Overview of Brain Research and Its Effect on Sub-Categories of Special Education

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OVERVIEW OF BRAIN RESEARCH AND ITS EFFECT
ON SUB-CATEGORIES OF SPECIAL EDUCATION

A Dissertation Submitted in Partial Fulfillment for the Degree of
Masters of Education

To the Faculty of the College of Education
at Lynn University

by Jamie Canterbury

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CHAPTER ONE

INTRODUCTION

The process by which we learn is both complex and intriguing. Each individual experiences learning in their own unique way; however, all humans possess the same structure by which they acquire knowledge. The common factor is the brain. The 1990’s have been called the “Decade of the Brain” (Bigler, Clark, & Farmer, 1996, p.513). “People are intrigued by dramatic developments in research technology, the ability to ‘get inside’ our brain and observe how it functions” (Brandt, 1997, p.16). Politicians, scientists, researchers, celebrities, and educators have turned their attention to this ground breaking topic (Lewis, 1997). “The study of the brain is multidisciplinary, requiring many professional groups, including educators, to employ their expertise and unique perspectives in exploring the functions, and potential of the brain” (Grady, 1984, p.1).

Brain research is needed to improve our teaching and learning (Caine & Caine, 1991). Many new teaching models will come out of the studies of the brain. These models will influence the twenty-first century like the work of theorists John Dewey, B.F. Skinner, and Jean Piaget have effected the century in which we live (Sylwester, 1997). “This advance will mark the beginning of a new era for educators” (Grady, 1984, p. vii). As educators begin to explore the current research they may feel overwhelmed and unqualified to study this topic. To overcome this barrier, education and science must unite and work together to pioneer this emerging frontier (Cohen, 1995). In an interview, Bob Sylwester
points out that educators may not have called their daily experiences in the classroom brain research, but he challenges them to think differently.

If you’re a teacher, you’re dealing every day with about 100 pounds of brain tissue floating several feet above the classroom floor. Over a 20- or 30-year career, watching how those brains react, what they like to do, what they do easily and what with great difficulty, you’re going to try to adapt your procedures to what works with brains. So, at that level, teachers have always been brain researchers (Brandt, 1997, p. 17).

Challenges of the 90’s classroom are demanding that the field of education look at its current methods. Classrooms have changed and the student’s brains have changed as well (Healy, 1990). Dr. Jane Healy’s (1990) survey of teachers and their concerns about these “changing brains” emphasize the imperative nature of brain research in education (Healy, 1990, p.13).

I feel like kids have one foot out the door on whatever they’re doing- they’re incredibly easily distracted. I think there may have been a shift in the last five years (Healy, 1990, p.14).

Ten years ago I gave students materials and they were able to figure out the experiment. Now I have to walk them through the activities step by step. I don’t do as much science because of their frustration level (Healy, 1990, p.14).

I’ve been hoping someone would notice! I’ve been worried about this for some time. Kid’s abilities are certainly different- I use with gifted sixth graders a lot of what I did with average fifth graders in ‘65- ‘66. They complain of the workload (Healy, 1990 p. 14-15).

With the recognition of the value of brain research in education, one must acknowledge that without scientific discoveries much of the current brain research would not be possible. Technological advances like the CT, MRI, and electron microscopes allow brain research to progress (Powledge, 1997). Computed tomography, known as a CT or CAT scan, is “... a method of ‘slicing’ thin brain
section with X-rays and then putting them back together as computer images known as tomographs” (Powledge, 1997, p. 331). “Magnetic resonance imaging MRI uses a magnetic field and radio waves to produce detailed images of the brain anatomy quickly” (Powledge, 1997, P. 332). MRI’s have been beneficial in learning about developmental language disorders, emotional disturbances, gender differences, and many other conditions (Powledge, 1997). Professionals can use electron microscopes to watch actual brain parts communicate (Brandt, 1997). “Progress in neuroscience today is breathtaking” (American Association for the Advancement of Science, 1992, p. 200).

Is brain research a pressing issue for educators to deal with? The statistics cry out the answer, yes. We live in a nation of academic decline (Caine & Caine, 1991). In 1988, Fortune magazine reported that thirty-six percent of businesses that were frustrated with academic limitations of workers had to offer classes in basic arithmetic, language and reading (Healy, 1990). Motorola, Inc. reported, in 1989, that when it administered a seventh grade English and fifth grade math test to its applicants only twenty percent passed (Healy, 1990). This frustration can be seen in school statistics as well. National Assessment of Educational Progress findings are equally as dim. In 1987, “. . . only 44% of high school graduates could compute the change that would be received from $3.00 for two items from a lunch menu” (Healy, 1990, p. 20). Albert Shanker produced the most frightening statistic of all for educators to ponder. Dr. Shanker reported “. . . only 20 to 25% of students currently in school can learn effectively from traditional methods of
teaching” (Healy, 1990, p. 21). Education must prepare to move away from our traditions in the classroom and begin to implement new brain-based theories (Caine & Caine, 1991).

Does brain research impact special education? The dramatic increase of special need students tells us that something needs to be addressed in our schools. “In the United States from 1976 to 1985, there was a 135% jump in diagnosed cases of learning disability from 796,596 to 1,868,447” (Healy, 1990, p. 139). The growth of this category in special education is so accelerated that 15,000 students per week are referred for special education services in the United States (Healy, 1990).

Another disorder which is sweeping our nation is attention deficit disorder. “Currently in the United States, anywhere from one and one-half million to four and one-half million school children, mainly boys, earn the official diagnosis of ADHD” (Healy, 1990, 140). The statistics continue to perplex our society, but what can be done? Educators must inform themselves and be willing to use brain research in the classrooms.

Brain research is invaluable, therefore, in part because it confirms that many of the criticisms of education are correct. It endorses what we already know and can be used to support the many innovative educators and members of the community who have been and are striving for change (Caine & Caine, 1991, p. 5).

Knowledge is the beginning of reformation in all things. This researcher will look at sub-categories of special education and analyze the brain research which is applicable to that area. Our society’s intentions are for the good of the children; however, we continue to use the same traditional methods which are failing a vast
majority of our students. "We care deeply about the 'smartness' of our children, but our culture lacks patience with the slow, time-consuming handwork by which intellects are woven" (Healy, 1990, p. 277).

With the field of education seeing "changing brains" (Healy, 1990, p. 13), the field of science experiencing technological advances, and declining statistics haunting our nation's educators, the time is right for brain research and education to combine its efforts and make a difference in American classrooms.
CHAPTER TWO

HISTORICAL PERSPECTIVE OF THE LITERATURE

Fascination with the brain has been spurred on by scientific discoveries and new research; however, brain research can be traced back twenty-five hundred years.

In 450 B.C. Hippocrates wrote:

Men ought to know that from the brain, and from the brain only, arise our pleasures, joys, laughter, and tears. Through it, in particular, we think, see, hear and distinguish the ugly from the beautiful, the bad from the good, the pleasant from the unpleasant. To consciousness the brain is messenger (Herrmann, 1990, p.26).

A conflict of opinions began at this point in history which lasted over a century and centered around Aristotle’s belief that the heart was the center of human intelligence (Herrmann, 1990). As the debates continued, Hippocrates made the monumental discovery that “within the brain of a patient, there can exist a mental duality” (Herrmann, 1990, p. 27). Assyrians held the belief that impaired mental ability was caused “when man’s brain holds fire” (Fromkin & Rodman, 1993, p.436). Over one thousand years elapsed before Roger Bacon identified two methods of human learning in 1236. He believed human brains learned by “experience” and “argument.” Today’s scientists now name these modes of knowledge as verbal and non-verbal (Herrmann, 1990). In the 1500’s our view of brain research was changed when Leonardo da Vinci distinguished between the human brain and the human mind (Herrmann, 1990). The importance of this discovery is the development of two separate concepts. “...[Leonardo da Vinci] provided the basis for studying the physical organ separately from the results of its
functioning, much as one would study the body separately from dancing” (Herrmann, 1990, p. 28). The next major discovery came in 1684 when a work by Sir Thomas Browne stated that the two hemispheres of the brain could affect the behavior of humans (Herrmann, 1990).

The eighteenth century brought brain research into a new realm. “Several ‘sciences’ developed as a result of efforts to explain the brain” (Grady, 1984, p.5). John Lavater, the developer of physiognomy, believed a person’s facial characteristics could determine IQ. He wrote: “. . . a low forehead and a thick neck indicate stupidity, where as a high forehead indicated intelligence” (Grady 1984, p. 5). Another “science” which was developed during this time period was phrenology. There is discrepancy in the literature whether phenology was a creation of Fraz Gall or one of Gall’s students, Spruzheim (Fromkin & Rodman, 1993). “In phrenology, various parts of the brain are thought of as locations for certain qualities and functions . . .” (Grady, 1984, p. 5-6). Phrenologists mapped out the entire skull to indicate where human’s characteristics were on the skull. (See Figure 1) Even though physiognomy and phrenology have long since been set aside as real theories, Gall’s theory of localization is still relevant today. Gall introduced localization in the early eighteen hundreds. It is the belief “. . . that different human abilities and behaviors were traceable to specific parts of the brain” (Fromkin & Rodman 1993, p. 439). Though Gall had correctly
(Fromkin & Rodman, 1993, p.439)

Phrenology Map
hypothesized the theory of localization, he was not accurate in his association of an ability with its location in the brain.

... [Gall] suggested that the frontal lobes of the brain were the locations of language because when he was young he had noticed that the most articulate and intelligent of his fellow students had protruding eyes, which he believed reflected over developed brain material (Fromkin & Rodman, 1993, p. 439).

As brain research continued to mature in the seventeen hundreds, theories were developed on the basis of animal experiments (Hollander, 1931). Flourens’ believed that as long as a small part of the brain remained, mental capacities would not be disturbed (Hollander, 1931). He made his conclusion based on the results of an experiment on a pigeon. Flourens’ theory was widely accepted for half a century while Gall’s theory of localization was scoffed (Hollander, 1931).

The 1830’s brought about a fresh perspective on the brain. During Marc Dax’s career as a doctor in a rural section of France, he observed stroke patients with aphasia and recorded his observations. The connection he observed was the loss of speech and the side of the brain which sustained injury after a stroke (Springer & Deutsch, 1985). “In more than 40 patients with aphasia, Dax noticed signs of damage to the left half, or hemisphere of the brain” (Springer & Deutsch, 1985, p.1). When Dax reported his findings at a medical convention 1836 it was considered a failure. Dax died in 1837 and never realized he was the father of one of the most ground breaking concepts in brain research, the theory of a left and right hemisphere (Springer & Deutsch, 1985). A few short years later in 1844,
A.L. Wigan M.D. published *The Duality of the Mind* and the theory of a left and right hemisphere was accepted as ingenious (Herrmann, 1988).

In 1848 a freak accident brought brain research into a whole new era (Fromkin & Rodman, 1993). Phineas Gage, a railroad builder, became the focus of many brain researchers when an "...explosion on the job rocketed a 13-pound iron rod upward into Gage’s cheek, through his brain’s frontal lobes, and out the top of his head,..." (Powledge, 1997, p. 330). Gage did not suffer a severe degree of injuries. He lost his eye, but sustained no other physical injuries, maintained his intellectual capacities, and continued to work (Powledge, 1997). Thanks to careful observations of Gage’s doctor, we have documentation of the severe personality changes Gage suffered. “He changed from a kindly, cheerful, sensible, and intelligent family man, efficient and popular at work, into a profane and eviltempered drinker, a pigheaded, willful, lazy, inconsiderate liar” (Powledge, 1997, p.330). Researchers recently studied Gage’s skull at Harvard University where it is displayed in the university’s museum. The researchers concluded that the left and right prefrontal cortex were injured. Our current research shows that this type of injury would produce the emotional disturbance Gage suffered. Gage’s misfortune brought about many advances in brain research. Along with scientific advances came a clash of opinions. Two distinct groups, one believing the frontal lobes maintained speech and the other denying localization as a theory, divided the researchers. This debate continued until 1861. The Society of Anthropology held a convention in Paris that year and a young doctor named Paul
Broca was impressed by Ernest Auburten’s remarks on localization. They teamed up to examine an aphasia patient. After that examination, the patient died, and Paul Broca performed a post-mortem exam (Springer & Deutsch, 1985). “It showed quite clearly a region of damaged tissue, or lesion, in part of the left frontal lobe” (Springer & Deutsch, 1985, p.9). When these results were accepted, Broca became “the chief proponent of cerebral localization of function” (Springer & Deutsch, 1985, p.9). Paul Broca’s discoveries were so prominent that the front area in the left hemisphere is still called Broca’s region (Fromkin & Rodman, 1995). (See Figure 2) Once Broca’s work was respected by most of the scientific community, the theory of cerebral dominance begin to arise. It was 1868 when John Hughlings Jackson projected the “... idea of the ‘leading’ hemisphere” (Springer & Deutsch, 1985, p.9). His idea was so developed he wrote “... that in most people the left side of the brain is the leading side-the side of the so-called will and that the right is the automatic side” (Springer & Deutsch, 1985, p. 12).

Left and right brain theories are still implemented today.

In the late eighteen hundreds researchers began to map out the points in the brain which correlated to movement. The maps they developed were based on research studies of animals (Hollander, 1931). In 1873, Jerrier mapped the whole brain, but his map was discounted by Horsley and Beevor in 1885 when “... it was discovered the motor field was restricted to the central convolutions of the
(Fromkin & Rodman, 1993, p.441)

Broca and Wernick Regions
brain” (Hollander, 1931, p. 48). Charlton Bastian changed this wave of thinking in 1909 when he reported in the British Medical Journal his findings: “. . . the true motor centers are lower down in the brain and spinal cord” (Hollander, 1931, p. 49).

It was not until the 1930’s that the findings of brain research were put into practice and advances could be made for humans. Wilder Penfield was a pioneer of this exciting phase of research. In 1930 he performed surgery on epilepsy patients to remove a portion of the brain (Springer & Deutsch, 1985).

Epilepsy, a disorder involving abnormal electrical activity generated within the brain, produces reactions that may range from short blackouts lasting a second or two to full-blown grand mal seizures. During an epileptic attack, the abnormal electrical activity often originates from a specific part of the brain and then spreads to other regions (Springer & Deutsch, 1985, p. 17).

When drug therapy was not effective, Penfield and his fellow surgeons would remove the problematic section (Springer & Deutsch, 1985). With the difficulty of precisely removing a section of the brain without damaging other vital sections of the brain, an improvement was needed. Penfield and the Montreal Neurological Institute began to implement a procedure that used direct stimulation to the brain to identify the precise area of the problem (Springer & Deutsch, 1985). This procedure was similar to an EEG in today’s medical field. Penfield and his associates basic use of this procedure allowed them to successfully remove the destroyed area of the brain.
At this point in the history of brain research six branches of science had performed its own research, but scientists had not related findings to their colleagues (Howard, 1994). World War II, with its enormous amounts of head injuries, forced all the sciences to work together to find solutions (Howard, 1994). Although Penfield had made enormous progress with brain surgery, the magnitude of his research was not known until the 1960’s. The California Institute of Technology sponsored a group of doctors headed by Dr. Roger Sperry to conduct split-brain studies on epileptic patients (Herrmann, 1990). Dr. Sperry altered Penfield’s technique by severing a patient’s corpus callosum, “... a large group of neural fibers that allow the two hemispheres to communicate with each other and to collaborate on many complex cognitive functions” (Sylwester, 1995, p.10). These studies showed no major changes in individuals with disconnected hemispheres (Springer & Deutsch, 1985).

The researchers continued to develop strategies, but only a certain amount of progress could be made with the technology of that day. There was a wave of new technological advances that pushed brain research forward like never before in its history.

Brain-imaging machines gather and rapidly process the vast amounts of electrochemical data continuously generated by our brain, and so take researchers well beyond observable behavior, two-dimensional black-and-white x-rays, and EEG reports-and into the world of three-dimensional color TV graphics with high spatial and temporal resolution (Sylwester, 1995, p. 12).

The most common brain-imaging techniques are the CAT (computerized axial tomography), MRI (magnetic resonance imaging), EEG (electroencephalogram),
and the PET (positron emission tomography) (Sylwester, 1995). Each of these imaging techniques are useful for some aspects of brain research. One of the most influential for educational research is the PET. “PET uses radioactive tracers to track the brain’s use of energy” (Anonymous, 1996, p.1). The ability to see the source of mental activity is invaluable for researchers.

Brain-imaging machines are expensive, so their use thus far has been limited to medical research and diagnosis facilities and university science and psychology departments. Computer technology tends to become cheaper and more powerful over time, however. Researchers in university education departments have just begun to use electrical imaging technologies, and we can expect this use to increase in the years ahead, as the technology advances. Eventually, K-12 schools will probably use adaptations of these technologies in the diagnosis and treatment of learning problems, as the graduate students involved in such university research move into jobs in school districts (Sylwester, 1995, p. 14).

After the implementation of brain imaging much was learned about how the brain works. The ability to understand the brain and how it learns is the penultimate of brain research for the twentieth century. The nineties have finally brought scientific brain information to American classrooms, and a person can only dream of the advances this exciting field will continue to make for education.
CHAPTER THREE

ANATOMICAL STRUCTURE AND EARLY DEVELOPMENT

Since Leonardo da Vinci recognized the separation of the human brain and the human mind in the 1500’s, much emphasis in literature has been on the functioning of the brain. This researcher is also focusing on the functions of the brain; however, it would be remise to overlook the anatomical structure entirely. Caine and Caine (1991) raise the question: Do educators need to be proficient in their understanding of brain anatomy? They concluded that educators need not be experts. “However, what educators must have is some appreciation of how multifaceted the brain is in order to more fully appreciate the complexities involved in education” (Caine & Caine, 1991, p.26).

The human brain is approximately three pounds and is visibly divided into three separate yet jointed parts (Myers, 1995). The cerebrum, brain stem, and cerebellum all control a variety of functions that when working together form the brain. (See Figure 3) “The cerebrum is the largest part of the human brain, making up approximately 85 percent of the brain’s weight; its large surface area (cortex) and intricate development account for the superior intelligence of humans, compared with other animals” (Myers, 1995, p.1). The cerebrum houses the left and right hemispheres which are joined by the communicative fibers called the corpus callosum (Myers, 1995). “Each hemisphere appears to be approximately a
Figure 3

Diagram of the Brain

(Barnes & Svarney, 1995, p.168)
mirror image of the other, very much in keeping with the general left-right
symmetry of the human body (Springer & Deutsch, 1985, p.2). Even
though the hemispheres are anatomically matched, their functions are distinct. (See
Figure 4) Through many years of research, researchers can now list specific skills
which correlate to a certain hemisphere (See Table 1).

Table 1

<table>
<thead>
<tr>
<th>LEFT HEMISPHERE</th>
<th>RIGHT HEMISPHERE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick recall of specific information (math facts)</td>
<td>Works with wholes, not parts</td>
</tr>
<tr>
<td>Analyzes and arranges details in order (time)</td>
<td>Associated with intuition</td>
</tr>
<tr>
<td>Sequential patterns of small motor movements</td>
<td>Understands the relative position of objects in space</td>
</tr>
<tr>
<td>Auditory</td>
<td>Visual</td>
</tr>
<tr>
<td>Distinguishes between sounds and their order</td>
<td>Thinks metaphorically</td>
</tr>
<tr>
<td>Distinguishes word order in sentences</td>
<td>Recognizes body gestures</td>
</tr>
<tr>
<td>Comprehends language</td>
<td>Comprehends speaker’s “gist”</td>
</tr>
<tr>
<td>Recognizes function words</td>
<td>Recognizes content words</td>
</tr>
<tr>
<td>Logical</td>
<td>Imaginative</td>
</tr>
<tr>
<td>Controls right the body side of</td>
<td>Controls left side of body</td>
</tr>
</tbody>
</table>


In 1979, Jerre Levy conducted a detailed study on the overall processing style of
the hemispheres.

She concluded that the left brain was analytic in its approach, finding patterns
in words, attributes in groups, putting parts into wholes, and using language to
express what it understood. Levy concluded that the right brain, by contrast,
was holistic in its approach to reasoning, taking the whole and deducing from
it how things were assembled; that each of the brains, left and right, was
Figure 4

Left Hemispheric Functions
Reading
Writing
Calculating

Right Hemispheric Functions
Art
Media
Meditation

Speech Area

Modal Descriptors
Linear
Sequential
Verbal
Analytic
Rational
Propositional
Explicit
Logical

Visual Area

Corpus Callosum

Modal Descriptors
Simultaneous
Holistic
Visual-spatial
Synthetic
Metaphoric
Appositional
Tacit
Intuitive

(Grady, 1984, p.21)

Hemisphere Map
The brain stem is broken in many sections (Myers, 1995). The complex structure of the brain’s stem consists of the thalamus, hypothalamus, midbrain, pons, medulla oblongata, and the limbic system (Myers, 1995). These sections are responsible for receiving and delivering sensory messages as well as other communicative duties.

The cerebellum is the final visible section to discuss. “The cerebellum lies in the posterior, or hind part, of the cranium, underneath the cerebral hemispheres” (Myers, 1995, p.2). The cerebellum is crucial “...to the control of movement of the human body in space” (Myers, 1995, p.2).

Within these three components lies a system of such intricacy and precision that science is only beginning to understand it’s capabilities.

By adulthood the brain is crisscrossed with more than 100 billion neurons, each reaching out to thousands of others so that, all told, the brain has more than 100 trillion connections. It is those connections-more than the number of galaxies in the known universe-that give the brain its unrivaled powers (Begley, 1996, p.56).

It is this “wiring” of the brain which has received much attention. “Taken together, neurons comprise the working elements of the thinking regions of the brain. It is through their interaction that the physical organ of the brain gives rise to the living mind” (Herrmann, 1988, p.29). The development of this system begins in an infant. “When a baby comes into the world her brain is a jumble of neurons, all waiting to be woven into the intricate tapestry of the mind” (Begley, 1996, p.55-56). A baby is born with over 100 billion neurons, the full capacity he
will ever obtain (Routh, 1996). A neuron is "...the basic conducting unit of the nervous system (also called the nerve cell), consisting of a cell body and threadlike projections that conduct electrical impulses" (Herrmann, 1988, p. 432). Dr. Jane Healy (1991) compares the look of a neuron to an outstretched hand. "Your palm represents the cell body, with its central nucleus, and your outreaching fingers are dendrites" (Healy, 1991, p. 51). The protruding dendrites gather information from neighboring neurons and when the message has been passed along it must form a synapse (Healy, 1991). (See Figure 5) Synapses carry messages by making connections between neurons (Viadero, 1996). "These connections, or synapses, form the brain’s physical ‘maps’ that allow learning to happen" (Lewis, 1997, p. 592). As the number of connections grow in the mind, "...the axons, or output parts of neurons, gradually develop a coating of waxy substance called myelin, which isolates the wiring and facilitates rapid and clear transmission" (Healy, 1991, p. 66). This process, in essence, seals the neuron connection while allowing communication between neurons to flow quickly and smoothly (Healy, 1991). While the connections made by the brain are involuntary, there is research which shows our environment affects the formation of the brain’s structure.
Figure 5

Diagram of a Neuron

(Herrmann, 1990, p.28)
Researchers have since accumulated a substantial amount of data indicating that the brain will grow physiologically if stimulated through interaction with the environment" (Caine & Caine, 1991, p.28). With this knowledge, researchers began to study the early years of development and have reported a mass amount of research on the importance of the brain’s development from the time of birth. “There is a growing recognition today that the kind of experiences the brain is exposed to in the first three years dramatically influence how it operates—for the rest of its life” (Kotulak, 1996, p.1).

Learning about early phases of brain development could literally change the way people look at the education process. “A child’s ability to learn and succeed in school is determined well before he or she walks in the school doors. It begins with the development of the most basic elements of the brain” (Healthy Brain Development, 1991, p.12). These foundations begin shortly after conception.

“They [neurons] are created at the average rate of 40,000 every minute for the first 180 days after conception” (Healthy Brain Development, 1991, p. 2). By the sixth month of pregnancy, ten billion neurons have formed (Healthy Brain Development, 1991). As a baby enters the world his/her experiences begin to form the brain.

Since the infant brain has all the neurons it will need at birth the work to be done is to make the connections (Lewis, 1997). “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”
Scientists are learning that the nine months of prenatal development can be an influential time for brain formation. The experiences the mother has, equally effects the infant. Maternal stress has been a focus of research studies. Researchers in Israel studied prenatal stress on rats. The results indicated that stress “. . . produced chemical brain changes resulting in permanent alterations in the relative size and shape of the two halves of the offspring’s brains” (Fride & Weinstock, 1988, p. 1059-65, as cited in Healy 1991). Researchers in the sixties and seventies began clinical research on the effect alcohol has on infants (Swayze, Johnson, Hanson, & Diven, 1997, p.233). Their research is still being developed as scientists learn more about fetal alcohol syndrome.

FAS [fetal alcohol syndrome] is a devastating disorder that affects children prenatally exposed to high levels of alcohol. This alcohol exposure causes abnormalities in a child’s physical as well as psychological well-being. Specifically, the developing brain appears to be especially sensitive to prenatal alcohol exposure, the effects of which are permanent (Mattson & Riley, 1995, p.281).

After birth, a child’s experiences begin to form the brain. Dr. Harry Chugani said almost all experiences in the first years of life are important. “The early years determine how we turn out” (Simmons & Sheehan, 1997, p.1). Since there is such a rapid formation of synapses in a child’s early life, a surplus forms. “In fact, a three-year-old has twice as many connections as an adult” (Read With Me, 1997, p.1). All these synapses are formed by experiences a child encounters (Healthy Brain Development, 1991). The brain begins to lose unused synapses during
adolescence. "Once a child reaches puberty, the brain activity that distinguishes the early years begins to ebb. By about age 16, the body's effort to maintain neurological connections hits a plateau, and it remains at that level throughout much of adult life" (Simmons & Sheehan, 1997, p. 5). The neurons which have been used and have made strong connections will survive the pruning process (Read With Me, 1997). This process is vital to the brain. People with mental retardation have been found to have too few neurons as well as too many (Healy, 1991). "It is something like pruning plants in a crowded garden; the ones that remain can grow larger and stronger. By eliminating seldom-used pathways, the brain leaves room for sturdier, more efficient neural networks" (Read With Me, 1997, p.1).

With the knowledge now available about the importance of the early years, changes should be made in our country. Rob Reiner, a famous movie director, aired a documentary in April of 1997 on the importance of the early years and brain research. As he spoke to an audience of governors, he showed the imbalance between our knowledge of and investment into these crucial year.

It [Reiner's chart] showed a rapid rise in brain growth and development during the first years of life. It also showed that public investment in children amounted to very little during the early years. Significant investment did not begin until about age 5 (Lewis, 1997, p.72).

Without a commitment to investing into the early years we are destined to stay on the same path of underdeveloped brains.
To take advantage of the current findings, educators must understand the brain's plasticity (Healy, 1991). Plasticity is "The brain's ability to change and adapt over time" (Viadero, 1996, p.7). The ability to alter the way a child uses his/her brain is both frightening and exciting.

...what children do every day, the ways in which they think and respond to the world what they learn, and the stimuli to which they decide to pay attention-shapes their brains. Not only does it change the ways in which the brain is used (functional change), but it also causes physical alterations (structural change) in neural wiring systems (Healy, 1991, p.50-51).

Combining our knowledge of the brain's plasticity with the recognition of a child's window of opportunity, will open our eyes to a new timeline of learning.

Simmons and Sheehan describe what occurs in the brain during these critical periods.

It is during these periods that long, thin fibers grow inside the brain, creating pathways that carry electrical impulses from cell to cell. ... The connections needed for some skills form quickly. ... But it takes almost four years before the brain is done building the neurological foundations that allow a child to pick up a pin or skip down the sidewalk. Once the critical periods pass, however, they are forever gone (Simmons & Sheehan, 1997, p.2-9).

Scientists have discovered several critical windows of opportunity: vision, vocabulary/speech, language, emotional development, logic/math, and music.

Vision is one of the first windows of opportunity to close. "Visual stimuli during the first six months create the permanent neural connections that form during this critical window" (Simmons & Sheehan, 1997, p.1). Torsten Wiesel and David Hubel experimented with vision development in the 1970's by sewing an eye of a infant kitten closed during this window of opportunity. They "... found that
sewing shut one eye of a new-born kitten rewired its brain: so few neurons connected from the shut eye to the visual cortex that the animal was blind even after its eye was reopened" (Begley, 1996, p.58). In humans, scientists have changed their medical practices in regard to infant eye problems. Doctors remove childhood cataracts before the age of two to prevent irreversible vision difficulties (Routh, 1997). Another vision disorder, amblyopia, otherwise known as lazy eye, is now treated early. Amblyopia is when the eyes do not work together properly.

Doctors have learned that this condition must be treated before age five, if it is to be corrected, because the sensitive period for this particular ability may end at that time. The treatment, logically, consists of intermittently patching the good eye to force all the cells in the system to do their work, develop their synapses, and survive (Healy, 1991, p.77-78).

To promote the proper visual stimulation, parents or caregivers should provide items which are intriguing to look at in every situation possible (Simmons & Sheehann, 1997).

"An adult’s vocabulary is largely determined by speech heard within the first three years" (Simmons & Sheehan, 1997, p.1) The foundation for language development starts with sounds. G. Reid Lyon, an employee of the National Institute of Child and Human Development, has identified a pattern in good reading and phonological awareness. (Wingert & Kantrowitz, 1997). “When a child hears a phoneme over and over, neurons from his ear stimulate formation of connections in his brain’s auditory cortex “ (Begley, 1996, p.56-57). Researchers believe the window of opportunity for language is birth to five years old and speech/vocabulary’s window closes at three years of age (Simmons & Sheehan,
There is much to be done in this short time. A key factor in language development is the amount of talk a child is exposed to during this time. "Verbal interactions in the home are where it all starts" (Healy, 1991, p.89). Dr. Huttenlocher of the University of Chicago believes the specific words are not necessarily important, but rather the proper use of language. "There is a huge vocabulary to be acquired," says Huttenlocher, "and it can only be acquired through repeated exposure to words" (as quoted in Begley, 1996, p.5). To promote healthy language development, parents should talk to their children in complete thoughts, read a variety of information, and introduce second languages during this adaptable time (Simmons & Sheehan, 1997).

Emotional development's critical window is birth to eighteen months (Simmons & Sheehan, 1997). Even before birth emotional characteristics are being formed (Begley, 1996). An infant’s mother plays an irreplaceable role in emotional development. “...[Scientist] now have evidence that nurturing the development of an infant’s secure relationship with an adult -- stimulates the brain to develop physically” (Lewis, 1997, p.52). A groundbreaking study changed the way we think of physical touch and infants. Saul Schanberg and Tiffany Field recorded observation of infant mice without the physical stimulation of their mother’s licking.

Newborn mice separated from their mothers stop growing. The researchers found that the mother’s licking was the cue that told the pups that all was well and that they could continue their development. Without the licking the brains of the pups went into survival mode. The absence of licking meant that the
mother was not present, so there was no food. Their brains shut down the feeding response to conserve what energy the animals had. After prolonged absence of licking, the pups failed to thrive. But the pups’ feeding response could be restored when the mother resumed licking them, or when researchers stroked them with a wet artist’s brush (Kotulak, 1996, p.7).

The researchers transferred their finding to premature infants. At that point, human touch was discouraged. Schanberg and Field believed that the babies should be held and should have their backs rubbed. “The researchers found that touching preemies in this way affected their brains, just as it did the infant mice” (Kotulak, 1996, p.7). Field found this to be effective for infants with a high amount of stress hormones and a low amount of interaction with their mother (Kotulak, 1996). Providing an environment of responsiveness, acceptance, love, and stability are key factors during the critical period for emotional development (Simmons & Sheehan, 1997).

The development of music, math, and logic are interwoven together. Math and logic begin to develop at one year old and continue to age four (Simmons & Sheehan, 1997). At this young age, a child’s brain is able to process concepts such as more and less rather than facts (Begley, 1996). Musical development begins at age three and continues to grow until ten years old. The areas in the brain which process musical and mathematical/logical thinking are in close proximity to one another. Research has proven that, “Listening to Mozart (and other classical music) early in life makes you smarter by exercising the same neurons used for mathematics” (Starting Points, 1997, p.1). Gordon Shaw, at UC Irvine, connected the learning process of higher levels of thinking with a pattern of brain activity
(Begley, 1996). Nineteen preschoolers were given some form of musical lessons for eight months. Their study found an increase in spatial reasoning when contrasted to preschoolers without musical training (Begley, 1996). “There appears to be a connection between the neurological pathways activated by music and the part of the brain used to understand spatial concepts in math” (Simmons & Sheehan, 1997, p.3).

Education has a crisis. We know the most important time for intervention and enriched environments and we have no control over that time. Educators are starting five years to late. Is the increase in special education enrollment due to our neglect of brain development? Does society understand the effects our neglect will have on children? No, they do not. Dr. Bruce Perry understands the crisis we are in. “. . . if the physical harm done to a young child’s brain by abuse or neglect were visible, ‘there would be a public outcry’” (Lewis, 1997, p.592). Special educators see this abuse every day as they teach these children. There are answers being found as brain research continues to make monumental advances.
CHAPTER FOUR

VARIOUS EXCEPTIONALITIES

The scope of brain research is beginning to reach beyond a general perspective to influence the various categories of special education. This researcher will examine the research concerning autism, speech and language disorders, ADD/ADHD, and learning disabilities.

AUTISM

Autism is one of the most puzzling disorders (Springer & Deutsch, 1985). The exact cause is not known and intervention methods are few in comparison to other disorders. “Autism is a condition marked by severe impairment of intellectual, social, and emotional functioning” (Heward, 1996, p.489). Out of every ten thousand children born, statistics show that four and one-half children will be autistic with a ratio of three to one being males (Edelson, 1995). The same characteristics of autism are not seen in all autistics and each trait will vary in degree of severity. Sensory deficits, affect isolation, self-stimulation, self-mutilation, tantrums, echolalic speech, and behavior deficiencies are some of the traits an autistic may display (Heward, 1996). The recent brain research has identified some neurological explanations for some of these behaviors.

We have not always looked at autism from a neurological perspective. During the search for a cause of autism, the theories have changed drastically over the years. The 1940’s through the 1970’s viewed autism as “a disorder of the mind, caused by poor parenting or perhaps early psychological trauma” (Top of the
Biological factors were the focus of the 1970’s and institutionalization was the main method of intervention (Edelson, 1995). The mid eighties brought about the use of technology and as a result, a neurological approach began (Edelson, 1995).

Once the use of technology became common place, many studies took place. Dr. Joseph Piven, from the University of Iowa, found the corpus callosum to be smaller in autistic individuals. Since the corpus callosum is responsible for the communication between hemispheres, an autistic is unable to connect thoughts and concepts in a normal flowing manner (Top of the News, 1997). Piven also discovered enlarged cerebellums in the brains of autistic (Top of the News, 1997). Other studies support these findings and have also observed smaller neuron cells and an over abundance of these cells in the amygdala and hippocampus areas of the brain (Edelson, 1995). Dr. Piven doesn’t contribute autism to one specific brain abnormality. “Piven believes the presence of multiple brain abnormalities is evidence of poor communication or connectivity throughout the brain and leads to the problems associated with autism” (Top of the News, 1997, p.2). In a post-mortem study of autistic brains, Dr. Courchesne identified an abnormal area within the cerebellum which has significance. He found that the vermal lobes six and seven were abnormal in size in autistics. The significance of this finding is that this section in the brain plays a role in one’s ability to pay attention (Edelson, 1995). A group of researchers from London have focused their study on the temporal
lobes of autistic individuals. A key factor in Bolton and Griffiths' study was the focus on tuberous sclerosis in temporal lobes. "Tuberous sclerosis (TS) is a multisystem genetic disorder that is associated with mental retardation, autism, and atypical autism" (Bolton & Griffiths, 1997, p. 392). Their research shows a correlation between right-hemisphere temporal lobe enlargement and autistics as well as the number of tubers and their locations in autistic's brains. (Ibid, 1997).

The connection between this brain abnormality and autistic behavior was evidenced in several studies on monkeys.

When medial temporal lobe structures are removed from newborn monkeys, the monkeys develop socioemotional abnormalities as they mature. These abnormalities are similar in quality to those of autistic children. The extent of damage to medial temporal lobe structures is related to the severity and type of socioemotional disturbance in the monkeys (Lainhart, 1997 p. 974).

In a similar study, macaque monkey’s temporal lobes were examined in respect to their role in facial expression and emotion.

For instance, in macaque monkeys the temporal lobes participate in the processing of information about facial expressions, and single polymodal neurons in the superior temporal sulcus selectively respond to eye contact and specific emotional expressions. Moreover, adult human beings with temporal-lobe abnormalities may have impairments in the visual recognition of facial expression (Bolton & Griffiths, 1997, p.395).

Bolton and Griffiths, like Piven, only view their research as a small piece to the autism puzzle.

Some of the most practical and exciting research came out of Harvard Medical School and Boston University School of Medicine. Dr. Margaret Bauman and Dr. Thomas Kemper have focused their research on the limbic system of
autistic individuals. The majority of their research has been on animals and they recognize the implications and concerns in transferring their research findings to humans without caution (Edelson, 1995). Drs. Bauman and Kemper found abnormalities in two specific sections in the brain: amygdala and hippocampus. (See Figure 6) They have been able to connect their findings to different aspects of autistic’s behavior. Self-mutilation and lack of emotion often characterize many people in this population (Heward, 1995). “The amygdala, (which means ‘almond-shaped’), controls our aggression and emotions” (Edelson, 1995, p.1). Bauman and Kemper extracted or injured the amygdala of animals. They found that under these circumstances, “...animals exhibit behaviors similar to autistic individuals, such as social withdrawal, compulsive behaviors, failure to learn about dangerous situations, difficulty retrieving information from memory, and difficulty adjusting to novel events or situations” (Edelson, 1995, p.1). The Center for the Study of Autism reports that the transition into puberty can be very difficult for autistic children. “Approximately 20% have seizures for the first time during puberty...” (Edelson, 1995, p.2). Such drastic responses to normal changes could be due to the difference in brain structure such as a missing or damaged amygdala.

The second area in the brain Bauman and Kemper examined was the hippocampus, the center for learning and memory (Edelson, 1998). In another
Diagram of the Amygdala and Hippocampus

(Herrmann, 1990, p.32)
set of studies comparing post-mortem autistic brains and normally developed
brains, they identified two types of memory within the hippocampus: “habit”
memory and “representational” memory (Bauman, 1994). The “habit” memory
works when an individual learns things such as throwing a ball, combing hair, or
brushing teeth. “The ‘habit’ memory system is believed to reside in areas that we
have found to be anatomically normal in autistic brains” (Bauman, 1994, p.67).
The evidence of the memory at work is the autistic’s need to maintain certain
habits.

Many children become overly insistent on routines; if one is changed, even
slightly, the child may become upset and tantrum. Some common examples
are: drinking and/or eating the same food items at every meal, wearing certain
clothing or insisting that others wear the same clothes, and going to school
using the same route (Edleson, 1995, p.2).

The second type of memory discovered is “representational memory”. “This
kind of memory is involved in organizing sensory input--what we see, hear, and
feel--generalizing and integrating information gained from sensory input to think
and reason” (Bauman, 1994, p. 67). The complications for autistics come into
effect with regard to the limbic system. This type of memory relies on the limbic
system to process the types of information that produces appropriate sensory data;
therefore, poor social skills are developed because of this malfunctioning portion
of the brain. (Bauman, 1994, p.67).

Brain research in the field of autism is only in its infancy. The studies reported
on are only the beginning. Many researchers have found isolated pieces of
information that they are working desperately to connect to a more solid body of
research. Bauman and Kemper have plans to implement a neurotransmitter to identify neurochemical studies of abnormalities in the brain (Bauman, 1994). There is growing research in the levels of serotonin in autistic’s cerebral spinal fluid (Edelson, 1995). Dr. Piven has plans to continue his research. “He plans to expand his research to include functional imaging studies to help determine whether the structurally different areas of the autistic brain are also functioning differently” (Top of the News, 1997, p.2). As these and others continue to find more pieces to this puzzle we continue to get closer to a complete understanding of this puzzling disorder.

**SPEECH AND LANGUAGE DISORDERS**

An element which separates humans from other species is our speech and language (Fromkin & Rodman, 1993). The process by which humans acquire language has been studied for years and has progressed to include two sciences: neurolinguistics and psycholinguistics. “The study concerned with the biological and neural foundations of language is called neurolinguistics and the study of the brain mechanisms underlying the use of language is called psycholinguistics” (Fromkin & Rodman, 1993, p.437). Looking at language from the perspective of the brain originated in 1861 with Paul Broca’s connection of language, and the left side of the brain. Carl Wernicke then specified the back section of the left hemisphere was responsible for comprehension and phonological tasks. Today’s neurologists still refer to Broca’s and Werenerk’s areas in the brain. Our progress has been substantial since these discoveries.
In special education, many students are diagnosed with language based learning disabilities and/or speech disorders. Speech and language are separate operations which interrelate in their usage. “Speech is the way we produce sounds that others understand as words. Language is our ability to use speech sounds to express thoughts and emotions” (Berger, 1981, p.10). When do language and/or speech disorders develop? This question has been examined by many researchers and breakthroughs have begun to happen due to the advancement of technology. A study was conducted with infants to test their sensitivity to basic phonetic sounds. The researchers used a device to monitor the sucking patterns of infants in relation to different stimuli (Fromkin & Rodman, 1993).

A baby hearing a human voice over a loudspeaker saying [pa] [pa] [pa] will slowly decrease her rate of sucking; if the sound changes to [ba] or even [pʼa], the sucking rate increases dramatically. There will be no response to sound signals that are intermediate between, say, [pa] and [pʼa], differences that never signal phonemic contrast in any human language. The infants could not have learned to make these phonetic distinctions; they seem to be born with the ability to perceive just those sounds that are phonemic in some language. Thus, children have the sensory and motor abilities to produce and comprehend speech, even in the period of life before language acquisition occurs (Fromkin & Rodman, 1993, p.396).

This study emphasizes the human's inherent ability to process sounds in our language. As shown in chapter three, current research supports the theory of early learning.

“Human growth and the development of speech and language are highly complex processes” (Berger, 1981, p.20).

A sound, like the phonic syllables, hits the ear and is sent as nerve impulses to the brain. In the brain, the thalamus processes incoming signals and sends them
to the auditory cortex. The nerve cells within the auditory cortex match incoming signals with patterns the cortex has previously started ("How the brain processes speech", 1996, p.63).

The structure of the brain is different in people with language disabilities. "Research within the last decade indicates that individuals with developmental language impairments frequently demonstrate reversed asymmetry of the planum temporal" (Gauger, Lombardino, & Leonard, 1997, p. 1275). In the non-disabled brain, the planum temporal is smaller in the right hemisphere than the planum temporal of the left hemisphere. "Reversed or weakened asymmetry has been interpreted to indicate atypical right hemisphere dominance or lack of dominance for language" (Cohen, Campbell, & Yaghmai, 1989, as cited in Gauger, et. al. 1997, p. 1275). Dr. Paul Kay reported two types of words: content words and function words (Healy, 1990). Verbs, nouns, and adjectives make up content words. This category is ever changing with adding new terminology or replacing of old terms (e.g. couch for davenport). Content words are mostly managed by the right hemisphere (Healy, 1990). Function words, the more complex of the two, are small words which stand for abstract things. Healy (1990) calls them "...‘little’ words, word endings and prefixes, conjunctions, preposition, auxiliary verbs, etc. (e.g. if, but, so, did, might, un-, -ment) ..." The left hemisphere controls the use of function words (Ibid, 1990). Dr. Kay’s analysis of function and content words coincide perfectly with the latest structural knowledge. We know that the language disabled brain has a smaller left hemisphere and a lack for
language dominance and this hemisphere also manages the function words. The result is a brain which is unable to process the higher levels of language.

Sentences containing mainly content words are the type termed "restricted," or "primitive."

*Children like to run.*

*Children like prizes.*

Adding some function words enables expression of more complexity.

*Some of the children in this group might like to run if we offered a prize.* (Healy, 1990, p.188).

There are many theories about how and why language disabilities develop.

By repeated exposure to spoken language, the neurons in the brain form patterns, or "phonic bins," associated with particular sounds. When children have difficulty distinguishing between rapid acoustic cues, like the consonants in ga and da, those bins may overlap. Some scientists believe this overlap may be the key to language-based learning disabilities ("How the brain processes speech", 1996, p.63).

Lack of proper stimulation during the critical window is a common theory for the cause of language disabilities (Begely, 1996). A disability can form from the breakdown in the process of a sound getting to the brain. As a sound enters the ear it travels to the brain as an electrical code. The code is translated by using the memory it has acquired. Once the code is translated, the information travels to various parts of the brain (Berger, 1981) (See Figure 7). Treatments for language disabilities are beginning to move away from non-scientific methods of drill and practice to highly technological methods. Rutgers and University of California have developed a program which slows down and emphasizes sounds. Their hope
Figure 7

Process of Decoding Sound

(Berger, 1981, p.17)
is for this program to retrain the brain to process sounds ("How the brain processes speech", 1996).

There is great hope for the population of language disabled individuals. Researchers are studying more complex forms of human language. A team of eleven researchers from the Center for Cognitive Brain Imaging are using functional magnetic resonance imaging (f.M.R.I). f.M.R.I. is a stronger model of the magnetic resonance imaging systems used in many medical professions today (Kiernan, 1998).

The f.M.R.I. researchers know that active parts of the brain use more oxygen than other parts do and that oxygen-rich blood flowing through the brain has a magnetization different from that of oxygen poor blood. The oxygen-rich areas show up as bright spots in the f.M.R.I.'s images of the brain, and the researchers analyze the pattern of bright spots (Kiernan, 1998, p.A-17).

Using this technology, the researchers have found four areas in the brain which are crucial in the understanding of language and are continuing to search for more answers (Kiernan, 1998). "We have not had a window on the brain like this ever before" (Kiernan, 1998, A-17).

ADD/ ADHD

Throughout the history of learning disabilities, many different categories have emerged; however, few have swept our nation with such intensity as Attention Deficit Disorder (ADD) and/or Attention Deficit Hyperactivity Disorder (ADHD). The numbers are astounding. Some researchers have reported that twenty to thirty percent of children suffer from the disorder (Baren, 1995). Many would dispute
such a high percentage. Estimates of three to five percent are the most commonly reported statistics (Handen, Janosky, & McAuliffe, 1997; Levy, 1997; Thomas, 1998; & Elmer-DeWitt, 1990). Attentional disorders are “... the most commonly diagnosed behavioral disorder in children” (Handen, et al, 1997, p.287). These disorders are most prevalent in boys with a ratio of 9:1 (Ballard, Bolan, Burton, & Snyder, 1997).

Even with the recently popularized label of ADD/ADHD, the symptoms have been around for years, but have had a variety of labels. In the early 1900’s, inattention could be classified as mental retardation, emotionally handicapped, or a result of an unenriched background (“History of the Condition”, 1998). The 1940 researchers hypothesized that an array of problems, such as hyperactivity, difficulty in learning, and short attention span were due to a problem in neurological functioning. This wide range of problems were categorized as Minimal Brain Damage Syndrome (Hallowell, 1997, p.42). As the years progressed, hyperactivity, distractibility, and impulsivity were separated to form a category entitled Hyperkinetic Disorder of Childhood. It was in the eighties that the term ADD came on the scene. ADHD was developed in the late 80’s to include the hyperactivity characteristic (“History of the Condition”, 1998).

To define ADD/ADHD is a very difficult task.

Yet despite a steady accumulation of knowledge, ADHD remains problematic. Clinicians and researchers continue to argue about how to define it, how prevalent it is, whether it’s overdiagnosed or underdiagnosed, what causes it,
and which treatments are best. . . . Definitive answers to these questions remain elusive (Varen, 1995, p. 56).

Through much debate and controversy, the American Psychiatric Association has published criteria for this disorder in their Diagnostic and Statistical Manual of Mental Disorder. (See Table 2). “To diagnose ADD, a physician must determine that a child consistently displays six or more symptoms of either inattention or hyperactivity-impulsivity for a period of at least six months” (Heward, 1996, p. 199). This very wide, subjective definition has caused much criticism among educators and researchers. Heward reports on a study by Goodman and Plilion (1992).

After their review of 48 articles and books written on ADD by leading authorities revealed that 69 characteristics and 38 different causes of ADD had been proposed Goodmand and Pollion (1992) concluded that ADD was an acronym for “Any Dysfunction or Difficulty” (Heward, 1993, p.199).

While some criticize the overdiagnosing, others say the subjectivity of the definition is not broad enough. “Clinicians who were dissatisfied with the DSM-III R revisions worried that the definitions missed too many children with attention problems who were not hyperactive, many of them girls” (Baren, 1995, p. 57). Amidst all the critics, a third group has arisen: the non-believers.

Some theorists challenge the entire concept of attention disorders. The behaviors attributed to ADHD may be viewed as generalized responses--such as mental effort, arousal, and energy--to a variety of CNS dysfunctions rather than as a specific disorder, much as inflammation is seen as a generalized response to a variety of inciting agents (Baren, 1995, p.58).
Table 2

Diagnostic Criteria for Attention-Deficit/Hyperactivity Disorder

A. Either (1) or (2):
   (1) six (or more) of the following symptoms of inattention have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:
   - often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities
   - often has difficulty sustaining attention in tasks or play activities
   - often does not seem to listen when spoken to directly
   - often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions)
   - often has difficulty organizing tasks and activities
   - often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)
   - often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or socks)
   - is often easily distracted by extraneous stimuli
   - is often forgetful in daily activities
   (2) six (or more) of the following symptoms of hyperactivity-impulsivity have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:
   - often fidgets with hands or feet or squirms in seat
   - often leaves seat in classroom or in other situations in which remaining seated is expected
   - often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of inner restlessness)
   - often has difficulty playing or engaging in leisure activities quietly
   - is often "on the go" or often acts as if "driven by a motor"
   - often talks excessively
   - often blurts out answers before questions have been completed
   - often has difficulty waiting turn
   - often interrupts or intrudes on others (e.g., buts into conversation or games)

B. Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before age 7 years.

C. Some impairment from the symptoms is present in two or more settings (e.g., at school [or work] and at home).

D. There must be clear evidence of clinically significant impairment in social, academic, or occupational functioning.

E. The symptoms do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder and are not better accounted for by another mental disorder (e.g., Mood Disorder, Anxiety Disorder, Dissociative Disorder, or a Personality Disorder).

Coded based on type:
- 31: Attention-Deficit/Hyperactivity Disorder, Combined Type: if both Criteria A1 and A2 are met for the past 6 months
- 32: Attention-Deficit/Hyperactivity Disorder, Predominantly Inattentive Type: if Criterion A1 is met but Criterion A2 is not met for the past 6 months
- 33: Attention-Deficit/Hyperactivity Disorder, Predominantly Hyperactive-Impulsive Type: if Criterion A2 is met but Criterion A1 is not met for the past 6 months

Coding note: For individuals (especially adolescents and adults) who currently have symptoms that no longer meet full criteria, "In Partial Remission" should be specified.

(Haward, 1996, p.199)
To properly comprehend attention problems, an understanding of the correct process of attention must be obtained. "Attention, like learning disability, is not a single measurable quantity" (as cited in Healy 1990, p.154). Theorists have linked attention to four mental operations. The four processes are: "...focusing in (the 'execute' function), sustaining attention, placing information in short-term memory (the 'encode' function), and shifting attention from one thing to another" (Baren, 1995, p. 58). These four operations can become impaired during any or all of the four processes resulting in an attentional problem due to the breakdown in the natural flow of information.

The flow of information through the brain begins with a stimulus (energy change) in the environment. The S impacts or impinges on the sense, i.e., the eyes, ears, the nostril, the mouth, the skin, and muscles. The impact is registered in the senses for about 3 seconds. The energy stimulus is then passed on to the short term memory system (STM), or it drops out of the flow of information. Within the STM system, the brain is very active and in 20-30 seconds transforms the energy stimulus of information as it is encoded for the long term memory system (LTM), or permits the information to drop out of the system. The electrical-chemical stimulus remains in the LTM, probably residing in the synapse, which is the gap between two neurons in dendrites (branch like endings) extending out from the neurons (White, 1996, p. 292).

Voeller (1991) has recognized three types of attention problems which correlate to the area of impairment in the brain (as cited in Ballard, et al, 1997).

The first category is the posterior system, and involves attentional deficits. These children are described as hypoaroused. The second is in the anterior system, and pertains to dysfunction in the frontal striato-nigral circuits. These children exhibit motor attentional deficits. The ventral system is the third category and involves dysfunction in the limb-nucleus system, which includes mesolimbic dopamine controls. These children have a high level of restlessness.

As the frenzy surrounding ADD/ADHD has grown, scientists have begun to make discoveries which connect this deficit to scientific fact.

In a landmark study that could help put to rest decades of confusion and controversy researchers at the National Institute of Mental Health have traced ADHD for the first time to a specific metabolic abnormality in the brain. The findings, published in the current issue of the New England Journal of Medicine, could lead to a much needed diagnostic test and should silence skeptics who maintained that the disorder resided more in the minds of grownup specialists than in the unruly children they were trying control (Elmer-DeWitt, 1990, p. 59).

With the advanced technology, scientists have used neurology to understand why people suffer from ADD/ADHD. By using a PET scan, the image shows the difference between the ADD and the non-ADD brain. (See Figure 8). “It shows that people with ADHD do not have enough activity in their brain to focus on what they’re doing or control their thoughts” (Shire, 1998, p.1). In 1995, the National Institute of Mental Health performed the largest study of the brain images of ADHD boys. Their study showed a lack of symmetry in the two hemispheres of the brain. In the ADHD boys’ brains, their centers of planning, decision making, and control of inhibition, were smaller in the right hemisphere than in the brains of children without ADHD (Travis, 1995). White reports of another study in 1995.

“Using neuroimaging, similar to PET, it was discovered that on the right side of
Figure 8

(Shire, 1998, p.1)

PET Scan of Brain
the brains of these ADD or ADHD students, three specific locations of the brain had significantly reduced electro-chemical activity” (White, 1996, p.294). The National Institute of Mental Health has reported findings on their study of the corpus callosum in the ADD brain. The corpus callosum, the communicative fibers which link the left and right hemisphere, was found to be an abnormal size (Hallowell, 1997). These researchers also noted “. . .differences in the size of the caudate nucleus, another switching station deep within the brain” (Hallowell, 1997, p.43).

Neurologists have not only connected ADD with anatomical differences, but neurochemical differences as well. The brain relies on neurotransmitters to relay messages between neurons. “The neurotransmitters involved in attentional systems are the catecholamines (dopamine and norepinephrine), which relay messages through neural circuits that control motivation and motor behaviors” (Ballard, et. al, 1997, p. 857). (See Figure 9) The brain utilized dopamine in carrying messages in the mid-brain to the frontal lobes. “These pathways appear to be related to attention and orienting . . .” (“Dopamine and Norepinephrine”, 1998, p.1). Norepinephrine enhances communication throughout the majority of the cortex and brainstem (Ibid, 1998). “These cells appear to be broadly involved with alertness and orienting” (Ibid, 1998, p.1).
Chemical Structure of Dopamine and Norepinephrine

(Dopamine and Norepinephrine, 1998, p.1)
Another facet of ADD has been connected to irregular brainwaves. “A brain wave is the recording of electrical activity that comes from the brain” (Druckman & Minevich, 1997, p.3). Dr. Joel Lubar has implemented neurofeedback with ADD children and has seen positive results (Padgitt, 1998).

Lubar noticed that those children with ADHD, with or without hyperactivity, demonstrated a difference in specific types of brain waves. For example, the ‘Beta’ brain wave was found to be significantly lower in shape and frequency compared to ‘theta’ activity, which was higher in amplitude. More specifically, he found those children with attentional and reading difficulties, but not with hyperactivity problems, produced excessive Theta activity and deficit Beta production (Druckman & Minevich, 1997, p.1).

The significance of the theta and beta brain waves are their particular functions. Research correlates distractibility with excessive theta activity and lack of concentration and focus correlates with underactive brain waves (Padgitt, 1998).

Worth noting is that in normal development, Alpha increases between the ages of 12-14, while Theta levels decrease at this time. This maturational stage is delayed in ADHD population throughout the 12-14-age range (Swartz, 1995 as cited in Druckman & Minevich, 1997, p.4).

A highly scientific treatment for this abnormal brain activity is EEG or neurofeedback. Dr. Joel Lubar began using biofeedback in the early seventies with patients with seizure disorders. In 1976, he began experimenting with a group of children which would be classified today as ADHD (Druckman and Minevich, 1997). Many researchers since then have refined biofeedback to make it the successful treatment it is today.

Electroencephalograph biofeedback or EEG biofeedback uses computerized electronic measurement devices placed on the surface of your head to monitor brain activity. The computer ‘feeds back’ to you important information relevant to ADD. Through guided techniques the patient is able to learn to
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significantly increase brain waves (beta) which are compatible with stronger attentional focus and enhanced mental performance. The patient learns to create ‘better’ waves automatically, a skill which quickly generalized to everyday life.

EEG biofeedback has physiological effects similar to those created by medication but has no side effects, is painless, and often provides long lasting results ("Attention Deficit Disorder", 1998, p.1).

Like other disorders, there is no specific level of disability. A person using neurofeedback may require as many as forty or more sessions or as few as five sessions (Padgitt, 1998). Dr. Michael Tansy has done a ten year follow-up study which reports an increase in self-esteem as well as sustained results (Padgitt, 1998). "Despite only a few decades of scientific research, neurofeedback is quickly growing into a mature science. In particular, the application of neurofeedback has become recognized as a valuable tool in the treatment of ADHD" (Druckman & Minevich, 1997, p.7).

While neurofeedback is a treatment found to be effective, it is not widely used in the treatment of ADD. The most common treatment for ADD/ADHD is stimulant drugs (Ballard, et.al., 1997). "Ritalin, is the most prescribed medication" (Heward, 1996, p.200). Dexedrine and Cylert are also popular medications (Barkley, 1990, as cited in Ballard, et. al, 1997). Stimulant medication increase the activity in the frontal cortex, brain stem, and mid-brain areas of the brain (Barkley, 1990; Hynd, et.al, 1993; as cited in Ballard, et.al, 1997). "These drugs produce an increase in the arousal or alertness of the central nervous system; structurally they mimic certain brain neurotransmitters" (Ballard, et al, 1997, p.857). Although the results of these medications are positive, there are concerns which accompany their
use. Some side effects which are common are "...insomnia, decreased appetite, headaches, disruption of normal growth patterns, irritability, reduced emotional affect, increased blood pressure..." (Heward, 1996, p.202). Due to these possible concerns, alternative approaches have been sought. Structure, motivation, and novelty are three strategies which are implemented in place of medication (Hallowell, 1997). Every family must look at all the options and choose the best intervention for their child.

ADD/ADHD poses a crisis for many families. Neurology is beginning to breakthrough into this disability with scientific alternatives which change the workings of the brain, but science can’t do it alone. "Parent training and educational intervention, with a team approach and an understanding of neurological, psychological, and educational dynamics, appear to lead to positive outcomes" (Ballard, et.al, 1997, p. 860). There is a positive outlook for ADD/ADHD sufferers as neuroscience continues to make progress.

DYSLEXIA

To live one day in the life of a dyslexic child would be both informative and shocking. Their daily experiences can be devastating.

The scene is a third grade classroom. The assignment is given. Students begin to open their readers and the dreadful process begins. The sea of letters and words, all in a seemingly random order, present themselves with overwhelming complexity. He lowers his head to get closer to the book. It does not work. The
puzzle continues. He turns his head from one side to the other while furrowing his brow. No help is given.

“I hope you read more than that, now get busy!” the teacher demands.

“I am busy. Can’t you understand!!” his thoughts plead.

Desperation begins. He looks anxiously at the pictures hoping for understanding. The time is gone, so he slowly closes his book. He slides down in his seat and hides from the teachers view. The first question is directed at him.

“Can you tell us the boy’s name in the story?” the teacher asks.

The pressure is too great. He mumbles an answer that is completely inaccurate. The disapproving look from the teacher bores through his heart. The giggles from his classmates burn in his ears. Dyslexia, a frightening, overwhelming disorder that children face.

To say dyslexia is “a severe reading disorder in which the individual cannot learn to read or does not acquire fluent and efficient reading skills,” (Lerner, 1993, p.580), only begins to describe this incubassing disorder. This definition by no means discusses all the aspects to be defined. There is an overall agreement of four basic points on dyslexia.

Dyslexia is probably due to a congenital neurological condition. The problem persists into adolescence and adulthood. It has perceptual, cognitive and language dimensions that create subtypes of dyslexia. And, finally, dyslexia leads to deficits in many skill areas as the individual matures. (Lerner, 1993, p.385).

Reading disabilities have been studied since the late 1800’s. The term congenital word blindness was used to describe all types of reading problems (Rumsey,
The British Medical Journal reported the first incident of congenital word blindness on November 7, 1896 (Snowling, 1996). "In 1925, neurologist Samuel Orton suggested that dyslexia is a dysfunction in visual perception and visual memory and is characterized by a tendency to perceive letters and words in reverse" (Irlen, 1991, p.98). By the 1930's, researchers had recognized the connection between reading and the brain.

By 1937, the term dyslexia was in use, and Orton had formulated a theory with two essential elements: (1) reading disability was the most obvious part of a generalized disturbance of language and (2) a failure to establish clear left-hemisphere dominance for language constituted the biological basis (Rumsey, 1992, p.913).

Dyslexia is many things to many people. There are people who refer to dyslexia as a learning disability and others use the term for any person who is not a good reader (Irlen, 1991). Even today the definitions vary widely. "The World Federation of Neurology defines dyslexia as 'a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence, and sociocultural opportunity'. It is dependent upon fundamental cognitive disabilities which are frequently of constitutional origin" (as cited in Irlen, 1991, p.96).

Out of every ten children in America one is dyslexic (Sawicki, 1997). Current research is beginning to dispute the fact of a dominance in male diagnosis. The research is indicating a balance in the diagnosing of both male and females (Rumsey, 1992).
The reading process is complex. To determine at which stage of this process is troublesome for dyslexics is no easy task. The process begins with a visual intake of information.

When light enters the eye it passes through the pupil to be absorbed by the retina, a light-sensitive tissue that lines the back of the eye. The retina changes the light into electric impulses, which are transmitted to the brain. The brain then interprets the information and tells us what we are seeing. In dyslexia the brain may have trouble processing the information sent by the eyes, or it may be receiving wrong information because of some fault in the transmission system (Eye Clinic, 1998, p.1).

The breakdown in this process has been linked to the neuroanatomy of the brain. A group of researchers studied the brains of four dyslexics in a post-mortem study. In all four brains, two significant findings were reported. “All brains showed unusual symmetry in the planum temporal, a structure important to language function” (Rumsey, 1992, p.916). Also of significance is the lack of neural connections. “On a microscopic level, these brains show a large number of cortical anomalies—dysplasias and ectopias—apparently reflecting the failure of neurons to reach their normal cortical targets during fetal development” (Rumsey, 1992, p.916). Galaburda, Sherman, Rosen, Aboitiiz, and Geshwind (1985) theorized that the enlarged right planum was due to an over abundance of neurons. This abundance results from an improper “pruning” of neurons after the window of opportunity has closed during the early years of brain development (Rumsey, 1992).

As the brain grows during the first six months of gestation, neurons cells that conduct impulses—are churned out in the brain’s ventricular zone. Attached to
fibers, the neurons travel to the cerebral cortex, which contains the language centers. Here they hit a barrier, stop and take their place in layers above previously deposited neurons. In the brains of dyslexics, however, there are breaches in the barrier and the neurons enter them, leaving clumps of nerve cells called ectopias, which appear to interfere with the brain’s ability to receive and transmit certain messages (Sawicki, 1997, p.150).

Dr. John R. Absher, assistant professor of neurology at Wake Forest University Baptist Medical Center, led a team of researchers in the study of dyslexia. With the use of PET scanning they discovered “...that people with dyslexia have less activity in the region of the brain known as the thalamus than people who do not have the reading disorder” (Gannon, 1998, p.1). The thalamus is vital to the reading process because it regulates the information entering the brain (Gannon, 1998).

A leading researcher of dyslexia is Paula Tallal of Rutgers University. Tallal believes dyslexia is a language problem.

Her research—with brain imaging as well as experiments with rats and with children—has led her to theorize this disorder is not a linguistic problem, as it is commonly regarded, but a ‘more basic neuroprocessing problem’ that has to do with the inability to process sensory information rapidly (Dana Foundation, 1994, p.1370).

There is scientific fact which reinforces this theory. Dyslexic brains have been found to have abnormalities in a language center, the cerebral cortex. Within the cortex, the center for auditory input has been located. “It is an area of tissue called the medial geniculate nucleus (MGN), which affects hearing by acting as a relay station for auditory signals” (“Time”, 1994, p.61).
That a reading problem could be related to a problem with hearing may seem paradoxical, but children must hear the basic sounds, or phonemes, of their language before they can become skilled readers. When they first read the word “cat”, for instance, they must learn to associate the three letters in the word with three phonemes—“kuh”, “ah” and “tuh”. Children become masters of the written word only when letters can be easily decoded into their corresponding phonemic sounds. Young children who are poor at mentally dividing spoken words into phonemes almost always develop dyslexia later on (“Economist”, 1997, p. 92).

Tallal has endured much criticism since she proposed her language based theory twenty years ago; however, she is beginning to have supporters (Ibid, 1997).

Michael Merzenich led a group of researchers from the University of San Francisco in a study of dyslexics and hearing ability. The subjects who were dyslexic were unable to identify slightly different sounds although all other types of hearing were normal (Ibid, 1997).

Dr. Tallal reckons that children suffering from such a hearing problem—which the researchers have also found in children who have SLI—many have trouble telling certain phonemes apart. For instance, with sounds such as ‘bah’ and ‘dah’, the ‘b’ and ‘d’ sounds are succeeded by the ‘ah’ after an interval of roughly forty milliseconds. Children who cannot hear these rapid transitions may confuse the sounds (“Economist”, 1997, p. 92-93).

The remediation technique used by Tallal and Merzenich are computer games. They experimented with several types which remediate this deficit in auditory processing. “The results are quite provocative and intriguing . . . and certainly suggest that his [therapy] is very potent,” says University of Iowa speech-language pathologist” (Barinage, 1996, p.27). The subjects used these games for four consecutive weeks. After being re-tested, the subjects showed a pattern of . . . gaining 1 to 2 years’ worth of language ability during the 4-week training period.
Much of the improvement was maintained when the children were tested again 6 weeks after the end of the training” (Barinaga, 1996, p.28).

Not everyone accepts these results willingly. Dr. Sally Shaywitz of Yale University, a dyslexia specialist, does not believe the problem is auditory but related to improper structure in the brain (Barinaga, 1996). Dr. Student-Kennedy of Haskins Laboratory is an adamant opponent of Tallal and Merzenich.

The researchers have not shown which aspects of the program lead to the improvements: a child’s language comprehension may improve simply because he or she is forced to listen to a barrage of phonemes, not something that an expensive and complicated computer game is necessary for (“Economist”, 1997, p.93).

The controversy will continue until long-term follow-up studies have been completed. There are many advancements being made to understand all the facets of dyslexia and brain research is one of the driving forces behind our emerging knowledge.
CHAPTER 5
MULTIPLE INTELLIGENCES

The roots of assessment go back to 1904 in Paris. Alfred Binet, a psychologist, was called on by the Minister of Public Instruction, to create a measurement tool to identify struggling students (Armstrong, 1994). This development produced many tests which quickly spread to the United States. World War I produced a desire for a largely normed instrument; therefore, the Army Alpha and Army Beta tests were conceived for wide-spread use (Hanley, 1994).

Paradoxically, as the testing movement grew, it moved farther and farther away from its origins in addressing the needs of less capable students. A concrete example is the systematic or selective exclusion of low-functioning students, including students with disabilities, from state exams and national achievement tests, such as the National Assessment of Educational Progress (NAEP) (Hanley, 1994, p.223).

In 1943, in a small town in Pennsylvania, a baby was born. His name is Howard Gardner. As he grew, he developed a love for music and learning. Upon graduating from high school, Gardner entered Harvard University as a psychology major. He later became interested in cognitive science and studied neuropsychology. With training in these two areas, he studied brain-damaged adults and cognitive patterns of average to gifted children. "My efforts to synthesize these two lines of work led me to develop, and introduce, the theory of multiple intelligences in my 1984 book Frames of Mind" (Gardner, 1997, p.1).

The original intent of multiple intelligences was for psychologists to look at the concept of intelligence with a critical view. "I think it's important to bear in mind
that, when I wrote the book, I was really writing as a psychologist . . .” (as quoted in Viadero, 1995, p.2).

As the base of Gardner’s theory is his new definition of intelligence. Traditionally, intelligence has been viewed as “. . .our ability to learn and do things [which] comes out of a uniform cognitive capacity . . .” (Traditional Intelligences, 1997, p.1).

He [Gardner] seriously questioned the validity of determining an individual’s intelligence through the practice of taking a person out of his natural learning environment and asking him to do isolated tasks he’d never done before-and probably would never choose to do again (Armstrong, 1994, p.1).

Gardner takes a more pluralistic view. “I define intelligence - that is, as the ability to solve problems, or to fashion products, that are valued in one or more cultural or community settings” (Gardner, 1993, p.7). Users of the multiple intelligences theory have developed their own definitions for the theory as a whole.

MI theory is a way of thinking, it is an attitude about people which allows for similarities and differences. It allows for inclusion and enrichment, for self-esteem building and the development of respect for each individual and the gifts they bring to the classroom (Beckman, 1997, p.3).

Others describe multiple intelligences as “. . . a minor industry in the United States” (Davies, 1996, p.1). The effects of multiple intelligences has been vast. Educators have no choice but to form an opinion. “In the decade since Frames, the work of Dr. Gardner and multiple intelligences theory has shaken educators with a most fundamental question: What is intelligence?” (Carvin, 1998, p.1).
In 1983, Dr. Howard Gardner proposed seven types of intelligence: linguistic, logical-mathematical, bodily-kinesthetic, spatial, musical, interpersonal, intrapersonal (Gardner, 1994). Since that time, Gardner has added an eighth and is contemplating a ninth intelligence. The eighth intelligence is naturalist intelligence and the possible ninth is existential intelligence (Checkley, 1997). The following is a table of the definitions of the seven types of intelligence and their everyday application (See Table 3).

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Linguistic Intelligence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>“The capacity to use language, your native language, and perhaps other languages, to express what’s on your mind and to understand other people” (Checkley, 1997, p.12).</td>
</tr>
<tr>
<td><strong>Jobs</strong></td>
<td>Poets, Politician, Journalists, Playwrights, etc. (Armstrong, 1994).</td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>T.S. Elliot</td>
</tr>
<tr>
<td><strong>Educational Influences</strong></td>
<td>“This child likes to read, write, and tell stories. Is good at memorizing names, places, dates, and trivia. Learns best by saying, hearing and seeing words” (Special, 1997, p.1).</td>
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<table>
<thead>
<tr>
<th>Table 3</th>
<th>Logical-Mathematical Intelligence</th>
</tr>
</thead>
</table>
| **Definition** | “Most securely documented of the intelligences” (Grow, 1997, p.1)  
“The capacity to use numbers effectively and to reason well” (Armstrong, 1997, p.2). |
| **Example** | Issac Newton (Grow, 1997) |
| **Educational Influences** | “This child likes to do experiments, figure things out, work with numbers, ask questions, explore patterns and relationships. Is good at math, reasoning, logic and problem solving. Learns best be categorizing, classifying and working with abstract patterns/relationships” (Special, 1997, p.1). |
Spatial Intelligence

<table>
<thead>
<tr>
<th><strong>Definition</strong></th>
<th>&quot;The ability to perceive the visual-spatial world accurately... and to perform transformations upon those perceptions...&quot; (Armstrong, 1994, p.2).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example</strong></td>
<td>Michael Angelo, Christopher Columbus</td>
</tr>
<tr>
<td><strong>Educational Influences</strong></td>
<td>“This child likes to draw, build, design and create things; daydream; look at pictures; watch movies; and play with machines. Is good at imagining things, sensing changes, mazes and puzzles, and reading maps and charts. Learns best by visualizing, dreaming, using the mind’s eye, and working with colors/pictures” (Special, 1997, p.1).</td>
</tr>
</tbody>
</table>

Bodily-Kinesthetic Intelligence

<table>
<thead>
<tr>
<th><strong>Definition</strong></th>
<th>&quot;...the capacity to use your whole body or parts of your body-your hand, your fingers, your arms-to solve a problem, make something, or put on some kind of production&quot; (Gardner, as cited in Checkley, 1997, p.12)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jobs</strong></td>
<td>Actor, Athlete, Dancer, Surgeon, Sculptor (Armstrong, 1994)</td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>Babe Ruth (Gardner, 1994)</td>
</tr>
<tr>
<td><strong>Educational Influences</strong></td>
<td>“This child lives to move around, touch and talk, and use body language. Is good at physical activities such as sport/dance/acting and crafts. Learns best by touching, moving, interacting with space, and processing knowledge through bodily sensations” (Special, 1997, p.1).</td>
</tr>
</tbody>
</table>

Musical Intelligence

<table>
<thead>
<tr>
<th><strong>Definition</strong></th>
<th>&quot;...the capacity to think in music, to be able to hear patterns, recognize them, remember them, and perhaps manipulate them&quot; (Gardner, as cited in Checkley, 1997, p.12).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jobs</strong></td>
<td>Composer, Performer, Music Critic (Armstrong, 1994)</td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>Bach</td>
</tr>
<tr>
<td><strong>Educational Influences</strong></td>
<td>“This child likes to sing, hum tunes, listen to music, and play an instrument. Is good at picking up sounds, remembering melodies, noticing pitches/rhythms, and keeping time. Learns best through rhythm, melody and music” (Special, 1997, p.1).</td>
</tr>
</tbody>
</table>
Interpersonal Intelligence

<table>
<thead>
<tr>
<th>Definition</th>
<th>“The ability to perceive and make distinctions in the moods, intentions, motivation, and feelings of other people” (Armstrong, 1994, p.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobs</td>
<td>Teachers, Therapist, Parents (Gardner, 1994)</td>
</tr>
<tr>
<td>Example</td>
<td>Anne Sullivan (Gardner, 1994)</td>
</tr>
<tr>
<td>Educational Influences</td>
<td>“This child likes to have lots of friends, talk to people and join groups. Is good at understanding people, leading others, organizing, communicating, manipulation, and mediating conflicts. Learns best by sharing comparing, relating, cooperating and interviewing” (Special, 1997, p.1)</td>
</tr>
</tbody>
</table>

Intrapersonal Intelligence

<table>
<thead>
<tr>
<th>Definition</th>
<th>“...knowledge of the internal aspects of a person: access to one’s own feeling life, one’s range of emotions, the capacity to effect discriminations among these emotions and eventually to label them and to draw upon them as a means of understanding and guiding one’s own behavior” (Gardner, 1994, p.25).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Influences</td>
<td>“This child likes to work alone and pursue own interests. Is good at understanding self; focusing inward on feelings/dreams; following instincts; pursuing interests/goals/ and being original. Learns best by working alone, having individualized projects and self-paced instruction, and having own space” (Special, 1997, p.1).</td>
</tr>
</tbody>
</table>

Multiple Intelligences is a theory with a solid foundation in brain research (Reiff, 1997). Gardner has founded his theory on two sciences. “...cognitive science (the study of the mind, and neuroscience (the study of the brain)” (Gardner, 1994, p.7). The origin of these intelligences was Gardner’s observations of brain damaged people at Boston Veterans Administration (Hoerr, 1996).

In several cases, brain lesions seemed to have selectively impaired one intelligence while leaving all the other intelligences intact. For example, a person with a lesion in Broca’s area (left frontal lobe) might have a substantial
portion of his linguistic intelligence damaged, and thus experience great
difficulty speaking, reading, and writing. Yet he might still be able to sing, do
math, dance, reflect on feelings, and relate to others. A person with a lesion on
the temporal lobe of the right hemisphere might have her musical capacities
selectively impaired, while frontal lobe lesions might primarily affect the
personal intelligences (Armstrong, 1994, p.4).

In accordance with brain research, Gardner has connected each intelligence with a
specific area in the brain (See Table 4).

<table>
<thead>
<tr>
<th>Intelligence</th>
<th>Brain Location</th>
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</thead>
<tbody>
<tr>
<td>Linguistic</td>
<td>Left temporal and frontal lobes</td>
</tr>
<tr>
<td>Logical-Mathematical</td>
<td>Left parietal lobes, right hemisphere</td>
</tr>
<tr>
<td>Spatial</td>
<td>Posterior regions of right hemisphere</td>
</tr>
<tr>
<td>Bodily-Kinesthetic</td>
<td>Cerebellum, basal ganglia, motor cortex</td>
</tr>
<tr>
<td>Musical</td>
<td>Right temporal lobe</td>
</tr>
<tr>
<td>Interpersonal</td>
<td>Frontal lobes, temporal lobe, limbic system</td>
</tr>
<tr>
<td>Intrapersonal</td>
<td>Frontal lobes, parietal lobes, limbic system</td>
</tr>
</tbody>
</table>

(Armstrong, 1994, p.7)

The development of an intelligence must fit three specific criteria established by
Gardner. "Is there a particular representation in the brain for the ability? Are
there populations that are especially good or especially impaired in an intelligence?
And, can an evolutionary history of the intelligence be seen in animals other than
human beings?" (Checkley, 1997, p.8).

With questions whose answers threaten to change education as we know it,
critics are plenty. "There is a revolutionary war going on, as there often tends to
be in fields where the excitement is the greatest" (Sternberg, 1996, p.25). In this
war, three participants have come to the front: Traditionalist, Revolutionist, and
Radicals. Traditionalist, or Classicists, view intelligence as society has for many years. They "...classify it in much the same way that 'physicists seek to identify the structure of the atom'" (Herrnstein & Murray, 1994, as cited in McCloskey, 1995, p.56-57). The Revolutionist see intelligence as an application of abilities in practical situations. "They believe that 'what really counts about intelligence are the ways in which people process the information they receive'" (Herrnstein & Murray, 1994, as cited in McClaskey, 1995, p.57). The third group represented is the Radicals. The radicals believe applications are a proper measure of intelligence; however, their "radical status" is achieved with their denial of a unitary intelligence (McClaskey, 1995). Gardner would be classified as a radical by those involved in this battle. Many researchers who criticize Gardner state two main criticisms.

"... he has no psychometric or other quantitative evidence to back up his definition. Secondly, they claim that re-labeling what have traditionally been called 'talents' as components of intelligence just muddies the water when discussing intelligence issues" (McClaskey, 1995, p.57).

Other critics become radical within their own points of reason. One such researcher has summarized an ultimate conclusion to this debate. "If intelligence can only be subjectively (or inter-subjectively) valued, then ultimately intelligence has no true value and perhaps, never existed to begin with" (Sempsey, 1993, p.4). Even though critics exist, the positive response far out-weighs these negative
opinions. “Rarely does an insight have the potential to change how we view students, teach, assess, and communicate with their parents. The theory of multiple intelligences (MI), however, does just that” (Hoerr, 1996, p.8).

Unlike many theories, Gardner’s theory has come beyond the written word into classrooms. The first multiple intelligences program became a reality only a few short years after *Frames of Minds* was published (Gardner, 1994). In 1984, Gardner was contacted by eight teachers from Indianapolis who presented a videotape of their interpretations of multiple intelligences into their classrooms. “While I was becoming increasingly interested in educational applications of the theory, it had never dawned on me that someone might take these ideas so seriously as actually to plan a school based upon them” (Gardner, 1994, p.112). Gardner offered to collaborate with the teachers, only on a consultant basis. “I told the ‘Indianapolis 8’ quite frankly that I would be happy to help them but that I knew little about schools. ‘You are the school people,’ I insisted, and ‘it will have to be your school’” (Gardner, 1994, p.112). In the next two years the teachers worked and fought to gain the funding, a building, and develop a curriculum. In September of 1987, the Key School opened in the inner-city of Indianapolis as an “options” school in the public school system (Gardner, 1994 & Armstrong, 1994). The school has experienced success and has maintained it’s founding conviction: “...each child should have his or her multiple intelligences (MI) stimulated each day” (Gardner, 1994, p.113). The school provides unique features which
incorporate multiple intelligences into everyday school experiences. As stated in their founding philosophy, all seven multiple intelligences are incorporated on a daily basis. "Compared with schools nationally, students at Key receive four times the exposure to art, music, and physical education than does the average student in the United States" (Armstrong, 1994, p.111). The instruction may be incorporated into a project or center, or be presented in a formal setting, such as musical instrument lessons. "Each child learns to play a musical instrument, starting with the violin in kindergarten" (Armstrong, 1994, p.111).

A second feature the Key School provides is the apprenticeship pods (Gardner, 1994).

These are special learning groups that students individually select based upon their interest. Pods are formed around specific disciplines (such as gardening, architecture or acting) or cognitive pursuits (such as mathematical thinking, problem solving, or "the mind and movement"). Students work with a teacher possessing special competence in the selected area in an apprenticeship-like context that emphasises mastering real-world skills and knowledge. In the architecture pod, for example, students "adopted" nine houses in the surrounding area and studied the designs of the houses through walking tours and other activities (Armstrong, 1994, p.112).

The daily work in the pod setting allows for a deeper understanding of real-life experiences (Gardner, 1994).

The work in the pods, and all other facets of learning, center around a school-wide theme (Gardner, 1994). "The themes can be quiet broad (such as "Patterns" or "Connections") or more focused ("The Renaissance-Then and Now" or "Mexican Heritage") (Gardner, 1994, p.114). Throughout a school year, three
themes will be incorporated into every function of the school. “For example, during the environmental theme, part of the school was turned into a simulated tropical rain forest” (Armstrong, 1994, p.112). Students demonstrate their understanding of a theme by developing a related project. Students may choose the format for their project (dance, play, experiment, etc.) (Gardner, 1994). The project is presented to fellow students and teachers. Part of the school’s transitional program is the development of a video portfolio for every student. “The portfolio may be considered as an evolving cognitive model of the student’s development over the course of his life in the Key School” (Gardner, 1994, p.114).

The Key School has developed their own assessment tools for use in their school. They have five criteria for project assessment. The first criteria is individual profile. The teachers look to see if the projects accurately incorporates the intelligences and displays that students cognitive strengths and weaknesses (Gardner, 1994). Mastery of facts, skills, and concepts is assessed by looking for a display of general understanding of the topic (Gardner, 1994). Another criteria is quality of work. “Among the aspects of quality that are customarily examined are innovation and imagination; aesthetic judgment and technique; the development of a project in order to foreground a particular concept; the execution of a performance” (Gardner, 1994, p.115). How the project is communicated is the fourth criteria for assessment. The main component in this area is for “... the student to communicate his findings skillfully...” (Gardner, 1994, p.115). The
last area of assessment is reflection. Students are asked to discuss how their project interrelates to their personal education (Gardner, 1994). The teachers use these criteria as a foundation for their assessment of student work.

The population at the Key School is also unique.

Students who attend the Key School are chosen randomly by a lottery system. Although some students had previously been labeled “learning disabled” and “gifted” and placed in special education programs, no such programs are currently in place at the Key School. Students in any one class have a wide range of ability levels, a factor that is seen to enrich the program through diversity (Armstrong, 1994, p.113).

Upon a quick review of this school, a critic may oppose the “free-spirit” atmosphere and liken it to the Montessori schools. The Key School has not sent children off to learn what they wish, but have them learn how they can (Gardner, 1994). Another hesitation is the abandonment of all traditional teaching. The Key School uses projects for a vast majority of their teaching; however, they are realistic about using only one approach. “It would be a mistake to consider projects as a panacea for all education ills, or as the royal road to a nirvana of knowledge. Some materials need to be taught in more disciplined, rote, or algorithmic ways” (Gardner, 1994, p.118). The students view of school speaks for this programs success. “School is not a chore to be endured; rather, it is a place to explore the world around them” (DuPont, 1997, p.1)

The Key School has now opened an extension of itself for grades six through eight. The Key Renaissance School is a magnet school which incorporates many of the same principles from it’s founder. Patricia Bolanos, the principal of the Key
School, writes, "The strengths of this middle school are a direct result of the collaboration between the instructional staffs of the two schools and our shared vision to establish a K-12 learning community at one site" (as quoted in Bolanos, 1996, p.24). An addition to the Key School is mental models. "Mental models" are deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action" (Senge, 1990 as cited in Bolanos, 1996, p.24). As teachers began to mold their mental models into a joint model for the school, they developed a contract they agreed to follow (See Figure 10). The commitment of these schools is great.

The number of schools which have incorporated multiple intelligences into their schools is astounding. In McLean, Virginia the Kent Gardens Elementary School’s Think Tank is their center for critical thinking.

On any given day, my students might be constructing a geodesic dome from straws or even with three-foot wooden dowel rods, or they might be engrossed in everything from robotics to how to identify animal footprints. All 620 children at Kent Gardens are scheduled to come to this room for up to an hour every other week. Many come more often, however. Faculty members and volunteer Room Guides (20-30 parents and community members) are trained to help out (Knodt, 1997, p.35).

In a math class in Edmonds, Washington, algebra is presented on a large graph painted on pavement. The students move around the graph during the lessons to understand the concept kinesthetically (Campbell, 197). A summer day camp in Connecticut has developed their program around multiple intelligences.
Figure 10

We, the people of the Key Learning Community, in order to secure a more complete education for all citizens, do solemnly proclaim the following beliefs:

Based upon their right to develop their multiple intelligences, it is our shared responsibility for all students to be provided with an equitable education.

The purpose of this education is to prepare the students for active lives as adults, fostering leadership and developing respect for the young citizen's own cultural values and those of others.

The basic values we hold in common are: honesty, respect, responsibility, compassion, self-discipline, perseverance, and generosity.

These beliefs are the basis for our collaborative efforts and agreements.

Teachers agree to the following criteria to be hired and to remain on the instructional staff:

I agree to contribute to the research and development of the application of Gardner's Multiple Intelligences, Csikszentmihalyi's Flow Theory, Feldman's Developmental Continuum, and Boyer's Human Commonalties and Virtues.

I agree to participate in collaborative activities to develop each schoolwide theme.

I agree to develop, implement, and assess theme-based curricula for my students.

I agree to teach multi-age classrooms.

I agree to reflect on my instructional methods.

I agree to set project criteria and evaluation standards for each theme.

I agree to be professionally literate regarding current research reported in educational periodicals and journals.

I agree to actively work with students and other staff members on community service.

(Bolanos, 1996, p.25-26)

Renaissance Contract
Now in its third year, the Summer Stars Program allows children ages 7-12 to choose materials and activities from many different topics and to participate in one of three internships: the Challenger Mission at the Bridgeport Discovery Museum, the Sea Voyage at the Norwalk Maritime Center, or simulated flight training at the Sikorsky Aircraft Corporation in Stratford (Cantrell, Ebdddon, Firlik, Johnson, & Rearick, 1997, p. 38).

The programs are countless. “Regardless of how they are structured, MI schools of the future will undoubtedly continue expanding the possibilities for unleashing children’s potentials in all intelligences” (Armstrong, 1994, p. 113).

Do multiple intelligences have an impact on special education? Yes. When asked if students who have lower IQs have the ability for forming a “deeper understanding” Gardner responded.

I am not interested in a student’s IQ I am interested in his or her current understanding and what can be done to enhance it. No human understands everything every human being understands some things. Education should strive to improve understanding as much as possible, whatever the student’s proclivities and potential might be (Siegel & Shaughnessesy, 1994, p. 564).

Gardner recognizes learning disabilities, but maintains they are within the context of specific intelligences. “These deficits, however, often operate relatively autonomously in the midst of other dimensions of the individual learning profile that are relatively intact and healthy” (Armstrong, 1994, p. 136). Gardner’s strongest example of this theory is the autistic savant. When viewed from a multiple intelligences perspective, the inability to speak is understood in contrast to the highly developed musical or mathematical ability. In order to teach special
education students, teachers must learn how to “tap into” their strong intelligences. “The best examples of this are braille (for the seeing-impaired) and sign language (for the hearing-impaired)” (Armstrong, 1994, p.138).

A study of dyslexic children with strong spatial and kinesthetic capabilities have mastered braille or sign language (McCoy, 1975, as cited in Armstrong, 1994). Another study introduced Chinese symbols to reading disabled students. The students learned these symbols with greater ease than traditional sight words (Rozin, Portisky & Sotsky, 1971 as cited in Armstrong, 1994). “In this case, an ideographic symbol system (Chinese) worked more successfully with these spatially oriented youngsters than the linguistic (symbol-sound) English code” (Armstrong, 1994, p.139). Thomas Armstrong has laid out charts which correlate different weaknesses in intelligences to activities to overcome deficits in the various intelligences. “Ultimately, the adoption of MI theory (or an MI-like philosophy) in education will move special education toward a growth paradigm and facilitate a greater level of cooperation between special education and regular education” (Armstrong, 1994, p .144).

Only time will tell the continued impact multiple intelligences will have on education.

As educators, parents, and other adults recognize that all children are born with a multitude of intelligences, they can better nurture the full range of each child’s abilities. When students experience environments that acknowledge and nurture their particular strengths and interests, they are more likely to feel engaged and satisfied. Ultimately, a pluralistic view of intelligence is a tool well suited to helping individuals understand and live in our increasingly diverse society (Gray & Viens, 1994, p.26).
CONCLUSION

My view of education is forever changed because of this project. I now understand that to teach a child is a far more in-depth process than the presentation of material. To teach is to mold a child’s brain into a more complex structure. “The student’s brain will never again be the same” (White, 1996, p.293).

The amount of research which has been devoted to the brain is unfathomable. Every aspect of learning has, or will be examined under the technological magnifying glass. We have learned many answers to why disorders occur; however, my point of frustration occurs when I don’t see educators asking another question: How can we use this knowledge to improve the learning process for our students? Unless education begins to question their traditional methods, scientific research is in vain.

For those who teach, knowledge about the functions of learning in the brain is an essential element. All of life should be a learning experience. Twentieth century technology is confronting the traditional viewpoint that the curriculum is the focus of learning. Teachers must be informed in this era that we are challenging our brains in the classroom, and, therefore, building brain circuitry (White, 1996, p.295).

I believe the strongest opponent we have to face is habits. “By the time most teachers experience innovative and creative ways of teaching, they also have experienced a minimum of 14-16 years of lecture and memorization” (Caine & Caine, 1991, p.172). Change is always a necessary agent for progress and many
educators are resisting the change with a passion. I see this resistance as a barrier
to progress in education. In order to change teacher’s perspectives, I believe the
field of science will have to transfer their terminology into understandable and easy
to read presentations.

Another important aspect is to incorporate the new scientific information into
teacher training programs, at both college and graduate levels. Until neurologists
begin to move into educational territory with their information, we will have a hard
time producing change. I do see the gap between science and education as great;
but, not uncloseable.

I found the topic of brain research to be very exciting. I believe special
education is one field which stands to benefit the most from this research. I have
reported on a small portion of the categories in special education, but the progress
is not limited to these areas. There are advancements being made in the majority
of specialties.

In summary of my findings, I have come to realize that this field is changing
faster than educators can possibly keep up. Even as I have researched for this
project, I’m sure some of the information has been updated. “Today we know
more than ever about the brain, but in learning more we have realized how little we
actually know” (Hallowell, 1997, p.41).

I would like to see major changes, but I also know that is not realistic. In
reality, we need to start with the basic principles of how the brain learns. From
that point some will become naturally curious, and others will continue to need education. Change must start with an open mind. If we continue to do what we have always done, we will continue to get what we have always gotten, and we are ready for a change in our educational outcomes. I view brain research as the starting point for change. I see brain research as a spark which has begun to develop a small flame of educational growth. As an educator who deals with special needs students, I must fan the flame with a vengeance. It will take my dedication to make a difference in my realm of influence and hopefully, that influence will grow. I understand that I am an intricate element in the change I so desire.

Change, of course, takes time. All learning is developmental, including the learning of educators. Many of the changes that are needed will also appear in unexpected ways and from unpredictable sources. Some of the most unlikely people will become the most valuable colleagues and collaborators. The transition from fragmentation to a higher degree of order is not easy. It is clear, however, when the right conditions are established, the transition can occur. Setting out to participate in the change is exciting, challenging, and immensely rewarding (Caine & Caine, 1991, p.180).

Special education is on the verge of advancement into a whole new realm and I plan to help make that transition a success.
REFERENCES


