that each these sectors represent will depend on the wisdom of their investment, as today’s children either take up society’s important work and roles as adults or are ill-prepared and unable to do so.
- Effective early childhood policies and practices will not eliminate all social and economic inequalities. However, when successful interventions are followed by continuing investments throughout the childhood years, they increase the odds that many more children will grow up to be adults who contribute positively to their communities and raise healthy and competent children themselves, while many fewer will end up on public assistance or in jail.

**All aspects of adult human capital, from work force skills to cooperative and lawful behavior, build on capacities that are developed during childhood, beginning at birth.**

## **Concept 2: Brains are built over time.**

The basic architecture of the brain is constructed through an ongoing process that begins before birth and continues into 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. Brain architecture is built over a succession of “sensitive periods,” each of which is associated with the formation of specific circuits that are associated with specific abilities. The development of increasingly complex skills and their underlying circuits builds on the circuits and skills that were formed earlier. Through this process, early experiences create a foundation for lifelong learning, behavior, and both physical and mental health. A strong foundation in the early years increases the probability of positive outcomes and a weak foundation increases the odds of later difficulties.



## **Implications for Policy and Practice**

- When systems are put in place to monitor the development of all children continuously over time, problems that require attention can be identified early and appropriate responses can be made. This can be accomplished by appropriately trained physicians, nurse practitioners, or developmental specialists within the context of regular health care, as well as through the ongoing observations of skilled providers of early care and education. Fully meeting this goal requires prenatal care for all pregnant women and sustained access to a consistent source of primary health care for all children.



- Environmental protection policies need continuous updating and enforcement if they are to succeed in reducing prenatal and early childhood exposures to substances that have clearly documented toxic effects on the immature brain. These include mercury in fish, lead in soil, and organophosphates in insecticides, among many others.
- The fact that fetal exposure to alcohol is the leading preventable cause of mental retardation in the United States directs our attention to the need for new and creative efforts to reduce alcohol consumption during pregnancy.

**Concept 3: The interactive influences of genes and experience literally shape the architecture of the developing brain, and the active ingredient is the “serve and return” nature of children’s engagement in relationships with their parents and other caregivers in their family or 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 individual experiences then shape how that formation unfolds. This developmental process is fueled by a self-initiated, inborn drive toward competence that is an essential characteristic of human nature. Appropriate sensory input (e.g., through hearing and vision) and stable, responsive relationships build healthy brain architecture that provides a strong foundation for lifelong learning, behavior, and health. The most important relationships begin in the family but often also involve other adults who play important roles in the lives of young children, including providers of early care and education.

What scientists refer to as interaction, mutuality, and reciprocity can be understood as comparable to the process of “serve and return” in games such as tennis and volleyball. In early childhood development, serve and return happens when young children naturally reach out for interaction through babbling, facial expressions, words, gestures, and cries, and adults respond by getting in sync and doing the same kind of vocalizing and gesturing back at them, and the process continues back and forth. Another important aspect of the serve and return notion of interaction is that it works best when it is embedded in an ongoing relationship between a child and an adult who is responsive to the child’s own unique individuality. Decades of research tell us that mutually rewarding interactions are essential prerequisites for the development of healthy brain circuits and increasingly complex skills.

**Implications for Policy and Practice**

- Healthy communities foster the development of healthy children through the informal support that families provide for each other. When parents are inexperienced in child-rearing or overwhelmed by economic insecurity or threatening community conditions, effective parent education and family support programs can help them sustain the kinds of growth-promoting experiences that build child competence and shape healthy brain architecture. When informal supports and community programs are not sufficient, professional assistance can make an important difference in preventing the formation of faulty brain circuits and the developmental problems that follow. However, professionals with appropriate expertise are relatively limited in number, and their availability will require significant investment in specialized training,



particularly in the domains of maternal and early childhood mental health.

- Business executives, civic leaders, and government officials at all levels should work together to develop better private sector and public policies to provide parents with more viable choices about how to balance their work and parenting responsibilities after the birth of a baby or adoption of a child. During early infancy, when parent-child bonding and emerging attachments are so important, there is a pressing need to strike a better balance between options that support parents to care for their babies at home and those that provide affordable, quality child care for parents who return to work or attend school. This also calls our attention to the need for a more child-oriented perspective on the implications of mandated employment for mothers of very young children who receive welfare support.
- The important influence of positive relationships in shaping the architecture of the developing brain indicates that all of society would benefit from better trained personnel in early child care settings, as well as reduced staff turnover rates which currently undermine the relationships that young children have with the adults who provide much of their daily care. Policy makers should examine the potential impact of alternative strategies for increasing the retention of qualified staff, such as competitive salaries and benefits, opportunities for career advancement linked to additional education, and greater respect for their work as a valued profession. Promising initiatives can be modeled after the successful investments made by the U.S. Department of Defense, which has a very high quality system of early care and education.

**Increasingly complex skills build on the more basic, foundational capabilities that precede them.**

**Concept 4: Both brain architecture and developing abilities are built “from the bottom up,” with simple circuits and skills providing the scaffolding for more advanced circuits and skills over time.**

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. For example, the ability to understand and then say the names of objects depends upon earlier development of the capacity to differentiate and reproduce the sounds of one’s native language. And the circuits that underlie the ability to put words together to speak in phrases form a foundation for the subsequent mastery of reading a written sentence in a book. Stated in simple terms, circuits build on circuits and skill begets skill.



## Implications for Policy and Practice

- Policy makers should consider increasing the availability of parent education and family support programs that have been demonstrated to be effective. These services should begin soon after birth for mothers and fathers with limited education to help them create a home environment that provides the kind of rich language exposure, positive social interactions, and early literacy experiences that increase the probability that their child will enter school with the skills needed to succeed.

When children are born under significantly adverse circumstances, immediate intervention is warranted, including prenatal support services where feasible. Effective programs can be provided through voluntary associations, community-based organizations, and employer-sponsored initiatives, as well as through government-funded services. Evidence-based supports that are provided earlier rather than later will have the greatest impact, as they help establish healthy brain architecture during the period when lower-level circuits are being constructed (even before birth), thereby creating a strong foundation on which higher-level skills can be built.

**Emotional well-being, social competence, and cognitive abilities together are the bricks and mortar that comprise the foundation of human development.**

- To help children with developmental impairments master the adaptive skills needed to realize their full potential, outreach efforts should be increased to enroll all eligible children in early intervention programs. When positive changes in development are promoted through interventions at a young age, they help build a sturdier foundation for the later achievement of higher level abilities. This underscores the urgent need to identify sensory impairments as soon after birth as possible, so that corrective devices (e.g., hearing aids and eyeglasses) as well as appropriate habilitative services can be provided during the time that basic brain architecture is being established.



## **Concept 5: Cognitive, emotional, and social capabilities are inextricably intertwined throughout the life course.**

The brain is a highly integrated organ and its multiple functions operate in a richly coordinated fashion. Emotional well-being and social competence provide a strong foundation for emerging cognitive abilities, and together they are the bricks and mortar that comprise the foundation of human development. Thus, oral language acquisition depends not only on adequate hearing, the ability to differentiate sounds, and the capacity to link meaning to specific words, but also on the ability to concentrate, pay attention, and engage in meaningful social interaction. Furthermore, the emotional health, social skills, and cognitive-linguistic capacities that emerge in the early years are all important prerequisites for success in school and later in the workplace and community. Brain architecture and the immune system also interact as they mature, which influences all domains of development and health.

## Implications for Policy and Practice

- When parents, informal community supports, and professionally staffed early childhood care and education programs all pay attention to young children's emotional and social needs as well as to their mastery of literacy and cognitive skills, they have maximum impact on the development of sturdy brain architecture.

Conversely, preschool policies and programs that place disproportionate emphasis on didactic approaches to academic skills are less likely to prepare young children to succeed in school than experiences that embed the promotion of literacy and numeracy in a rich environment of age-appropriate social interaction. The science of early childhood and early brain development clearly indicates that state and local officials should support the implementation of both child care standards and preschool curricula that promote a balanced and developmentally appropriate approach to the “whole child.”

- Parents, child care providers, and early educators who are seeking help to manage problematic behavior in young children warrant serious attention. With increasing numbers of children being expelled from preschool programs and/or treated with drugs, greater investments are needed to confront the serious shortage of professionals who are qualified to address the behavioral and mental health needs of infants, toddlers, and preschoolers. Expanded opportunities for professional training, stronger incentives for clinicians to work with young children and their parents, and the promotion of consulting relationships among early childhood mental health experts, child care providers, and preschool teachers would provide important first steps toward closing the gap between what we know and what we do to deal with difficult behavior and prevent more serious mental health problems in the earliest years of life.



**Concept 6: Toxic stress in early childhood is associated with persistent effects on the nervous system and stress hormone systems that can damage developing brain architecture 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, rise in blood pressure, and elevated levels of stress hormones (e.g., cortisol) and proteins associated with inflammation (e.g., cytokines). Such responses prepare the body to deal with threat (i.e., “fight or flight”) 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 return to baseline when the threat has been mastered. When these physiological responses remain activated at high levels over a significant period of time, they can have adverse effects. Most prominent among these are the consequences of persistently elevated cortisol levels, which can literally be toxic to developing brain architecture.

The experience of stress in early childhood can be either growth-promoting or seriously damaging, depending on the intensity and duration of the experience, individual differences in children’s physiological responsiveness to stress, and the extent to which a supportive adult is available to provide individualized support to help the child deal with adversity. This can be understood within the context of three different kinds of stress, which lead to different outcomes.

- 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. Precipitants include a wide variety of normal early childhood experiences, such as the challenges of meeting new people, dealing with frustration, mastering separation, getting an immunization, and coping with adult limit-setting or discipline. Positive stress is an important and necessary aspect of healthy

development that occurs in the context of stable and supportive relationships, which help to bring levels of cortisol and other stress hormones back within a normal range and assist the child to develop a sense of mastery and self control.



- The second kind of stress experience, called **tolerable stress**, is associated with physiological responses that could 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. Precipitants include significant threats, such as the death or serious illness of a loved one, a frightening injury, parent divorce, a natural disaster (such as Hurricane Katrina), or an act of terrorism (such as 9-11). These kinds of experiences could have long term consequences but they are tolerable when they occur in a time-limited period in which supportive adults protect the child by reducing the stressful experience, thereby giving the brain an opportunity to recover from the potentially damaging effects of an overactive stress management system.

- The third and most threatening kind of stress experience, called **toxic stress**, is associated with strong and prolonged activation of the body's stress management systems in the absence of the buffering protection of adult support. Precipitants include extreme poverty in conjunction with continuous family chaos, recurrent physical or emotional abuse, chronic neglect, severe and enduring maternal depression, persistent parental substance abuse, or repeated exposure to violence in the community or within the family. The essential feature of toxic stress is the absence of consistent, supportive relationships to help the child cope and thereby bring the physiological response to threat back to baseline. In such circumstances, persistent elevations of stress hormones and altered levels of key brain chemicals produce an internal physiological state that disrupts the architecture of the developing brain and can lead to difficulties in learning, memory, and self-regulation. Continuous stimulation of the stress response system also can affect the immune system and other metabolic regulatory mechanisms, leading to a permanently lower threshold for their activation throughout life. As a result, children who experience toxic stress in early

## Stress in early childhood can be either growth-promoting or seriously damaging.

childhood may develop a lifetime of greater susceptibility to stress-related physical illnesses (such as cardiovascular disease, hypertension, and diabetes) as well as mental health problems (such as depression, anxiety disorders, and substance abuse). They also are more likely to exhibit health-damaging behaviors and adult lifestyles that undermine well-being.

### Implications for Policy and Practice

- Policy makers who administer early intervention programs should update their eligibility criteria, based on new brain research, and actively enroll infants and toddlers who are experiencing toxic stress for either preventive or therapeutic services, as needed. Two groups of children and families already known to public agencies are prime candidates for assessment. The first (which is currently mandated for referral by new federal legislation) includes all young children referred to the child welfare department for evaluation of suspected abuse or neglect. When circumstances require removal of a child from his or her home, it is especially critical that policies be in place and implemented consistently to make sure that the



establishment of a nurturing relationship with a new primary caregiver is given the highest priority. The second group that warrants closer attention is young children of mothers supported by welfare who have reached their time limits for public assistance and are unable to secure stable employment. Effective developmental intervention for both groups will require expanded access to child and adult mental health services, which are already burdened by demands that far exceed their capacity.

- Greater attention should be directed toward maternal depression, not only because it is a common adult mental health problem but also because it is a threat to the health and well-being of a young child. The prevention of developmental impairments in children of depressed mothers requires prompt diagnosis and specialized treatment of both the mother and the mother-child relationship. These findings direct our attention to the need for early detection of maternal depression in pediatric offices and in all programs that serve very young children, as well as the need for expanded clinical services that focus on the mother and child together.
- When accessible and affordable mental health services are available, they put a preventive system in place that catches children before they fall. Programs that target vulnerable young children within a family-centered model can be particularly effective, but the current gap between the supply and demand for skilled personnel requires a major investment in professional development. The costs of increased training and expanded services in early childhood mental health are substantial, but the money “saved” by not treating emotional problems in early childhood is likely to be modest in comparison to the greater long-term costs of serious adult mental illness and/or criminal behavior.
- Generally speaking, policies that focus on the delivery of evidence-based services for the most vulnerable young children will achieve greater financial return than services for children at lesser risk. To this end, issues of quality and cost must be viewed in the context of what a program is expected to do. Programs for families coping with severe depression, substance abuse, or violence must be staffed by skilled clinicians who require higher compensation and smaller case loads than basic supportive services for inexperienced mothers. When program resources match the needs of the children and families they are set up to serve, they can be very effective. When services are asked to address needs that are beyond their capacity to meet, they are likely to have little impact and are therefore too expensive, despite their low cost.

**The essential feature of toxic stress is the absence of consistent, supportive relationships to help the child cope.**



**Concept 7: Creating the right conditions for early childhood development is likely to be more effective and less costly than addressing problems at a later age.**



As the maturing brain becomes more specialized to assume more complex functions, it is less capable of reorganizing and adapting to new or unexpected challenges. Once a circuit is “wired,” it stabilizes with age, making it increasingly difficult to alter. Scientists use the term “plasticity” to refer to the capacity of the brain to change. Plasticity is maximal in early 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, this means that greater amounts of physiological energy are needed to compensate for circuits that do not perform in an expected fashion. For society, this means that remedial education, clinical treatment, and other professional interventions are more costly than the provision of nurturing, protective relationships and appropriate learning experiences earlier in life. Stated simply, getting things right the first time is more efficient and ultimately more effective than trying to fix them later.

**Implications for Policy and Practice**

- These findings direct our attention to the importance of informal family support and formal preventive services (when needed) for vulnerable children before they exhibit significant problems in behavior or development. When policy makers assure that all young children who are at high risk for poor outcomes are enrolled in high quality programs whose effectiveness has been documented, the returns are far greater than those achieved when only a subgroup of eligible children are served. At the same time, the extent to which some early concerns may be self-correcting maturational delays underscores the need to avoid premature labelling of vulnerable children and families who could benefit from early assistance.
- The basic principles of neuroscience and the process of human skill formation indicate that early intervention for the most vulnerable children will generate the greatest payback. Although the large number of children and families who could benefit from additional assistance will require significant

increases in funding, extensive research indicates that investment in high quality interventions will generate substantial future returns through increased taxes paid by more productive adults and significant reductions in public expenditures for special education, grade retention, welfare assistance, and incarceration. Stated simply, the largest returns will be realized from effective services for the neediest children and families well before they enter school.

**Getting things right the first time is more efficient and ultimately more effective than trying to fix them later.**

- Research indicates that policy makers can achieve greater return on investments in early childhood education for children from families with low incomes and limited parent education than from remedial programs for adults with limited workforce skills. In fact, long-term studies show that model programs for three- and four-year-olds living in poverty can produce benefit-cost ratios as high as 17:1 and annualized internal rates of return of 18% over 35 years, with most of the benefits from these investments accruing to

the general public. While it is not realistic to assume that all scaled-up early childhood programs will provide such handsome returns, it is likely that benefit-cost ratios still will be considerably greater than 1:1.

- The essence of quality in early childhood services is embodied in the expertise, skills, and relationship-building capacities of their staff. The striking imbalance between the supply and demand for well-trained personnel in the field today indicates that substantial investments in training, recruiting, compensating, and retaining a high quality workforce must be a top priority for society.

Responsible investments in services for young children and their families focus on benefits relative to cost. Inexpensive services that do not meet quality standards are a waste of money. Stated simply, sound policies seek maximum value rather than minimal cost.

## Concluding Thoughts

Decades of rigorous science and centuries of common sense all converge on the core principles articulated in this paper. Within this context, the time has come to begin to close the gap between what we know (from systematic scientific inquiry across a broad range of disciplines) and what we do (through both public and private sector policies and practices) to promote the healthy development of all young children.

The need to address significant inequalities in opportunity, beginning in the earliest years of life, is both a fundamental moral responsibility and a critical investment in our nation's social and economic future. As such, it is a compelling task that calls for broad, bipartisan collaboration. And yet, debate in the policy arena often highlights ideological differences and value conflicts more than it seeks common interest. In this context, the science of early childhood development can provide a values-neutral framework for informing choices among alternative priorities and for building consensus around a shared plan of action. The well-being of our nation's children and the security of our collective future would be well-served by such wise choices and concerted commitment.

It is in this spirit that we, as scientists, offer this paper as a way to share what we know about how brain architecture is constructed and competence is built over time, beginning in the earliest years of life. We trust that the content of this document will inform the important work of citizens and policy makers to support families and communities in promoting the healthy development of young children, just as it will serve as a foundation on which the next generation of scientific knowledge will be built. ●



## Selected Background Readings

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### 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.

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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)

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<http://developingchild.net/pubs/wp-abstracts/wp4.html>