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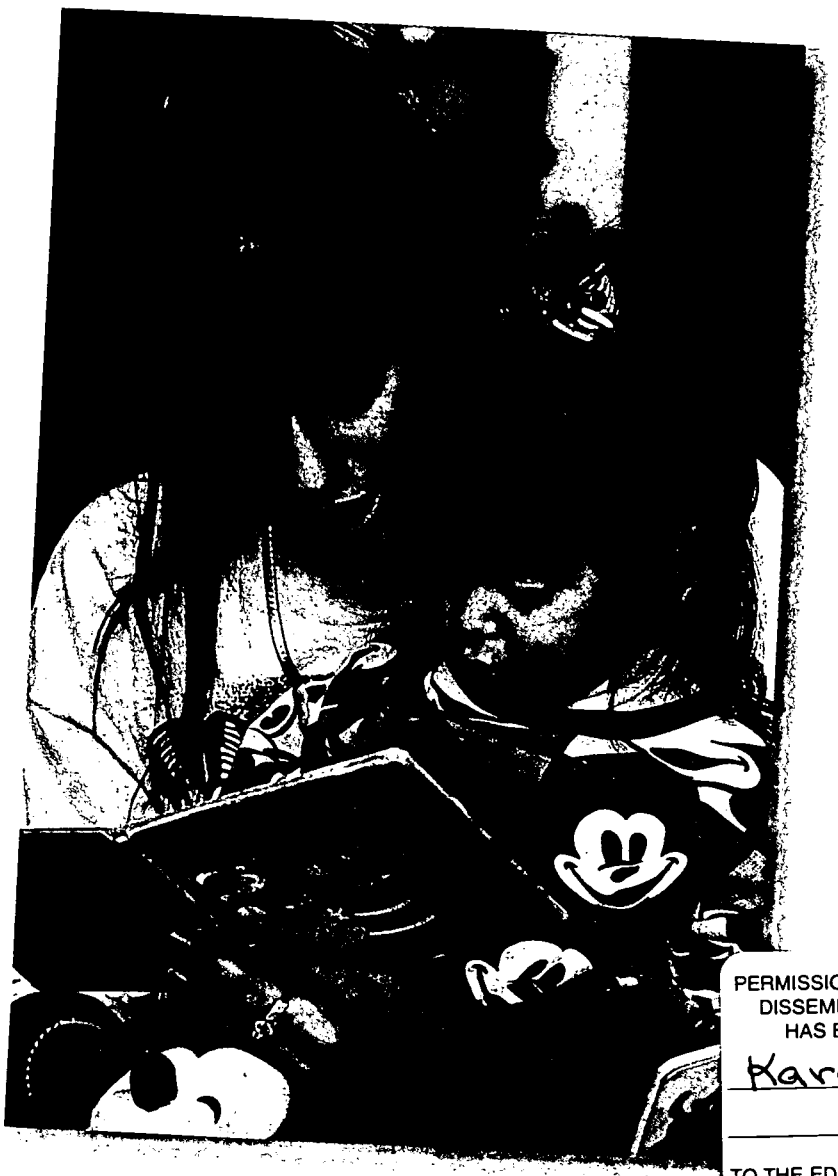
ABSTRACT

Recent research has provided great insight into the impact of early experience on brain development. It is now believed that brain growth is highly dependent upon early experiences. Neurons allow communication and coordinated functioning among various brain areas. Brain development after birth consists of an ongoing process of wiring and rewiring the connections among neurons. The forming and breaking of neural connections depends directly on the child's experiences; only those connections and pathways frequently activated are retained. Children who have little opportunity to explore and experiment with their environment may fail to fully develop neural connections and pathways that facilitate later learning and thus may be at a permanent intellectual disadvantage. Further, exposure to trauma or chronic stress can make children more prone to emotional disturbances and less able to learn because they have overactive neural pathways that control the fear response, causing their brains to be organized primarily for survival. It is possible to influence disadvantaged children's development through early intervention programs as evidenced by the results of the Abecedarian Project. Communities can help families promote their children's brain development by: (1) educating them about the importance of early experience; (2) preventing abuse and neglect; (3) providing accessible quality mental health services; and (4) ensuring adequate early nutrition. Child care providers need training in devising appropriate environments, and parents need information on choosing quality child care. (Recommended readings are included. Contains 14 references.) (KDFB)

Starting Smart

How early experiences affect brain development



An Ounce of Prevention Fund Paper

Michael Stevens is a healthy, beautiful newborn baby. As his parents admire him, they wonder, "What will Michael be like when he grows up? Will he do well in school? Will he get along with other kids and be happy?" Scientists now believe that the answers to these questions depend in large part on how young Michael's brain develops, and that this development in turn depends largely on the kinds of experiences that his parents, extended family, and community provide for him over the next few years.

Recent advances in brain research have provided great insight into how the brain, the most immature of all organs at birth, continues to grow and develop during the first years of life. Whereas this growth was once thought to be determined primarily by genetics, scientists now believe that it is also highly dependent upon the child's experiences. Research shows that, like protein, fat, and vitamins, interactions with other people and objects are vital nutrients for the growing and developing brain and different experiences can literally cause the brain to develop in different ways. It is this "plasticity" of the brain, its ability to develop and change in response to the demands of the environment, that will enable Michael to learn how to use computers as successfully as his ancestors learned how to hunt animals in the wild.

As he grows, Michael's ability to understand language, solve problems, and get along with other people will be strongly influenced by what he experiences as an infant and young child. This is not to say that individual genetic differences have no influence on how a child develops; they do. But there is mounting evidence that early experiences can dramatically alter the way genes are expressed in the developing brain. While good early experiences help the brain to develop well, poor early experiences can literally cause a genetically normal child to become mentally retarded or a temperamentally easy-going child to develop serious emotional difficulties.

Understanding How the Brain Develops

In order to understand how this happens, we need to understand a bit about how the brain works. The brain is comprised of many distinct regions, each devoted to a specific function, such as identifying what we see, processing spoken language, or assessing whether we are in danger. Within each of these brain areas are millions of neurons, or nerve cells, which are connected to each other by synapses. These trillions of synapses and the pathways they form make up the "wiring" of the brain; they allow all of the various brain areas to communicate and function together in a coordinated way. The number and organization of connections in the brain influences everything from the ability to recognize letters of the alphabet to facility at managing complex social relationships.

Neurons develop rapidly before birth, but after birth no new neurons are formed. Instead, brain development after birth consists of an ongoing process of wiring and re-wiring the connections among neurons. New synapses between cells are constantly being formed, while others are broken or pruned away. During the first eight months after birth, connections are formed more quickly than they are broken, so that at age eight months a baby may have an astounding 1,000 trillion synapses in his brain! After the first year, pruning occurs more rapidly than synapse formation until age 10, when a child has about 500 trillion synapses, roughly the same number as the average adult[1]. Early experiences can have a dramatic impact on this brain-wiring process, causing the final number of synapses in the brain to increase or decrease by as much as 25 percent.[2]

The Ounce of Prevention Fund was established in 1982 as a public/private partnership to promote the well-being of children and adolescents by working with families, communities, and policy-makers. The Ounce's work is based on the conviction that it is more cost-effective and caring to prevent physical, and psychological problems early on than to treat such problems later in life. The Ounce of Prevention has compiled this paper, which has been ped from the work of a number of scientific researchers, to raise awareness of issues vital to early childhood development.

New scientific data have taught us that the forming and breaking of neural connections depends directly on the child's experiences. The brain operates on a "use it or lose it" principle as it develops: only those connections and pathways that are frequently activated are retained.[3] The way infants learn to understand spoken language provides a good example of this experience-dependent development of neural connections. When an infant is three months old, his brain can distinguish several hundred different spoken sounds, many more than are present in his native language. Over the next several months, however, his brain will organize itself more efficiently so that it only recognizes those sounds that are part of the language he regularly hears. For example, a one-year-old Japanese baby will not recognize that "la" is different from "ra," because the former sound is never used in his language. During early childhood, the brain retains the ability to re-learn sounds it has discarded, so young children typically learn new languages easily and without an accent. After about age ten, however, plasticity for this function is lost; therefore, most adolescents and adults find it difficult to learn to speak and understand foreign languages

Windows of Opportunity in Brain Development

This new understanding of how the young brain develops has already altered the practices of medical professionals who work with children born with hearing and vision impairment. For example, surgeons now remove congenital cataracts as early in infancy as possible, because they know if they wait until the child is older, the neural connections between his eyes and his brain will fail to develop properly, and he will never be able to see. Similarly, scientists now know that if children born deaf do not hear people talking before they are ten, they will never learn to understand spoken language. As a result, new hearing aids called cochlear implants have been developed to provide at least some hearing for very young deaf children.

A new consensus about the importance of intervening in the first months and years is also emerging in the field of early intervention with disadvantaged children. Psychologists have long known that children of poorly educated, low-income parents are at risk for mental retardation. The recent developments in brain research have provided new insights into why this is so. Parents who are preoccupied with a daily struggle to ensure that their children have enough to eat and are safe from harm may not have the resources, information, or time they need to provide the stimulating experiences that foster brain growth. Infants and children who are rarely spoken to, who are exposed to few toys, and who have little opportunity to explore and experiment with their environment may fail to fully develop the neural connections and pathways that facilitate later learning.[4] Despite their normal genetic endowment, these children are at a permanent intellectual disadvantage and are likely to require costly special education or other remedial services when they enter school. Fortunately, intervention programs that start working with children and their families at birth or even prenatally can help prevent this tragic loss of potential[5] (*see box below*).

An impressive example of the power of adult-child interactions to facilitate children's successful development comes from a study of early language skills.[6] Researchers found that when mothers frequently spoke to their infants, their children learned almost 300 more words by age two than did their peers whose mothers rarely spoke to them. Furthermore, the study suggested that mere exposure to language such as listening to the television or to adults talking amongst themselves provided little benefit. Rather, infants need to interact directly with other human beings, to hear people talk to them about what the they are seeing and experiencing, in order for their brains to develop optimal language skills. Unfortunately, many parents are under the mistaken impression that talking to babies is not very important, since babies are too young to understand what is said. Parents need to be educated about how children develop and about the importance of their early interactions with their children.

Reducing the Risk of Mental Retardation

Through the University of North Carolina's "Abecedarian Project," Craig Ramey and his colleagues demonstrated that intensive early intervention could greatly reduce the risk of mental retardation among children of mothers with low income and education levels. The children in the project were randomly assigned to receive either an intensive five-year program of full-day, full-year child care and parent involvement activities beginning in the first few months after the child's birth, or to receive only free formula and diapers. After just three years, dramatic results were evident: the program children had an average IQ score of 105, while the control group children averaged only 85. And unlike many programs which began interventions at age four, the effects of the program on IQ held over time. At age 12, the children who participated in the five-year program still displayed a significant IQ advantage over the control children. More importantly, only 13 percent of the program children scored in the "borderline" category of intellectual functioning (IQ = 70 to 85) or lower, compared to 44 percent of the control group children. The program children were also less likely to repeat a grade in school and demonstrated better achievement in reading and mathematics.

Emotional Development and the Infant Brain

One of the most fundamental tasks an infant undertakes is determining whether and how he can get his needs met in the world in which he lives. He is constantly assessing whether his cries for food and comfort are ignored or lovingly answered, whether he is powerless or can influence what adults do. If the adults in his life respond predictably to his cries and provide for his needs, the infant will feel secure. He can then focus his attention on exploring, allowing his brain to take in all the wonders of the world around him. If, however, his needs are met only sporadically and pleas for comfort are usually ignored or met with harsh words and rough handling, the infant will focus his energies on ensuring that his needs are met. He will have more and more difficulty interacting with people and objects in his environment, and his brain will shut out the stimulation it needs to develop healthy cognitive and social skills.[7]

Children who receive sensitive, responsive care from their parents and other caregivers in the first years of life enjoy an important head start toward success in their lives. The secure relationships they develop with the important adults in their lives lay the foundation for healthy emotional development and help protect them from the many stresses they may face as they grow. Researchers who examine the life histories of children who have succeeded despite many challenges in their lives have consistently found that these children have had at least one stable, supportive relationship with an adult (usually a parent, other relative, or teacher) beginning early in life.[8]

The Effects of Trauma and Chronic Stress

Scientists have discovered that chaotic or overwhelming experiences can be as damaging to the developing brain as a lack of stimulation. Exposure to trauma or chronically stressful environments can dramatically change the way an infant or young child's brain develops, making the child both more prone to emotional disturbances and less able to learn. Unpredictable, chaotic, or traumatic experiences over-activate the neural pathways that control the fear response, causing children's brains to be organized for survival in a persistently threatening and violent world.[9] The result is that such children live life on high alert, overly quick to interpret others' actions as threatening, and quick to respond aggressively in their own defense. Although this ability of the brain to adapt to what it perceives as constant threats may help the child avoid future harm (e.g., a battered child may learn to keep out of his father's way when the father is in a bad mood) it exacts a great cost. Children exposed to severe stress frequently develop learning disabilities and emotional and behavioral problems (e.g., attention deficits, anxiety, depression) and appear to be at risk for a host of medical problems, such as asthma, immune-system dysfunction, and heart disease (*see box to the right*).

It is important that we not assume that a poorly parented or traumatized child is incapable of healthy functioning later in childhood or adolescence. Research on the developing brain suggests continuing opportunity for change into adulthood and provides no evidence that there is some age beyond which intervention will fail to make a difference. In fact, this research provides exciting new clues as to what kinds of therapy might be most helpful for children who have experienced difficult lives.[10] Clearly, however, the costs (in human suffering, loss of potential, and real money) of trying to repair, remediate, or heal these children is far greater than the costs of preventing these problems by promoting healthy development of the brain during the first few years of life.

The Impact of Neglect and Trauma on the Developing Brain: How Nurture Becomes Nature

At the CIVITAS Child Trauma Programs at Baylor College of Medicine, Bruce Perry and co-workers have studied the impact of neglect and trauma on the neurobiology of over 1,000 abused and neglected children. In one study, twenty children who had been raised in globally under-stimulating environments—children who were rarely touched or spoken to and who had little opportunity to explore and experiment with toys—were examined with sophisticated new brain-imaging techniques and other measures of brain growth. The children were found to have brains that were 20 to 30 percent smaller than most children their age and, in over half the cases, parts of the children's brains appeared to have literally wasted away.

Another study suggests that childhood trauma, such as being repeatedly abused or witnessing a murder, can directly effect the way the brain functions. The researchers discovered that traumatized children continue to show physical symptoms of fear even in the absence of threatening stimuli, as if their brains are "stuck" in their reaction to the traumatic experience. These children have very high resting heart rates, high levels of stress hormones in their blood, and problematic sleep patterns, all of which suggest that their experiences have left their brains in a permanent state of "high alert." Without proper intervention, these children are likely to develop emotional, behavioral, and learning problems.

Helping Families Support Healthy Brain Development

It is now clear that what a child experiences in the first few years of life largely determines how his brain will develop and how he will interact with the world throughout his life. Parents play the most important role in providing the nurturing and stimulation that children require, but they need information and support to develop good parenting skills. In the past, extended family members were often close by, offering advice and acting as role models for inexperienced parents. Young families today often live far away from grandparents and other family and rely more on community resources for information and support in parenting. There is much that communities can do to help families promote their children's healthy brain development.

Educate parents about the importance of early experiences for their children's development. Often parents don't know about the many little things they can do to foster their child's healthy cognitive and emotional development, like talking to the child beginning in infancy, reading to him from a very early age, and helping him play simple games. Parents, especially new or young parents, may also need help learning to recognize their child's cues that he is hungry for stimulation or has had enough.

In some cases, written materials or a few sessions of parenting education classes may be all that a parent needs to learn how to provide his or her child with appropriate stimulation. However, parenting styles and beliefs that have evolved over generations, like rarely talking to babies, can be difficult for parents to change. Many parents benefit from community-based programs in which a parent group leader or a home visitor acts as a role model and friend, supporting parents in their relationship with their children. Programs that work with parents over several years can be very successful in helping them become effective "first teachers" of their children.[11]

Prevent abuse and neglect. Children who are abused or severely neglected are at extremely high risk of developing emotional, behavioral, social, and intellectual disabilities. By the time a child is identified as having been neglected or abused, these problems have already begun to develop. Greater attention must be given to preventing maltreatment before it starts. High-quality home visiting programs which start working with families as soon as the child is born have proven to be effective in preventing abuse and neglect.[12] The key to these programs' success is that they help parents manage the stresses of raising children before unhealthy patterns develop and things get out of control.

Provide accessible, quality mental health services for parents. Research has shown that parents suffering from untreated depression often fail to respond sensitively to their children's cries and bids for attention, and that they are unlikely to provide the child with the kind of cognitive stimulation that promotes healthy brain development.[13] Other mental illnesses like schizophrenia can also dramatically affect a parent's ability to interact appropriately with his or her child. Proper mental health treatment for these parents can make a real difference in their ability to raise a competent, happy child.

Ensure adequate nutrition prenatally and in the first years after birth. Numerous studies have shown the devastating effects on intelligence and brain development of a lack of basic nutrients at the prenatal stage and in infancy and early childhood. Programs such as the Special Supplemental Program for Women, Infants, and Children (WIC) can be effective in ensuring that babies

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receive the kinds of foods they need to thrive.[14] Educational and outreach campaigns to alert women to the importance of nutrition in the first trimester of pregnancy would also be helpful in preventing problems that can arise in this critical period when brain cells begin to form.

The Importance of Quality in Infant-Toddler Child Care

Increasing numbers of American infants and toddlers spend several hours each day in various child care arrangements because their parents work or attend school. It is critical that the care these children receive promotes their healthy growth and development. Too often, however, child care providers are poorly trained and do not provide children with appropriate stimulation. Research has shown that in the majority of infant care arrangements in the U.S., children are not talked to and played with enough, and they do not have the opportunity to form the kind of comfortable, secure relationships with a caregiver that will promote their healthy emotional development.[15]

Parents should be given information about how to choose quality care for their children. In addition, special attention must be given to the development and enforcement of child care licensing standards that promote high-quality care: adequate pre-service and in-service training for caregivers; low child-to-teacher ratios, and small group sizes. Finally, child care reimbursement rates for families moving from welfare to work must be high enough to fund well-trained teachers who can deliver developmentally appropriate care and education.

Conclusion

Like most children, Michael Stevens has a family that will provide the stimulation and nurturing that he needs to grow and develop to his potential. Unfortunately, rising rates of child abuse and neglect across the country and persistently high rates of school failure in some communities indicate that far too many children do not receive what they need during their first few years for healthy brain growth and development. Our increasingly technically and socially complex society cannot afford to continue to allow large numbers of children to miss out on the positive experiences they need in infancy and early childhood; the costs, in terms of lost intellectual potential and increased rates of emotional and behavioral problems, are too high. The new developments in brain research show us what children need; our challenge is to ensure that every child receives it.

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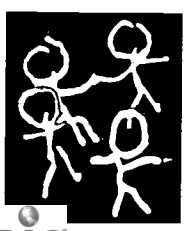

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