



# Windows of Opportunity

**What the New  
Brain Research  
Tells Us About Early  
Intervention and  
School Success  
.....  
Summer 1998**



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**What the New Brain Research Tells Us  
About Early Intervention and School  
Success**

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## Executive Summary

Ensuring that all children enter school ready to learn is Florida's number one educational goal. But this goal cannot be met until the state's educational and human-service agencies have the resources, knowledge and tools they need to serve every child well, so that all children-with and without disabilities-can reach their full capacities.

Today many Floridians take for granted the special services for children with disabilities. But as recently as the 1970's, across the United States, more than one million children with disabilities received no public education whatsoever, and another 3.5 million did not receive appropriate programs within public schools. Many spent their childhoods in dehumanizing state institutions for the mentally retarded. Their futures were essentially written off.

Now, infants and toddlers with disabilities can receive early intervention services that help get them on the right developmental track from the start. Research has conclusively shown that the earlier students receive the services they need to become effective learners, the better their chances for success. This conclusion is based on independent evaluations of numerous early intervention programs serving children with a wide range of disabilities.

## New Brain Research Strengthens the Case for Early Intervention

The children themselves constitute the most compelling case for early intervention. The most impressive "results" are the graduates of early intervention programs who thrive in classrooms, in families and communities, on playing fields and, in due time, on the job. Based on years of experience, developmental psychologists and special educators have found that appropriate, intensive early intervention can ameliorate some disabling conditions and minimize the impact of others. Experience has shown that early intervention can produce good results for children with many kinds of disabilities. For example, early identi-

fication of cerebral palsy can lessen developmental problems and lead to appropriate intervention when it helps the most.

Scientific research is strengthening the case for early intervention. Neuroscientists are uncovering the biological mechanisms that account for the power of early intervention. With the aid of sophisticated new research tools, including brain scans, they have learned that brain development during the early years is more rapid, more extensive and more vulnerable to experience than they ever realized. They have learned more about the brain's plasticity-its capacity to change its physical structure in response to experience.

The human brain is remarkably unfinished at birth. It is a work in progress. The brain's plasticity makes it possible for people to adapt to many different kinds of environments and circumstances. For people with disabilities, brain plasticity creates a potential for improving, stabilizing or compensating for disabling conditions.

Brain development continues throughout the human life span, but in general, brain plasticity is more marked in the preschool years than at any other time of life. Moreover, different parts of the brain are most plastic-most sensitive to outside influence-at particular times. Scientists refer to these times as "sensitive" or "critical" periods. That is why the same intervention can be more or less effective depending on when it is introduced. Critical periods are therefore windows of opportunity when therapies and interventions may be most effective. All of these findings confirm the importance of early screening and timely intervention.

Early intervention for children with disabilities is a good public investment. Examples abound. Premature infants at a Boston hospital who received developmental care and intervention had much shorter hospital stays than those who received traditional care (87 vs. 151 days), saving \$91,000 per infant. In Florida, home visits and primary health care for children with special health needs reduced emergency room visits by 69 percent and hospitalization by 34 percent.

## Addressing Specific Disabling Conditions

Thanks to research conducted over the last two decades, children with diverse conditions are no longer treated under the general umbrella of “mental retardation.” Much more is known than ever before about the neurological characteristics, developmental trajectories and learning processes associated with different kinds of developmental delays or disabilities.

In particular, brain researchers have a much fuller picture of the biological bases of conditions like autism, schizophrenia and attention deficit hyperactivity disorder (ADHD). Their investigations have made use of brain scans, which allow researchers to study how the brains of living people look, work and use energy. A landmark study conducted by the National Institute of Mental Health made use of Positron Emission Tomography (PET) scans to show that the brains of people with ADHD tend to have a lower metabolic rate than those of other people. PET scans have also helped researchers design and test early interventions. NIMH researchers investigating ADHD offer an example. Using brain scans, they are trying to determine why some medications work better than others, and whether the more effective medications increase activity levels in the parts of the brain that control attention.

Insights into the nature of specific disabilities, gleaned from research in neuroscience and other fields, is leading to new, more effective interventions. For example, it was once thought that children with Down Syndrome acquire language just like non-delayed children, only slower. Studies have shown that this is not the case. Researchers now have a much better idea of the specific processes and challenges associated with language learning by children with Down Syndrome, and can design strategies geared to their individual needs and strengths.

In summary, the new brain research strengthens the case for early screening and intervention. There are some cases and some conditions that are difficult to improve, given current knowledge and methods; but the scientific literature provides sufficient evidence of positive results in cases once thought to be untreatable to hold out hope for every individual.

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## Introduction: All the Difference in the World

Ensuring that all children enter school ready to learn is Florida's number one educational goal. But this goal cannot be met until the state's educational and human-service agencies have the resources, knowledge and tools they need to serve every child well, so that all children-with and without disabilities-can reach their full capacities.

Today many Floridians take for granted the special services for children with disabilities. But as recently as the 1970's, across the United States, more than one million school-age children with disabilities received no public education whatsoever, and another 3.5 million did not receive appropriate programs within public schools. Many spent their childhoods in dehumanizing state institutions

for the mentally retarded. Their futures were essentially written off.<sup>1</sup>

Public investments in special services for preschoolers (aged three to five) came even later. When the federal Preschool Grants Program was established in 1986, only 24 states and jurisdictions had mandates to provide special education to all preschoolers with disabilities. Not until this decade was special education for preschool children with disabilities provided in all of the nation's 50 states and 7 other jurisdictions, as well as the children of military personnel stationed outside the United States.<sup>2</sup>

Now the challenge is to provide services that will ensure the healthy development and learning of all young children. Today Florida's infants and toddlers with disabilities can receive early intervention services that help get them on the right developmental track from the start. Research has conclusively shown that the earlier children receive the services they need to become effective learners, the better their chances for success. This conclusion is based on independent evaluations of numerous early intervention programs serving children with a wide range of disabilities.<sup>3</sup>

## Who Will Learn?

In recent years school reformers across the nation have proclaimed that all children can learn to high standards.<sup>4</sup> Indeed, this notion informs Florida's strenuous efforts to raise achievement throughout the state. Today's, scientific evidence is lending support to the view that healthy development and school success are within the reach of virtually every child if-and it is a big "if"-they receive warm, responsive parenting, good health care, appropriate teaching and timely help when problems arise.<sup>5</sup> Much of this evidence comes from the field of neuroscience. The conviction that only some children are destined for school success is rooted in the assumption that intelligence is pre-set and genetically determined. Recent brain research acknowledges the role of heredity, but shows that when it comes to academic ability, both nature and nurture count.<sup>6</sup>

By studying the human brain, scientists have established that early experience plays a crucial role in determining an individual's long-term intellectual, social, and emotional capacities.<sup>7</sup> They report that children's brains are highly flexible and that there are windows of opportunity-known as critical periods-when young brains are particularly responsive to intervention. These findings refute the notion that heredity is destiny. They confirm the importance of prevention and the promise of intervention.

## Prevention is Best

Recent brain research has shed light on early development and learning, showing how children's early experiences affect their capacities as older children and adults. Many of these findings are not new. Parents and teachers have long known that children who grow up in poverty have a harder time in school. They have observed that the children of alcoholic mothers are more likely than other children to have developmental delays. They have known that children who have very little stimulation in the first years of life may develop learning problems that are difficult to reverse.

What is new is that thanks to advances in neuroscience, we now know much more than ever before about the biological mechanisms underlying these observations. Thanks to advances in research and technology, including sophisticated brain scans, scientists can literally see how and when different parts of the brain develop. When a child runs into difficulty, they can pinpoint the problem, and sometimes its cause, with more precision than ever before. They cannot cure every ill. Some disabilities-like those resulting from strokes-are still difficult to reverse, given today's knowledge and methods. But researchers in neuroscience and other fields now know more than ever before how to prevent, treat or lessen the impact of a wide range of developmental disabilities.<sup>8</sup>

We have long known that prevention is best. It is the most humane, sensible and cost-effective approach to ensuring the well-being of our children. We now know that prevention also makes sense from a biological stand-

point. Brain research shows that in the first years of life, a brain is more active and more flexible than it is at any other time in the human life cycle. Young children's brains are therefore more vulnerable to experience—both positive and negative—than those of adolescents or adults.<sup>9</sup>

The overriding concern for everyone who cares for children must therefore be the physician's cardinal rule: first do no harm. Malnutrition is always terrible. Abuse and neglect are always traumatic. Exposure to violence, whether in real life or on television, is always disturbing. Impersonal, mechanical care, whether at home or in child care, is always heartbreaking. But the impact of these experiences is far more dramatic and long-lasting when they occur in the the first years of life.<sup>10</sup>

Brain research also points to simple things parents and child-care providers can do to promote healthy development. Warm, responsive care is pleasant and reassuring at any stage of life, but it plays an especially vital role in the early years, fostering growth across the entire developmental spectrum (cognitive, emotional, social, etc.). Conversation with a child is always good, but its effects are especially positive and lasting when it takes place in the early years.<sup>11</sup>

## Prevention Is Not Enough

Many of the conditions that impede school readiness and school success are preventable. For example, the Centers for Disease Control estimate that half of all cases of mild retardation can be averted.<sup>12</sup> If preventive measures are taken early enough—beginning before birth with parent education, voluntary family planning, preconception care, and prenatal services—they can brighten the future for many of our children.

But prevention is not enough. Millions of children have not enjoyed the benefits of preventive services. They need and deserve Floridians' best efforts to help them live up to their full capacities. There are some developmental delays and disabilities which cannot be prevented, but which may respond to timely intervention. Moreover, in some cases

intervention may not improve a condition but may minimize its impact or keep it from getting worse. The children and families who are living with these conditions need and deserve our best efforts to help them.

## Focus on Early Intervention

Bright From the Start addressed preventive efforts aimed at averting or reducing the risk for a condition that need not exist. In contrast, this paper deals with intervention. In its broadest sense an intervention is an action taken to improve, interrupt or treat an existing condition. Brain surgery is an intervention, but so is a vitamin, a special education program, a speech therapy session or a class for teen parents. Interventions may be one-time events or sustained efforts. They are generally designed and timed to address specific issues. And they are often based on evidence gathered by researchers and practitioners about what works.

Windows of Opportunity is about problems. It addresses a wide range of disabilities. But this paper is also about solutions. It brings home to policy makers, parents, teachers and professionals across the state a trifold message:

- First, prevention is best, but when problems arise, timely intervention can often help.
- Second, thanks to scientific and technological breakthroughs, researchers and practitioners now know more than ever before about how to remedy or improve a wide range of conditions once thought to be irreversible.
- And third, in the realm of intervention, time is of the essence, but it is never too late to help an individual gain new competencies and improve her life prospects.

Windows of Opportunity sends a message of hope. Focusing on school success, it confirms that with rare exception, every child can meet parents' and teachers' high expectations, and it extends the notion that "all children can learn" to include the vast majority of those with disabilities. It shows how early intervention programs-

including some that are already up and running in Florida-can make all the difference in the world.

## I. Florida's Children

Millions of children throughout Florida are on track for success in school and in their later lives. But tens of thousands of other children have health problems, disabilities or impairments that place them at risk for low achievement. Many of these children have a range of other risk factors as well, including poverty.

Approximately 310,000 children and youth in Florida-about 14.3 percent-are currently receiving special-education services.<sup>13</sup> Children under the age of six are the fastest growing segment of this population, reflecting a stronger emphasis in recent years on early identification and intervention. Nationwide, the total special-education population increased by 31 percent in the first half of the nineties, while the under-six population rose by more than 60 percent.<sup>14</sup>

More Florida children under the age of six are receiving early intervention services than ever before.

- In 1995-96, 27,080 Florida children under the age of six received special education services under the Individuals with Disabilities Education Act and Chapter 1.<sup>15</sup>

- In 1995-96, 26,158 of Florida's premature, delayed or disabled infants and toddlers received early intervention services.<sup>16</sup>

Behind these statistics are young children with a wide range of disabilities. Many of these disabilities are preventable; some are not. Some only affect a child's mastery of particular competencies; others are more global. Some are mild and improve dramatically in response to warm, responsive care and good teaching; others are more severe and require more intensive intervention. And some do not improve, despite the best efforts of parents, teachers and health-care professionals.

But virtually all children who have disabilities benefit when they receive warm, responsive early care and good, consistent health care-the essential requirements for any child's healthy development. They benefit when their disability is identified early, and when parents and professionals work together to address the issue in a timely way. And finally, they benefit when all concerned-families, teachers, and health professionals-recognize that the disability is but one aspect of who they are, and when comprehensive efforts are made to assure their healthy development and school success.

## Accomplishments

During the 1980's, Florida's population rose sharply, especially our population of families with young children living in poverty. Under the leadership of both Republican and Democratic governors, the state made significant investments in services for very young children and their families, increasing funding for established programs and creating a number of new statewide initiatives. These programs included preschool and early intervention services for young children with disabilities, under Part H of the Individuals with Disabilities Education Act (IDEA). Florida elected to participate in Part H only after a major state-funded research and evaluation study and years of work by families, child advocates, researchers, policy makers, the media and foundations. Forums were held across the state to discuss the results. This process has been cited as an example of how research can help change the policy landscape.<sup>17</sup>

The study documenting the need for early intervention was a landmark in Florida's history. For the first time, data were available that decision makers in each county could use to estimate the number of families and children at risk for disabilities. The study noted the multiple services needs of children with disabilities and their families. It underscored the benefits of a family- and child-centered approach combining the efforts of medical and social service providers.

Florida has been participating in Part H since 1993. Evaluations show that the program is considered to be



“effective” or “very effective” by a large majority of participating families. The vast majority—93 percent—say that without the program, they could not have afforded the early intervention services.

Florida has also put into place a range of other services for young children with disabilities and their families:<sup>18</sup>

- All newborns are eligible for comprehensive screening. Every infant born in the state is eligible for a comprehensive screening for a wide range of factors—physical, nutritional, social, economic, environmental and behavioral—that are associated with poor health. Those children considered to be at high risk are followed closely. This process allows the state to target its limited resources to the children who are most in need of preventive services and early intervention.
- Families with at-risk infants receive support throughout the first year. More than 80 percent of the children identified as at-risk for poor health outcomes take part in the Healthy Start Program. This program provides care coordination, home visiting and parenting support during the crucial first year of life.
- Many more low-income children are receiving Prekindergarten Early Intervention services. The number of special-needs children served has nearly quadrupled, going from approximately 7,000 in 1989 to more than 27,000 in 1995-96.
- Assistance is now available for child-care providers who work with special-needs children. To ensure that child-care programs are ready to meet the needs of children with disabilities, the Florida Children’s Forum and Florida Developmental Disabilities Council have worked together to begin providing training and mentoring for child-care personnel who lack experience in working with children with disabilities.

## Major Challenges

While these are significant achievements, a great deal

remains to be done. Many experts agree that if prevention and early intervention programs were available to all, and if they were sufficiently intensive and timely, most children with disabilities could enjoy school success.<sup>19</sup> But that is not yet the case. As a group, special-education students have lower-than-average rates of high school completion, college attendance or work force participation.<sup>20</sup> Moreover, for too many children, a referral to special education has been a one-way ticket. Studies show that in some urban districts across the nation, the rate of “decertifying” children from special education may be five percent or less.<sup>21</sup>

Florida has put into place a framework for supporting healthy development and learning for all children, but significant challenges remain. First, we need to ensure that all children have access to adequate health care. This is a concern for all families, but when children have disabilities or chronic illness, they often need a variety of specialized and costly medical services. SSI restrictions resulting from welfare-reform legislation have ended Medicaid eligibility for many children with disabilities. Many others are covered by managed-care plans, but these providers may not offer all of the medications, therapies and interventions needed to produce improvement or prevent regression. Many children lack access to mental health and family therapies. These services are especially important for children with disabilities, because they are abused and neglected more frequently than other children.<sup>22</sup>

Second, too many children with disabilities lack the high-quality developmental supports and services that could help them reach their full potential. While Florida is statutorily committed to furnishing a full spectrum of preventive and early intervention services to children from birth to age five, funding does not meet the need. Healthy Start, which provides services for infants with disabilities and their families, ends when babies reach their first birthday. Four-year-olds are given priority for limited slots in Head Start and Prekindergarten Early Intervention Programs. Many toddlers and preschoolers therefore fall through the cracks. Funding also compromises the quality of early intervention services: in 1994-95, the average expenditure per child (for Part H services and Prekindergarten Early Intervention Programs) was \$1,148-

much less than the intensity of services known to be effective.<sup>23</sup> Early intervention services also need to be on a more stable footing. Despite substantial data on the effectiveness of early intervention, Florida continues to have only proviso language authorizing these services.

Shortcomings in the scope and quality of services are all the more distressing in light of compelling evidence that well-timed, high-caliber early intervention can indeed ameliorate or minimize the impact of many disabling conditions; that it results in better results for many special-needs children; and that it is cost-effective.

## II. New Brain Research and Early Intervention

Child-development expert Dr. Craig Ramey has said, “Intervention at kindergarten appears to provide only a minuscule benefit compared to intervention in the first weeks of life.”<sup>24</sup> His is a rather dramatic statement of a principle that increasingly informs policy in education and the human services: when it comes to intervention, time is of the essence.

The children themselves constitute the most compelling case for early intervention. The most impressive “results” are the graduates of early intervention programs who thrive in classrooms, in families and communities, on playing fields and, in due time, on the job. Based on years of experience, developmental psychologists and special educators have found that appropriate, intensive early intervention can ameliorate some disabling conditions and minimize the impact of others.<sup>25</sup>

### Fifty Years of Research

The evidence, based on more than 50 years of research, is both quantitative (based on statistics) and qualitative (based on reports by parents and teachers). It shows that early intervention increases children’s developmental and educational gains, improves family functioning and reaps long-term benefits for society. Given early intervention that

is well timed and high in quality, children are less likely to need fewer special education or remedial services later in life and less likely to be held back in the same grade.<sup>26</sup>

Early intervention for children with disabilities is a good public investment. Examples abound. Premature infants at a Boston hospital who received developmental care and intervention had much shorter hospital stays than those who received traditional care (87 vs. 151 days), saving \$91,000 per infant.<sup>27</sup> In Florida, home visits and primary health care for children with special health needs reduced emergency room visits by 69 percent and hospitalization by 34 percent.

Children with disabilities may need special services as they grow into adulthood, whether or not they receive early intervention; but with early intervention, their later needs often become less intense, and costs are therefore lower. One study calculated the total cumulative costs to age 18 of special-education services for children who began to receive special services at birth, at age two, and at age six. It found that the total costs were actually less if services began at birth.<sup>28</sup>

Researchers and practitioners have shown that early intervention can produce good results for children with many kinds of disabilities. They have shown that early identification and early intervention can minimize or lessen the impact of diverse conditions such as of cerebral palsy, autism, Down’s syndrome, hearing and vision impairments, and many other disabling conditions.

One important national study, the Early Intervention Collaborative Study, followed 190 children with Down’s syndrome, motor impairment or developmental delay in 29 programs. All but 11 children made significant gains. Although those with severe impairments made slower progress, early intervention helped them maintain their skills and prevent regression.<sup>29</sup> A Florida program showed similar results. A study at the University of Miami’s Debbie School found that the developmental status of 44 special-needs children improved following intervention; again, those with less severe impairments made the fastest progress.<sup>30</sup>

Early intervention can also improve the developmental status of children with illnesses that impede their development. The University of Miami's Department of Pediatrics provided home visits, therapies and developmental intervention for 30 infants and toddlers with HIV and their families. Over the course of a year, the great majority made gains or remained stable in cognitive development, motor development, and communication. Given the degenerative course of this disease, these results were impressive.<sup>31</sup>

## The Brain's Remarkable Plasticity

All of this research, conducted over several decades, has pointed to the wisdom of early intervention. Today's brain scientists are strengthening the case for early intervention by uncovering the biological mechanisms that account for its power.<sup>32</sup> With the aid of sophisticated new research tools, they have learned that brain development during the early years is more rapid, more extensive and more vulnerable to experience than they ever realized. They have learned more about the brain's plasticity-its capacity to change its physical structure in response to experience.

The human brain is remarkably unfinished at birth. It is a work in progress. The brain's plasticity makes it possible for people to adapt to many different kinds of environments and circumstances. For people with disabilities, brain plasticity creates a potential for improving, stabilizing or compensating for disabling conditions. According to the National Institute for Mental Health, "The brain's flexibility to learn new skills is probably the greatest in young children and may diminish somewhat after puberty. This is why early intervention is so important. Nevertheless, we retain the ability to learn throughout our lives."<sup>33</sup>

The brain is remarkably flexible throughout the life cycle, and this allows us to learn and grow at any age. But its plasticity is most marked in the early years, a time of frenetic activity when the brain is busy linking up billions of brain cells (neurons) into a dense network. A newborn has virtually all of the neurons he will need for a lifetime of thinking and learning, but there are relatively few con-

nections (synapses) among them. By the time he is three, a thousand trillion synapses have formed-twice as many as he will need in adulthood. These connections are not automatic. They are not preprogrammed. While heredity plays a role in brain development, experience is a crucial factor in the early years.<sup>34</sup>

Moreover, different parts of the brain are most plastic-most sensitive to outside influence-at particular times. Scientists used to think that early brain development was a linear process-one that followed a steady course. Thanks to new research tools, including sophisticated brain scan technologies, they now know that different parts of the brain develop at different rates.<sup>35</sup> One part of the brain may be a busy construction site during the fourth month of life with synapses forming at breakneck speed, while another may be more active during the ninth or tenth month. This phenomenon opens windows of opportunity-scientists call them "critical periods"-when the brain is particularly efficient at learning particular kinds of skills and is especially vulnerable to intervention.<sup>36</sup> That is why the same intervention can be more or less effective depending on when it is introduced. Critical periods are therefore windows of opportunity when therapies and interventions may be most effective. All of these findings confirm the importance of early screening and timely intervention.<sup>37</sup>

## Time is of the Essence

Recent brain research suggests that interventions that address developmental delays or impairments should be carefully timed. But how do we know when different parts of the brain and the activities they control are likely to be most flexible? This is often difficult, but thanks to new technologies, our best guesses are getting more and more precise.

The notion that there are windows of opportunity for optimal development is not new. A quarter century ago, psychologists were promoting the notion that "critical periods" exist in the development of each child.<sup>38</sup> They identified periods when children succeeded or failed in bonding with their mothers, or when the foundations of language development were established. But in past decades scien-

tists had only indirect evidence of critical periods.

Brain scans are providing more direct and more detailed knowledge today. Functional magnetic resonance imaging (MRI) allows researchers to see changes in various parts of the brain while subjects perform specific tasks. Researchers can use positron emission tomography (PET) scans to get not only a detailed view of various parts of the brain, but also precise measurements of their activity levels. Meanwhile, older technologies such as electroencephalograms (EEG's), which measure brain waves, have been refined and put to new uses.

By studying PET scans, Dr. Harry Chugani and his colleagues at Wayne State University have found that between the second and third months of life, there is a dramatic surge of activity in the parts of the cortex that need visual and auditory stimulation. By about eight months of age, the brain's frontal cortex-which is involved with thinking and planning, as well as regulating and expressing emotion-shows a rise in activity which coincides with major developmental milestones. At about this age, babies make important leaps in both self-regulation and strengthening their attachment to primary caregivers. That is one reason for "stranger anxiety," which often becomes pronounced at this time. Here is a window of opportunity, when parents and other providers can help babies develop these capacities by paying particular attention their cues and signals.<sup>39</sup>

### III. Expanding Knowledge about Disabilities

This kind of brain research has illuminated the developmental paths that most children follow. But it also sheds light on the nature of many different kinds of disability. Thanks to research conducted over the last two decades, children with diverse conditions are no longer treated under the general umbrella of "mental retardation." Much more is known than ever before about the neurological characteristics, developmental trajectories and learning processes asso-

ciated with different kinds of developmental delays or disabilities.<sup>40</sup> Over the last decade, scientists have begun to use new research tools, including brain scans, to learn about the specific effects of such diverse conditions as attention deficit/hyperactivity disorder (ADHD), autism, depression, schizophrenia and post-traumatic stress syndrome.

### New Insights

Congress has declared the 1990's the "Decade of the Brain," stating that "We stand at the threshold of a new era in brain and behavioral sciences. Through research, we will learn even more about mental and brain disorders...."<sup>41</sup> According to the National Institute of Mental Health, "Sophisticated brain imaging technology is now making it possible to directly observe the brain at work and to detect subtle malfunctions that could never been seen before. Other techniques allow scientists to study the points of contact among brain cells and the way signals are transmitted from cell to cell."<sup>42</sup> These techniques are being used to study a wide range of conditions-from severe disabling conditions to mild learning disabilities.

In some cases brain scans have helped scientists to identify structural characteristics associated with a particular condition. For example, brain scans show that children with Down's syndrome tend to have a smaller Broca's area and smaller cerebellum than other children-characteristics that appear to affect cognitive and language development.<sup>43</sup>

In other cases researchers have studied patterns of brain activity. Many researchers are using brain scans to study autism, for example, and they have found that children with autism show higher-than-usual levels of activity in certain parts of the brain.<sup>44</sup>

PET scans are also providing insight into ADHD, a disability which affects about five percent of school-aged children. A landmark study conducted by the National Institute of Mental Health showed that the brains of people with ADHD tend to have a lower metabolic rate than those of other people; there tends to be less activity in the parts of the brain that control attention. Scientists at the National

Institute of Mental Health are now investigating differences in activity levels in mild and severe cases of ADHD.<sup>45</sup>

A broad range of learning disabilities are now the subject of brain research. Scientists once thought that all learning disabilities were caused by a single neurological problem. They now know that the causes are more varied and complex. New evidence suggests that most learning disabilities do not stem from a single, specific area of the brain, but from difficulties in bringing together information from various brain regions. By comparing people with and without learning disabilities, researchers have noticed certain differences in the structure and functioning of the brain. For example, new studies suggest that there may be variations in the brain structure called the planum temporale, a language-related area found in both sides of the brain. In people with dyslexia, the two structures were found to be equal in size. In people who were not dyslexic, however, the left planum temporale was significantly larger. Some scientists believe that reading problems may be related to such differences.<sup>46</sup>

## New Interventions

Insights into the nature of specific disabilities, gleaned from research in neuroscience and other fields, is leading to new, more effective interventions. Some of these advances stem from close study of specific impairments. For example, it was once thought that children with Down's Syndrome acquire language just like non-delayed children, only slower. Studies have shown that this is not the case. Researchers now have a much better idea of the specific processes and challenges associated with language learning by children with Down's Syndrome, and can design strategies geared to their individual needs and strengths.<sup>47</sup>

Other breakthroughs stem from brain science that makes use of new research tools. For example, brain scientists are designing new interventions for children with language delays. Using brain scans they have been able to identify children who are likely to have language delays during the first year, before such delays are usually noticed. They have found that these children often have

trouble processing very rapid shifts from one sound to another. This insight has led to effective, new early interventions, including computer games that help toddlers accelerate their rate of processing acoustic changes.<sup>48</sup>

New research tools are also allowing scientists to test new interventions. Scientists have known for some time that intensive intervention prior to age two can result in significant gains for some children with autism and related disorders.<sup>49</sup> National Institute of Mental Health (NIMH) researchers investigating ADHD offer an example. They are trying to determine with brain scans why some medications work better than others, and whether the more effective medications increase activity levels in the parts of the brain that control attention.<sup>50</sup>

In summary, new brain research strengthens the case for early screening and intervention. There are some cases and some conditions that are difficult to improve, given current knowledge and methods; but the scientific literature provides sufficient evidence of positive results in cases once thought to be untreatable to hold out hope for every individual.

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