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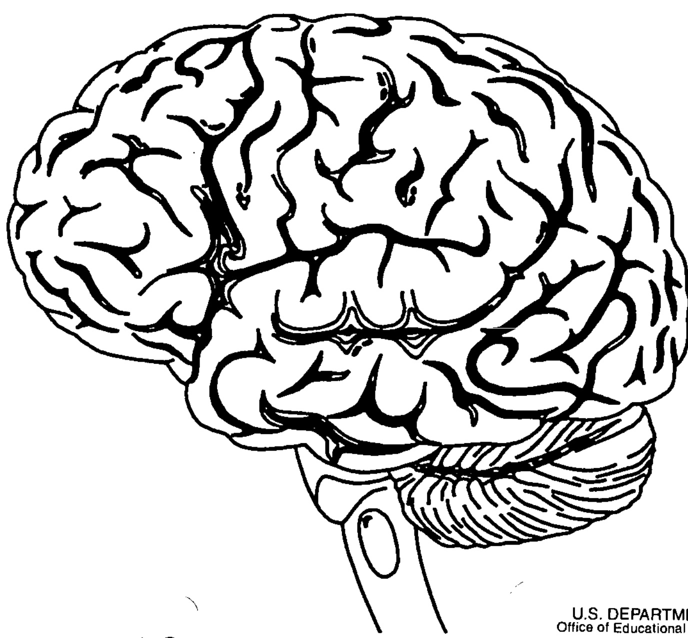
ABSTRACT

This manual is intended to give teachers a basic understanding of traumatic brain injury (TBI) and an in-depth understanding of techniques for evaluating the student with TBI in order to provide appropriate programming. Section 1 introduces a definition of TBI including incidence and causes, an overview of neuroanatomy, primary and secondary medical effects of TBI, and TBI and the schools. Section 2 offers fundamentals of brain development and function, such as basic principles of brain development, effects of damage on the developing brain, and brain-behavior relationships. Section 3 is on best practices in the assessment of students with TBI. It covers foundations of a TBI assessment battery and specific assessment techniques in general cognitive functioning, language, memory and learning, attention, visuoperceptual functioning, motor functioning, social-emotional functioning, and academic achievement. A seven-step procedure for conducting evaluations is also provided. Section 4 covers school reentry and appropriate programming for TBI students with suggested school reentry procedures and guidelines for programming, such as developing an intervention program, basic forms of intervention with TBI students, the use of computers in cognitive retraining, developing the TBI student's individualized education program, and dealing with the family of the TBI student. Appended are a glossary, descriptions of tests and ordering information, and a sample TBI report. (Contains approximately 175 references, a glossary of terms, test descriptions, and a sample TBI report.) (DB)

Best Practices *in* Assessment *and* Programming *for* Students *with* Traumatic Brain Injuries



January 1997

Public Schools of North Carolina
State Board of Education . Jay Robinson, Chairman
Department of Public Instruction . Michael E. Ward, State Superintendent
Exceptional Children Division
Raleigh, North Carolina

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PREFACE

This manual has the following objectives.

1. To increase your basic understanding and knowledge of traumatic brain injury, including:
   - the demographic characteristics of TBI, e.g. incidence, causes, etc.; and
   - the mechanics of TBI, e.g. what happens when an individual sustains a TBI.
2. To give you a basic understanding of how the brain works, including:
   - basic fundamentals of neuroanatomy, including an overview of important developmental factors; and
   - brain-behavior relationships, i.e. the relationship between the injury itself and the functional manifestations of the injury (medical/physical, cognitive, and social-emotional effects).
3. To give you an in-depth understanding of techniques designed to amend and expand your current assessment methods in order to better meet the needs of the TBI student, including:
   - increasing your ability to interpret the assessment techniques currently being used from a neuropsychological perspective;
   - how and when to choose supplementary instruments/techniques to more accurately assess students with TBI;
   - a description of supplementary testing instruments/techniques appropriate for TBI students; and
   - strategies for test administration, data analysis and interpretation, developing appropriate recommendations, and report writing, etc. that best meet the needs of TBI students.
4. To give you an in-depth understanding of the reentry process and school programming appropriate for students with TBI, including:
   - preparing the school staff for the reentering TBI student;
   - developing a cognitive retraining program;
   - sample teaching strategies; and
   - dealing with the family of the TBI student.

Additional and/or clarifying information will be provided to assist you in how to best serve students with TBI through two mechanisms, the Info Box and Case Notes.

Info Boxes

The Info Boxes will contain information on the topic being covered that may provide an additional perspective to facilitate the understanding of the topic. The Info Boxes will also contain additional information on the subject to allow those who are interested in learning more about the topic.

Case Notes

Case Notes boxes will contain brief case summaries to help clarify the topic, technique, etc. in question. These case summaries are taken from the author's experience and are amalgams of several cases. Descriptive demographic information has been altered to protect the identity of the child or adolescent being described.

References and Appendixes

A list of References and Appendixes with additional material appear at the end of the manual.

Note. The scope of this manual is limited to situations that are relevant to the federal definition of traumatic brain injury and to school-age children and adolescents. The information and techniques are intended to provide a foundation for school personnel working with TBI students. Additional information and consultation should be sought in individual cases. One final caveat: this manual is intended as an introduction to the appropriate assessment and programming for students surviving TBI. Competency in this area can only be gained through further structured training and experience.

Acknowledgments

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N. William Walker, Ed.D.

In Appreciation

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E. Lowell Harris
Exceptional Children Division

SECTION ONE:
Introduction to Traumatic Brain Injury (TBI)

AN OVERVIEW

Brain injury has been around since there have been brains to injure. There is evidence of crude "craniotomies" (brain surgery), called **trephining** being performed in prehistoric times, although why is still a matter of speculation. An amazing survival rate of approximately 50% has been reported with evidence that as many as five of these crude procedures being performed on a single individual (Walsh, 1992)!

War has played a significant role in what we know about brain injury. The term brain itself was first introduced somewhere between 2500 and 3000 BC in descriptions of war wounds by Edwin Smith. Hippocrates, in describing brain injuries incurred during battle, was the first to notice that an injury to one side of the brain produces motor effects on the contralateral side of the body (Walsh, 1992).

If all of this is so, why then does TBI *appear* to be a recent phenomenon? The answer lies in the growing medical/technical advances that have been made during recent wars, especially Vietnam. These advances have taught us how to save brain- injured victims who ordinarily would have perished. Unfortunately, this ability to save gravely wounded soldiers also means that we have an ever growing body of "walking wounded," i.e. TBI survivors (they prefer to be referred to as survivors rather than victims) who need rehabilitation. One of the earliest recognized attempts to rehabilitate brain-injury survivors was organized for soldiers wounded in the war between Israel and Egypt in the early 1970s. This program was a collaborative effort between the Rusk Institute of Rehabilitation in New York City and Yehuda Ben-Yishay (Rattok & Ross, 1994).

Another indication of the "recency" of TBI phenomenon is the fact that the National Head Injury Foundation (now the Brain Injury Association) was not created until 1980. These events all speak to the fact that TBI is a very old, yet relatively recent social phenomenon.

INFO BOX

Head vs. Brain — The phrase "head" injury is used in much of the literature, particularly the older literature, and some TBI organizations. The reference to head injury is somewhat of a misnomer. It is possible to have an injury to your head and not your brain, e.g. a scalp wound. The more accurate term is brain injury to distinguish it from the many types of benign head injuries. In fact, the National Head Injury Foundation, an organization created to raise public and professional consciousness to TBI, has recently changed its name to the Brain Injury Association. Unfortunately, head injury continues to be the term used in many situations. For your purposes, these two terms — head injury and brain injury — should be thought of as interchangeable.

The Incidence and Causes of TBI

Incidence of TBI

Calculating an accurate annual figure of how many individuals suffer a TBI annually is very difficult. Factors such as the criteria used for case inclusion vary from study to study (Kraus, 1995). As an example, Kraus and Sorenson (1995) reported on several epidemiological studies where the estimated annual incidence of TBI ranged from a low of 132 per 100,000 to a high of 376 per 100,000. Most annual estimates, however, range between 500,000 and 1,000,000 (Lehr, 1990; Savage & Wolcott, 1994), but some researchers consider even these figures to be low (Parker, 1990).

Annual estimates of TBI alone do not tell the whole story. There is a cumulative factor also. Using an elaborate formula involving several relevant factors such as the number of TBIs per year, hospital admissions, and injury severity, Kraus and Sorenson estimate that approximately 82,000 individuals per year will become permanently disabled as a result of TBI. Thus, each new TBI survivor needing long-term or permanent care must be added to the growing, cumulative population of TBI survivors with permanent physical, cognitive and/or emotional disabilities.

TBI Incidence in Children and Adolescents

TBI strikes the young. Approximately 200 in every 100,000 school-age children and adolescents in the United States - 1 in every 500 - will sustain a TBI each year (Lehr, 1990). There are some studies that suggest this figure may be low. As an example, 15% of 5,000 Swedish parents (approximately 750) reported that their child had experienced a TBI. The parents also reported that approximately 250 of these children had experienced a period of coma, a significant factor in judging the severity of brain injury (Rune, 1970). TBI is now the leading killer and cause of disability in children through young adults (Havey, 1995) and it is the most common neurological condition requiring hospitalization in children and adolescents under the age of 19 (Fenichel, 1988). In children and adolescents, approximately 41% of all deaths involve head trauma. The average annual fatality rate in children through adults is about 25 in every 100,000 TBIs (Hinds, 1989; Marshall & Marshall, 1985). In the birth to 14 year range, 10 of every 100,000 will die from TBI (Lehr, 1990). To set this mortality rate in proper perspective, the next highest cause of death in childhood is leukemia with a rate of 1.9 per 100,000. The TBI fatality rate increases dramatically from age 14 reaching a peak of approximately 500 in every 100,000 at 19 years of age.

Unaccounted for in these incidence figures is a high number of students with "mild" TBI which often goes unreported because the symptoms (e.g. mild organization, confusion, and attention problems) can be difficult to recognize even for the survivor. Research suggests that without pre-existing neurologic or psychiatric compromise these symptoms will generally resolve in three to six months (Levin, Eisenberg & Benton, 1989). Other research suggests that there is the potential for "mild" brain injuries to cause long-lasting or permanent cognitive and behavioral difficulties (Carney & Schoenbrodt, 1994; Kraus, Fife, Cox, Ramstine, & Conroy, 1986; Langfitt & Gennarelli, 1982; Polissar, Fay, Jaffe, Liao, Martin, Shurtleff, Rivara, & Winn, 1994). Although the effects of milder forms of brain injury may be less dramatic than those associated with more severe forms of TBI, the chronicity can be very disruptive to the survivors cognitive and emotional behaviors. This along with the fact that the symptoms often go unrecognized can lead to heightened anxiety in survivors and those around them.

Age as a factor in incidence. The highest incidence of TBI occurs between the ages of 15 to 24 years. One in every 181 children and adolescent in this age group will experience a TBI (Annegers, Grabow, Kurland, & Laws, 1980). It is no coincidence that these are also the early driving years. The second highest incidence group includes infants to age 14, where approximately 1 in every 454 children sustains a TBI.

Gender as a factor in incidence. Gender data reveal that male TBI survivors outnumber females by 2 to 4 times although this ratio may depend on the specific age group. In very young children, 0-5 years, the male-female ratio is approximately equal. From age five on, however, males clearly outnumber females.

The silent epidemic. In spite of the relatively high incidence, traumatic brain injury still goes largely unrecognized. It is, in fact, often referred to as "the silent epidemic" (Walker, 1993). Unfortunately, it is still not uncommon for a TBI survivor to be released from an emergency room or hospital without sufficient attention paid to possible non-medical aftereffects of TBI, such as cognitive (memory, attention, etc.) and/or behavior problems (impulsivity, agitation, etc.). Why does this situation exist? Parker (1990), lists several reasons:

- False information regarding such things as the effects of early brain damage and superficial recovery (i.e. survivor appears physically fine but still has major cognitive and social-emotional problems).
- Lack of information and misjudgment by professionals, particularly with regard to what appears to be "milder" forms of TBI where there is no loss of consciousness (i.e. concussions, etc.). Reduced mental levels may not be recognized since individuals are often able to carry on "normal" conversations after TBI. Often, emergency room personnel will not look for brain injury if the patient appears to be talking "OK".
- Not recognizing injurious events such as past brain injuries. Brain injuries can have a cumulative effect since the survivor probably never fully recovered from the previous injuries.
- Overestimating the value of the cognitive/social-emotional portions of the neurological examination. These examination procedures are not thorough enough to pick up the subtle effects of diffuse or mild brain injuries.
- Overestimating the value of EEG and neuroimaging techniques. Many types of brain injury will not be diagnosed with routine EEGs and CAT scans, particularly the effects of mild or diffuse injury.

- Ignoring "soft" signs. Although definitions can be vague, there are reliable soft symptoms which when looked at together rather than as unrelated symptoms can suggest mild but pervasive brain damage.
- Use of inappropriate criterion of recovery. Often patients can be discharged from the hospital because their medical concerns have been stabilized, with little regard to cognitive and social-emotional effects.

Causes of TBI

The causes of TBI in children and adolescents generally fall into four broad categories: (a) transport injuries (automobiles, bicycles, all-terrain-vehicles, etc.), (b) falls, (c) assaults/abuse, and (d) sports/recreation injuries (Berg, 1986). Data from a collection of studies suggest that motor vehicle accidents and falls account for at least 75% of the traumatic brain injuries between birth and age 19 (Kraus, 1995). Motor vehicle accidents (MVA) alone account for approximately one-third of all TBIs in children and approximately one-half of all TBIs in young adults.

For young children, MVAs and falls account for nearly half of all TBIs. In this age group children are passengers in automobile accidents or are struck by a motor vehicle. Bicycle and sports injuries are also major causes. Assaults, particularly in urban areas, appear to be on the rise. Recent helmet laws have assisted in dropping the number of children and adults injured on bicycles, but the incidence of these injuries continues to be very high.

In addition, there are causes of TBI that have been difficult to document historically. One such cause is child neglect and abuse. Currently, it is estimated that 64% of infant brain injuries are the result of abuse. When parents strike their child they typically do so in the head. Add to this the "shaken baby syndrome" which can do serious injury to the developing brain. Unfortunately, when these children are taken to the emergency room these types of brain injuries may not present themselves as visibly as a broken bone or obvious bruising, but the long-term effects are much more devastating. Often, the true effects do not become noticeable until the child becomes involved in situations (e.g. school) where cognitive demands highlight the earlier damage.

Causes of TBI also may vary geographically. It seems likely that professionals in rural and semi-rural areas will see many more all-terrain-vehicle (ATV) accident victims, as well as TBIs related to carrying children in the back of pick-up trucks. Those who work in urban areas may, on the other hand, see a higher incidence of brain injuries due to assaults.

The Cost of TBI

Although exact figures are difficult to calculate (and probably changing as we speak due to skyrocketing health costs in general), the cost of TBI is staggering. In 1985 the average lifetime cost per survivor averaged $85,000, although this figure varied by age. As is usually the case, less was spent on children and adolescents in the 0-14 age group (approximately $60-70,000) while the outlay for survivors in the 15-44 age group was well over $150,000. The total cost for brain injuries during that year was approximately $37 billion (Max, MacKenzie, & Rice, 1991). Forecasting those figures ahead to the present would probably double the 1985 figures.

A Brief Overview of Neuroanatomy

In order to understand TBI, it is important to have some knowledge of the mechanics of a trauma to the brain. In other words, what actually happens when an individual suffers a traumatic brain injury? To set the stage for a discussion of the mechanics of TBI, we need to briefly discuss some basic neuroanatomy.

Along with assisting in learning the mechanics of TBI, this basic overview of neuroanatomy will hopefully give you the necessary perspective to guide you in choosing and interpreting your assessment techniques and allow you to better understand the medical and neuropsychological reports you may receive. Finally, this information should allow you to help parents and teachers understand what TBI is all about. You should attempt to add to these basic principles of neuroanatomy through additional readings and/or through neuroanatomy courses or workshops. For our purposes, the descriptions of the various neuroanatomical features will be confined to TBI as defined by the federal government and North Carolina specifically.

Info Box

The "terminology blues" — Unfortunately, when studying brain injury or neuropsychology, you will encounter myriad technical, medical, Latin, etc. terms which seem designed only to confuse newcomers to these topics. Please bear with this; things will become clearer! In the meantime, common aliases to some of these terms will be identified along with the technical terms to help prepare you for other readings. In addition, there is a Glossary in Appendix A.

Fundamental Neuroanatomical Features of the Brain

The brain of the average adult weighs approximately 1400 grams (about 3 pounds). If you were to put your palms together and then made two fists, this would approximate the size of your brain. Although it is possible for brain weight to vary in either direction by as much as 400 grams with no discernable difference in intellectual capacity.

Figure 1 shows the major neuroanatomical features of the brain and related areas of the central nervous system.

The brain is encased in the skull which helps to protect it against injury. Along with the skull, it is protected by three membranes called the **meninges**. The three membranes or layers are called the **dura mater**, the **arachnoid mater** and the **pia mater** (see Figure 2).

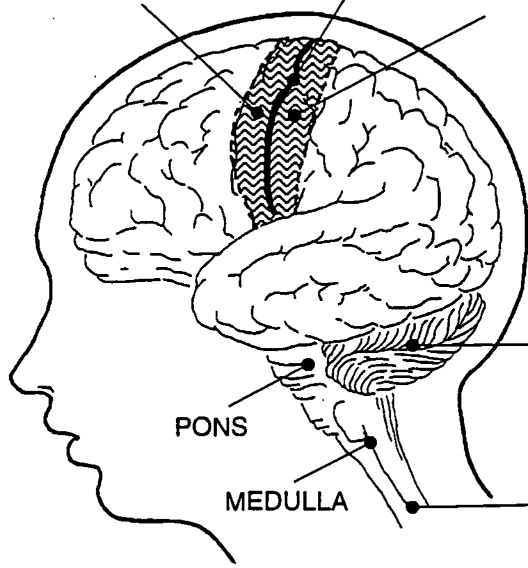

Figure 1.
Major neuroanatomical features of the brain.

There is a space between the arachnoid and pia layers of the meninges that is filled with a clear, colorless liquid composed mostly of water called **cerebrospinal fluid** (CSF). This fluid also acts as a protective buffer. The CFS also flows through four interconnected reservoirs

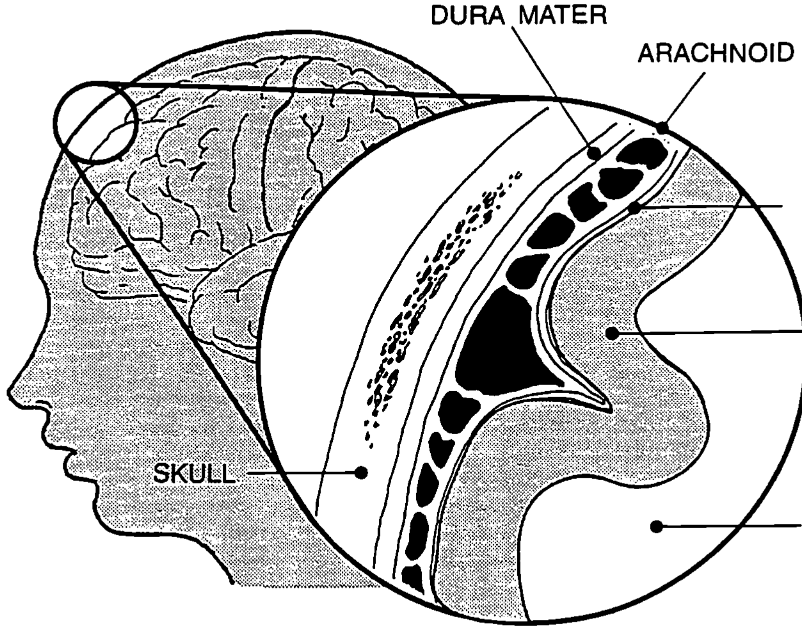

Figure 2.
The meninges of the brain.

called **ventricles** which produce, store, and help circulate the CSF (Walsh, 1992). The CFS is produced primarily by mechanisms within the lateral ventricles and is a precisely regulated, closed system. The CSF eventually drains off into the blood system.

Each brain has billions of **neurons**. This is an important concept in brain injury because destroyed neurons can never be replaced, unlike other somatic cells in our body that are able to reproduce if damaged, e.g. blood cells reproduce after blood loss, bones knit after being broken, etc. These neurons (also called nerve cells) specialize in receiving, transporting and generating messages. Each neuron has an **axon** and many **dendrites** (branches) which facilitate the sending and receiving of messages between the neurons. Neurons are the basic functional unit of the brain, signaling each other through **synaptic conduction** along neuronal "pathways" that allow for our complex cognitive and emotional functioning. These synapses are finely balanced and wonderfully orchestrated processes that can be disturbed by many factors, including brain trauma. A disruption anywhere along a neuronal pathway will affect the behavior served by the particular path (more on this later).

The brain has three major divisions: the **cerebral hemispheres,** the **brain stem,** and the **cerebellum** (see Figure 1). We will focus on the cerebral hemispheres. The hemispheres are basically mirror images of one another and are covered by a relatively thin layer of gray colored matter referred to as the **cortex** (Latin for *bark*) or **neocortex** (*new bark*). Within this cortical gray matter most of what we consider brain functioning occurs. The presence of a sophisticated cortex separates us from lower forms of life.

The surface of the cortex is intricately **convoluted** with hills (called **gyri**) and valleys (called **sulci**). We are not exactly sure why this has occurred, but the most logical theory is that the convolutions allow us to squeeze more cortical surface into our skull cavities. If the brain was blown up as you would a balloon to eliminate the convolutions it would resemble a large beach ball. The left and right hemispheres are connected by a dense band of fibers called the **corpus callosum.** The corpus callosum (also referred to as a commissure) allows the left and right hemisphere to communicate with one another.

Each hemisphere has four relatively distinct topical areas called **lobes,** the **occipital,** the **parietal,** the **temporal,** and the **frontal lobes** (see Figure 3).

Two noteworthy areas are located in narrow bands on both sides of the **central sulcus** called the motor and somatosensory strips (see Figure 1). The **motor strip** borders the posterior (rear) edge of the frontal lobes and is responsible for the primary control of the body's muscle systems. The **somatosensory strip,** located on the anterior (front) edge of the parietal lobe, is responsible for receiving tactile input from all parts of our body. There are

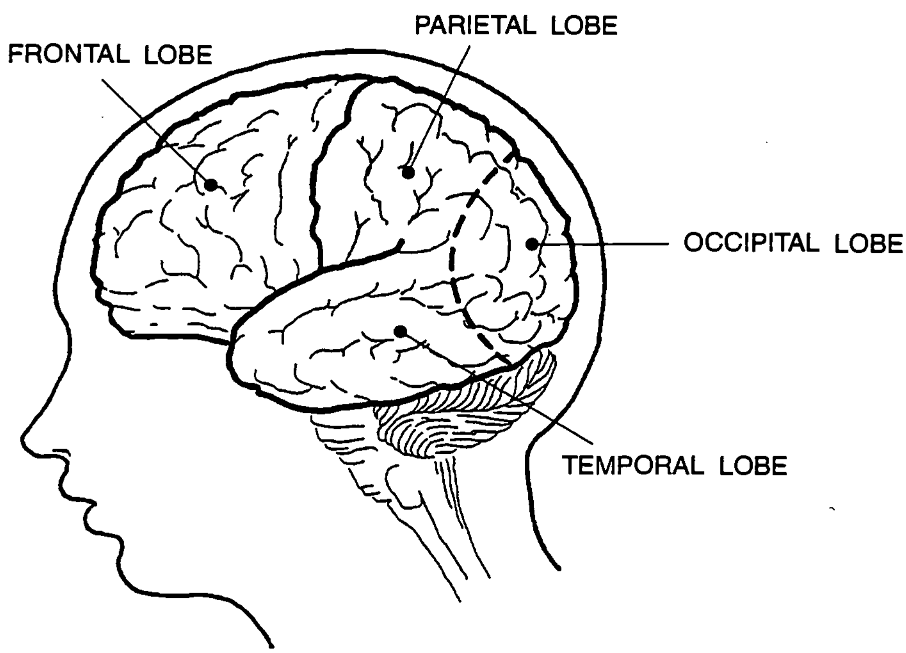

Figure 3.
The lobes of the brain.

specific points along each of these bands that correlate with movement (motor strip) and touch (somatosensory strip). We will discuss the lobes in more detail in a later section on brain-behavior relationships.

The Relationship of the Brain to the Central Nervous System

To get some perspective on how the brain interacts with the **central nervous system (CNS)**, consider the role it plays in the overall functioning of the CNS. The CNS is a term used to describe the system that stretches from the brain down through and including the spinal cord. There are several sections within this system (see Figure 1) that have separate and yet interrelated functions.

In terms of evolutionary development, the most recent part of the brain is the **cortex**. It houses all the higher cognitive and social-emotional functions attributed to humans. Relative to the other, older portions of the brain, the cortex has grown considerably more in size over the ages to accommodate the increasing complexity of our environment.

The cortex (also called cerebrum) sits on top of the next most recent evolutionary development, the **mid-brain** which contains the major portion of the **reticular activating system (RAS)** which has a primary role in maintaining a general arousal level in the brain. The mid-brain is situated on top of the **hind brain**, the next oldest evolutionary stage of CNS development. At this level we find the **pons** (Latin for *bridge*), **cerebellum** and **medulla oblongata** (see Figure 1). In general, the hind brain is responsible for many life-sustaining functions such as respiration, blood pressure, and heart beat.

The pons and cerebellum help to coordinate and "smooth out" muscle movement, and to help regulate motor impulses relayed from the cortex. The role of the cerebellum in cognition, if any, is unknown (Schmahmann, 1991). The medulla is best known as the site at which **decussation** occurs. Decussation is the place where the crossing over or intersection of sensory and motor fibers to the contralateral side of the brain occurs. It is decussation that permits one side of the brain to control motor movements on the other side of the body, e.g. right hemisphere injuries will affect motor movements on the left side of the body; however, it is not fully understood why this occurs.

The CNS is a wonderfully orchestrated system of interrelated

INFO BOX

Labels and location — The term used to describe an injury, tumor, disease, etc. of the brain will often be related to the location of the damage in the brain. As an example, meningitis is an infection of the cerebrospinal fluid with inflammation of the meninges, i.e. pia mater and arachnoid tissue and the subarachnoid (below the arachnoid) space. Meningiomas are tumors that grow entirely outside the brain within the layers of the meninges. Still other examples are hematomas (areas of bleeding in the brain) that are referred to by location, e.g. subdural hematoma (beneath the dura mater) and epidural hematoma (above the dura mater).

parts. It's safe to say that every function normally associated with the brain is the product of the interrelatedness of the entire CNS. Messages stream up and down along this system of neuronal pathways on a constant basis. Disruption — injury — to one part affects all others in some fashion. It is important to have some sense of the interrelatedness of this system to appreciate the functions of the brain, which is only one part of the central nervous system.

PRIMARY AND SECONDARY MEDICAL EFFECTS OF TBI

(Note. In this manual we will restrict our discussion of TBI to situations that would arise as a result of "external force" injuries in keeping with categorical definition of TBI. Please note that the mechanisms related to other "internal" causes such as strokes, tumors, etc. can be very different although the effects may be quite similar.)

As we see in Figure 1, the brain "floats" to some degree within the skull cavity, protected by the meninges and CSF. Over the course of our life we may bump our heads several times. Normally, our protective mechanisms do an excellent job of cushioning the brain against injury by these external forces. However, there are times when the head impacts with such force that these protective mechanisms are insufficient. There are primary and secondary effects that result from these external force traumas to the brain.

Primary Medical Effects

The primary effects of the initial insult in a TBI include damage to or **death of neurons**, **lacerations** (tears) in the surface of the cortex, and **contusions** (resembling bruises) on the surface of the brain. Secondary effects of TBI generally occur as a result of the primary effects. They include **hematomas** (lacerations in the vascular system of the brain), **cerebral edema** (swelling of the brain), **hydrocephalus** (excessive amounts of CSF in the ventricular system), **increased intercranial pressure** (build up of pressure due to hematomas, edema, and/or hydrocephalus), and **anoxia/hypoxia** (oxygen deprivation to the brain).

To understand the primary effects of TBI, let us discuss what actually happens in a TBI. The example shown in Figure 4 shows the typical mechanisms of brain injury in a situation where the head is striking an immovable object such as a dashboard or windshield in an automobile accident. This type of injury is called an **acceleration injury**. The "accelerating" head strikes the dashboard or windshield and stops abruptly on impact. Because it is "floating," however, the brain keeps going in the direction the head was traveling and crashes initially against the inside of the skull at the site of impact (see **coup** injury, Figure 4).

The brain then literally "bounces" back and strikes against the inside of the skull at a point opposite the initial impact site (see **contrecoup injury**, Figure 4). This bouncing can be a relatively straightforward, front-to-back, or side-to-side movement or it can involve a rotational movement (or both).

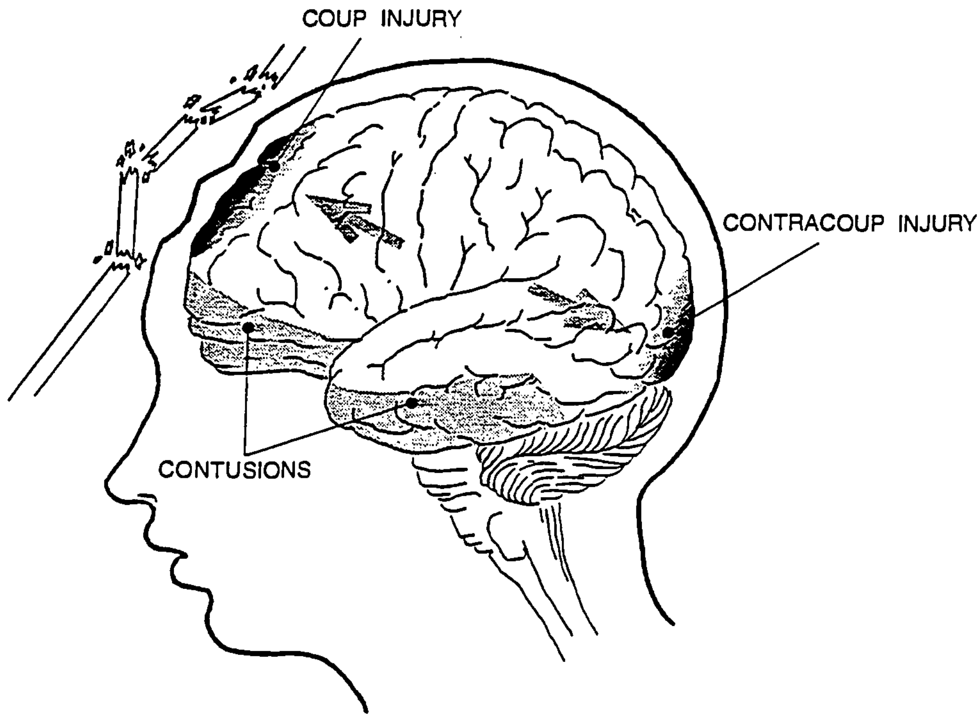

Figure 4.
Typical mechanisms of a traumatic brain injury.

A second type of external force injury is referred to as a **deceleration injury**. In these situations, the head is stationary and is struck by a moving object such as a baseball bat.

The inside of the skull is rough in many spots and the brain may suffer **contusions** or bruises (see Figure 4) from the bouncing and twisting movement within the skull even though the skull itself remains intact. Because they are situated close to the inside surface of the skull, the frontal and temporal lobes are particularly vulnerable to contusional damage (Silver, Yudofsky, & Hales, 1994).

Another, equally destructive but more subtle effect of TBI is referred to as **diffuse axonal injury**. This type of injury damages the brain at the cell level through a process called **shearing** which destroys and damages neurons (Silver et al., 1994). Diffuse axonal injury is usually not visible on neuroimaging techniques such as CAT and MRI scans. The diffuseness of the damage makes it particularly troublesome since many brain functions can be affected.

Contusions and diffuse axonal damage are characteristic of a class of brain injuries referred to as **closed head** injuries, the most common type of injury in children (Havey, 1995).

INFO BOX

Whiplash injuries — It should be noted that the head does not necessarily have to impact against an object. It is quite possible to injure the brain in a whiplash- type accident also. The effect is the same. The head accelerates then quickly decelerates (the whiplash) and the brain smashes against the inside of the skull in the same coup/contrecoup fashion. Whiplash accidents are often the cause of "mild" brain injury although moderate to severe brain injury can result as well.

Secondary Medical Effects

The secondary medical effects of TBI include hematomas, cerebral edema, hydrocephalus, increased intercranial pressure, and anoxia/hypoxia. Let us discuss each briefly.

Hematomas are pockets of blood in and around the brain and are named for their location in the brain. There are three major types based on location.

- **Epidural hematomas** are bleeds between the dura mater and the skull. Most epidural hematomas are associated with skull fractures (Ford & McLaurin, 1963).
- **Subdural hematomas** (bleeding beneath the dura mater) are a relatively frequent complication in childhood TBI (Silver et al., 1994). Subdural hematomas are also frequently seen in traumas such as child abuse (Menkes & Till, 1990).
- **Intercerebral hematomas** are found within the cerebral tissue itself. This type of hematoma is often the result of open head/penetrating injuries which include depressed skull fracture and/or deep shearing effects (Silver et al., 1994).

Cerebral edema is a term used to describe an increase in the total volume of water in the brain. In cases of moderate or severe injury, the brain and/or brain stem can swell also. This can be a serious, life threatening condition that can contribute to the diffuse damage mentioned earlier. The effects of this disruption in the distribution of the CSF usually evolves gradually within the first several hours following TBI (Silver et al. 1994).

As the brain swells, it is compressed against the inside of the skull causing damage. Since the brain is trapped inside the skull cavity, swelling must be stopped or **herniation** can occur. The brain tries to force its way down the hole in back of the skull called the **foreman magnum** (literally a "hole" in the skull in the occipital region) that the brain stem passes through. This type of herniation is usually fatal.

INFO BOX

Closed vs. open head injuries — Over 90% of major pediatric brain injuries are classified as closed head injuries (Silver et al., 1994). Although the skull remains intact, damage to the brain comes from compression against the inside of the skull, and stretching/shearing of neurons. In closed head injuries, the damage to the brain is often diffuse. Diffuse is a term used to describe damage that involves several areas of the brain due to such factors as the coup-contrecoup effects described earlier, "shearing" which describes widespread, microscopic damage to neurons, and/or anoxia/hypoxia (stopping or seriously reducing the flow of blood and oxygen to areas of the brain). Because of this widespread, diffuse damage, closed head TBIs often affect a wider range of cognitive, social-emotional and physical abilities than more focal brain injuries.

In "open head" injuries, the damage to the brain is usually more focal as in the case of a bullet or knife wound. These more focal, open head injuries will usually involve more discrete areas of the brain causing less diffuseness in the effects from the injury. However, there may be more severe damage to the specific area of the brain involved.

Hydrocephalus (many years ago called "water on the brain") is related to cerebral edema. The term describes a blockage that interferes with the normal absorption of the CSF into the blood system causing the build up of fluid which can displace the brain matter and cause atrophy (brain deterioration). One method of circumventing the effects of hydrocephalus is by a process called **shunting**. Shunts are essentially valves that allow the CSF to drain away from the brain, simulating the normal process and preventing CSF build up.

Increased intercranial pressure is a term used to describe the separate or collective effects hematomas, edema, and hydrocephalus may have on increasing the pressure within the skull cavity. Because the swelling brain (from any of these factors) has no place to go within the confines of the skull, the pressing of the brain against the inside of the skull can lead to such effects as reduced blood flow to the brain. This reduction in blood flow will eventually cause irreversible damage to nerve cells (neurons). There are devices, which look something like bolts, that are actually inserted into the skull to measure intercranial pressure (ICP). These readings provide valuable feedback as the physician attempts to reduce the intercranial pressure.

Hypoxia (sometimes called hypoxemia) occurs in over 30% of severe brain injuries and can occur as a result of injury to any component of the respiratory system (Silver et al., 1994). Hypoxia can also occur when there is damage to deep areas of the brain and brain stem controlling basic body mechanisms. Because of the diffuse effects, hypoxia is often particularly devastating to brain functioning, causing severe damage and widespread deficits.

INFO BOX

Shunting to relieve the effects of hydrocephalus — Disruptions in the normal flow and drainage of CSF can occur as a result of TBI. This condition, if not corrected, can cause a build-up in CSF volume which in turn can cause further brain damage. Since there is no place for the additional CSF to go inside the skull, the fluid build-up can cause the displacement of the brain and cause it to be pressed against the inside of the skull. There is also the possibility of brain herniation. In the case of the very young child, the fluid will occupy space the developing brain would normally occupy.

To relieve this condition, a valve (called a silastic valve) was developed in order to facilitate normal drainage of CSF and prevent fluid build-up. The valve is placed somewhere in the CSF system (often in a lateral ventricle) with a catheter (tube) draining the excess CSF into the jugular vein (called a ventriculoatrial shunt), or the peritoneum (called a ventriculoperitoneal shunt). In some situations, the shunt is placed in the lumbar area of the spinal cord, with the drain placed in the peritoneum. These are called lumbaroperitoneal shunts. (The peritoneum is the lining of the abdomen.)

Shunts are not without their own set of problems, however. They often have to be replaced in young children due to physical growth. At times there is infection at the shunt site. Many brain injured individuals will damage and dislodge shunts in falls. Nevertheless, shunts have saved many individuals from further brain damage.

Location and Severity of Damage as Factors

Location. The site of the brain injury is also an important consideration. This will be discussed in greater depth later, but for now consider that injuries to more important "functional" areas such as the language area of the left hemisphere can potentially have a more disastrous effect on the individual's overall cognitive functioning since language is so important to our everyday lives. While there are no "unimportant" areas of the brain, some cognitive functions may not appear to be as important as others. As an example, some injuries to the right hemisphere may have only subtle effects on academic functioning. Obviously, if the injury is diffuse, involving many areas of the brain (e.g., when the brain is deprived of oxygen), the effects can be widespread and catastrophic. If the injury is more focalized, as in the case of a penetrating injury, and affects a less obvious area of cognitive functioning, the effects may appear quite mild or even non-existent to the untrained eye. Therefore, if you have a case in which the survivor sustained a diffuse injury to the brain including the left hemisphere, and was in coma for 2 months, your expectations (and perhaps the focus of your assessment) should be very different from one in which the survivor suffered a gunshot wound to the right frontal lobe and never lost consciousness.

Severity. The typical classifications of severity used in TBI are mild, moderate, and severe. There is, however, no single universally accepted criteria for these classifications (Lehr, 1990). The most common criteria involves length of coma, as measured by the **Glasgow Coma Scale** (GCS) (Teasdale & Jennett, 1974), and the length of **post-traumatic amnesia** (PTA), the length of time that expires after the injury before the survivor begins to remember ongoing events.

The GCS was developed for adult brain injury patients to reliably judge the depth of unconsciousness. The GCS uses ongoing observations of three indices (eye opening, motor response, and verbal response) that are given a numerical score with 1 being the deepest level of unconsciousness. Using this scale, coma is defined as absence of eye movement, inability to obey commands, and failure to speak recognizable words. Although the GCS is useful in determining the depth of coma, it does not measure coma length. Total scores on the GCS range from 3, indicating no response to stimulus (deep coma) to 15, indicating no abnormalities in consciousness. Research with children suggests that scores of 3-8 indicate severe TBI, 9-12 indicate moderate TBI, and 13-15 suggest mild TBI (Broman & Michel, 1995). PTA is a bit more difficult to measure since it relies on the brain injury survivor's own account of when he/she regained functional memory. The **Galveston Orientation and Amnesia Test** (GOAT), which has met with mixed success, was developed to attempt to quantify this process (Levin, O'Donnell, & Grossman, 1979).

While these measures have been fairly reliable indices of severity with adults, their value in predicting child and adolescent severity is less encouraging. This appears to be particularly so with respect to PTA, which is also difficult to administer in adult populations. These difficulties led to the development of the **Children's Coma Scale** (CCS) (Raimmondi & Hirschauer, 1984) and the **Children's Orientation and Amnesia Scale** (COAT) (Ewing-Cobbs, Levin, Fletcher, Minor, & Eisenberg, 1989), as more child-appropriate counterparts to the GCS and GOAT. While it is useful to understand how these instruments are used, they are typically administered early in the recovery process, well before the survivor attempts to reenter school.

Sequence of Events After a TBI

It may help the newcomer to better understand TBI by providing some perspective on the events that immediately follow a TBI. Although there can be great variation from case to case, the following scenario is fairly typical of moderate to severe TBIs.

When a TBI occurs such as the one depicted in Figure 4, the survivor is usually transported to the emergency room (ER) of an acute care hospital or trauma center. (In cases of "mild" injury, however, the survivor may refuse to go to a hospital or an ambulance may not even be called.) The first course of action at the scene or in the hospital ER is to ensure basic medical stability. As an example, if the victim is unconscious and in respiratory distress, an airway needs to be created and a tracheotomy inserted to facilitate breathing.

In cases of moderate to severe TBI, the survivor may be hospitalized until he or she is stabilized medically. This stage of the recovery process is often referred to as the acute hospitalization stage, to differentiate it from the rehabilitation hospitalization stage. Once stabilized, the TBI survivor may be transferred to a rehabilitation hospital where he or she will receive a range of therapies according to the need. These therapies typically include physical and occupational therapy, neuropsychological evaluation, speech and hearing therapy, educational programming and counseling. Depending on his or her progress, the TBI survivor may return home with additional rehabilitation being provided by an outpatient therapy program or private therapists. In cases of extreme severity, such as those involving prolonged coma (also called persistent vegetative states), it may be necessary for the TBI survivor to be placed in a long-term care program similar to a nursing home.

The cases you will encounter will range from relatively mild TBI, where the survivor may have been sent home from the emergency room (if the individual went at all) to a scenario similar to that just described. It is unlikely that you will ever be involved in a case where the survivor is in a prolonged coma. Your school may receive TBI students directly after their injury, within a few months following the injury, or you may have TBI students transfer into your school district who were injured several years earlier. Before, or as soon after they arrive as possible, it is important to document what has transpired educationally and medically. It will save you time and prevent frustration on the part of the incoming TBI student and family.

TBI AND THE SCHOOLS

Prior to recent changes in federal regulations, students surviving TBI were not officially recognized as needing special education services. Some school systems, however, attempted to accommodate moderate or severe TBI survivors using other exceptional classifications such as Other Health Impaired (OHI), Specific Learning Disabled (SLD), or Mental Retardation (MR), (Walker, Easley-Bowman, Smith-Scott, & Luckhardt, 1987). With the signing of P.L.101-476, the Individuals with Disabilities Education Act (IDEA), in October of 1990, the definition of "children with disabilities" now includes children with traumatic brain injuries, making them eligible for consideration for special education services (Executive Order No. 34, 1991).

These legislative changes paved the way for the provision of appropriate services to students surviving TBI.

The Definition of TBI

The current definition of TBI as determined by the federal government is as follows:

> "Traumatic brain injury means an acquired injury to the brain caused by an external force, resulting in total or partial disability or psychosocial impairment, or both, that adversely affects a child's educational performance. The term applies to open or closed head injuries resulting in impairments in one or more areas, such as cognition; language; memory; attention; reasoning; abstract thinking; judgment; problem-solving; sensory, perceptual and motor abilities; psychosocial behavior; physical functions; information processing; and speech. The term does not apply to brain injuries that are congenital or degenerative, or brain injuries induced by birth trauma." (Individuals with Disabilities Act of 1990.) (Federal Register, Vol. 57, No. 189, Tuesday, 9/29/92, p.44802.)

It is interesting to note that the original draft version of the definition was considerably broader, and included internal causes such as brain tumors, circulatory disorders (e.g. strokes), seizure disorders, and diseases. However, as the decision-making process progressed, the definition was narrowed to include only those TBIs caused by an "...external force...," thus excluding any internal causes. The definition of TBI used by North Carolina is very similar to the current federal definition and is as follows:

> "Traumatic brain injury means an acquired open or closed head injury caused by an external force that impairs a student's cognitive, communicative, perceptual, behavioral, social-emotional, and/or physical abilities to the extent that the student requires special education. Congenital, degenerative, or brain injuries induced by birth trauma are not included in this definition." (Procedures Governing Programs and Services for Children with Special Needs, 1993 Edition, Exceptional Children Division, State Department of Public Instruction, Raleigh, North Carolina.)

While the North Carolina definition also excludes injuries other than those from an external force, it is recommended that students with non-traumatic injuries such as tumors, vascular/circulatory disorders, and degenerative diseases be considered for the same assessment procedures as outlined for acceptable TBI referrals.

Differences Between TBI and other Exceptional Students

In discussing the effects of TBI on the school-age child or adolescent, it will become obvious that there are many common problems shared with other exceptional students. There are significant differences in these students, however, that impact placement and programming.

1. To begin with, TBI differs from other categorical labels in that the cognitive, physical and emotional problems are the result of post-birth brain trauma. Other major categories, such as Learning Disabled or Mentally Handicapped are the result of heredity, pre-birth or birth trauma to the brain. Although this may seem an insignificant difference, there are far-reaching implications. Unlike those exceptional students with heredity or pre-birth etiologies, TBI students can remember how they used to function. This difference can contribute to significant social-emotional reactions including poor self-esteem, frustration, and depression.

2. The TBI student's performance can change dramatically over a short period of time, especially in the early stages of recovery. Programming and placement based on assessments made during this rapid recovery period will often be inappropriate and inadequate in a short time.

3. Test scores alone can often misrepresent the TBI student's actual abilities and prognosis. As an example, it is possible for a TBI student to achieve intellectual and standardized test scores suggesting learning disabilities or a mild mental handicap. However, they will also demonstrate pockets of preserved ability and unique sensory and motor problems not usually found in learning disabilities or mentally handicapped.

4. The TBI student's learning problems will often respond to different programming alternatives than students with permanent learning handicaps. As an example, certain types of memory may be preserved making it possible to stimulate learning with appropriate remedial compensations. On the other hand, TBI students may quickly regain old levels of cognitive ability but have significant difficulties learning new material at the same rate.

5. Emotional lability (mood swings) are a common phenomenon with TBI students. At times they may appear to be appropriate for placement in programs for emotionally handicapped students. As a general rule, however, this would be inappropriate since the behavior may be quite transient. The cause of the TBI student's behavior problems is injury to the brain. Remedial programs designed for students with psychiatrically-based behavior problems will not work adequately with the TBI student.

6. TBI students may show erratic rates of progress throughout their school career following TBI. This will demand closer monitoring of performance and more flexibility in reconceptualizing their remedial program.

7. Activity and arousal levels will be altered in TBI students also. Fatigue (a common effect of TBI) may hamper the TBI student's school reentry and performance. Activity levels will be erratic. Impulsive behaviors will be juxtaposed with slow processing, making it difficult for teachers to know when (and how) to intervene.

These are only a few of the differences between TBI students and other exceptional students. Others, unique to your particular TBI student, must also be addressed.

The Effects of TBI On School Performance

We can group the effects of TBI into three major categories: (a) medical, motor, and sensory effects, (b) cognitive effects, and (c) social-emotional effects. It should be noted, however, that what follows are the most common effects according to a survey of the existing literature. It is very possible, and indeed probable, that you will encounter problems in your TBI cases that do not appear in these lists. A widely held informal rule of thumb in working with brain injury is that there are no two cases alike. This is probably an overstatement, but worth noting nonetheless. After listing the more common effects in each category, some effects will be described more fully to give you a sense of the impact on the TBI student's functioning. It is important that you pursue other resources such as those listed in the references.

Medical, Motor, and Sensory Effects

The most common medical, motor and sensory effects of TBI include:

1. fine and gross motor problems, including:
   - reduced speed;
   - hemiplegia, hemiparesis;
   - hypotonicity, rigidity, spasticity;
   - ataxia, tremors; and
   - apraxia;
2. visual, auditory and tactile deficits;
3. fatigue;
4. seizures; and
5. headaches.

Each of these effects will be discussed in detail.

Motor problems. There are a wide variety of motor problems experienced by the student with TBI. Most motor effects seen in TBI survivors are due to damage to (a) the motor strip (located in the most posterior/rear portion of the frontal lobes), (b) the cerebellum, (c) the peripheral nervous system, or (d) some combination of the above. All of these motor problems have implications for school performance and should not be overlooked simply because there is no apparent direct link to cognitive or social-emotional school performance. As an example, **motor speed** is involved in many activities, sometimes in subtle ways. You may also see the reduced motor speed demonstrated during such activities as the timed subtests on the WISC III (Wechsler, 1991). Students with TBI may have difficulty moving quickly enough to avoid collisions in crowded halls, or to protect themselves from flying objects. They may have difficulty performing tasks that require coordinated movements. It is possible for the TBI student to "overshoot" in attempting eye-hand coordinated movements.

The motor effects of TBI can range in severity from total paralysis of large muscle groups of the body as in the case of **hemiplegia** (motor paralysis of one side of the body) and **hemiparesis** (motor weakness of one side of the body) to more subtle motor difficulties such as **tremors** and **apraxia.** Hemiplegia/hemiparesis can limit large muscle movements such as walking and may necessitate ambulation assistive devices, such as canes or wheelchairs.

Hypotonicity (loss/weakness of muscle tone), **hypertonicity** (rigidity in muscle tone), and **spasticity** (lack of coordination of muscle tone) can also result from TBI. These motor problems usually affect the coordination and smoothness of muscle movements. **Motor ataxia** involves a loss of ability to coordinate movements and gait, and usually affects a wide range of body movements including balance problems. Ataxia often is the result of damage to the motor strip in one hemisphere that causes disturbances in the coordination of movements on the contralateral side. However, the ataxic movements can be more widespread. Widespread ataxia usually indicates cerebellum or brain stem damage. Tremors in TBI students are usually caused by involuntary movements resulting from contractions (spasticity) of opposing muscles (Feenick & Judd, 1994).

Apraxia is more subtle than most motor problems since it involves the planning, organizing and actual carrying out of a sequence of motor movements, usually *on command.* A typical method of diagnosing apraxia is to ask the brain injury survivor to pantomime a task such as hair combing or pouring a cup of tea. The TBI survivor will either not be able to do this or will perform another task instead, believing that it is the one being asked for. Apraxia is often difficult to detect since the TBI survivor may be able to perform these tasks quite readily of his or her own volition. A lesser known and understood motor apraxia involves the production of speech (referred to as oral or verbal apraxia). **Oral apraxia** refers to difficulty coordinating and executing the motor movements of speech. Although most TBI survivors recover usable speech, some are left with a range of symptoms from **articulation** problems (also referred to as **dysarthria**), **phonatory weakness** (poor volume), and slow or rapid (cluttered speech) rate of speech (Savage & Wolcott, 1994).

Students with TBI can be very embarrassed by their motor deficits to the extent that school avoidance becomes a legitimate concern. To the lay person, TBI survivors often appear to be under the influence of alcohol or another drug due to their motor coordination problems.

Visual, auditory, and tactile problems. Of these three areas, visual effects appear to be the most frequent and problematic. Our visual system is widely spread across almost the entire brain, extending from the eyes themselves along the visual tracts in the brain all the way to the rearmost portion of the brain, the occipital lobes. Consequently, TBI frequently disturbs the visual processes in some way. It is somewhat rare, however, for the TBI survivor to be blinded as a result of the injury. It is more typical that the visual deficits will range from subtle, yet annoying difficulties such as **double vision (diplopia)** or blurriness to **visual field cuts (hemianopsia).**

Field **cuts** can be quite complex, but generally they involve defective vision or blindness in one half (hemianopsia) or one quarter (quadrantopsia) of the visual field of both eyes. They often involve "blind spots" to the extreme left or right visual field such that the student neglects tasks placed in those areas or doesn't seem aware of objects in the field cut area. Field cuts often go undetected until the survivor begins bumping into walls, objects, etc. to one side or the other, or neglects items such as cards on the Wechsler Picture Arrangement subtest that have been placed to the extreme left or right. There can be many varieties of hemianopsia, too numerous to deal with in-depth in this manual. You should be aware that these unusual visual deficits can exist and often go undetected.

The incidence of auditory and tactile problems following pediatric TBI is not well documented, although Jennett and Bond (1975) reported partial loss of hearing in more than one-half of adult TBI survivors. Auditory and auditory perception problems are usually subsumed under communication problems. Tactile deficits, although diagnostically significant (suggesting damage to the somatosensory strip) are not typically assessed due to their apparent lack of relevance for school programming. Both these areas need more research to determine their true effects on school performance.

Fatigue. One the most common and troublesome effects of TBI to parents and teachers, and perhaps the least well understood by professionals, is fatigue (Feenick & Judd, 1994; Levin & Eisenberg, 1979; Hinkeldey & Corrigan, 1990). TBI students tire more easily probably due to the tremendous effort necessary to perform tasks that were automatic for them prior to their injury (Silver et al., 1994). It is not uncommon for TBI students to require shortened days when first attempting school reentry in order to accommodate their need for rest or afternoon naps. Fatigue can be very disruptive to the school schedule and requires considerable patience on the part of all concerned, many of whom believe this behavior is just laziness.

Seizures. Another medical condition common to TBI is seizures. In general, the presence of a seizure disorder following TBI suggests a poorer prognosis than if the survivor is seizure free. Why one TBI survivor develops seizures following injury and another does not is not clear. However, the incidence of seizures accompanying brain injury is so high it is not uncommon to find that the TBI student has been put on anti-seizure medication prophylactically during acute hospitalization or in the emergency room just after the injury.

The incidence of seizures following TBI appears to be higher in children than adults (Silver et al., 1994). The risk for seizures increases twofold if there is penetration of the dura (as in the case of a depressed skull fracture) and if the patient had more than 24 hours of posttraumatic amnesia (PTA) (Silver et al., 1994). The incidence of developing seizures after penetrating, open head injury varies from 28%-50% (Salazar, Jabbari, & Vance, 1985).

Apart from the effects of the injury itself that led to the seizure disorder, other factors related to seizures that affect cognition and social-emotional functioning include the effects (if any) of the anti-seizure medication the TBI survivor has been placed on, and the increasing damage the seizures themselves can have on the brain. Very often anti-seizure medications will have side effects that can contribute to the survivor's cognitive difficulties (Trimble, 1987). Problems such as cognitive "blunting," a term that is used to refer to slowed processing and/or lethargy, can accompany many of the medications. With some TBI survivors, it is very difficult to find the proper medication and/or dosage to ameliorate the seizure disorder. Several different drugs will be attempted before the most effective one is discovered. It is wise

Case Notes

SEIZURE DISORDERS AND TBI — ***Anne, a teenage TBI survivor who was five years post-injury, continued to have social-emotional difficulties that deprived her of an adequate social life. Individual counseling was arranged. During a counseling session the therapist noticed a curious look on her face and the fact that she seemed detached from the conversation; yet Anne was still able to respond to questioning. Upon further investigation, she volunteered that she had these "spells" fairly often and they seemed to occur at times when she felt very agitated and argumentative. Past EEG workups had not identified a seizure disorder. However, a more thorough, sleep deprived EEG evaluation revealed the presence of a subtle seizure disorder requiring medication. After some experimentation to find the best medication and to set the appropriate dosage level, Anne's seizures were significantly reduced in number and intensity. The reduction of her "spells" helped Anne to feel more comfortable engaging in social situations.***

to study the medication used by your TBI students in order to anticipate possible side effects.

In some cases, the seizures do not begin until a considerable period of time after the injury, sometimes as much as a year or two after. Generally speaking, these seizures are more problematic and pervasive than those which occur at the time of or directly after the injury.

There are many social-emotional effects that accompany seizure disorders. The general public is often very insensitive to this disorder and there are many distorted beliefs about seizure disorders. It will be important for you to learn about seizures and the medications used to control them in order to help other school personnel and parents to deal with seizures.

It is not uncommon for the seizure disorder, particularly the more subtle forms of the disorder such as absence (petit mal) seizures, to go undiagnosed for a long period. In general, if there has been an insult to the brain it is important to rule out the presence of a seizure disorder. Careful history taking and review of the medical records can be very helpful.

An important thing to glean from this scenario is not only to be aware of the high incidence of seizure activity following TBI, but that there can be a wide variation in the manifestations of the seizure disorder as well, making detection difficult. Some can be extremely subtle, as in this case.

Headaches. Research suggests that one of the most pervasive physical problems following brain injury is recurring headaches (Broman & Michel, 1995; Adams & Victor, 1985). In one study, over 45 percent of TBI survivors with postconcussion syndrome were still complaining of headaches three months after their injury. There are numerous theories regarding the exact etiology of headaches in TBI survivors. You should regard headaches as a common occurrence in the TBI students you will work with regardless of whether or not they have specific complaints. Further, be aware that these headaches can seriously disrupt their lives and the lives of those with whom they must interact.

Cognitive Effects

Generally speaking, when we think of the problems encountered by the typical TBI student, we think first of the many cognitive effects associated with TBI. Assessing and providing remedial plans to accommodate cognitive problems represents an area of strength for school psychologists. However, many of the more common effects of TBI involve areas of cognitive functioning that school psychologists do not routinely assess in their evaluations.

The most common cognitive effects of TBI include impairments in:

1. memory and learning (especially new learning);
2. attention;
3. communication (speech and language);
4. judgment and reasoning;
5. mental processing rate;
6. visuoperception/visuoconstruction;
7. orientation;
8. abstract thinking; and
9. planning and organization.

Memory and learning. In terms of cognitive effects, memory disorders are the most common and persistent consequences of TBI (Levin, 1985; Havey, 1995). This appears to be true regardless of the nature, extent or location of the injury and is particularly true of memory involved in new learning. It is not uncommon for TBI survivors to perform on cognitive/intellectual testing at levels very similar to their pre-injury levels, particularly on tasks requiring "old," overlearned material, such as the Verbal Scale of the Wechsler. Much of the demand on the Wechsler Verbal Scale involves memory for "old," overlearned material. On the Performance Scale which has many timed, novel tasks, however, the same student's performance can be significantly lower than their preinjury performance levels. The Wechsler Performance Scale primarily taps new learning, and penalizes TBI students with slowed processing.

Interpreting a Wechsler Full Scale IQ score without recognizing these subtle differences can cause school personnel to assume *incorrectly* that the injury has not had a significant effect on the student's verbal abilities. More importantly, because of the student's difficulty with new learning, it is likely that he or she will not be able to progress at the same rate as prior to the injury. It is not uncommon for the performance of the TBI student to appear to drop as time passes. However, the drop in performance is due to the fact that they are unable to keep up with the increasing demands of standardized testing which has norms based on age. The TBI students have not been able to meet the sequential "new learning" demands of the test. Their non-TBI classmates are progressing normally while they are falling further behind.

School-age children and adolescents with TBI who are attempting to return to school are at a greater disadvantage than adults trying to return to former jobs because of the new learning demands of school. Unlike the adult, they are continually faced with situations at school that emphasize these weakness in new learning.

Attention. A closely aligned factor to memory is attention/concentration, which in some researchers' eyes is the first step in the memory process. A simplistic overview of the role of attention in the memory process is as follows:

Attention —> Short-term memory (working memory) —> Long-term memory

One needs to attend to a stimulus first before it can be memorized. The stimulus then enters the short-term memory (often referred to as working memory) holds the material to be memorized long enough to organize it in order for the memories to enter long-term memory. Once lodged in the long-term memory, the cycle is completed when the memory is retrieved.

There are many components to attention, including such factors as the **span of attention, selective attention, inhibition,** and **scanning.** TBI students have great difficulties attending to tasks in situations with even minor distraction. When interviewed, these students will readily volunteer this information. It is often one of the first complaints about changes they perceive after their TBI. They will often comment that before their injury, they used to be able to do their homework, listen to music and watch TV all at the same time. Now they complain that they can only focus on one thing at a time and then in circumstances with no distractions.

If you are interested in learning more about attention there are many excellent resources (see references). For our purposes it is enough to know that attention, along with memory are two of the relatively few effects that appear to be very common among TBI students. It is wise to assume that, until proven otherwise, these functions will be compromised in your TBI students.

Communication (speech and language). Perhaps the most disabling problems encountered by TBI survivors are language and communication. Disturbances in language and communication have been noted in up to 85% of individuals following TBI (Groher, 1977). It is usually the first area targeted for cognitive intervention in the rehabilitation setting. Communication problems vary widely.

Often, TBI survivors will lose the ability to speak for a period of time, or their speech will be very weak. This may be due to the injury itself which can affect the vocal cords or to the prolonged use of a traechiotomy (a device to facilitate breathing). Permanent loss of speech is relatively rare (see earlier description of oral apraxia) and is more likely to result from severe damage to the area of the brain that facilitates the motor production of speech, i.e. Broca's area. (More on Broca later.)

Language is made up of many components. Receptive, expressive, oral, written, and non-verbal language are just a few components that comprise the totality of our ability to communicate through language. In addition, these functions are served by many separate, yet interrelated areas of the brain. In brain injury, it seems almost certain that one or more of these components will be disrupted for some period of time. The amount of disruption will depend on the severity and site of the injury. It is clear, however, that damage to any one of these components can alter our ability to communicate effectively.

It is likely that the TBI students attempting to reenter school will possess subtle difficulties in communication, such as comprehending auditory instructions. This will be particularly true when the instructions are rapid and/or there are distractions in the environment. This type of processing deficit is often associated with damage to an area of the left temporal-parietal lobe referred to as Wernicke's area (more on Wernicke later).

Word finding (also called word retrieval) problems are a subtle form of memory disorder that can seriously affect spontaneous language. This disorder can lead to frustration and stress which further exacerbate the condition. Written communication can also be affected by word-finding difficulties. In addition, written language can be affected by subtle motor deficits that force the TBI student to focus so intently on the production of writing that he or she will lose track of or seriously shorten written communication.

Judgment and reasoning. We seem to know less about what contributes to the poor judgment and reasoning we see in TBI survivors than other cognitive problems. We have fewer formal ways to measure these characteristics and they are particularly difficult to remediate. Reasoning and judgment are very complex behaviors. They require organization of data, remembering consequences from past similar situations, and they require reflecting over alternative responses in your mind before responding. These are all memory, impulse control, and abstract thinking skills that are commonly compromised in TBI students. Deficits of the type mentioned are often the result of damage to the frontal lobes. Regardless of causation, poor judgment and reasoning can be particularly disruptive to the student, school personnel, and the family. (See the case example on following page.)

Students recovering from TBI often go through a period when judgment will be questionable. This should be expected, and close monitoring and understanding that it is often not within their power to make sound judgments is important. This type of understanding and explanation can help school personnel separate the behavior from the student.

Mental processing rate. One of the more frustrating effects of TBI for both the survivor and teacher is slow mental processing. This, again, is a fairly common effect of brain trauma and one that is not well understood. An analogy might be helpful. Imagine an intricate circuit board controlling the functioning of a computer. Then imagine taking the board and cracking it in several places. This cracking would damage some of the connections and completely destroy others. The effect would be to slow down or eliminate some of the functions of the computer. This is comparable to what happens in the brain. Many widely distributed "circuits" are destroyed or damaged.

Slow mental processing is characteristic of diffuse brain damage regardless of etiology (Lezak, 1995). Neuronal synapses are damaged or destroyed, and the brain's processing slows down. The manifestations (slowing) of this type of injury are also widely distributed across many cognitive and motor functions. As an example, TBI students often do poorly on timed tests at least in part due to slow processing. They simply can't think as fast as they used to.

This slowed processing rate also limits the amount of information the TBI student can attend to and organize. We will discuss this in more depth later in the manual, but keep in mind that the neurons of the TBI student's brain has been damaged in a way that slows down synapses and thus information processing. Finally, it should be noted that this slowed processing can be just as frustrating for the survivor as it may be for the teacher and family.

__Visuoperception/visuoconstruction.__ The range of possible problems within this category is extensive in concert with the many areas of the brain contributing to our visual, perceptual and construction processes. The range of problems includes the inability to recognize information coming from a particular sensory modality (e.g. recognizing familiar objects), visual analysis and synthesis, visual organization, scanning, facial recognition, and drawing and/or assembling (construction) skills (Parker, 1990).

Visuoperceptual and/or visuoconstruction deficits can often be very subtle. Because these abilities are not in as much demand as verbal/language skills in the school setting, they often go unnoticed. Students recovering from TBI can manifest these deficits in several ways. Often, they will have difficulty on written assignments. This may not appear in the graphic representation of their writing, but may instead show up in weak story construction or organization. One theory is that these students have to exert so much effort with the motor demands of writing due to visuoconstruction deficits that the content of the writing assignment may be lost.

> **Case Notes**
>
> **POOR JUDGMENT AND REASONING** — ***Mike, a high school student reentering school after surviving a TBI, appeared to be making a successful adjustment to school but began to "hang" with a crowd of trouble-making students. Because of poor judgment and reasoning due to his brain injury, Mike was easily led by these students who convinced him to participate in several episodes of acting-out behavior, often using him as the scapegoat. Prior to his injury, Mike was doing well in school and was not a behavior problem. Clearly, he would not have succumbed to the prompting of members of the troublesome group nor would he have associated with them at all. It was important to convince the school staff that this was uncharacteristic behavior for Mike and a new plan consisting of counseling and more structure for his free time at school was developed.***

Visuoperception and construction weaknesses can lead to subtle mistakes in subject areas such as math as well. TBI students may misalign numbers in a simple addition, subtraction or multiplication stage of a more complex problem causing an incorrect answer while, in fact, the overall math procedures were correctly done.

Spatial disorientation, one of the components of visuoperception, refers to the inability to relate to the position, direction, or movements of objects in space (Lezak, 1995). These deficits appear to be related to damage in different areas of the brain and they can affect many functions (McCarthy & Warrington, 1990). Deficits in spatial orientation are related to visual scanning and can impair distance judgment, left-right orientation, and spatial memory as well (Lezak, 1995).

__Orientation.__ Orientation, or our awareness of ourselves in relation to our surroundings, involves "...consistent and reliable integration of attention, perception, and memory." (Lezak, 1995). Deficits in orientation are most often seen in the early stages of recovery and/or immediately after the brain injury. Early in the recovery process, TBI survivors will exhibit a good deal of "fogginess" regarding who they are, where they are, and what day, month, or year it is. This is typically referred to in medical and/or rehabilitation records in the following manner: "The patient was oriented times three" (meaning person, place and time). In general, orientation problems are resolved over time, often well before returning to school. There are, however, disorientation problems which are more long term or even permanent. As an example, chronic spatial disorientation can inhibit the student's travel around the school building or prohibit driving. He or she will tend to get lost easily in unfamiliar surroundings, particularly when there is a fair amount of commotion such as during change of classes, or at recess or lunch. It is important to attend to this situation early. One method is to assign another trustworthy student to help the TBI student negotiate the school environment. This is particularly important in large schools, e.g. campus-type high schools.

Abstract thinking. The capacity for abstract thinking is often reduced after TBI. Abstract thought requires multistep, analytic processing skills that are associated with the frontal lobes. As mentioned earlier, these lobes are particularly vulnerable to brain damage. Students surviving a TBI will often become very concrete and inflexible in their thinking, seemingly unable to move from linear thought to higher level sequential or analytic thinking. Abstract thinking problems are difficult to measure and remediate due to their complexity. An effective way to measure and intervene with problems of abstract thought is to consider it an amalgam of many sub-components, each of which can be addressed and remediated individually.

Planning and organization. As you will see in later chapters, part of the brain functions primarily as a sensory input mechanism (vision, hearing, touch, etc.) while the remainder organizes the input and plans the appropriate response. The part of the brain primarily responsible for organizing and executing these plans is the frontal lobes.

Organization and planning are critical to academic success and impact a wide variety of functional areas. As an example, organizing material properly can affect the amount of information you can memorize and how long you will be able to retain it. Conversations and written assignments may be loosely woven or tangential because of organizational difficulties (Savage & Wolcott, 1994). A TBI student may have great difficulty organizing notes taken in class and in preparing for exams.

Social-Emotional Effects

Research evidence supports changes in the child's personality due to brain trauma (Levin & Eisenberg, 1979). Children with neurological impairment have been found to be six times more likely to experience behavior disorders than non-impaired children (Dean, 1986). In terms of school programming, the medical, motor, and sensory effects of TBI can be accommodated relatively easily by most school personnel. The same is true for cognitive/intellectual problems. Students with cognitive difficulties, or significant physical handicapping conditions, are regular occurrences within a school system. Social-emotional problems, however, represent an area in which teachers and parents feel particularly inept. These problems are the most difficult to tolerate within the school setting, and they are the most difficult to remediate. It should not be surprising that social-emotional problems resulting from TBI are also the least well understood by brain injury professionals. One reason for our difficulties in dealing with social-emotional problems in TBI students is that there is great variability in theses symptoms and there is no consistent picture or syndrome among TBI survivors (Boll, 1983).

Generally speaking, there are relatively few research studies devoted to these problems even though they are the most troublesome of the TBI student's profile of problem areas (Bond, 1975; Brooks, 1984; Lezak, 1987; Oddy, 1984). As an example, counseling is very often needed by TBI students for several reasons, yet it is rarely incorporated into the TBI student's IEP.

The social-emotional/behavioral effects that follow are those most commonly seen, keeping in mind the wide variation in presenting symptoms in TBI students:

1. behavioral control problems(disinhibition/impulsivity);
2. poor self-esteem/self-image;
3. mood disorders (lability, apathy, social withdrawal/indifference, depression);
4. denial of disability;
5. anxiety disorder;
6. inappropriate social/sexual behavior; and
7. aggressive, agitated behavior.

Behavioral control problems (disinhibition/impulsivity). Many of the behavior problems demonstrated by TBI students stem from reduced emotional control often associated with damage to the brain's overarousal and underarousal systems (Lehr, 1990). The controls for our arousal systems are primarily found in the frontal lobes, particularly the orbitofrontal surfaces, a region low on the anterior (front) portion of the frontal lobe just behind the eyes (Gualtieri, 1991; Mattson & Levin, 1990). As discussed earlier, the frontal lobes are particularly vulnerable to injury in a TBI, thus a high percentage of survivors will present with a frontal lobe symptom profile, including impulse control problems.

Students recovering from TBI can be very disinhibited in their interactions with peers and school staff. It would not be uncommon for these students to act out in a socially inappropriate or sexually provocative manner. Even though those around them perceive their behavior as socially improper, judgment problems may cause the TBI student to fail to see the inappropriateness of his or her actions.

Poor self-esteem/self-image. Interestingly, relatively little research has been devoted to changes in self-esteem or self-image as a result of TBI. When one understands the changes that come about in the student's status due to the brain injury, e.g. changes in self-identity, short-term memory impairments, disorientation, and physical disabilities, the potential impact on self-esteem/image becomes clearer (Silver et al., 1994).

Mood disorders (depression, apathy, social withdrawal). One of the most frequent emotional complaints of TBI survivors is depression. Depression may be a related to the severity of the cognitive and physical effects of TBI (Silver et al., 1994). Location of injury may also be a factor. TBI students with right hemisphere damage (both anterior and posterior) often demonstrate depressive symptoms.

The apathy and motivation problems often seen in TBI survivors are also considered to be a manifestation of depression. These symptoms have been shown to be associated with frontal lobe damage in TBI (Savage & Wolcott, 1994).

TBI students often manifest withdrawal in response to the cognitive and physical losses they have experienced. Remediating this withdrawal may be particularly tricky, since it may be playing some part in coping with the tremendous emotional impact the TBI has brought (Parker, 1990).

There is also a high degree of lability in the post-injury, social-emotional behavior of TBI students. These students may display intermittent episodes of depression and mania. It is not uncommon for TBI students to display crying and laughing behaviors in the same conversation. There also appears to be an association between post-injury manic syndrome and the development of a seizure disorder from the TBI (Shukla, Cook, & Mukherjee, et al., 1987). More studies need to be done in the area of mood disorders related to TBI in children.

Denial of disability. Denial in survivors of TBI ranges from physiological unawareness (e.g. visuoperceptual problems) of deficits to refusal to understand the severity or limitations of impairments. It is not clear what role denial plays in the TBI survivor's coping mechanisms. Thus, attempts to confront denial aggressively should be carefully thought out for fear of inducing even more severe reactions to the injury (Parker, 1990).

Family members can also demonstrate denial. They may insist that there is no change in their child in spite of overwhelmingly obvious evidence to the contrary (Lehr, 1990). One gets the impression of a desperate attempt to ignore the obvious in the hopes it might just "go away." Personal experience suggests that the family denial may be greater than the survivor's and may impose added pressure on the TBI student to perform as he or she once did. It is not uncommon for the parents to encourage returning to school too early or taking on too much academically when they do return. Parents appear to be searching for some sort of "benchmark" of a return to normalcy, although this behavior may also be due to the failure of professionals to state for certain when the child should reenter.

Denial may not be an accurate term. To deny the existence of something suggests you are aware of what it is you're denying. It may be more accurate and helpful to think of the denial in TBI survivors as unawareness. Denial may be a more accurate term for what the family members of the TBI survivor may be experiencing. Parents have been deluged with doomsday messages from various professionals. It is the responsibility of the school professionals to establish some structure in these circumstances if for no other reason than to avoid reentering the child too soon and risking failure.

Anxiety-type disorders. Silver et al. (1994), presents a compilation of 12 studies which revealed that approximately 29% of adult TBI survivors were diagnosed with some form of anxiety disorder although there was wide variability in the study populations with regard to age, severity and type of injury. While most of the formal anxiety disorders would not apply to young children, there are behavioral manifestations in children that can be related to the increased anxiety brought on by TBI. Childhood behavior problems such as ADD/ADHD, school phobia, elimination disorders, tic disorders, etc. can be caused or exacerbated by the anxiety induced by a TBI. In the case of the older child or adolescent, full blown anxiety disorders such as panic attacks, phobias, and posttraumatic stress disorders are very possible, although there is limited research in this area.

Inappropriate social/sexual behavior. These behaviors are listed separately due to the importance they play in the eyes of parents and teachers. However, they are closely related to the aforementioned impulse control problems, poor judgment, and reasoning. There are subtle factors that also cause them to stand alone. Included in the concerns TBI survivors have about their future and their functioning in general is sexuality. Consider also that the greatest incidence of TBI occurs in males between the ages of 15 and 24, when sexuality concerns would be at a peak in most non-injured individuals as well. While much of this sexual acting out behavior can be directly linked to the loosening of impulse controls, there is also the possibility that the TBI survivor may be overcompensating in his or her attempt to cope with sexual concerns (Lehr, 1990; Lezak, 1987). Often, the TBI survivor's self image is low and he or she will use sexuality as a tool to foster greater social accceptance or prowess.

Aggressive, agitated behavior. In a study comparing brain-injured and non-injured children, brain-injured children displayed significantly higher aggression scores than non-injured children as rated by parents and teachers (Bijur & Haslum, 1995). As we will see several times throughout this manual, having knowledge of the TBI student's preinjury (premorbid) cognitive and behavioral status is extremely important. In the case of aggression, for example, the injury to the brain can release through disinhibition previously inhibited aggression (Broman & Michel, 1995).

As the TBI survivor emerges from the fog and confusion surrounding the early stages of recovery, a state of agitation can ensue. Labile behavior and excesses in behavior are common during this period also (Lehr, 1990). If the child or adolescent has been in a prolonged coma, agitation is viewed as a positive sign of an end to the comatose state by professionals. For parents, however, the agitation presents some confusion since they often assume their child will come out of the coma and be himself or herself immediately. Unfortunately, this assumption is often encouraged by movies and television. This early recovery stage of agitation usually abates fairly quickly; however, the confusion that spawned the agitation may continue for a prolonged period. The agitation that appears in the TBI student attempting to reenter school may be related to this confusion but may also simply be frustration over the differences in themselves they may be seeing for the first time.

Factors that Contribute to Social-Emotional Problems in TBI Students

There are several factors which contribute to or exacerbate the social-emotional problems exhibited by students with TBI. Some of these are listed below:

1. increasing awareness of deficits;
2. comparisons to premorbid (preinjury) levels;
3. poor understanding of TBI and the recovery process;
4. pessimistic predictions from professionals;
5. loss of significant relationship;
6. premature return to school;

7. tendency to "use" disabilities; and
8. substance abuse.

Increasing awareness of deficits. One of the most dramatic differences between TBI students and other exceptional students is that TBI survivors usually remember what they used to be like. As the initial confusion and fogginess begin to clear, the TBI student sees these differences increasingly. This and the fact that they are being confronted with their deficits on a daily basis in the school setting, contribute to high levels of frustration, depression and self-image problems. They are continually being asked to do things that they once did with ease, but are now difficult.

Comparisons to premorbid performance levels. This factor is related to increasing awareness of deficits. Family members, friends and teachers inadvertently make comparisons with past performance, or perhaps do so in an attempt to encourage greater effort on the part of the TBI student. These reminders, however, serve to heighten frustration and feelings of low self-esteem. In addition, they put unwanted pressure on the student to perform as they once did causing even more anxiety.

Poor understanding of TBI and the recovery process. Often, when working with TBI survivors and their families, it is not unusual to find they have never had their injury explained to them nor have they been given very much information on what to expect regarding recovery. Without such information, inaccurate expectations abound.

Much of what non-professionals know about TBI comes from movies and television. People are portrayed as being knocked unconscious and simply "bouncing back up again," or they emerge from coma and immediately resume pre-coma levels of functioning. Unfortunately, these results are rarely seen in the real world. Perhaps one of the most important roles you will play is to create accurate expectations for your TBI students and their families.

Pessimistic predictions from professionals. As mentioned earlier, TBI is a relatively new phenomenon. We need to appreciate the fact that professionals as well as non-professionals still have relatively little knowledge of TBI and the recovery process, particularly in children and adolescents. Understanding this situation puts into perspective the fact that it is not uncommon for physicians in an emergency room to overlook the possibility of cognitive or social-emotional deficits after an accident when there are multiple physical injuries or life threatening concerns; or if the injury appears to be "minor."

The lack of knowledge and predictability regarding TBI appears to contribute to a range of responses from professionals, from overlooking significant effects of brain trauma to very dire and pessimistic predictions. Many family members have informed me that they were told their loved one was going to die or remain in a vegetative state if he or she survived, only to see recovery to the point that their child was able to once again enter school. This lack of knowledge contributes significantly to the anxiety levels of both the survivors and their support network. They often complain of having trouble "getting a straight answer."

Loss of significant relationships. In the initial stages of the recovery of the TBI survivor, the support group (i.e. family and friends) plays a significant role. As the recovery progresses, however, it is not uncommon for friends to gradually drift off and go on with their own lives.

This is particularly true in the more severe cases where deficits will almost completely change the survivor's looks, personality and cognitive level. In these cases, the survivor truly becomes a different person in the eyes of friends and relatives.

There appear to be at least two significant factors to consider with respect to the maintenance of friendships after TBI. The first involves the reduced ability of the TBI survivor to do the things it takes to maintain friendships. While it's true that they often do not look and act the same, survivors often lose the social sensitivity and skill necessary to maintain relationships. The second factor involves the confused feelings friends have for someone who may now be very different than the friend they once knew and who may be, in addition, disabled (Lehr, 1990).

Close family members will continue to support the survivor. But even here there may be significant conflict. One family member (typically the mother) will take on primary care responsibilities, in some cases too much responsibility. Other family members, e.g. the husband, siblings, begin to feel left out. In the rehabilitation profession it is often said that TBI "makes or breaks" the family and friends support system, and all too often there is a breakdown. As friends drift away, the TBI student feels abandoned and has no outlet for socialization. He or she will spend long periods alone, watching television, etc., with little or no stimulation.

Premature return to school. Premature return to school often sets the TBI student up for failure, leading to increased frustration, poor self-image, and acting out. Admittedly, judging when and under what circumstances the student should reenter is something of an art form. A general rule of thumb, however, is to start off very slowly building the number of classes or time at school gradually, and only after seeing that the previous level of involvement was well tolerated.

It is important for the TBI student to experience success early in the school reentry process. It is far better to err on the side of conservatism. It's safe to say that there will be great pressure from all sides. The family, the student, and perhaps the school may contribute to reenter TBI students prematurely. You must convince all parties to start reentry at the right time and at the right pace. It is not unusual to start TBI students with as little as one hour a day, and sometimes this is too much! Often, it is necessary to begin the reentry process with a period of home school tutoring.

Tendency to "use" disabilities. Although a relatively rare occurrence, there is a tendency for some TBI survivors to use their disabilities to escape responsibility. The reasons for this are complex but it seems certain that poor judgment and reasoning enter into the picture. Keep in mind that they are often acting at a very concrete level and cannot truly understand the subtleties of their situation. Often, these TBI students fail to see the inappropriateness of this form of manipulation. It is also very possible that some students were somewhat manipulative before their injury, and as we learned earlier, TBI tends to exacerbate premorbid behavior patterns.

Substance abuse. The incidence of substance abuse is unusually high in TBI survivors. Several factors seem to be operating to contribute to this phenomenon. It is possible that TBI students who became substance abusers after their injury were abusing before their injury. Perhaps the abuse was involved somehow in the injury itself, as in the case of drinking while driving.

In addition, judgment is poor and controls are weak in many TBI survivors, which makes them very vulnerable for substance abuse. Many TBI survivors "treat" their depression and low self-esteem through substance abuse as well. Because of these factors substance abuse is often a major concern with pre-teen and teenage TBI survivors, who may be easily led by others because they have lost the ability to make wise decisions.

SECTION TWO:
The Fundamentals of Brain Development and Function

"The brain is a wonderful thing. It starts working the moment you get up in the morning and doesn't stop until you get into the office."

— Robert Frost

The brain is truly a fascinating instrument. Discovering how it works is perhaps the last great frontier of psychological discovery. It is safe to say that what we do not know about the brain closely parallels or exceeds what we do know. Nevertheless, there are many things we can say about the brain with some confidence.

In order to understand how a trauma to the child's brain affects functioning, it is important to have a fundamental knowledge of how the brain develops. This is particularly true in trying to understand how damage early in life can affect functioning at later stages of development. It is beyond the scope of this manual to present this material in depth. Rather, the intent is to set a perspective for you to use in trying to understand what may have led to the effects in functioning that you are now seeing.

Some Basic Principles of Brain Development

The development of the brain in children continues throughout the developmental age span (Lehr, 1990). During the early stages of development, brain growth is very rapid. This is particularly true during the first two years of life. At birth the brain weighs approximately 350 grams. By age 2 the brain's weight has risen to about 1300 grams, almost the weight of the adult brain (Spreen, Risser, & Edgell, 1995). Injuries to the brain during this rapid growth period can have a significant effect on later cognitive development. This is at least one reason why it is so important to question parents regarding any medical, physical, etc. traumas that may have occurred during this period.

Early Stages of Brain Development

There are a series of noteworthy stages in the early development of the brain that occur in a rigid, chronological sequence. Disturbance of this sequence affects later cognitive, physical and emotional development. These processes are **cell proliferation, cell migration, aggregation**, and **myelination.**

Early in the gestation period, the precursors of what will become neurons **proliferate** by a cell generation process called **mitosis.** This results in the production of **neuroblasts** (soon to be neurons) and **glial cells** (soon to be the white matter which supports the neurons). This whole process, which occurs in the first few weeks of gestation, is called **neurogenesis** (Spreen et al., 1995). Brain cells (neurons) are produced in large numbers, larger actually than we need. This is important, since in the process of development many will not survive due to a form of programmed cell death which is not well understood known as **apotosis**.

The next stage of development involves the **migration** of different brain cells to specific, permanent sites in the central nervous system. It is not clear what factors contribute to this cell migration but recent evidence suggests that brain cells may be "guided" by glial fibers (Rakic, 1975; Spreen et al., 1995). Disturbance of this migratory process through failure to migrate, premature curtailment of migration, or errors in the placement of cells, cause severe and often fatal brain abnormalities. An example of such a brain abnormality is **lissencephaly** or "smooth brain" (the brain develops without convolutions, i.e. gyri and sulci) (Spreen et al., 1995). The precise role of trauma in the disturbance of these processes is not clear.

Following migration two related processes known as aggregation and differentation take place. **Aggregation** (also called lamination), is a process where neurons aggregate to form major cellular masses such as the corpus callosum, the cortical lobes, etc. **Differentiation** describes the process where refinements in neuron development such as axonal and dendrite development take place.

The final stage involves **myelination**. Although the formation of brain cells stops around the end of the second year of life, brain weight continues to increase by another 25% (Friede, 1975). This increase in weight is, at least in part, due to the process of myelination which continues into young adulthood. Myelination is a process in which the neurons are sheathed in a protective layer of proteins and lipids not unlike the covering found on a common electrical cord. This sheathing facilitates efficient transmission of impulses (**synapses**). The myelination process begins before birth and continues throughout the early developmental years into early adulthood (Lehr, 1990). Different areas of the brain myelinate at different rates and at different chronological stages. While it is not known why this occurs, there may be a relationship between those parts of the brain that myelinate first and necessary survival abilities in the developing infant.

In general, myelination begins in the lower sections of the CNS (e.g. spinal cord) progressing up to the cortex, and from the back of the brain (occipital lobes) to the front (frontal lobes). The significance of the later development of the frontal lobes will be discussed in a later section.

It is important to note that although much of brain development occurs in a very predictable fashion owing to our genetics, perhaps an equal amount (no one really knows) occurs due to interactions with the environment. The first stages of development, proliferation and migration, appear to be primarily influenced by genetic predisposition. It is thought that later developmental stages such as myelination may be equally, if not more, vulnerable to interactions with the environment (Gottlieb, 1976). As an example, children who have survived horrific abuses, such as being locked in closets, do not have brains of comparable size and functional development as do non-abused, normally thriving children.

Luria's Theory of Brain Function Development

We know that cognitive, physical, and emotional development occurs in predictable stages which are somewhat, although not directly, dependent on the concurrent development of the brain. Thus, if there is an insult to the brain during any developmental sequence, it is likely to have an effect on those developmental stages yet to come. Aleksandr R. Luria (1966), considered by many to be the father of modern neuropsychology, was one of the first to recognize this phenomenon. Subsequently, he developed a theory to explain the way brain injuries sustained early in life might affect later functioning. His theory proposed five stages of development linked to the sequential emergence of stages of brain function.

Stage 1. Stage 1 includes maturation of areas of the brain responsible for basic arousal and attention. This stage starts before birth and continues up to shortly after birth. The brain is most vulnerable to injury during this period because it is a period of rapid growth.

Stage 2. The second stage overlaps the first and includes the development of those areas of the brain serving basic sensory and motor functioning. Many of these functions are related to survival in the newborn infant.

Stage 3. Stage 3 continues through the preschool years and includes the development of areas of the brain responsible for refining the basic functions developed during the first and second stages. Such things as the smoothing out of motor movements, and the development of secondary auditory and visual skills (more complex skills than simple vision and hearing) characterize this stage.

Stage 4. This stage sees the development of the posterior (rear) areas of the brain, linking perception with those areas responsible for the basic academic skills, i.e. reading, math, reasoning, etc. This stage occurs between 5 to 8 years of age and damage during this period can seriously limit the development of what we commonly consider to be intelligence.

Stage 5. This final developmental stage involves maturation of the anterior (front) areas of the brain, primarily the frontal lobes. As we know, this area has primary responsibility for organizing input from our senses and planning our response to that input. This stage of development usually does not take place until early adolescence.

The Effects of Damage on the Developing Brain

We should begin by identifying some features of the developing brain that make the effects of damage different from in the adult brain. The brain of the young child is proportionately larger than the adult in comparison to body size (Lehr, 1990). The skull of the child is thinner and more pliable to allow for growth, but it is not clear whether or not this makes the child more vulnerable to trauma (Shapiro, 1985). The young child's brain also has less cushioning than the adult's and can move about more freely perhaps making it more vulnerable to small blood vessel rupture and diffuse axonal injury from such traumas as shaken baby syndrome.

Plasticity

To fully understand the effects of an injury to the developing brain, we must understand the concept of plasticity, a term that refers to the brain's ability to compensate for acquired deficits. Modern notions of plasticity have their origins in the early research of Kennard (1936). In her research with brain injuries in monkeys, Kennard noticed that younger monkeys seemed to recover better than older ones. From this came the notion that the earlier a brain injury is sustained the better the chances of recovering function. More recent research, however, suggests that early brain injury may result in more severe long-term deficits than an injury sustained later (Dennis, 1988).

The amount of plasticity or compensation that can occur appears to depend on many factors including the age of the child, and the size and severity of the injury. Although children do appear to profit more than adults in terms of the effects of plasticity, there appear to be limits to how much the brain can compensate. In general, the earlier the injury occurs the more possible plasticity can occur. However, in many areas of the brain neurons are already committed to specific functions, even before birth (Lehr, 1990).

There are additional constraints to plasticity. Kinsbourne (1974) has shown that partial destruction of a particular area of the brain may be more of a disadvantage than if the entire area was destroyed. Kinsbourne proposed that the brain will not attempt to "transfer" responsibility for the missing function if it thinks the original site is still operational.

Although the brain has this wonderful compensatory device, we must be clear in our understanding that it cannot totally make up for early damage. Unfortunately, the primary effects of plasticity appear to be reserved for very young brains still in the early developmental stages. We frankly do not know how long plasticity extends into the growth cycle but some researchers have estimated that significant plasticity probably does not occur after 6 or 7 years of age. Even in extreme cases where the child is born with only one hemisphere, it is generally thought he or she will never reach the levels of cognitive ability of a child born with two, normally functioning hemispheres. The child will, however, acquire many abilities associated with the missing cerebral hemisphere through plasticity.

1. The effects of plasticity and the consequent effects on damage to the developing brain have been the focus of much debate. The following question highlights some issues in this debate. If you had such an option, choose whether you would prefer to suffer an injury to the language area of the brain (left hemisphere) at the age of 2 or 10, and defend your answer. A typical response might be to defend the age two option on the basis of plasticity effects, i.e. the undamaged brain will assume the responsibilities of the damaged portion. A second alternative is to choose 10 years of age because you would have already learned crucial language skills such as reading and therefore would have this "old learning" to call on. Which would you choose?

2. Although it is not clear if the delayed effects of damage to the brain can be ameliorated through early intervention (Lehr, 1990), animal studies suggest that such training may be effective (Goldman, 1976; Rudel, 1978).

Outcomes of Early Brain Damage

Teuber & Rudel (1962) suggested three possible outcomes in cases of early injury to the brain. These outcomes are dependant on the child's age and the degree and nature of the injury.

1. Effects of early brain injury may appear immediately after the injury and then curiously disappear. This type of outcome suggests that an adjacent area of the brain has, in fact, taken on the functions of the damaged area(i.e. plasticity).

2. Some injury effects will become a permanent part of the survivor's cognitive profile. These permanent disturbances include such things as slowed reaction/processing speed, and may be related to a less adequate part of the brain attempting to take on the functions of the initially more competent, damaged site.

3. Deficits may become apparent only after a delay because the structures damaged may not have reached their full, functional maturity at the time of the injury. Thus, the effect will not become apparent until later in the child's life when higher level task demands call for the functions served by the damaged brain structure. A classic example of this phenomenon is early damage to the frontal lobes that characteristically do not fully mature until late childhood or adolescence.

A model for understanding the effects of early brain damage on later functioning

Maureen Dennis (1988) has proposed a useful model to help us understand the effects of brain damage on emerging, developing, and established cognitive skills. This model draws from some of the early observations on early vs. later damage effects on brain function. In particular, Dennis' model takes into account Kennard's views regarding the relationship between early and later brain damage and developing cognitive skills. Although Dennis' model was developed specifically to account for the effects of brain damage on language development, the principles seem applicable to the development of cognitive skills in general.

In essence, this model proposes that damage which occurs during infancy will affect emerging skills in such a way that their time of **onset** will be delayed or the **sequential order** of appearance of these skills will be disrupted. During childhood, when skills are developing, damage can affect the rate of development of the skill, the **strategy** needed to put the skill into effect, or the **mastery** (competence) of the skill. At a later stage, when skills have been established, the **control** of the skill (e.g. using the skill effectively), and the long-term maintenance or **upkeep** of the skill can be affected (Dennis, 1988).

BRAIN-BEHAVIOR RELATIONSHIPS

The essence of brain injury assessment lies in a working knowledge of the associations between the damaged areas of the brain and the functional manifestations thereof. What follows is a brief overview of the primary functions associated with various areas of the brain.

A method of organizing this material will be proposed that will allow you to make associations between brain injury and the functions affected.

Primary Functions Associated with Areas of the Brain

The hemispheres. We know that each brain has two hemispheres. Much has been written about the functions associated with each hemisphere. It is widely recognized that the left hemisphere is the primary site of language and verbal communication in the brain for the vast majority of individuals, while the right hemisphere is regarded as the primary site of the visual-spatial functions. This statement, however, brings us to an important caveat.

Caveat: Although most cognitive and social-emotional functions are mediated primarily by one hemisphere, we use both hemispheres to some degree for almost all these functions. As an example, although arithmetical processes are primarily situated in the left hemisphere, certain aspects of arithmetic depend heavily on visuospatial processes, e.g. geometry or aligning numbers correctly in addition problems.

General Cognitive Functions Associated with the Left vs. Right Hemisphere

We have known for some time now that the left hemisphere organizes and categorizes information linguistically (Gazzaniga, 1970). It is also believed that the left hemisphere is better prepared to process information in a more analytical, temporal, logical, and sequential fashion than the right hemisphere.

The right hemisphere is normally considered to serve those functions associated with an individual's perception of body image in space, perception of non-verbal (e.g. melodic) communication, and in the comprehension and expression attached to visual, facial and verbal stimuli (Bryden & Lay, 1983). The right hemisphere seems better suited to processing information in a holistic, simultaneous, or concrete fashion (Bogen & Gazzaniga, 1965).

The Lobes and their Primary Functions

As learned earlier, the brain has four lobes (you could say eight since there are mirror images of each on the left and right hemisphere), the frontal, temporal, parietal, and occipital lobes. Figure 3 shows the position of each lobe.

As with the hemispheres, there are primary functional attributes associated with each lobe. The previous caveat for the hemispheres holds for the lobes of the brain as well. Although there are primary functions associated with each lobe, most brain functioning is complex, made up of many sub-processes which are served by many different areas of the brain. Let us take a brief look at the primary functions of each lobe.

The frontal lobes. The area constituting the frontal lobes is shown in Figure 5. The left and right frontal lobes are the easiest to locate since they are in the front of the brain, as their name implies. At the rear (posterior) edge of the frontal lobes is the motor strip. This area controls the muscles of the body in a contralateral fashion, i.e. the left hemisphere motor strip controls the right side of the body and vice versa. This muscle/motor control is the primary role of the

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Handedness and its relationship to site of language in the brain —
Neuropsychological reports usually indicate the dominant hand used by the individual being assessed. Why? Research indicates that of the 90% of us who are right handed, 95% have our language in the left hemisphere (Code, 1987). This research shows that of the remaining 10% who are left handed, about half have their language in the left hemisphere also. Of the remaining 1-2% of the population, language may be in the right hemisphere or divided between the hemispheres. Interpretations regarding test results for these few individuals will need to be done with this in mind.

Complicating this picture further is the fact that many left-handed individuals may not "truly" be left handed. Research has shown that some left-handed individuals may be so because of injury during gestation or during birth which damaged the area on the left side of the brain controlling the muscles of the right side. This injury may have caused the child to switch to the left hand rather than the natural, right hand (Satz, 1972). It's safe to say, however, that almost all of those students you will test will have their language in the left hemisphere.

frontal lobes; however, for the assessment of brain injury the frontal lobes take on a much more important role in cognitive functioning.

Because of their complex nature and their importance to our higher order cognitive functioning, the frontal lobes have been the source of numerous research studies. This area of the brain is often referred to as the "executive" area since virtually all of the brain's output is mediated by the frontal lobes. (The other sections of the brain are mainly associated with input to the brain.)

The primary "executive" functions of the frontal lobes include:

- initiating and stopping action;
- controlling our impulses - e.g. disinhibition;
- planning / organizing our actions; and
- "abstract" / flexible thinking.

As you can see these are all complex behaviors requiring many different yet related functions of the brain.

The parietal lobes. The parietal lobes are best known as the primary site of the somatosensory strip. This is an area found at the anterior (front most) edge of the parietal lobes parallel to the motor strip of the frontal lobes. The somatosensory strip is the input area for all tactile sensation. Like the motor strip, it functions in a contralateral fashion. Tactile sensations such as a needle pricking the skin on the right arm will be recorded on a portion of the somatosensory strip located in the left hemisphere. As with the frontal lobes, the parietal lobes play a greater role than simply tactile input.

More subtle functions of the parietal lobes include:

- spatial imagery - e.g. judging size, distance;

- left-right orientation;
- agraphia (writing ability);
- visuoperception and visuoconstruction;
- facial recognition; and
- spatial ideation (ability to simulate complex movements on command, etc.).

The temporal lobes. The primary function associated with the temporal lobes is hearing. Neuroanatomically, it is important to note that input from each ear goes to both auditory cortices. Although both ears feed input into both hemispheres, there is a slight contra-lateral effect. If auditory input is received by both ears simultaneously, the input received by the left ear goes to the right hemisphere while the input to the right ear goes to the left hemisphere. However, if auditory input is received by one ear only, the input goes to the same side hemisphere (R. Conder, personal communication, March 7, 1996). Research indicates that our left ear may be slightly more sensitive to hearing non-verbal sounds such as musical melodies while our right ear may be more sensitive to verbal sounds such as words.

The temporal lobes also play a significant role in memory. The left temporal lobe is more involved with auditory/verbal learning and memory while the right temporal lobe is primarily concerned with non-verbal learning and memory (e.g., melodies). Areas positioned just behind the temporal lobes, the hippocampus and amygdala, play critical roles in short-term memory.

The occipital lobes. The occipital lobes are located in the posterior (rear) of the brain. Unlike other lobes, there is no observable demarcation on the brain to separate the occipital lobes from the parietal and temporal lobes. Figure 3 shows the approximate position of the occipital lobes. The primary responsibility for the occipital lobes is vision/visual acuity which is associated with the area of the occipital lobes at the extreme rear of the brain sometimes referred to as the occipital "pole." The left occipital lobe is connected to the left side of each eye, and the right occipital lobe is connected to the right side of each eye.

Other, more complex visual processes are located in the areas of the occipital lobe that lie between the occipital poles and the parietal lobes. These areas are often referred to as visual association areas, meaning that there is a visual component to the function but there are other processes involved as well. These association areas provide meaning to what we see. Functions such as visual perception are located in these areas.

Toward a Working Theory of Brain-Behavior Relationships: An Overview of the Historical Development of Brain-Behavior Theories

We have seen that there are primary brain functions associated with each hemisphere and each lobe. However, most brain functions that we will encounter in our TBI evaluations are complex and often involve behaviors associated with more than one lobe.

Brain-behavior theories are attempts to understand the connection between what we know about the areas of the brain and complex behavior. While it is beyond the scope of this manual to cover the historical development of brain-behavior theories in depth, a brief review might help set a useful perspective for the assessment process. One of the earliest theories of brain-behavior relationships was **Phrenology**, developed by Franz Josef Gall and Johann Casper Spurzheim around 1796 (Walsh, 1992). Their theory was an outgrowth of faculty psychology which sought to divide mental processes into a number of separate, innate personality characteristics or "faculties." Gall and Spurzheim concluded that the development of these faculties in the brain would lead to prominences (bumps) on the individual's skull that could be felt if you palpated the scalp (Walsh, 1992).

We know now that this theory was absurd, yet it attracted a wide following (for almost a century) and in many ways contributed to the more scientifically sound discoveries of brain-behavior relationships of Broca and Wernicke that were to follow. Broca's contributions helped to uncover the role of left hemisphere damage in verbal communication deficits (aphasia). In 1861 he revealed the damaged brain of his now famous patient "Tan" (tan was the only word he could say intelligibly) who had lost the ability to communicate verbally. The autopsy confirmed the site of the damage in the left hemisphere which has come to be known as the speech center or "Broca's area."

Wernicke followed in 1874 with discoveries that greatly contributed to our knowledge of the role of the left superior temporal gyrus located at the junction between the left temporal and parierial lobes in the comprehension of speech. As with Broca, this area of the brain is now commonly referred to as Wernicke's area.

In essence, these early theories can be categorized into those which follow a strict localizationist view (i.e. function A is located in area A on the brain), or those that hold the view that the brain is organized into complex, interconnected systems such that several brain regions are involved in a functional "system" for each behavior.

Luria's Functional Systems Theory

Luria's theory is based on the belief that the brain is organized into functional systems and that these systems change and develop as the brain develops (Lehr, 1990). Any part of the brain can participate in several, various functions (often referred to as pluripotentiality). This functional systems approach developed by Luria may help in understanding the mechanisms involved in TBI (Spreen et al., 1995).

Luria's theory divides the brain into two "units" that are basic to cognitive and social-emotional functioning, the **Sensory-Input Unit**, and the **Motor-Output Unit** (Luria, 1973). These units are shown in Figure 5.

(Note. Luria also identified a third unit — the ***Arousal Unit****. We will not discuss this unit specifically although it is important to understand that it's function is necessary to all brain functioning. The primary contribution of the Arousal Unit is to make sure the CNS reaches and maintains a sufficient level of arousal to function. In Figure 6, it involves the areas of the brain and brain stem not included in the Motor-Output and Sensory-Input Units. The Arousal Unit includes deep cortical structures of the brain and brain stem. Damage to this unit is usually catastrophic in nature and often leads to coma and death. It is the other two units that we seek to understand in shedding light on brain-behavior relationships.)*

The **Sensory-Input Unit** is just that. It mediates incoming information from our environment to the brain. This unit, located in the rear (posterior) portion of the brain, processes basic input through areas in the temporal lobe (hearing), the parietal lobe (tactile), and the occipital lobe (vision). The **Motor-Output Unit** primarily consists of the frontal lobes and organizes and plans our responses to the incoming data from the Sensory-Input Unit.

The Sensory-Input and Motor-Output units are further divided into cortical "zones," i.e. **primary, secondary, and tertiary cortical zones** (see Figure 6). These zones allow us to gain additional perspective on how damage to the brain affects functional systems involving different behaviors. In essence, these zones radiate out from the primary areas of each lobe in increasing levels of functional complexity (with the primary zones being responsible for the basic function of each lobe).

An example might be helpful here. The primary zone of the occipital lobe is responsible for visual acuity. Damage to that area would be likely to affect vision. As you move from the primary zone of the occipital lobe toward the parietal lobe, you pass through the secondary and tertiary zones associated with the occipital lobe, with the tertiary zone being farthest from the primary zone of the lobe (see Figure 6). The tertiary zones integrate information across all modalities and are restricted to purposeful output. These areas encompass the "borders" of the parietal, temporal, occipital lobes, and the entire frontal region of the brain. Functions in the secondary and tertiary zones of the brain are more complex, involving functions associated with more than one lobe.

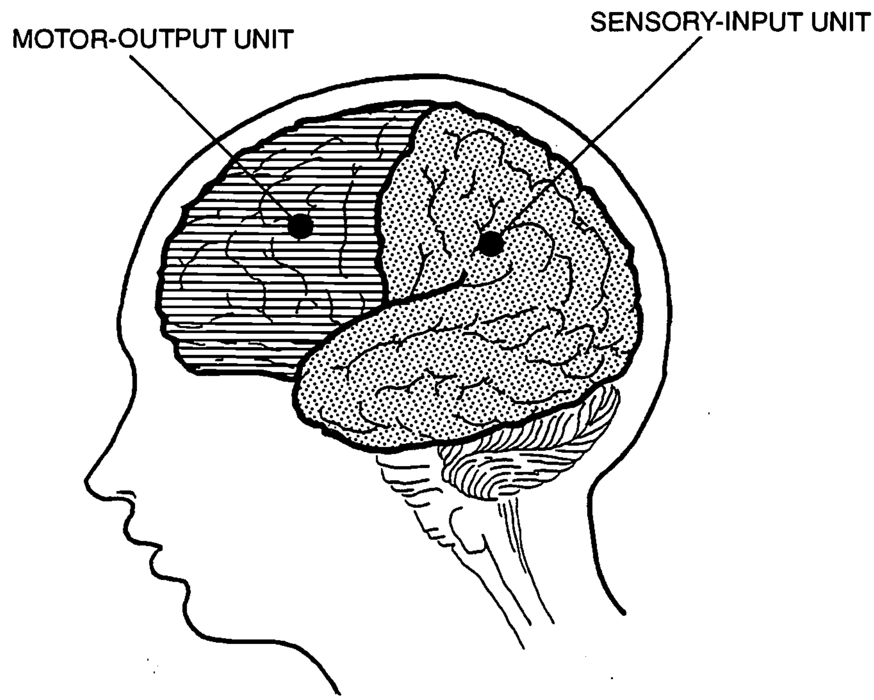

Figure 5.
Luria's motor-output and sensory-input units of the brain.

Damage to the secondary or tertiary zones of the occipital lobe might produce problems in more complex functioning such as reading which involves visual acuity, form perception, comprehension, etc. Further, if the injury was in the right hemisphere occipital secondary zone, the reading problem might express itself as some form of perceptual distortion such as letter reversal.

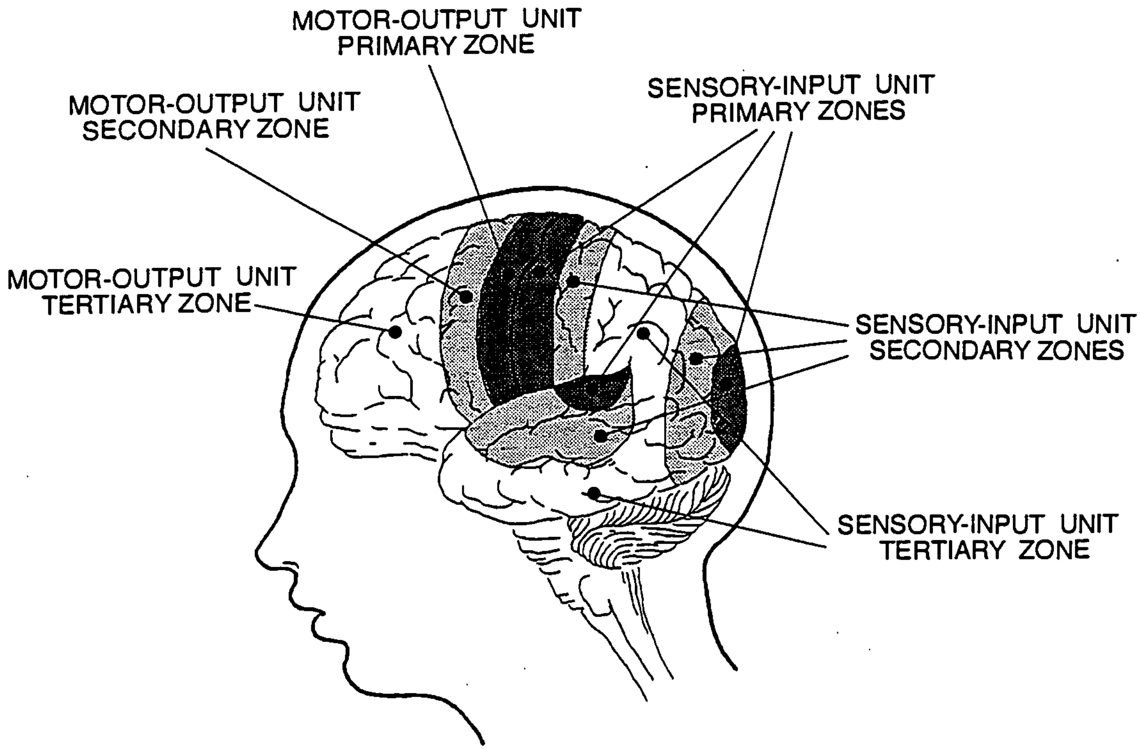

Figure 6.
Luria's primary, secondary, and tertiary zones.

Luria believed that the relationships between the cortical zones change as the child's brain develops, in a sequential building fashion. Primary zones would be established first (by the end of the first year of life) to meet primary sensory and motor needs. The secondary and tertiary zones would develop thereafter to meet expanding cognitive demands. Secondary zones are thought to be fully functional by the age of 7 (which is also thought to be the upper age limit of significant plasticity). Tertiary zones are the last to mature, perhaps comparable to the Formal Operations Stage of Piaget (Piaget, 1960). Damage to a single tertiary area can conceivably compromise many different functional abilities.

As a further example of Luria's functional systems approach, let's consider the primary language "paths" in the brain as conceptualized by Luria. These paths involve the major anatomical areas that are responsible for the primary input involved in language, i.e. the temporal lobes for hearing input and the occipital lobes for visual input. As we learned earlier there are other, secondary, and tertiary areas that are also involved if the behavior we are looking at is anything more complex than basic hearing and vision. These other areas might include Wernicke's area which allows us to decipher and interpret what we hear or read (e.g. receptive language), and Broca's area which allows us to respond verbally.

These paths are arranged in the brain in a very organized fashion. What follows are the simplified anatomical-functional paths for some common language functions which are provided to assist you in understanding these concepts.

The task: Ask the individual to repeat the word "banana." What follows is a graphical depiction of the language "path" that is activated with this request.

TASK = "SAY BANANA."

⬇

SOUND ("SAY BANANA") ENTERS PRIMARY HEARING AREA OF TEMPORAL LOBE

⬇

GOES TO WERNICKE'S AREA FOR COMPREHENSION

⬇

GOES TO BROCA'S AREA FOR RESPONSE ("BANANA")

When we say the word "banana," the sound of the word enters the temporal lobe, at the area designated as the primary zone (Luria) for hearing input. The sound then travels (via nerve bundles in the white matter) to the area of the brain known as Wernicke's area which is primarily responsible for comprehending the meaning of this sound. Wernicke's area determines that the sound is the word "banana." (Notice that Wernicke's area is in the secondary zone close to the border of the temporal and parietal lobes. This accounts for its more complex responsibilities.) Since the task is to repeat the word, Wernicke's area sends the word "banana" (via another nerve bundle called the arcuate fasciculus) on to Broca's area, which is responsible for the spoken response. (Notice that Broca's area is in the tertiary zone of the frontal lobe and, in addition, it covers the area of the motor strip responsible for the muscles involved in the production of speech.)

Therefore, if the individual can successfully repeat a word on command, you can establish that the structures in this "path" are not damaged. Let's try another example. This time the demand is a bit more complex.

The task: Ask the individual to read a passage aloud. Graphically, it would look like this.

TASK = "READ THIS ALOUD."

⬇

SOUND ("READ THIS.") ENTERS PRIMARY HEARING AREA OF TEMPORAL LOBE

⬇

GOES TO WERNICKE'S AREA TO COMPREHEND TASK

⬇

GOES TO OCCIPITAL LOBE FOR READING PORTION OF TASK

⬇

BACK TO WERNICKE'S AREA FOR COMPREHENSION OF READING

⬇

ON TO BROCA'S AREA FOR SPOKEN RESPONSE (READING ALOUD)

This path is obviously more complex because the task itself is more complex. First, the spoken request goes to the temporal lobe to be heard, then on to Wernicke's area for comprehension of the request. Next, the occipital lobes become involved for the act of reading the passage. (This is actually considerably more complex since the act of reading is complex in and of itself.) The read words must go back to Wernicke's area (via another nerve bundle called the angular gyrus) for comprehension and, finally, on to Broca's area to allow the read words to be read aloud.

I have greatly simplified the language paths described here, but this demonstration will serve to explain the principles involved. It serves to illustrate the functional systems approach to understanding the relationship between behavior and neuroanatomy. As you become more familiar with these concepts you will find them very useful in isolating which part(s) of the particular path or functional system is the primary culprit in the student's problems.

Important Differences in Brain-Behavior Relationships in Children vs. Adults

All that we have just discussed regarding brain-behavior relationships was developed using the adult brain as the model. Relatively few of the existing brain-behavior theories have been applied to the child's developing brain. It has been assumed that adult brain-behavior theories would hold for the developing brain as well. With regard to children, however, we must understand that brain-behavior theories such as Luria's are just that - theories. Cognitive functioning in childhood is a developing process. We cannot directly apply what we know about adult left vs. right hemisphere functioning to the child and adolescent brain injury survivor. This is an important concept that has significant meaning for the interpretation of brain injury effects. As an example, one theory suggests that most tasks in early childhood are best solved using functions normally attributed to the right hemisphere (Goldberg & Costa, 1981). We also know that the right hemisphere develops first, and that these strategies are transferred to the later developing left hemisphere when the tasks become routine or crystallized (Bracco, Tiezzi, Ginanneschi, Campanella, Amaducci, 1984).

With the preceding sections providing a background, we will now move on to assessment.

SECTION THREE: Best Practices in the Assessment of Students with TBI

(Note. Each of the tests mentioned in this section are described in depth in Appendix B. The only exceptions will be the major instruments commonly used by school psychologists such as the Wechsler tests, K-ABC, SB-IV, etc.)

TBI and Neuropsychological Assessment

Many professionals have often wondered why an individual they were testing would approach an item in a certain, sometimes unusual, way. As an example, in constructing a Block Design item from the Wechsler, some individuals assemble the blocks in the required square shape but make "internal" errors in the arrangement. Others will totally ignore the square shape, preferring to arrange the blocks in a seemingly haphazard fashion. These different styles have meaning. Unfortunately, most of us spent a great deal of time (and rightfully so) learning how to administer the tests we use and less time in learning to interpret the performance of the individual we are testing. This includes not only the interpretation of the quantitative test results, but also the interpretation of observations of the strategies (or lack of strategies) used by the student being evaluated. Further, what does all this mean for remedial planning?

Many professionals learned about interpretation through a sort of "cookbook" approach. We were taught also to observe carefully during our assessments. However, what we were to look for and why was usually less clear. Since standardized tests are nothing more than structured observations, what we observe during assessment is at least as important, if not more important, to interpretation as are the scores we obtain from these tests. Neuropsychology will help teach you what to look for and how to observe in order to get the most out of your assessment efforts.

A Brief History of Brain Injury Assessment

When we speak of assessment with TBI students we are speaking about a subdiscipline within psychology known as neuropsychology. Neuropsychology is a relatively new field which developed as an offshoot of neurology. Its history can be traced back to the findings of early pioneers such as Broca and Wernicke, and perhaps even further back to Edwin Smith and Hippocrates, somewhere around 3000 B.C. The Edwin Smith papyrus (papers) contain the earliest known anatomical, physiological, and pathological descriptions of the brain (a term that was coined in these papers).

The testing techniques used in most clinical (as opposed to research) neuropsychological evaluations have evolved over the years to provide the following information.

1. presence or absence of brain damage;
2. severity of the damage;
3. nature (diffuse vs. focal) and location of the damage;
4. possible premorbid characteristics of the patient (e.g. pre-injury levels);
5. patterns of cognitive strengths and weaknesses relative to TBI;
6. assistance in determining whether to remediate or compensate; and
7. suggestions as to how to remediate or compensate.

Neuropsychology is perhaps best known for its role in the clinical assessment of brain injury. Traumontana and Hooper (1988) have identified the following stages in the development of neuropsychological assessment.

1. **Single-test stage** — This stage (mid-1940s to mid-1960s) was based on the prevailing belief that brain damage manifested itself in a unilateral fashion regardless of severity, location, or etiology. Thus, it was thought that a single test, such as the Bender Visual Motor Gestalt Test (BG) (Bender, 1938), would be sufficient to identify brain injured from non-brain injured individuals.

2. **Test battery/Lesion-specification stage** — The development of test batteries specific to neurological injury signaled the end of the single-test stage and the beginning of the next phase of neuropsychological assessment. This stage was also concerned with the identification of brain injured individuals. These test batteries are objective, and the emphasis is on establishing cut-off scores to categorize individuals as brain injured vs. non-brain injured.

3. **Functional profile or Cognitive stage** — The need for more intervention-oriented information and the increase in sophisticated neuroimaging techniques has caused the field of neuropsychology to move toward more functional approaches. The emphasis in this stage focuses on the effects of the brain injury, i.e. preserved abilities vs. impaired abilities. Although the focus is different, the tests used are basically the same as in the Test Battery stage.

4. **Current stage** — According to Traumontana and Hooper (1988), the emphasis in this stage is on ecological validation, i.e. relating assessment results to the individual's everyday environment. In actuality, however, this stage may still not have arrived and there are those who adhere to the emphases noted in Stages 2 and 3.

Early in the development of neuropsychology there was a need for the information regarding the presence of brain damage and the location of the damage in the brain. However, since the development of sophisticated neuroimaging techniques such as the CAT and MRI scans, this need has almost vanished. Clearly, the emphasis in neuropsychological assessment has swung toward obtaining information relevant to functional differences and remedial planning.

As you have learned, the brain is extremely complex. There are, however, some basic rules as to how it works. In general, we know that language is primarily a left hemisphere function and that visual-spatial abilities are primarily served by the right hemisphere. We know that cognitive functions are usually not discretely located in a single area of the brain, but rather these functions are themselves complex and thus may involve many areas of the brain. A safe, general assumption is that most tasks are much more complex than they appear to be. The final act of completing a task may involve many different functions and different areas of the brain. What we need to look for in our assessments are those strengths and weaknesses that may help us to generalize to other related functions, and to provide us with valuable information to develop effective remedial plans.

Current Approaches in Neuropsychological Assessment

Currently, there are several approaches that can be used to detect the functional strengths and weaknesses of an individual who has survived an injury to the brain. These approaches seem to fall into two major groups - the fixed battery approach and the process approach.

The Fixed Battery Approach

Two commonly used, ready-made adult neuropsychological assessment batteries are the Halstead-Reitan Battery (HRB; Reitan & Wolfson, 1993) and the Luria-Nebraska Neuropsychological Battery (LNNB; Golden, Purisch, & Hammeke, 1985). Neuropsychological batteries for children have also been developed by these authors. They include the Reitan-Indiana Neuropsychological Test Battery for Children, ages 5-8 (Reitan, 1969), the Halstead-Reitan Neuropsychological Test Battery for Children, ages 9-14 (Reitan, 1969), and the Luria-Nebraska Neuropsychological Battery for Children, ages 8-14, (Golden, Hammeke, & Purisch, 1978). These are primarily quantitative assessment instruments, using cutoff scores to determine the presence or absence of significant brain damage (Batchelor & Dean, 1996).

Lezak (1995) suggests that ready-made batteries offer reliable scoring methods for gross diagnosis. She states, however, that "...no battery can substitute for knowledge..." and that these batteries do not give the naive user diagnostic opinions nor behavioral descriptions - clinicians do this (see Lezak, 1995 for more information on neuropsychological batteries). Both batteries require extensive training in interpretation and were intended to be interpreted by trained neuropsychologists. A primary role of these fixed batteries is to discriminate between normal individuals and those who are brain damaged. In general, this will not be an important feature of our assessments since we will already have verification that the student has sustained a TBI in most cases.

The Process Approach

A second "group" of techniques or approaches used in neurological assessment can, perhaps, best be referred to as non-fixed "batteries." These include the hypothesis-testing approach (Mapou & Spector, 1995), the ecological approach (Traumontana & Hooper, 1988), and the process approach (Kaplan, 1988), often referred to as the Boston Process Approach. Of these techniques, the Process Approach seems better suited to the needs and training of school psychologists. This approach does not use one of the formal neuropsychological batteries, but rather allows the test administrator to put together a "battery" of his or her own choosing tests and techniques that are sensitive to brain injury and specific to the individual being tested.

The focus is on thorough history taking, careful analysis of presenting problems, observations of strategies used to complete tasks, and the analysis of errors (Batchelor & Dean, 1996). This can also be called a hybrid approach in that it combines standardized instruments (e.g. WAIS-R, WISC III) with tests selected on the basis of the particular needs of the student, and careful, structured observations of *how* the individual performs.

The Process Approach is based on the contention that most tests are multifactorial and that a solution to a particular task or problem can be arrived at in diverse ways. These "paths" to the solution can themselves reflect the activity of different structures within the brain. The emphasis of this approach is to determine a functional profile of the brain-injury survivor's strengths and weaknesses in order to best determine a remedial program. Systematic observation of the individual's performance during the evaluation can suggest new hypotheses which can then be further assessed. An added advantage to this approach is that the battery can be unique to the individual being evaluated — a significant feature for our purposes - and a disadvantage of the battery approach.

The Foundations of an Appropriate TBI Assessment Battery for School Psychologists

Appropriate Testing Domains

Telzrow (1987) suggests that school psychologists follow an assessment approach similar to that found in neuropsychological evaluations, referred to as a domain approach. In fact, the evaluations done by school psychologists (and other psychologists as well) follow this approach now. However, the domains of the typical school psychology evaluation are restricted to those necessary for evaluating children and adolescents for special education. The following list contains the domains found in a school psychology assessment.

- academic history/background;
- cognitive/intellectual functioning;
- psychomotor functioning; and
- academic skill levels.

A typical battery for a child referred for cognitive difficulties might include a WISC III, Bender Gestalt, and Woodcock-Johnson Test of Academic Achievement (WJ-R). While these tests are adequate for such a referral, this battery would not be appropriate for the TBI student. Let's examine the domains found in a typical clinical neuropsychological battery as a comparison.

An example of the domains covered in a neuropsychological battery might include the following.

- complete medical*, social, and academic history;

- general cognitive/intellectual functioning;

- attention/concentration;*
- memory and learning;*
- visuoperception/visuoconstruction;*
- language functioning;*
- executive, higher-order functions;*
- fine motor ability;*
- social-emotional functioning; and
- academic skills (Lezak, 1995).

While these domains will be reasonably consistent from examiner to examiner, the tests/techniques used in neuropsychological evaluations may vary considerably. This is particularly true in the process approach to brain injury assessment (Lezak, 1995).

(Note. The information, data, etc., obtained in each domain is provided by a combination of testing instruments, observations, and interviews.)

The asterisks shown in the preceding list denote those areas not assessed or incompletely assessed (relevant to TBI referrals) in a typical school psychology testing battery. Depth and/or comprehensiveness of testing is also an issue. While a typical school psychology battery will include some information (or clues) to most of the areas listed in the neuropsychological battery, neuropsychological assessments are usually carried out in greater depth and comprehensiveness to determine specific effects of the brain injury on function. You will also notice that the domains to be assessed follow closely the areas listed earlier as typical effects of TBI.

Toward a Suggested Approach

What we need for the assessment of the TBI student is an approach, similar to that used in neuropsychological assessment, that will enable us to determine the impact of the TBI student's brain damage and to determine a remedial plan. Clearly, it would not be possible to have all school psychologists become trained neuropsychologists. What does seem logical is to use the skills and training inherent in school psychology and build on this base to construct an "expanded battery" approach to the assessment of TBI students.

The typical school psychology battery can be expanded in two ways. First, you need to examine the techniques you are using now to see if this information can be used differently by scrutinizing the data. We will do this using a "neuropsychological perspective." This will involve both test data and observations obtained in a manner relevant to TBI. The second aspect of this expanded battery approach will be to examine the use of additional, supplementary tests to cover areas of assessment not ordinarily included in most school psychology batteries. In the following section, we will learn how to use more efficiently the information we have already gathered, and how and when to add tests and techniques to our assessment "battery" to get the information needed.

A Framework for TBI Assessments for School Psychologists

What follows is a suggested framework for TBI assessments that is built on neuropsychological theory and practice. First, in developing our assessment framework, we will use assessment domains that will cover the areas outlined in the North Carolina TBI definition. The definition states that the TBI must impair "... a student's *cognitive, communicative, perceptual, behavioral, social-emotional, and/or physical abilities* to the extent that the student requires special education." These areas closely parallel the domains covered in the typical neuropsychological battery mentioned earlier. Covering these domains in our TBI assessments will ensure comprehensive, in-depth results regarding the TBI student's strengths and weaknesses which will in turn lead to the most effective remedial programming.

Second, we will use the Process Approach as the basis for our assessment framework since it seems the most likely approach to best capitalize on the testing experiences and skills of the school psychologist. Our "core" battery will closely simulate the typical battery used by many school psychologists and will consist primarily of a test of overall cognitive ability (a test of general intelligence) and an achievement battery. The Wechsler will be used as our primary core test. In addition to obtaining necessary information regarding the TBI student's intellectual profile, we will use this test essentially as a structured observation or screening instrument from which we will develop our hypotheses for further, more specific assessment.

Third, we will need to expand the "core" battery by: (a) learning how to look at what you are already doing using a "neuropsychological perspective" and (b) learning how and when to use supplementary tests/techniques in your assessment batteries to more thoroughly analyze the TBI student's strengths and weaknesses. Examples of each of these strategies may help clarify their application.

<u>Expanding Your Test Battery by Using a "Neuropsychological Perspective"</u>

This section could have also been named "How to get more out of what you're already doing." To demonstrate the principles behind the "neuropsychological perspective," let's use the following example.

Kaplan (1988) and others have published some interesting observations on the differences in performance on the WAIS-R Block Design subtest associated with damage to the left vs. the right hemisphere. Briefly, it involves observing the types of errors made by the individual during the task, rather than the score obtained. Individuals with left hemisphere brain damage tend to make errors on the interior details of a design, while those with right hemisphere damage tend to break the 2 x 2 or 3 x 3 gestalt of the design. These errors highlight the distinctive processing qualities of the two hemispheres. The left hemisphere tends to solve the problem sequentially by breaking the task into visual details (which are then assembled using the strengths of the right hemisphere). Thus, the damaged left hemisphere cannot properly sequence the interior details, but the intact right hemisphere continues to maintain the gestalt (See Figure 7).

If the right hemisphere is damaged, the interior details are basically intact but the damaged right hemisphere cannot assemble the details and creates something other than the

3 x 3 gestalt (See Figure 7). You may have had such performance differences in the past and wondered why.

There is another important point. Both incorrect constructions in Figure 7 result in the same score of 0. This brings to light the importance of observing how TBI students perform tasks (i.e. the type of errors made), not necessarily just the score obtained. Although Kaplan's work was developed from studies of adults, it seems logical that the basic principles would still be true for pediatric populations. (We will revisit the concept of error analysis later in this section.)

This is just one example of how it is possible to analyze the performance of TBI students using a slightly different perspective (i.e. derived from neuropsychological research) of tests and techniques in your current testing battery. Other examples will be highlighted as we go through the assessment techniques.

Expanding Your TBI Battery Using Supplementary Tests

Now we will discuss the concept of using supplementary tests to expand your testing techniques to include domains that are necessary for TBI assessments not often found in the typical school psychology battery. The domains specified earlier and those in the N.C. definition of TBI, i.e. cognitive, communicative, perceptual, behavioral, social-emotional, and/or physical abilities, will dictate what areas we will need to consider using supplementary tests. We know that intellectual functioning and academic achievement will be the areas most adequately covered by the current school psychology testing batteries. The areas identified earlier as not being adequately represented during routine school psychology assessments include:

- memory and learning;
- attention;
- language and communication;
- visuoperceptual, visuospatial, and visuoconstruction abilities;
- motor (fine motor) functioning;
- social-emotional functioning; and
- higher-order/executive functioning.

Supplementary tests/techniques will be addressed for each of the areas listed. Comments regarding a "neuropsychological perspective" in interpretation will be primarily confined to the cognitive/intellectual domain since this testing will represent the "core" of your TBI assessments. There will also be suggestions regarding the use of supplementary testing for the cognitive/intellectual and academic achievement domains.

It should be noted that the supplemental tests discussed in this manual are examples only! Your eventual choice should be made on the basis of several factors both personal and professional. Take a moment to analyze why you use the tests you presently use. Are these the only ones you were taught? The ones expected by your school system? Have you since added others? Why? Here are some factors to consider in choosing the supplementary assessment instruments or techniques you will use.

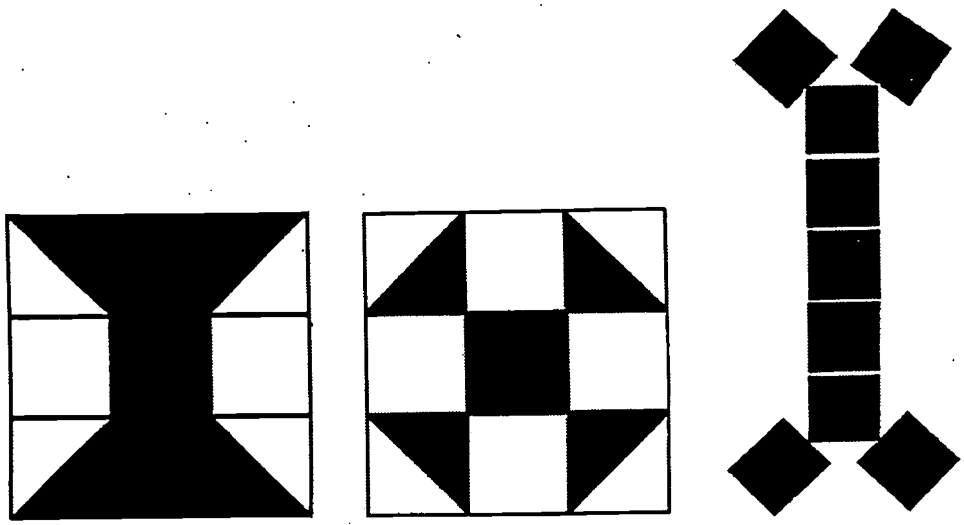

Figure 7.
Examples of right and left hemisphere injury on Block Design.

- **Personal comfort level:** There are probably certain tests you have been taught or learned yourself over the years in which you have great confidence.
- **Cost:** Who is going to pay for the new test(s)?
- **Time demands:** Note that although TBI assessments will take you longer than more routine assessments, many tests are fairly quick to administer without losing psychometric strength.
- **Psychometric quality:** Psychometric strength, reliability, validity, adequacy of normative data, etc., are extremely important. As you will see, however, many of the tests typically used by neuropsychologists (particularly those often used in the process approach) rely on observations as much as scores. Thus, while they may have less than desirable standardization, they may offer excellent opportunities to observe the individual's task strategies, etc. This is not to suggest that it is acceptable to ignore psychometric characteristics. What most neuropsychologists do is try to balance these less rigid techniques with more standardized tests.

With these caveats in mind, we will examine some examples of supplementary tests as we address each domain of our assessment framework. In addition, Appendix B contains descriptions of specific supplementary tests by category. In selecting supplementary testing instruments, the focus will be on those tests and techniques that (a) are reasonably psychometrically sound (and are suited to children), (b) require relatively short administration time, (c) do not require extensive training to administer and interpret, and (d) are typically used in the school setting and/or educational evaluations.

(Note. To be effective in assessing brain injury survivors you must stay abreast of new developments in the field.)

— Specific Assessment Techniques for TBI Students —

Using the domains outlined in the N.C. definition of TBI as our framework, we will explore each domain using the two basic approaches to expanding your TBI assessment battery: (1) interpreting what you are currently doing a little differently - "the neuropsychological perspective," and (2) looking at supplementary tests to cover areas not currently included in your assessment battery.

In the Process Approach, it is common to first administer a "core" battery, moving to more specific, sometimes called satellite, tests/techniques depending on what we uncover with the core battery. The suggested core battery for your purposes is comprised of those tests found in the typical assessment battery (e.g. intelligence test, achievement test, and visuoconstruction screening). From the core battery we will move to more specific measures if necessary. For our purposes, the age-appropriate Wechsler will be the core measure of general cognitive/intellectual functioning. In addition to providing the requisite IQ scores, the Wechsler will be used as our screening measure to determine areas which we may want to pursue in depth. (The WISC III, WAIS-R, or WPPSI-R will be referred to as "Wechsler" to save time. Also, in the interest of saving time, each individual mention of a Wechsler intellectual assessment instrument will not be referenced.)

Domain I. General Cognitive/Intellectual Functioning

This domain is sometimes referred to as Global Functioning and consists primarily of intelligence testing using such instruments as the Wechsler series, the Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983), and the Stanford- Binet Intelligence Scale (SB IV; Thorndike, Hagen & Sattler, 1986). In addition to these tests, many neuropsychologists include tests of "higher order/executive functioning" usually associated with the frontal lobes because of the influence of these functions on overall cognitive functioning.

We will focus on the Wechsler since it is probably the most widely used instrument in the school psychologist's testing battery. In addition, the children's versions of the Wechsler have been found to be very sensitive to the effects of brain injury (Boll, 1983; Rutter, Chadwick & Shaffer, 1983). This focus will also allow us an opportunity to discuss the neuropsychological perspective with respect to performance on the Wechsler.

(Note. Although the Wechsler will be used in the examples of how to obtain and interpret useful data with regard to TBI effects, the basic principles involved will probably apply to other instruments, such as the K-ABC. For a review of the K-ABC in screening for brain damage in children, see Franzen & Berg, 1989.)

The Wechsler as a Screening Instrument for TBI

The Wechsler is a very comprehensive, psychometrically sound instrument that can offer us a great deal of information above and beyond the scores we obtain. In fact, for the TBI student, the usefulness of the scores may be rivaled or exceeded by the value of the information we obtain from our observations of how the student performs on these tests. There are instances when the scores alone may even serve to mislead us regarding the abilities of the TBI student.

For our purposes, the Wechsler will serve two functions. First, it will provide objective data regarding the global intellectual functioning of the TBI student - Domain I. Of equal importance, however, will be the use of the Wechsler as the primary instrument in our core battery to screen for clues about which cognitive areas need further, or more focused assessment.

There are at least four major assumptions in considering the use of the Wechsler as a screening instrument for the effects of brain damage. These assumptions reflect the application of the "neuropsychological perspective" in the interpretation of your test results.

Premise 1. **The Wechsler contains diagnostic clues about most, if not all, the domains found in a typical TBI assessment battery.**

At first this seems like an overstatement; however, the Wechsler (and most other global batteries of intellectual ability) are actually just structured observations, and it is how we choose to use the information that is important. An example will demonstrate this point. Although there is no formal measure of memory retrieval on the Wechsler, there are subtle indications of this type of problem on many of the subtests. Poor performance on the Vocabulary subtest can suggest problems in long-term memory storage (note that this may be specific to verbal material only), or it can suggest problems in long-term memory retrieval. We will see other examples of this premise as we continue our discussion of the Wechsler as a screening instrument.

Premise 2. **The Wechsler Verbal and Performance scales emphasize the skills and abilities that are primarily associated with the left and right hemisphere respectively.**

To a great degree, the skills and abilities necessary to perform well on the Wechsler Verbal scale are housed in the left hemisphere and those necessary for successful completion of the Performance scale subtests reside in the right hemisphere. Thus, if you have a TBI student with well documented left hemisphere brain damage, you should expect that student to have more difficulty, in general, with the Verbal scale subtests. We must also consider the effects of other factors such as disrupted memory, slow processing, stage of recovery, etc. before drawing final conclusions.

Premise 3. **The "score" one obtains in a particular subtest may not be as important as the manner in which the individual approached that task or in the types of errors made.**

The testing techniques in the Process Approach do not differ markedly from those used by most school psychologists. The major differences between these two approaches lies in the interpretation of the testing results and the observations made during the testing. Careful analysis of errors can add to your understanding of the TBI student's specific difficulties. The nature of the errors can reflect specific impairments.

Premise 4. To get the full benefit of the Wechsler as a screening instrument, it will be necessary to modify some tasks and/or the administration of these tasks.

What follows is a breakdown of the major sources of assessment data (i.e. Full scale, Verbal and Performance scales, and individual subtests) in terms of (a) the probable effects of TBI that you can expect to see, and (b) some suggested administration modifications to test the TBI student's functional limits in order to obtain more data.

Effects of TBI on Full Scale, and Verbal vs. Performance Functioning

There are a great many studies demonstrating the effects of brain injury on Wechsler performance. We will limit our discussion to only a few of the primary findings. (For additional information on the effects of TBI on the Wechsler tests, see Lezak, 1995, or Franzen & Berg, 1989.)

In general, diffuse or multifocal brain injury will have a generalized effect on intelligence test performance (i.e. full scale IQ score) whereas more focalized brain injury (i.e. left vs. right hemisphere) will tend to affect Verbal vs. Performance scale IQ scores respectively. The generalized effects of diffuse or multifocal damage are often seen either early in the recovery process or in those survivors with severe TBI (Spreen et al., 1995). Thus, it is important to know when the TBI occurred before making judgments regarding a student's IQ test performance.

It is generally accepted that there is a correlation between injury severity and global IQ scores (Goldstein & Levin, 1985). Length of coma, a primary prognosticator of severity, appears to be related to global intelligence test scores. In one study, children in coma for 24 hours or more demonstrated below average IQ scores (85 or below) 6 months after their TBI (Levin & Eisenberg, 1979). TBI severity is a factor also. In mild to moderate injuries, however, steady improvements in global intelligence test performance have been recorded up to 5 years post-injury (Spreen et al., 1995). Klonoff, Crockett, and Clark (1984) found the Wechsler Full Scale IQ score to be more predictive of long-term cognitive impairments than length of coma.

In terms of **Verbal IQ vs Performance IQ** scores, it is widely accepted that injury to the left hemisphere will impact Verbal IQ more than Performance IQ. The reverse is true for right hemisphere brain injuries. Typically, the TBI student will demonstrate higher Verbal then Performance IQ scores early in the recovery stage due, in part, to the aforementioned "old memory" demands of the Verbal scale subtests. This discrepancy, however, tends to disappear approximately one year post-injury (Lehr, 1990).

Be aware that it is fairly common to get Verbal-Performance discrepancies on the Wechsler with no brain injury pathology. Kaufman (1979) has shown that 43% of "normal" students will have Verbal-Performance discrepancies of 10 points. Many brain injury professionals do not consider the Verbal-Performance discrepancy meaningful until it reaches 15-20 points. Even then it is often difficult to find sufficient evidence of any brain dysfunction to account for the discrepancy.

In most cases of closed head injury (and many open head injuries as well), the damage to the brain is diffuse, meaning that both hemispheres will probably be compromised to some degree, particularly early in recovery. The effects of diffuse damage will be evident on the Wechsler through such things as "flat" scoring profiles reminiscent of the patterns found in low functioning students. These findings can be very misleading. TBI students have been placed in EMR or TMR programs on the basis of such results. As these kinds of results can be common in the initial stages of recovery, it is important to determine when the injury took place. Generally speaking, it is possible to evoke "spikes" in performance through extensive limit testing. If it is possible to obtain such responses, it is likely that the results you are getting (i.e. the flat profile) are inaccurate. If, on the other hand, the TBI occurred some time ago (more than two years), the results may be accurate. This flattening of scores is more common in instances of severe TBI.

If the assessment is done within the first six months or so after the injury, it is quite possible for a TBI student with left hemisphere damage to do better on the Verbal Scale than on the Performance Scale, the direct opposite of what you might expect on the basis of what you know about the site of the brain injury. This is one of the "myths" that often prevent TBI students from receiving appropriate exceptional services. On the first full testing after their injury they will often do quite well on the verbal sections of the testing. When tested again after 6 months or a year, however, their verbal skills appear to have dropped. The explanation lies in the fact that the Verbal Scale on the Wechsler is generally made up of old, overlearned material, whereas the Performance Scale is primarily made up of new and novel tasks. On top of this, most of the Performance tasks are timed, a serious handicap to TBI students who generally need additional time to complete tasks due to slow processing. Thus, TBI students will often test at or close to their pre-injury full scale IQ levels (or assumed levels) because their Verbal scale scores tend to mask the true picture of their cognitive impairment.

Future assessments with the Wechsler will require that the TBI student make a year's gain in a year's time to keep up with age-based normative data. If you were to test this same student again in two years, you might see what appears to be a significant drop in Verbal scale performance. Although the TBI student may not have lost any intellectual ability, the age-based nature of the instrument demands that the student show increases in ability to maintain previous scores.

There is an easy way to check this phenomenon. Compare the responses at the item level of the two Wechsler protocols. What you may find is that the level of the TBI student's responses on both protocols is very similar even though a significant time period has passed. The student's intellect hasn't developed in keeping with his or her increasing age. TBI students are often unable to continue gaining new information at a normal pace because of new learning problems resulting from the TBI.

__Some general comments about limit testing/administration modifications.__ One technique used to get additional, specific information beyond the "score" one obtains from a particular testing instruments is known as "testing the limits." This technique often involves modifying the administration of some items. Testing the limits can be a particularly important technique for the school psychologist faced with the task of converting test findings into classroom interventions.

There are no specific guidelines for this technique, but the general procedure is to return to a subtest or item once the standard administration of the test has been completed and then readminister items using administration variations designed to clarify the nature of the deficit(s). The idea is to see if the individual being tested can improve his or her performance under different circumstances. This can be of great value when developing remedial programming for TBI students. As an example, it is common for TBI survivors to suffer from slow processing. This can be particularly troublesome during timed subtests such as those found on the Wechsler Performance Scale. By allowing the TBI student unlimited time to complete the subtest (successfully or otherwise), you can see how much the timing itself accounted for the score on the subtest or if there were other factors affecting performance.

It is possible, of course, to do this during the initial administration of the test. This approach should be avoided for several reasons. Most importantly, administration modifications such as permitting a slow processing student more time than is called for on an item alters the standardization (even if you score the item after the allotted time has expired). Keeping in mind the fatigue factor, giving extra time during timed subtests extends the overall testing time. There is the danger of "wearing the student out." Finally, there is the risk of changing the expectations of the student such that he or she may assume these limit testing modifications will occur on every item. Such an expectation might alter the way the student responds thereafter, or if he or she responds at all.

In general, limit testing should only be done after completing the standardized administration of an instrument. The only exception to this may be in testing situations with TBI students who have significant memory disorders and/or who are in the early stages of recovery. In these cases, you may have to do your limit testing while administering the test, since many of these students may be unable to remember which strategy they employed and why.

To avoid any chance of training effect, use only a few items from those subtests which gave the student the greatest difficulty. You will probably need only a few items to assess the impact of limit testing and to get information regarding possible intervention strategies. Since limit testing with TBI students demands adequate knowledge of both the instrument and brain injury, the techniques are best used under the supervision of an individual with appropriate training. Obtaining additional information regarding the student's approach to the tasks will help you focus the remainder of the assessment, perhaps using supplementary testing instruments.

Limit testing in neuropsychological assessment has been objectified somewhat by Kaplan, Fein, Morris, and Dellis (1991).

A frequently used administration modification during limit testing is the clarification of the task demands. This is particularly important for the TBI student since brain functions related to communication (input and output) are commonly compromised. Rephrasing the questions or instructions in different ways may allow the student to better understand the task. This will allow you to verify whether or not comprehesion of instructions is impaired. Never assume that the TBI student understands what you're saying! TBI students get very good at "faking" understanding due to embarrassment. Always check by asking the student to repeat the question or instruction.

Another general limit testing technique with TBI students involves questioning regarding strategies employed. This technique should be done after the testing is completed. Simply ask the student how they did the task. The student's preferred strategies will provide important remedial clues.

Effects of TBI on Verbal Scale Subtests

Although the effects of left hemisphere brain damage affect the **Verbal scale subtests**, some of these subtests are more vulnerable to these effects than others. As an example, while left hemisphere damage can have a serious affect on the Arithmetic subtest, the first few items involving counting objects can be affected by right hemisphere damage also due to the visual demands. Interestingly, **Information, Vocabulary** and **Comprehension** are among the least affected by diffuse or bilateral (both hemispheres) damage. TBI students often do well on these subtests in spite of significant deficits, because these subtests make use of "old," typically spared memory. For this reason, these subtests are often used as rough estimates of premorbid (preinjury) intellectual levels. All three are not, however, equally invulnerable to left hemisphere damage. In general, brain injured individuals tend to make lower scores on Comprehension than Information or Vocabulary. This is probably due to the complexity of the demands on the Comprehension subtests involving functions other than memory.

Similarities tends to be more sensitive to the effects of brain injury than Information, Vocabulary and

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The Wechsler Adult Intelligence Scale-Revised Neuropsychological Instrument (WAIS-RNI; Kaplan et al., 1991) — In this instrument (or system) the authors attempt to organize many of the limit testing modifications of the WAIS-R suggested in the research with brain-injured individuals into a set of structured test procedures. The WAIS-RNI allows the examiner to test the limits in an organized, systematic yet flexible fashion. For example, there are Information, Vocabulary, Comprehension and Similarities subtest multiple choice options that can be used during a second (testing the limits) administration. Using a multiple choice format allows the examiner to test for memory retrieval problems via the cuing inherent in the multiple choice. In another example, the Block Design subtest differs in that 12 rather than 9 blocks are provided. This gives the individual more opportunity to make the mistakes that may suggest left or right hemisphere brain damage (Lezak, 1995). As of this writing, Kaplan is developing a version of the NI to accommodate the WISC III. (See Appendix C for orderinginformation on the WAIS-RNI.)

Comprehension, regardless of the location of the damage. (Again, probably for the same reasons as the comprehension subtest.) Specifically, low Similarities scores are associated with left temporal and frontal lobe damage (McFie, 1975; Newcombe, 1969). Responses can become very literal and concrete on the Similarities subtest as a result of TBI. You are much more likely to get one-point responses than the more abstract two-point responses.

Although the **Digit Span** subtest has been widely recognized as a test of short-term memory, it is so brief that the attentional demands are minimal. In addition, it can be affected by many factors other than memory (Franzen & Berg, 1989). Poor Digits Backward performance is associated with brain injury because of the greater complexity of cognitive demands (Golden, 1981). Because it involves many abilities other than arithmetic such as memory, auditory discrimination, auditory attention, and poor performance, the **Arithmetic** subtest may not signal dysfunction in mathematical ability. Generally, however, low scores will accompany left hemisphere damage (Golden, 1979).

Some limit testing suggestions specific to the verbal scale. Before discussing specific limit testing suggestions, it seems important to say a few words about test **specificity**. In spite of what you may have been taught, the individual subtests in any intelligence battery (including the Wechsler) do not measure **specific, discrete abilities**. This can be demonstrated using a relatively straightforward subtest such as the Wechsler Coding subtest. The Coding subtest is generally considered to be a test of psychomotor ability; however, motor speed, visual memory, organization, sustained attention, visuo-motor coordination, and vision are just a few of the abilities necessary to successfully complete this subtest. When a student does not do well on this (or any other) subtest your job is to uncover which of the typically complex abilities contributed to the lack of success. To do this may involve supplementary testing as well as limit testing.

As an example of the use of supplementary testing, the **Symbol Digit Modalities Test** (SDMT; Smith, 1968) could be administered as a way of clarifying the contribution of writing deficits performance on the Coding subtest. The SDMT is very similar to the Coding and Digit Symbol subtests except that the symbols and numbers are reversed. The student does not have to draw the symbol but rather list the number of the symbol in the empty boxes. This relatively small but clever change allows you to administer the test in both written and oral formats. By observing the difference between oral and written performance on the SDMT, you can estimate the effect writing demands have on overall performance. This can be a significant finding since it is not unusual to find that TBI students have difficulty with written task demands due to the fine motor demands involved in writing. TBI students often have to put so much effort into the motor demands of the task that they are unable to focus on any other aspect.

Returning to the issue of limit testing, the following suggestions will allow you to gather more specific information regrading the TBI student's deficits. You should try to experiement with your own modifications once you begin to get comfortable with the principles involved.

Although there are some unique qualities to each of the Wechsler subtests, the principles behind the limit testing and administration modifications will be somewhat similar. In general, these techniques are attempts to clarify problems commonly found in TBI students including:

- memory difficulties;
- attention problems;
- slow processing;
- motor difficulties;
- communication difficulties; and
- input/output mode difficulties.

As an example, **memory retrieval difficulties** on the Information, Vocabulary, Comprehension, and Similarities subtests can be clarified through a multiple choice format such as is found on the WAIS-RNI. If the student can respond correctly after the **cuing** provided by the multiple choice format, it would suggest that the information was registered in long-term memory and the difficulty was, instead, in the retrieval process. (More on this later.)

Multiple choice formats also have the advantage of reducing the **oral communication demands**, since the student can indicate an alternative using minimal communication. You can make these multiple choices up as you test the limits on specific items. You can give more obvious cues if necessary such as prompting the student with the first letter or sound of the correct response. You only need to do this on a few items to get some notion of what seems to facilitate the student's performance.

Extending time limits will give you information as to whether or not students with processing difficulties actually do know the correct response but cannot get it out in time. **Continuing beyond the cut-off** item on subtests will tell you if they can do what the test is calling for despite missing earlier items for other reasons such as inattention.

The following specific modifications are suggested for selected subtests. The **Information** subtest is basically a measure of knowledge acquisition and retention, although other abilities are involved as well (Lezak, 1995). If the TBI student has a weakness on this subtest, your task is to find out which of these factors - acquisition or retention - is not functioning correctly. Suggested limit testing modifications for the Information subtest might include spelling out some of the more obscure concepts. If the Information is the first test administered in the core battery (e.g. before the visuoconstructional task or achievement test), and you have any concern about adequate rapport, simply readminister the subtest after the testing is completed to test the rapport effect (you cannot use the score, however). You may be getting a "cold start" effect. A second administration will usually answer this question. It is also effective to continue beyond the standard number of items answered incorrectly to see if the student can respond correctly to more difficult items. Be careful, however, to avoid overly frustrating the student during this procedure.

On the **Vocabulary** subtest, varying the input mode by allowing the student to read the words may facilitate the student's response and give you valuable programming information as well. Asking the student to write the words down may help those with severe memory difficulties who may forget the word as they are attempting to find a meaning. Another way to check the memory retrieval hypothesis is to go back after completing the standardized administration and "pull" on those words the student may have missed. You can do this by cuing or, even further, providing multiple choice possibilities (see the info box on Kaplan's WAIS-RNI on page 59 for more on multiple choice formats). If the student can recall the meaning of the word with cuing (regardless of the degree of cuing), the problem is likely to be retrieval rather than long-term memory. Do not do this on all missed vocabulary items; you will risk spoiling the subtest for future testings. One or two words will give you enough of a clue to pursue the hypothesis in more depth through supplementary memory testing.

Comprehension is essentially a measure of verbal reasoning that requires "playing" with factual information as opposed to simple factual regurgitation as found in the Vocabulary and Information subtests. Make note of attentional problems on those items that are longer than others. Keep in mind also that Comprehension is the best subtest for content interpretation, because some of the questions ask for social judgment (Lezak, 1995). Responses to comprehension items can provide valuable information for social-emotional functioning. Try to get the student to work through a solution to a comprehension item by strategizing out loud. This technique will give you an opportunity to insert cues and to observe the reasoning process in detail. (I will typically introduce this by saying " Let's try this one together, but this time I want you to tell me where you're going and what you're thinking. You start, and I'll do some also." This technique also works well on the **Arithmetic** subtest.)

The **Similarities** subtest is a test of verbal concept formation and reasoning. TBI students will have greatest difficulty learning (and remembering) the task demands. Limit testing will give you an opportunity to go outside the standard instructions in clarifying the demands of the subtest to get a better view of the TBI student's verbal concept formation. It will also allow you to pull for better quality responses. Even though you cannot use this data in the scoring, the information can be very helpful in developing a remedial program for the student. It is also a good strategy to ask the student to explain incorrect or unusual responses to get some feeling for reasoning ability.

TBI students may have to write out the **Arithmetic** subtest problems due to short-term memory or attention deficits. Allowing them to do so will give you valuable remedial clues. This procedure will also allow you to observe the student's writing and, if the problem is worked out on paper, his or her strategy or approach to the tasks. Another way to compensate for memory is to have a few beginning level questions typed on cards. Allow the student to read the problem to see if this facilitates correct responses.

<u>Effects of TBI on Performance Scale Subtests</u>

Before we discuss the effects of TBI on specific performance scale subtests, we should consider the general effects of visual disturbances caused by TBI, such as hemianopsias (field cuts). As discussed earlier, visual defects are common in TBI. Unfortunately, they often go undiagnosed as well. You can detect a visual field defect such as left hemianopsia (a field cut to the extreme left peripheral field) by noting the TBI student's approach on many of the

Performance subtests. Picture Arrangement provides such an opportunity. Once you have placed the cards, notice whether or not the student tends to ignore (or not "find" until the last moment) those cards placed out to the extreme left or right. This behavior can be an indication of a field cut. This deficit can also present itself on the Coding subtest where the student does not fill in boxes to the extreme left or right. Also, be aware of "special adjustments" made by TBI students to avoid such mistakes. Often, they have taught themselves to "over scan" to one side or the other to compensate for a field cut.

In general, Performance scale subtests are vulnerable to right hemisphere brain injury; however, **Picture Completion** appears to be the least vulnerable to TBI (Lezak, 1995; Franzen & Berg, 1989). Because of this, Golden (1981) felt that the picture completion subtest may be the best single estimate of the student's preinjury functioning. The functions demanded by the test appear to be located in the right posterior hemisphere (Lezak, 1995). Unlike Picture Completion, **Picture Arrangement** appears to be vulnerable to brain injury in general but more so with right hemisphere injuries. Poor performance on this subtest has been shown to be associated with right temporal lobe damage (Dodrill & Wilkus, 1976; Piercy, 1964).

Of all the Wechsler subtests, **Block Design** is recognized as the best measure of visuospatial organization (Lezak, 1995). The abilities needed to perform this task are found primarily in the right parietal region of the brain. Brain injury in general can also affect this subtest due to the speed component. Right and left hemisphere damaged individuals tend to make more errors on the contralateral side of the design (Lezak, 1995). In other words, right hemisphere damaged students will make mistakes on the left side of the design, and vice versa. Error analysis is an important feature when using the Wechsler, and there is no better demonstration of this analysis than on the Block Design subtest.

Like Block Design, the **Object Assembly** subtest is vulnerable to diffuse brain damage due to the speed demands. As with Block Design, this subtest is served by the right parietal regions of the brain. Error analysis is also applicable to performance on this subtest. Left hemisphere damaged individuals tend to employ edge or contour strategies and are able to solve designs with these characteristics (e.g. the horse) more readily. Right hemisphere damaged students, on the other hand, tend to make errors of contour, such as constructing odd looking horses with pieces aligned incorrectly (Kaplan et al., 1991).

Some limit testing specific to the Performance scale. As a general rule, modifying the time demands on the Performance subtests should be attempted first. This will allow you to eliminate the time variable and give you information regarding the student's ability to perform the task without speed constraints. The effects of frontal lobe damage can sometimes be observed in the manner in which the student attempts to solve the Block Design and, to a lesser degree, the Object Assembly subtests. The Block Design items begin with the lines clearly shown on stimulus cards, which are left out in the later, more difficult designs. Since the frontal lobes allow us to organize stimuli, damage may prevent or weaken the TBI student's ability to "organize" the design without lines. Kaplan (1988) devised a compensation mechanism which consists of a clear piece of plastic with lines drawn on it the same size as the Block Design images. During limit testing, you can place the clear piece of plastic over those designs with no lines to see if the added organization assists the student in completing the design. If the student is successful with the added structure it may suggest that frontal lobe damage has affected organizational ability, and further that structure will allow this student to perform better on visuoperceptual and/or visuoconstruction tasks.

(*Note.* *I once tested a young TBI student, who when shown the Block Design stimuli, put her hand on the design stimulus, covering all but one square. She would then take a block and place it. She then placed her hand on the picture again, this time covering all but the block she had placed and the one next to it. She repeated this procedure until she successfully completed the design. This accomodation appeared to be her way of compensating for an organizational deficit probably caused by frontal lobe damage.)*

A good practice in limit testing on the **Picture Arrangement** subtest is to have the student explain the story behind the arrangement of the cards on failed items (or those you feel the student arrived at by chance). This technique will allow you to check the student's strategy (if any) in organizing the sequential stimuli. If the story is logical but the arrangement is incorrect it can suggest visual sequencing difficulties. If the arrangement is correct but the story is illogical, it suggests a reasoning deficit (Mapou & Spector, 1995). For **Picture Completion**, allowing more time per item is an effective technique. If the student points out an insignificant characteristic during the limit testing stage, request him or her to find

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Error analysis — A more subtle approach to observation can be made by analyzing the errors made on visuoconstruction tasks such as the Wechsler Block Design subtest or any drawing task. In general, individuals with damage to the left hemisphere (which can result in a right visual field problems) will start constructing the designs on the left (the good visual field) and make more errors to the right side (the damaged visual field) of the design or drawing. The opposite will be true of individuals with right hemisphere damage. It's always a good idea to note which side the student starts the design replication or drawing. Most individuals normally start on the left side of the design (or drawing) regardless of handedness.

Kaplan (1988) suggests that it is also possible to detect the presence of left vs. right hemisphere brain damage by carefully observing the nature of errors on drawing and construction tasks. As an example, a TBI student can proceed along many different paths in completing a Block Design item, all of which may result in a score of 0. Even though the "score" for these different approaches would be the same, the strategies used are very different and potentially very informative. Kaplan indicates that errors made within the outside configuration of a design or drawing will suggest left hemisphere damage. Disruptions in the outside "gestalt" of the design or drawing will suggest right hemisphere damage. As an example, many students "break" the gestalt of Block Design items (e.g. the 3 X 3 square), creating designs violating the 3 x 3 gestalt. TBI students who make this type of error will tend to have right hemisphere damage. Interior errors, those in which the 3 x 3 gestalt is intact but the blocks have been placed incorrectly, are more likely to be caused by left hemisphere damage. The second replication has broken the gestalt. Blocks are not in the 3 X 3 square. These are inferences, of course, but they may help to confirm reported damage or they may suggest other, perhaps unnoticed areas of damage. The following case note demonstrates this latter issue.

Case Notes

UNDIAGNOSED CONTRACOUP EFFECT — ***Peter, a fifth-grade student with a long-standing TBI, had been having difficulty in his school work in the area of reading comprehension. His TBI history was well known to school personnel, having been injured at the age of 2 after being thrown from a moving vehicle. At the time of his injury, he was diagnosed with a depressed right parietal skull fracture and left side weaknesses in his extremities. Early in his school career he showed deficits in visuoperception and construction, particularly on drawing tasks. At the time of the injury, skills normally associated with left hemisphere functioning (e.g. language) appeared to be spared. From about the third grade on, however, as language demands increased in school, his parents began to notice difficulties with language-related academics such as reading. In spite of his documented TBI, he was not placed in an exceptional program, primarily because he did not appear to need special education. At the request of his mother, Peter was referred for school-based evaluation. An error analysis of Peter's performance on the Block Design subtest clearly showed interior errors as opposed to the expected gestalt errors. This, along with other language-related testing errors, established the strong possibility that Peter's TBI may have been more extensive than first thought. There was evidence of left hemisphere damage, probably from an undiagnosed contrecoup effect during the initial accident. Often, the search for more subtle effects of TBI stop after other, more obvious (and perhaps at first more life-threatening) damage has been discovered.***

another important thing that is missing (don't do this on more than one or two items, however). It is also important to ask the student to explain responses that are illogical, in order to test his or her reasoning.

The **Coding** subtest of the Wechsler is often regarded as a test of visuoconstruction ability. While it is recognized that this ability enters into successful completion of this subtest, to "score" well on this subtest the student needs to work quickly (motor speed) as well. The responses themselves do not need to be particularly well done, in terms of quality. In these situations, you should comment on the quality of the reproductions in your report, since this issue may help you support a hypothesis on fine motor control. Students who score well on this subtest generally have committed many of the symbols to memory partway through the task, which greatly aids the speed of their responses. Thus, this test is probably more a test of visual memory, particularly incidental memory (more on incidental memory later) and motor speed, and not what we typically think of as visuomotor ability.

(Note. The best limit testing and modifications come from the examiner at the time of the testing when all the factors are "on display." You should always try out new "hunches" during the limit testing period. "Pulling apart" these subtests in this manner will help you analyze the specific weaknesses a TBI student has, which can be masked by the fact that most of the subtests demand a combination of abilities. What you are doing, in effect, is a "mini learning experiment" to uncover as clearly as possible what the student cannot do and what can be done to help him or her do it better.)

Measures of Higher Order/"Executive" Functions

Higher order/executive functions are integral to general cognitive functioning and serve to mediate our overall response patterns. These functions are housed primarily in the frontal lobes. In general, they include: (a) problem-solving abilities such as reasoning, planning, and organization, (b) flexibility in thinking, and (c) the ability to profit from feedback. Careful observation during the administration of the Wechsler will reveal the role these functions play in performance. As an example, verbal reasoning is demonstrated on the Similarities and Comprehension subtests, while non-verbal reasoning can be observed on the Picture Arrangement, Block Design and Object Assembly subtests. If the Wechsler performance suggests higher order/executive disorders, tests designed specifically to elicit information on these functions should be considered. Samples of such tests follow.

The **Wisconsin Card Sorting** Test (WCST; Heaton, Chelune, Talley, Kay & Curtiss, 1993) and the **Category** Test (Reitan & Wolfson, 1993) are both measures of flexibility of thinking (also referred to as the ability to change mental sets) and the ability to profit from feedback. How much either of these instruments measures frontal lobe functioning is still being debated in the research literature. Perhaps of more relevance, they do appear able to measure deficits in flexibility of thinking, i.e. being able to effectively use feedback in making necessary alterations in approaching a cognitive task. Individuals taking such tests must use minimal feedback effectively as well as remember both the feedback and their previous performance patterns. Students with problems of inattention and/or memory will have difficulty with these tasks. Of the two, the WCST can be administered and scored more quickly. Since the WCST reportedly correlates well with the Category test, it may be measuring similar abilities. Also, there is a computerized version of the WCST available (see Appendix B). Spreen and Strauss (1991) report normative data on the WCST for children ages 6 through 12.

Another option for measuring executive functioning is the **Controlled Oral Word Association** (COWA) test (also called Word Fluency and FAS tests). There are no specific materials required for this test aside from a piece of paper to record the responses of the subject. There are children and adolescent norms for this technique in Spreen and Strauss (1991). The COWA is actually considered to be a test of language fluency, but since it emphasizes initiation in control of language, it has implications for frontal lobe functioning as well.

Keep in mind that there does not appear to be any universally accepted measure of frontal lobe functioning. This diagnosis is characteristically made on the basis of different data sources, using tests such as those just described (often all three), interviews and medical histories, and observations. Most symptoms of higher order/executive dysfunction, will be readily observed during your assessment. These instruments and others purported to measure higher order functions can be administered to support your hypotheses (or perhaps to refute the fact that what you are observing does not appear to be related to frontal lobe damage).

(Note. There is sufficient evidence to indicate that the functions associated with the frontal lobes do not mature until late childhood/early adolescence. Even though there is documented damage to the frontal lobes in the medical history, the effects (if any) may not present themselves in a young child's test

performance. In such cases, it is best to rely on observations. These observations should be conveyed to those who will be involved in further observation and programming as the child becomes older.)

Summary: Domain I

The cognitive/intellectual domain represents the starting point for your TBI evaluations. The age-appropriate Wechsler will serve as both a measure of general intelligence and as a screening instrument to determine which areas of general cognitive ability you need to pursue further in your assessment. There are some basic assumptions surrounding our use of the Wechsler that enhance its value as our core instrument in TBI assessment. The Wechsler: (a) can provide clues to abilities in many areas of functioning, (b) allows us to look at basic functioning differences between the left and right hemisphere, (c) provides a structure which allows us to observe *how* a student approaches various tasks, and (d) with some modifications in administration, can help us gain even more information on the student's cognitive strengths and weaknesses.

The information provided by the Wechsler can be analyzed on various levels corresponding to the levels of the instrument itself. The Full-Scale scores allows you to see the impact of the TBI on general cognitive ability. Individual subtest performance may allow you to assess the effects on more specific areas of brain functioning. Limit testing and error analysis can give you additional clues to specific areas of impairment that can be assessed further using supplementary testing. Tests of higher order/executive functioning allows you to assess impairments in general task-approach skills mediated by the frontal lobes that may be affecting general cognitive abilities.

Domain II. Language Functioning

There is perhaps no single more important area in our lives than the ability to communicate. Unfortunately, our communication abilities are a function of many interrelated elements of language. Damage to any one of these elements can compromise the TBI student's ability to communicate. While a thorough analysis of all the various elements of language is beyond the scope of this manual, we will address some basic issues in language assessment. For the purposes of this manual, it will be assumed that this testing will be done by the school psychologist, although in many instances this aspect of the overall assessment will be completed by other specialists most likely a speech and hearing specialist.

(Note. Before assessment of language reception/comprehension can begin, you should establish that basic hearing and auditory discrimination abilities are intact. A very informal assessment of these skills can be accomplished by standing behind the student and simply rubbing your fingers together close to the student's ear. Alternate ears and then do both sides simultaneously to see if the student can discriminate the direction of the rubbing sound. The student should have no difficulty doing so. This technique is a very gross measure and should not replace an appropriate hearing evaluation. A quick measure of auditory discrimination, which is much more complex than the basic ability to hear, can be obtained using tests such as the Wepman Auditory Discrimination Test (see Appendix B).

If you still have concerns about the student's hearing/discrimination processes, the student should be referred for an audiological evaluation.)

Communication is a very broad concept that is made up of many individual functions. In testing for language and communication difficulties it is best to separate these concepts into functions that can be more readily assessed. A convenient functional way to sub-divide communication is written vs. oral, and expressive vs. receptive. As an example, comprehension of written vs. spoken language might be an effective paradigm to screen in a TBI student since these concepts readily generalize to the classroom.

Be sure you have carefully analyzed past evaluations, medical records, and past teacher reports, to see if there are any indications of communication disorders. You will need this information to judge how much depth you should go into in testing the student's communication and language functioning. If you know from the TBI student's records that language is a problem area, be prepared to go into some depth in testing this domain. In addition, you may have observed language difficulties in the administration of the Wechsler or during the history taking interview.

Some examples of test instruments to assess language and communication follow. Remember, it is not important whether or not you agree with the specific instruments chosen here but rather that you attempt to isolate individual components of communication abilities such as the aforementioned oral reception and expression, and written reception and expression.

(Note. Ylvisaker, Hartwick, Ross, & Nussbaum [1994], provide an excellent overview of language assessment in Chapter 4 of their book Educational Dimensions of Acquired Brain Injury, Chapter 4. See the references at the end of the manual.)

General Measures of Language Functioning

Unless past information suggests very specific language difficulties on which you can focus, it's probably best to start with a general measure of language functioning. Estimates of general language functioning can be obtained using batteries such as the **Clinical Evaluation of Language Fundamentals-Revised** (CELF-3; Semel, Wiig, & Secord, 1987) or the **Detroit Test of Learning Aptitude-Third Edition** (DTLA-3; Hammill, 1991). Instruments such as these will provide an overview of the student's language functioning with respect to oral vs. written, and receptive vs. expressive strengths and weaknesses. An advantage of these instruments is that many of the elements of language functioning and communication can be isolated through the various subtests.

Specific Measures of Language Functioning

Once you have completed the general language assessment and/or you had prior data to allow you to focus your assessment without the general assessment, you can then move to more specific assessment.

Language reception can be assessed by carefully noting responses to tests allowing non-verbal responses such as the **Performance subtests of the Wechsler** (particularly those with lengthy instructions, such as the Block Design or Object Assembly subtests). Supplementary tests that can offer opportunities to observe reception and comprehension of language include the **Token Test for Children** (DiSimoni, 1978), and the **Receptive One-Word Picture Vocabulary Test-Revised** (ROWPVT-R; Gardener, 1985) or **Peabody Picture Vocabulary Test-Revised** (PPVT-R; Dunn & Dunn, 1981) for older students. Note that the Wechsler subtests and the Token Test tap syntax comprehension while the ROWPVT and PPVT-R measure single word comprehension.

Expressive language (also called speech production in some neuropsychology texts) can be measured in a variety of ways. As an example of a formal measure, the **Expressive One-Word Picture Vocabulary Test-Revised** (EOWPVT-R; Gardener, 1990) is also a good measure for younger children. (Incidentally, tests such as the EOWPVT and ROWPVT or PPVT-R can also serve "double duty" in detecting word-finding problems.)

Expressive language can perhaps most easily be assessed informally during testing or interviewing through careful observation of speech problems often associated with TBI. These symptoms include:

- articulation problems, particularly those associated with speech muscle weaknesses;
- phonatory weakness (e.g. speech volume, quality, etc.);
- impaired prosody (e.g. pitch variation problems, etc.); and
- unusually slow or rapid rates of speech.

(Ylvisaker et al., 1994)

Another technique might include a repetition task similar to the one discussed earlier, wherein the examiner simply asks the student to repeat a word such as "banana." (This technique is often used in a quick screening of language by neurologists.) This task has the added advantage of checking a major language "path" (see pp. 43,44).

If time is an issue, it is possible to obtain a quick screening of basic language by making some of the tests administered for other purposes also serve "double duty." As an example, reception/comprehension and production of spoken language can be screened through careful observation of response patterns on tests such as the **Wechsler Verbal Scale subtests** or **The Token Test for Children**, which you may be administering for attentional difficulties. Reception/comprehension is demonstrated by the accuracy with which the TBI student responds. Is the student's speech clear and intelligible? Does it reflect an understanding of the questions asked or instructions given?

Samples of oral and written language can also be obtained using subtests or tests which are being administered primarily for other purposes. For example, it is possible to put a "mini" battery together in any of the language assessment areas by looking for consistencies across selected subtests from comprehensive tests of academic achievement such as the **Woodcock-Johnson Psycho-Educational Test Battery-Revised** (WJ-R; Woodcock & Johnson, 1989). For other examples of assessing written language comprehension, Mapou & Spector (1995) suggests using the Reading subtest from the **Wide Range Achievement Test-Third Edition** (WRAT-3; Wilkinson, 1993), and the **Letter-Word Identification and Passage Comprehension subtests from the WJ-R**. For writing ability, they suggest the Spelling subtest from the WRAT 3 and the Dictation and Writing Samples subtests from the WJ-R.

Summary: Domain II

Before doing any language assessment, gather as much data as possible from past records. There are many opportunities to observe language functioning difficulties, ranging from formal tests to informal, observational techniques. Be sure to learn what to look for and take advantage of opportunities to use tests in several ways, i.e. "double duty." Attempt to measure as many separate elements of language functioning as possible to isolate specific problems.

Ylvisaker, et al. (1994) have identified several questions you should attempt to answer in language assessment.

1. What are the basic levels of language ability?
2. How is language affected by increased stressors such as processing demands and/or distractions?
3. Is there a discrepancy between receptive and expressive language? What does this mean in terms of known vs. unknown brain damage?

Finally, which tests/techniques you use to measure language functioning is not as important as your understanding of the principles behind the testing and your ability to specify problem areas. It is much easier to remediate specific as opposed to general problems.

Domain III. Memory and Learning

The Importance of Memory Revisited

As mentioned earlier, memory problems are one of the few effects of TBI common to most survivors. Memory is also necessary to the learning process. When we assess students as to what they have learned in school, we are, in fact, assessing what they remember about what they have been taught. Unfortunately, many individuals use the terms memory and learning synonymously. For our purposes, we will focus on memory assessment as a measure of the ability to learn.

Many people do not realize the importance of memory in our daily functioning. The involvement of memory in cognitive processes may be obvious; however, the involvement of memory in the area of social-emotional behavior may be less clear. When we act in a reasonable, socially conscious manner, we are using our memory to identify the socially correct manner (i.e. something that was taught to us in the past) and/or we are using our memory to remember the consequences of a certain action from our past and its use in deciding how we should best act in the future. We need to remember that when we did "X" in the past, "Y" (a consequence) happened. Considering consequences before acting requires memory. Impulsivity in TBI students often reflects the simple inability to remember the socially appropriate consequence.

It may be helpful to revisit the simplified memory sequence presented earlier. This will put into perspective what memory is and what it is we are trying to uncover. The simplified memory sequence is as follows.

Attending —> Short-Term (Working) Memory —> Long-Term Memory —> Retrieval

Based on the information we have about the TBI student, we are trying to answer the following questions.

1. What is the current overall status of the student's memory in terms of
   - visual vs. auditory memory;
   - delayed memory;
   - effect of distractions;
   - content specific memory problems (e.g. words vs. faces, etc.); and
   - memory retrieval processes?
2. Are there any discrepancies between basic memory processes (e.g. visual vs. auditory), and what are the specific problems accounting for the discrepancy?
3. Through which basic mode of memory (visual vs. auditory) will the student learn best?
4. Which aspect of the memory sequence (if any) has been affected by the TBI? In what way(s)?

When assessing memory, start by gathering as much information as possible about the student's memory processes before the TBI. Keep in mind that each of us probably has a "stronger mode" of memory to begin with, perhaps as part of our genetic endowment. As an example, it may be possible for you to approximate your preferred mode by recalling the strategies you used in preparing for exams when you were in school. Some prefer to write an outline of the material they were studying and then try to "visualize" this outline during the exam. Those of you who did this probably have visual memory preferences. Those who read the material aloud (to yourself) probably have stronger auditory memory.

Another example may be helpful. If you have been in a situation where you had to ask for fairly complex directions, and after receiving these directions had no difficulty finding your way, you probably have a strong auditory memory. Those of you who would have preferred the direction giver to "draw you a map" are more likely to have stronger visual than auditory memories.

There is much about memory we still don't fully understand. Why do some individuals have stronger visual than auditory memories? How did we learn the memory strategies we now use? The first question is still largely unanswered. The answer to the second question is most likely by trial and error.

Memory is one of the few effects of TBI that appear to be consistent across most survivors. The "type" of memory affected (e.g. visual/auditory, long-term/short-term, etc.), however, may differ from one survivor to another depending on several factors such as the location and severity of the brain injury. Some students with left hemisphere injury (particularly involving the left temporal lobe) may have difficulty memorizing and storing auditory/verbal material. Some TBI students may have the most difficulty retrieving material from their memory. Memory retrieval problems affect all of us to some degree, particularly as we get older. As an example, when we cannot retrieve an individual's name from memory although we know this is a person we recognize visually (a common problem, by the way), we may begin to think that we are in the early stages of Alzheimer's disease.

Still other TBI students may have difficulty with short-term vs. long-term memory. This does not seem important in comparison with retrieval memory at first until we understand that short-term memory must work properly in order for material to *enter* our long-term memory. These problems are all different but they all still involve memory in some fashion.

General Measures of Memory and Learning

Although some clues to memory problems can be observed in your "core" tests such as the Wechsler, you must consider supplementary testing in this domain if you are to achieve a comprehensive assessment of memory processes.

In testing memory, it is best to start with a general memory battery to gain some sense of the TBI student's overall memory functioning and to note any possible discrepancies in the student's mode of learning. This step may not be necessary if you have specific memory weaknesses documented from past evaluations (e.g. the rehabilitation testing). Your framework for memory assessment should always be the memory sequence. You are trying to isolate which step(s) in the process are not functioning or not functioning adequately. You should also attempt to identify which mode of memory (e.g. visual or auditory) appears to be preserved and which has been damaged. This information will be of great importance when developing remedial programming.

Memory batteries typically assess a wide range of memory functions. In this way they are much like the broad-based intellectual or achievement tests. Because of this broad-based assessment, however, they may not measure any one memory factor in great depth. What you should be able to achieve in using a memory battery is the student's "general" level of memory, as well as some comparison of memory processes across various "modes," e.g. auditory vs. visual, short-term vs. long-term, etc.

There are several memory batteries available today, and more are currently under development. Relatively few, however, have been developed for the school-age range. **The Wide Range Assessment of Memory and Learning** (WRAML; Sheslow & Adams, 1990), and the more recent **Test of Memory and Learning** (TOMAL; Reynolds and Bigler, 1994) are specifically designed for children. **The Wechsler Memory Scale - Revised** (WMS-R; Wechsler, 1987) can be used when the student is beyond the age range of the WRAML.

If the memory battery does identify problems and/or you have information from past evaluations documenting specific memory weaknesses, the next step would be to use specific supplementary testing. What follows are some supplementary memory tests that assess specific areas of memory functioning or in situations where time does not permit a full memory battery.

Specific Measures of Memory and Learning

Assessment of auditory-verbal memory. If you can measure only one memory mode, it should be auditory memory. Since teachers tend to rely on the lecture mode as a primary teaching technique, a student with a specific deficit in auditory memory would be at a significant disadvantage.

If you suspect (on the basis of a general memory battery, past reports, or observations) that the TBI student has a weakness in auditory-verbal memory, you might want to consider using tests such as the **Children's Auditory Verbal Learning Test-2** (CAVLT-2; Talley, 1993) or the **Rey Auditory Verbal Learning Test** (RAVLT; Rey, 1941). Both of these instruments examine auditory-verbal memory and learning specifically. They are composed of word lists that the student must commit to memory. The list of words is presented several times, so it is also possible to gain some knowledge about the student's ability to learn through the auditory mode. Tests such as these can provide further confirmation of a hypothesis of auditory-verbal difficulties suggested by a general memory battery. Both tests are easy to learn and have short administration times. They also have a test of distractability and a delay task to measure these two important elements of memory. The CAVLT has more recent and more comprehensive normative data.

Other auditory-verbal memory tests use sentences of increasing length. The Sentence Memory subtest of the **WRAML** uses this approach, as does a subtest from the **Multilingual Aphasia Examination** (MAE; Benton & Hamsher, 1989). Successful performance on these tests in the face of poor performance on the CAVLT or RAVLT may suggest that the TBI student can remember auditory information when it is presented in a more structured or meaningful context. This would be an important bit of information for remedial programming.

Before we leave auditory-verbal memory testing, we should say a few words about other "modes" and "content" mixtures. As an example, the **Wechsler Digit Span** subtest is often thought of as a short-term memory test. Although this may be debatable, if the digit span subtest does measure short-term memory, we could only say that it would be short-term memory for *numbers*, since the stimuli consists of numbers only. In some ways, we are taking a chance using the Digit Span as a measure of short-term memory in general. This will be covered in more detail when we discuss attention.

There are also tests that measure auditory memory for non-verbal stimuli, e.g. musical melodies. The **Seashore Rhythm Test**, which is part of the Halstead-Reitan Neuropsychology Battery, measures precisely this ability. While there is a certain functional utility for this type of test for diagnosis and location in brain injury, the utility for remedial planning may not be readily apparent (except, of course, for a musician). Because of functional utility limitations, measuring auditory memory for non-verbal, melodic stimuli is often excluded from the typical neuropsychological battery.

Assessment of visual memory. If specific visual memory difficulties were noted in the comprehensive memory battery, tests specific to visual memory such as the **Rey-Osterrieth Complex Figure** (Rey, 1941; Osterrieth, 1944) may provide more support for the visual problem hypothesis and help clarify the visual problem further. The Rey-Osterrieth is easy to administer and score. Normative data for children and adolescents are available in Spreen and Strauss (1991). There are some interesting variations in the administration of this test that allow for interpretation of executive functions as well as visual memory. For your purposes, however, using it as a visual memory test should prove very helpful.

> **INFO BOX**
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> **Visual vs. "Verbal" Memory — Many general memory tests use the comparison of visual vs. verbal memory in differentiating mode preferences. In a sense, this is an "apples and oranges" comparison. Visual memory is an *input mode* (e.g. trying to memorize a map), while verbal memory is the *content* being remembered (i.e. verbal material). In terms of everyday usage, it would seem more accurate to think in terms of comparing two input modes (i.e. visual vs. auditory), or two types of content (i.e. verbal vs. graphical). It should be noted that the auditory memory demands of school far outweigh the visual memory demands, since students are exposed to auditory learning situations (e.g. teachers' oral lectures) much more than any other. Thus, you want to be sure auditory memory abilities are assessed thoroughly.**

A major disadvantage to most visual memory tests is that they usually involve constructional abilities as well, thus complicating interpretation. The designs are presented to the student and after looking it over for a period of time he or she is told to draw the design from memory. Using this format it is very difficult to separate out the memory functioning from the constructional demands. Non-motor visual memory tests such as the **Rey Visual Design Learning** Test (RVDLT; Rey, 1964) have the advantage of eliminating constructional demands. If we want to test visual memory only, we must attempt to eliminate any other confounding task demands.

Another disadvantage to many visual memory tests is that the stimuli are geometric figures. It is curious that few, if any, of the visual memory tests available involve verbal material (e.g. words, letters). Although there appears to be no evidence to suggest that visual memory using words or letters as stimuli involves other confounding processes, the typical visual memory test does not use the stimuli encountered in the school setting.

A Note About Memory Delay Testing

With those tests that use a delay period before administering the final phase of the memory test (e.g. WRAML, CAVLT) be sure **not** to fill the delay period with competing tasks. As an example, while you are waiting for the delay period to expire during the CAVLT, administer tasks requiring other skills such as fine motor testing, drawing, etc. to be certain you are not creating an interference situation. If you were to present similar tasks during the delay, TBI students could be at a distinct disadvantage.

Some informal memory assessment techniques. There are some informal techniques that may be helpful in screening for memory problems. These techniques are not standardized or normed but rather offer the examiner a glimpse at the student's memory functioning. Often there is limited time available for formal testing, or you may only want to do a gross screening of the TBI student during the administration of the "core" testing portion of your assessment. These techniques may help in deciding if you need to go further with the memory testing or on which areas of memory you need to focus. Statements in your assessment reports regarding the results of these techniques should reflect their informal, non-normative nature.

Here is an example of how to test for incidental memory problems using the WISC III, Coding or WAIS-R, Digit Symbol subtests. **Incidental memory** (also referred to as non-purposeful memory), is the memory you have for material you have been exposed to but do not purposefully attempt to memorize - in other words, the memory you use in most of your daily life. You can test an individual's incidental memory through a certain amount of trickery. As an example, ask the individual to take a short test (10-15 words) in spelling, where you will dictate the words. (The student must write each word as it is dictated.) When the "test" is completed, take the paper with the spelled words out of vision and ask the individual to recall the words you dictated. Since the purpose of the test was to spell, most individuals would not purposely attempt to memorize the words - thus it becomes a test of incidental memory.

It is possible to separate out the effects of incidental memory on the Coding or Digit Symbol subtests with the following procedure suggested by Kaplan et al. (1991). After noting which item the student was on when he or she reached the time limit (to determine the score), allow the student to complete the rest of the items on the subtest but stop before the final row is started. Cover the completed items and ask the student to try and recall from memory the symbols for the final row. Although there are no norms, Kaplan found that the "average performance" was in the range of 5-7 symbols. It is an admittedly rough estimate, but it will give you some sense of the influence of visual, incidental memory functioning on the student's performance.

It is possible to use a similar approach with the **Bender-Gestalt Test** (BG; Bender, 1938). There are at least two variations originally suggested by Wepman (see Lezak, 1995, p. 563) that can be used to test visual memory. (You may actually know others as well.) Version one involves the normal administration with a delayed incidental or purposeful memory element. Approximately 20-30 minutes after administering the BG (I will typically do it in between Wechsler subtests), ask the student to see how many designs he or she can recall from the BG. Typical recall is approximately six designs. You can make this a test of purposeful memory by simply adding the following statement to the original administration of the BG, "I want you to try and remember the designs because I will ask you to draw them again in a little while."

In version two, instead of the usual administration, show each BG card to the student for 5 seconds, take it away, and then ask the student to draw it from memory. A slight twist on this procedure is to show the card for five seconds, turn the card over and ask the student to wait another five seconds before starting to draw the design. This last version would be very difficult for anyone with visual attention and/or short-term deficits, i.e. the TBI student. Be aware that there is the confounding variable of construction with any visual memory test involving drawing.

Another Wepman version involves a three-stage procedure involving a five-second recall of each card (short-term visual memory), followed by the standard administration. When the standard administration is completed, and a period of time has elapsed, the cards are removed and the student is asked to draw as many figures as he or she can remember (long-term visual memory). Care must be taken, however, since there are no standardized procedures or norms for these procedures. Also, you must consider the complications presented by combining constructional abilities with memory functioning (Lezak, 1995).

Still another informal technique for testing auditory-verbal memory is one that is often used in neurological exams to check an individual's mental status. Some time early in the evaluation ask the student to remember these four words: Sparrow, Blue, Potato, and Guitar. Have the student repeat the words after you until you are sure he or she understands them. Tell the student to try and remember these words because you will be asking for them later. After approximately 20-30 minutes, ask the student to repeat the four words. If the student is able to remember them without cuing, it suggests the "pure" retrieval from long-term memory (at least for auditory-verbal material) is intact. If the student cannot remember one or more words, try cuing by giving a categorical hint, e.g. for Sparrow the cue would be "it's a bird"; for Blue you would say "it's a color," and so on. If this doesn't work, try more evocative cuing using a multiple-choice format, e.g. for Sparrow, "Was it an eagle, a robin, a sparrow, or canary?" If the student is able to respond even though extensive cuing is used, it suggests that the material did enter the long-term memory but the difficulty is most likely primarily due to retrieval difficulties. The more evocative cuing necessary, the more difficulty the student is having with retrieval.

There are many such informal memory testing techniques. These are only a few samples. The main point is that these techniques provide clues only and must be verified through more formal memory testing.

Summary: Domain III

Memory impairment is one of the few effects of TBI that appears to be common among survivors. It impacts many diverse areas of cognitive and social-emotional functioning. Keeping in mind the memory sequence, your task is to find out which stage of the sequence has been affected by the TBI. Although you can obtain some clues to memory functioning in the initial core testing, you will probably need to use supplementary tests to adequately assess the TBI student's memory functioning. The questions posed at the beginning of this section should help to structure your assessment. Be sure to start with whatever information is available on the student's memory functioning prior to testing and determine whether it is necessary to administer a general memory battery. If you need more specific information, use the specific supplementary tests suggested (or others of your choosing) adding information from informal techniques and limit testing if necessary. Remember also, that our goal is to develop a remedial program capitalizing on the student's memory strengths avoiding specific memory weaknesses where possible.

Domain IV. Attention

Like memory, attention is another frequently compromised ability area in TBI students. This is due in part to the fact that many TBI survivors suffer frontal lobe contusions regardless of the specific site of injury. The frontal lobes play an important role in mediating our attentional abilities.

Attention is important because it is generally regarded as the first stage in the memory process, and is often found linked with memory in the research literature. As with memory, you will find clues to attentional problems during your administration of the intellectual measure or achievement testing. To assess this area adequately, you will need to add specific measures of attention to your battery through supplementary tests.

Some Basic Issues in Attention

Before discussing specific supplemental tests of attention, it seems necessary to highlight a few basic issues about this complex area. What becomes immediately apparent to the professional researching attention is that there is no universally accepted definition in the existing literature (Lezak, 1995). This is due in part to the fact that attention is a very broad term incorporating many sub-components. Care must be taken in determining which form of attention we are attempting to measure. Sub-components of attention include focused vs. selective attention, sustained attention (vigilance), divided attention, alternating attention, distractibility, orientation and alertness. Complicating this definitional issue further, many of these sub-components overlap with other cognitive and physiological functions such as memory and motor planning (Lezak, 1995; Barkley, 1988).

Selective attention is what most of us think of when we consider attention. It is the ability to selectively attend to stimuli in the face of distractions, e.g. studying while watching TV. **Sustained attention**, on the other hand, involves the ability to maintain attention over a period of time, often referred to as concentration. **Divided attention** refers to the ability to maintain attention to more than one task at a time. **Alternating attention** refers to the ability to shift attention easily from task to task without losing your attentional focus.

We will focus on those sub-components of attention that have been found to be associated with TBI. Zomeren, van Brouwer and Deelman (1984) identify three characteristics of the attentional process frequently seen in TBI survivors.

1. selective attention;
2. speed of information processing; and
3. alertness.

You should pay particular attention to these characteristics in your observation and assessment. In addition, it can be particularly helpful to intervention programming in TBI students to identify which input mode (auditory vs. visual) of attention seems impaired and which seems preserved.

The Assessment of Attention

In testing for attention problems in TBI students, the following questions should be considered.

- What effect(s) is the attention problem having on the overall performance of the student?
- Which sub-component(s) of attention seems most impaired?

- Which sub-components seem preserved?
- What is the best method of intervening with the attentional deficit?

The initial core assessment instruments can offer us glimpses of attentional deficits. As an example, the frequently used **Freedom from Distractibility** factor (Wechsler scales) is often used (perhaps overused) as a measure of attention. Be certain to note how the individuals you are testing have performed on the Wechsler subtests requiring fairly lengthy instructions such as Comprehension, Picture Arrangement, Block Design, and Object Assembly. Isolating the student's performance on these and other tests with lengthy instructions will give clues to the student's ability to sustain attention. In addition, we have many opportunities to observe what we assume is inattention. We often have a student who does not appear to be attending but manages to respond in a manner that would indicate that he or she has been attentive. Also, teachers often equate eye contact with attending; however, it is clear that a student can maintain excellent eye contact but actually be "miles away." It is safe to say that although there are many excellent opportunities to informally observe attentional ability, you need to consider supplementary testing techniques to obtain a comprehensive and accurate assessment of attention.

A basic premise behind testing for attention problems is to try to replicate as closely as possible the situation in which attention is a concern. To do this, you must adopt a multifaceted approach. It is not enough to use the following suggested testing techniques alone. It is important to get representational information from as many relevant sources as possible. **Behavior rating scales** such as the Conners Rating Scales (Goyette, Conners & Ulrich, 1978) discussed below, should be included to obtain information from both the student's teacher(s) and family. Direct observations provide useful information as well, although care must be taken to include both structured (e.g. the classroom), and unstructured (e.g. lunch room), settings. The testing techniques mentioned here will assume that information from these other sources has been included in the comprehensive evaluation of attention.

Most research indicates that the best measures of attention seem to be those that are long and tedious, such as tasks referred to as **Continuous Performance Tests** (Barkley, 1988). It is probably possible for anyone, regardless of attentional difficulties, to attend to almost any task for short periods of time. (This is one reason I personally do not put much faith in tests such as the Wechsler Digit Span as a measure of attention. The Digit Span subtest is somewhat constrained in focus, measuring short-term auditory attention for numbers only.) It is probably also true that when novel stimuli are used or when the testing situation has reduced distractions, as in one-on-one situations, students may appear to be attending well even though they have significant attentional difficulties in "real world" environments.

Other important considerations in determining an appropriate test of attention are the nature of the stimuli (visual vs. auditory) and the content (verbal vs. non-verbal), although these variables do not seem well represented in the research literature. As an example, it is possible for a TBI student to have difficulty attending to auditory stimuli but no difficulty attending to visual stimuli. This would, of course, be an important distinction in developing remedial programming.

A comprehensive assessment of attention should include the following approaches to be most successful.

- behavior rating scales;
- "laboratory" measures of attention; and
- formal and informal observations.

Behavior Rating Scales

In 1986, Rosenberg and Beck found that 60% of the school psychologists they surveyed were routinely using rating scales to assess Attention Deficit Disorder (ADD) and Attention Deficit Disorder with Hyperactivity (ADHD) (DSM IV, 1994). Undoubtedly, this percentage has risen with the heightened awareness to ADD/ADHD in the schools. Barkley (1988), has identified several advantages of behavior rating scales, including:

1. the ability to evaluate a variety of different behaviors in a relatively short time;
2. the ability to more easily collapse observations that occur over a period of time;
3. enabling you to see the student's attentional characteristics in the natural setting;
4. providing a quantitative assessment of the views of parents and teachers;
5. allowing statistical comparison with a normative sample; and
6. permitting frequently repetitions to allow comparisons over time to demonstrate the effects of interventions.

Because of the recent upsurge of ADD/ADHD referrals, several rating scales measuring attention are currently available. An example is the **Conners Rating Scales (1978)** which includes Parent and Teacher forms. You may be using a scale such as this now. There seems to be no reason to change your current approach to meet any specific attentional problems of the TBI student. Their attention problems are very similar to other, non-TBI students, although the etiology and course of their attention problem might be different. The attention problem of

INFO BOX

Hemi-inattention — For the TBI student we must consider at least one other unique subdivision of attentional difficulty, that of hemi-inattention. This is a neurological condition that results in the individual selectively not attending to a particular field of vision, usually the extreme left visual field. In some cases the inattention may be restricted to a portion of the left field and this is referred to as a quadrant, i.e. one-half of the visual field. Left visual field hemi-inattention is usually associated with damage to the right hemisphere, more specifically the right posterior (rear) portion. This condition is often transient (Barkley, 1988), and interestingly, is <u>not</u> the same as the hemianopsia (visual field cut) described earlier. While both are produced by damage to the brain, field cuts are generally permanent and can be either in the left or right visual field depending on the site of the damage.

the TBI student (if there was no history of attentional difficulties prior to the TBI) is more likely to have a physiological etiology. Also, unlike the non-TBI student's attention problem, the TBI student's may be transient. (For this latter consideration, remember to take into account how long post-injury the student is.) The choice of which rating scale to use should be made on the basis of most recent and comprehensive normative data, best psychometric strengths, flexibility, and ease of use.

(Note. See Barkley, 1988, pp. 145-176, in Traumontana & Hooper, 1988, for a review of rating scales. Also, see other references at the end of the manual.)

Laboratory Measures of Attention

The term laboratory in this context comes from the research literature and describes those measures of attention you might administer in the testing situation, i.e. your "lab." The advantages of this form of assessing attention include the following:

1. They allow you to manipulate the testing circumstances (e.g. limit testing) to further analyze the attention problem (they will also allow you to focus your assessment on various sub-components of attention).
2. As with the rating scales, they provide an objective measure of the student's performance compared with a normative sample.
3. They are less affected by rater bias.
4. Many can be administered and scored quickly.

(Barkley, 1988)

Used alone, laboratory tests of attention have limited value. The same can probably be said of rating scales. In combination, however, rating scales, laboratory tests, and informal observations can be very helpful in providing a complete picture of the TBI student's attentional difficulties.

Some Examples of Specific Laboratory Measures of Attention

(Note. The testing techniques mentioned in this section along with other alternatives, can be found in Appendix B)

There are many laboratory tests of attention available. Some are "free-standing" tests developed specifically for measuring attention while some are subtests from other tests such as memory batteries or the Wechsler. Those that follow should be seen as only a sample of some of the measures of attention currently available. The tests will be categorized by input since this is one of the more helpful divisions in terms of developing remedial programming.

Measures of auditory attention. Most laboratory tests of attention use visual stimuli. There are relatively few tests of auditory attention. Why this is so is not entirely clear since most of our attentional demands are auditory. This is certainly the case in the school setting. Essentially, any task that requires attending to oral commands or instructions can be thought of as a test of auditory attention.

For short-term auditory attention, tests such as the Wechsler **Digit Span** subtest (a very similar subtest is found in the Wechsler Memory Scale-Revised also) or the **Number/Letter Memory** subtest from the WRAML can be used.

The Token Test is specifically designed to assess attention to auditory instructions. This test also uses instructions of increasing length for added difficulty. Some users think this test is a measure of attention replicating the natural circumstances involved in following instructions.

For older students (16 years or older), **The Paced Auditory Serial Addition Test** (PASAT; Gronwall, 1977; Gronwall & Sampson, 1974) can be used. This test involves auditory input and verbal responses to a series of random numbers, pairs of which must be added together as they are presented. The numbers are presented on an audio tap, and the rate of presentation is speeded up over successive trials increasing the attentional demands. The PASAT can be a particularly difficult test as the rate of presentation increases. For this reason, many clinicians will use it in cases of suspected "mild" TBI where other less difficult tests may be too easy.

Sentence repetition tasks, such as the subtest of the same name in the WRAML, or the Sentence Repetition subtest from the Multilingual Aphasia Examination (MAE; Benton & Hamsher, 1989) mentioned earlier, can also be used as measures of auditory attention. In tests of this type, the examiner reads sentences of successively greater length. The student must repeat each sentence verbatim. These tests have the apparent advantage of replicating more natural auditory attention demands. At the higher level items, the tasks can require a considerable amount of sustained auditory attention, unlike tests with briefer stimuli such as the Digit Span subtest.

Measures of visual attention. Many laboratory tests are patterned after the **Continuous Performance Test** (CPT), originally developed by Rosvold, Mirsky, Sarason, Bransome & Beck (1956). There have been many versions developed since, including several computerized versions such as the **Gordon Diagnostic System** (Gordon, 1988), **Connors Continuous Performance Test** (Connors, 1994), **IVA**, and the **Vigil** (See Appendix B). The premise is basically similar in each of these tests. "Targets" are presented among competing stimuli (usually numbers or letters) which the student is supposed to identify. These tests are usually long and tedious by design and thus effectively identify those individuals who cannot sustain attention. (The IVA has the added advantage of having the capacity for testing auditory attention.)

In addition to an overall score (which can be compared with normative data), further error analysis can be done by separating two types of measures which are common to most CPT instruments. These two measures are referred to as **omission errors** and **commission errors**. Omission errors occur when the student misses targets, suggesting lapses in attention. Commission errors occur when the student identifies targets falsely, suggesting impulsive, careless responding. Although the analysis of errors (i.e. omission vs. commission) is usually done in context to visual testing, you can also analyze errors in the same fashion with tests of auditory attention.

A popular version of the continuous performance task format is the **cancellation** test. Originally developed by Talland (1965), there are countless versions of this task available today. Most have no normative data, however. These tests involve striking through "target" letters, numbers, or geometric figures, that are presented amongst competing stimuli. The **Visual Search and Attention** Test (VSAT; Trenerry et al., 1990) is one example of a standardized, normed cancellation test. Unfortunately, it can only be used with individuals 18 years and older. It is, however, possible to use it with adolescents as a rough screening test. In addition to attention to visual stimuli, cancellation tests (particularly paper and pencil versions) can be very helpful in measuring scanning deficits and field cuts (hemianopsia) often found in TBI students. Students with field cuts will miss targets in the affected visual field.

One disadvantage of many visual attention tests is that the stimuli are very rarely verbal. One exception is the **Stroop** Tests, originally developed by Stroop (1935). This testing format has undergone many revisions. The **Stroop Color and Word** Test (Golden, 1978) is most appropriate for children. The **Stroop Neuropsychological Screening** Test (Trenerry, et al., 1989) is normed on individuals 18 years and older but can be used as a rough screening of attention in adolescents. These tests measure the ability to inhibit responses. Students are presented with a series of colors or words which they usually have no difficulty recognizing or reading. This first task establishes a mind set. Then they are presented with a second series which asks them to inhibit the first mind set (e.g. "This time say the color of the word, do not read it."). Individuals with attention problems have difficulty suppressing the tendency to respond with the initial mind set. Concentration and the ability to ward off distractions are measured in these tasks. Thus, they are excellent measures of selective attention.

The **Trail Making Test** (TMT; Reitan, 1958) is an easily administered test of visuomotor tracking. The TMT has two parts (A and B) and, older child (8-14), and adult (15-adult) versions. For part A, the student must draw a line connecting a series of numbers on a page in sequence. The task is very similar to the childrens' "connect the dots" games. Part B, however, is more complex. The student is required to do basically the same connecting operation as in part A except there are numbers and letters on the page. The student is asked to connect the number and letters in the following alternating sequence, 1 - A, 2 - B, 3 - C, and so on. Scoring is on the basis of time only, with slower times suggesting attentional difficulties.

TBI students usually do better on part A than B where the task of having to deal with the two parallel sequences (letters and numbers) at the same time strains their attentional abilities. Research shows that Part B is particularly sensitive to brain damage (Reitan, 1958; Teeter, 1986). If time is limited, it is possible to administer Part B only. Keep in mind, however, that the normative data is predicted on administering both versions during one sitting. Spreen and Strauss (1991) provide additional norms for children ages 8 to 15.

Another test that can be effective for measuring the impact of impulsivity on attention is the **Matching Familiar Figures** Test (MFFT; Kagan, Rosman, Day, Albert & Phillips, 1964). Originally developed as a research instrument, the MFFT has been used to diagnose cognitive impulsivity. There are a few versions of the MMFT but none appear to be published commercially. There are some norms available but they were not systematically gathered and thus may not be generalizable. In spite of these negatives, however, the MFFT is an excellent test to use in observing the TBI student's attention and scanning abilities, and impulsivity. The test requires the student to match a drawn figure with an exact replication that is mixed in amongst five similar drawings. Scoring is on the basis of mean response time to first match and total numbers of errors across 12 items. The test results can be interpreted on the basis of omission and commission errors also. The MMFT is quick to administer, easy to score, and children seem to enjoy it.

Summary: Domain IV

Attention is a broad, ill-defined concept that can be divided into many sub-components. Characteristics of attention that appear to be associated with TBI include (a) selective attention, (b) speed of information processing, and (c) arousal. In assessing attentional processes it is important to use a multifaceted approach employing rating scales, "laboratory" tests, and informal observations. Some measures of attention were discussed, including those that tap auditory attention vs. those that measure visual attention.

Domain V. Visuoperceptual, Visuospatial, and Visuoconstruction Functioning

Visual problems are very common among TBI students because the functional systems and areas of the brain serving these complex processes are widely distributed across the brain. Thus, with injury to almost any area of the brain, visual processes are likely to be disrupted. Visuoperception, visuospatial and visuoconstruction are somewhat overlapping terms that describe the constellation of abilities necessary to perform perception and construction tasks involving visual processes. Briefly, **visuoperceptual** impairment affects the ability to perform simple visual discrimination tasks such as identifying size, form, brightness, and length (Capruso, Hamsher, & Benton, 1995). Impairment of **visuospatial** abilities results in problems such as misreaching or overreaching (also called visuomotor apraxia), impaired visual attention, and defective judgment of distances (also called stereopsis). **Visuoconstruction** deficits refer to disturbances in assembling or drawing objects. Although these three types of brain disorders are often referred to synonymously, they are distinct impairments and have different anatomical bases in the brain. The many and complex sub-components of these processes are too numerous to go into in this manual. For our purposes, we will focus on the basic principles underlying these abilities with an emphasis on assessment specific to school programming.

As discussed earlier, these abilities appear to be situated primarily in the posterior parietal area of the cortex (usually right hemisphere) although, as with any complex functioning, other areas of the brain can be involved. As an example, there are elements of these abilities (e.g. processing form and color of objects) that appear to be located in the temporal lobes (Capruso et al., 1995).

Assessment of Visuoperceptual, Visuospatial, and Visuoconstruction Functioning

The following disorders, common to TBI, involve one or more of the functions in this domain.

1. Primary sensory impairment (simple **visual discrimination** ability).
2. Inability to recognize common objects (also called **visual agnosia**).

3. Inability to recognize familiar faces (also called **prosopagnosia**).
4. **Visual analysis** (discrimination of overlapping figures) and **visual synthesis** (visual closure, organization, and integration) deficits.
5. **Color perception** difficulties.
6. Visual neglect (also called **hemi-inattention** or **hemi-neglect**).
7. **Stereopsis** (depth perception difficulties).
8. Impaired judgment of line direction.
9. Inability to navigate familiar surroundings (**topographic disorientation**).

(Capruso, et al., 1995).

Clues to impairments in these abilities can be observed during the administration of the core intelligence test and the BG. For a comprehensive assessment of these abilities, you will need to use supplementary tests/techniques.

Visuoperceptual assessment measures. Visuoperceptual deficits can best be elicited through non-motor, visual recognition tests such as the **Hooper Visual Organization Test** (VOT; Hooper, 1983), which measures visual closure and the ability to conceptually rearrange pictures of objects that have been cut up and disarranged. The **Benton Visual Form Discrimination Test** (Benton, Hamsher, Varney & Spreen, 1983), and **Motor-Free Visual Perception** Test (Colarusso & Hammill, 1972), measure visual form discrimination with no motor requirements. These instruments will allow you to separate the perceptual demands from motor demands in visuoconstruction impairments identified on tests such as the Bender Gestalt Test and the Developmental Test of Visual-Motor Integration-Revised (Beery and Buktenica, 1989).

Visuoperceptual difficulties also will become evident during other portions of your assessment. As an example, the **Peabody Picture Vocabulary Test-Revised** (PPVT-R) and **Receptive and Expressive One Word Vocabulary Tests** (ROWVT & EOWVT) can also be used to identify gross difficulties in visual recognition, although this is not what they were originally designed to do. You will see visuoperceptual errors readily in most cases. If you want to pursue the errors a bit more, you can test the limits after the standardized administration of the test by simply asking the student to name some of the objects pictured. Remember, however, that this is an informal assessment.

Visuospatial and visuoconstruction assessment measures. Visuospatial and visuoconstruction abilities involve more complex brain functioning. Both the left and right cerebral hemispheres are involved since both vision and construction (along with other sub-component abilities) are used. Tests of visuospatial and visuoconstruction abilities are often referred to as visual-motor tests. The **Bender-Gestalt Test** and **Developmental Test of Visual-Motor Integration-Revised** (see above) are perhaps the best known and most used (and perhaps most misused) of these instruments (Berg, Franzen & Wedding, 1987). The BG was one of the first tests used to identify brain damage (Traumontana & Hooper, 1988) when such diagnosis was in a very primitive stage. Thankfully, we have long since passed the time when the diagnosis of brain injury can be effectively made using a single, relatively gross measure such as the BG.

Visuospatial and visuoconstruction abilities can also be assessed using the **Block Design** subtest of the Wechsler. However, poor performance on this task by a TBI student can involve several factors including visual neglect, visuospatial impairment, visuoconstruction impairment, motor slowing, poor planning ability, or intellectual impairment (Capruso et al., 1995). Careful error analysis will help to clarify the specific nature of the disorder. Visual neglect can be identified using any of the visual attention tasks, particularly the cancellation tasks. The previously mentioned Trail Making Test can serve "double duty" as a measure of visuoconstruction ability while also measuring visual attention.

There are several drawing tasks that can be used to measure visuospatial and visuoconstruction abilities. Subtests from both the **WRAML** and **WMS-R** explore these abilities. The **Complex Figure Test** (CFT; Rey, 1941; Osterrieth, 1944), which is commonly referred to as the **Rey-Osterrieth Complex Figure Test**, has been used by neuropsychologists to measure visuoconstruction abilities for many years. Several variations to this instrument are available (see Lezak, 1995, p. 569-573). There are structured scoring procedures and norms for children as well (see Spreen & Strauss, 1991, for more information on normative data). Testing consists of asking the student to copy a design that has many features to it (i.e. "complex") and then asking the student to recall the design some time later (usually 30 minutes). Care must be taken to avoid filling the time between copy and recall with competing visuoconstruction tasks. The Rey-Osterrieth is also used as a measure of visual memory and in that sense can be thought of as still another "double duty" test.

Error analysis on instruments measuring visuoconstruction abilities should include the principles mentioned earlier in relation to the Block Design subtest, i.e. left hemisphere damage will produce errors in internal details of the figure with adequate gross spatial elements (outside gestalt), while right hemisphere damage will produce distortions in gestalt with internal details largely intact (Gainotti, 1985; Kirk, & Kertesz, 1989; McFie & Zangwill, 1960; Kaplan, 1990).

*Note. A new instrument, **The Wide Range Assessment of Visual Motor Abilities** (WRAVMA; Adams & Sheslow, 1995) shows promise as a visual-motor battery. The WRAVMA assesses (a) visual-motor (visuoconstruction) ability using a drawing task, (b) visuospatial ability via a non-motor matching task, and (c) fine motor control through a pegboard test. It yields subtest scores for each task and a composite visual-motor score as well. Age range is 3 to 18 years.*

Summary Domain V

Visuoperceptual, visuospatial and visuoconstruction abilities overlap to some degree yet there are distinct differences in the specific skills needed for each, in the area(s) of the brain which serve them, and in how you assess each. There are many instruments that are designed to measure visuoperceptual, visuospatial, and visuoconstruction abilities. In addition, there are many opportunities to informally observe these abilities in the context of testing under other domains. For a comprehensive assessment of this constellation of abilities, you will probably have to use supplementary tests. You may have other "favorites" that you are more comfortable with and/or new tests may have been developed since this writing. The important thing is to be sure that you have a good sense of the TBI student's strengths and weaknesses in these areas and a good sense of what each of these abilities entails. Remember, for a thorough assessment of these abilities the Bender Gestalt or Developmental Test of Visual-Motor Integration-Revised alone is not enough!

Domain VI. Motor Functioning

As we learned earlier, injury to the brain often compromises motor functioning. Thus, assessment of motor functioning (also referred to as fine motor or manual motor functioning) is included in every comprehensive neuropsychological assessment of a brain-injured individual. It is important to note, however, that many motor disorders cannot be linked to specific areas of the brain (e.g. the motor strip of the frontal lobes) but may be due to subcortical, peripheral nerve pathology (Lezak, 1995).

Along with clarifying the nature, extent, and impact on schooling that the motor deficit(s) will have, this testing can be helpful in detecting lateralization of damage, if there are still unanswered questions regarding the location(s) of the damage (Goldstein, 1974). The term lateralization refers to the contralateral (opposite side) indications of damage. As an example, if you discovered subtle yet formerly undetected weaknesses in the left hand fine motor functioning of a TBI child, it could suggest damage to the right hemisphere. This particular scenario is probably more frequent than one might assume since the impairments associated with right hemisphere damage are not always readily apparent in the school setting.

The following case demonstrates the importance of establishing the site of damage.

The Assessment of Motor Functioning

This domain is usually not included in most school psychology assessments, but it is crucial in TBI assessments. It is unlikely that you will be called on to perform a complete assessment of motor functioning, since such examinations are generally the purview of Physical and Occupational Therapists. A complete examination of motor involvement in cognition involves many complex functions including, (a) response to commands, (b) coordination of movements, (c) complex motor sequences, and (d) integration of motor behavior with speech and thought. (For a complete description of motor assessment in neuropsychology, see Lezak, 1995, pp. 676-685.)

We will confine our motor assessment to a relatively gross measurement of speed, dexterity, and to some degree, strength.

The primary purposes of this assessment will be:

1. to establish or confirm documented laterality of brain damage, i.e. which side of the brain is damaged;
2. to determine weaknesses in speed and dexterity that may impact the TBI student's school performance; and
3. to determine motor speed and dexterity strengths and weaknesses to facilitate remedial programming.

Since there are very few ways you can assess this domain using the tests typically included in a school psychology battery, you will have to add supplementary tests that elicit signs of fine motor speed, dexterity, and strength. Glimpses of these skills can be observed in visuoconstructive tests such as the Wechsler Block Design and Object Assembly subtests, where you may be able to observe subtle lateral differences in speed and dexterity. As an example, TBI students with subtle motor damage may use one hand almost exclusively or in an unusual manner (e.g. not holding the paper with the non-dominant hand during drawing tasks or using the non-dominant hand to assemble the blocks or puzzle pieces on the Block Design or Object Assembly tests). The **Hand Movements** subtest of the K-ABC (Kaufman & Kaufman, 1983) can be very effective in observing subtle differences in speed and dexterity, particularly in younger children.

It is best, however, to use standardized tests that are designed to measure fine motor speed, dexterity, and strength. The supplementary test typically used to elicit motor speed deficits is the **Finger Tapping** Test (FTT; Reitan & Wolfson, 1993, see Appendix B). The FTT consists of a small board with a manual tapping key and a device that records the number of taps. Administration is easily learned and the test takes 5-10 minutes to complete. The student makes five alternating trials with each hand, tapping as quickly as possible for 10 seconds. The mean number of taps for each hand is compared in the normative data with the assumption that there will be a 10 percent advantage for the dominant hand.

Either the **Grooved Pegboard** test (Matthews & Klove, 1964, see Appendix B) or the **Purdue Pegboard** Test (Purdue Research Foundation, 1948) can be used to compare dominant vs. non-dominant hands for motor dexterity. Both these instruments use similar procedures. The student is required to insert pegs into holes ("keyhole" slots in the case of the Grooved Pegboard) with the dominant hand first, followed by the non-dominant hand, and then finally with both hands. The instructions are to complete the task as quickly as possible. The tests are scored on the basis of speed and errors. Lateralization effects are demonstrated by comparing the performance of one hand vs. the other. Research suggests that right hemisphere impairments may be more visible (i.e. left hand slowing) than left hemisphere impairments. (I use the Grooved Pegboard test in my evaluations primarily because, (a) it has been designed to be used in testing brain injured individuals, (b) appears to require more dexterity because of the necessity to twist the pegs to accommodate the "keyhole slots," and (c) because it is easier to carry than the larger Purdue Pegboard.)

The standard test of motor strength is the **Hand Dynamometer,** also called the **Grip Strength** Test (Reitan & Wolfson, 1993). The student "squeezes" the grip assembly of the dynamometer attempting to exert as much force as possible. This task is not timed, rather the "score" is the number of kilograms of force exerted with each hand. The assumption is that hand strength is an indicator of lateralized brain damage. This device is fairly expensive (approximately $ 300.00) and the information it adds to the Finger Tapping and Grooved or Purdue Pegboard techniques may not justify its inclusion. Gross differences in hand strength can be elicited by asking the TBI student to squeeze your hand "as hard as you can" with each hand (although I don't suggest this with older, stronger TBI students).

In carrying out motor testing of any kind it is necessary to determine lateral dominance (especially handedness), since the normative data for these instruments has been assembled using the dominant vs. non-dominant hand. As mentioned earlier, handedness is sometimes difficult to establish in children and the suggestions outlined should be followed. There are tests specifically designed for this, but you will find that checking the records and interviewing parents will generally suffice. (I will often do informal testing of lateral dominance using a rolled up piece of paper which I have the student throw, catch and kick. This technique also provides a nice movement break during long evaluations.)

Both the Finger Tapping Test and the Grooved Pegboard Test provide a fairly comprehensive assessment of fine motor functioning. Any fine motor instrument that allows you to compare left vs. right hand motor speed and motor dexterity will do. These tests take very little time to administer (approximately 5-10 minutes each) and are easy to score. The important thing is to somehow compare the motor functioning of the left vs. right side, preferably using a standardized, normed technique.

Summary: Domain VI

A **comprehensive** evaluation of the many ways motor functioning can affect physical and cognitive processes is very involved and beyond the scope of your TBI assessments; however, testing dominant vs. non-dominant hand motor functioning (primarily speed, dexterity, and strength) can augment the overall assessment. For your purposes, motor assessment should emphasize, (a) the confirmation of brain injury laterality, (b) determining significant motoric weaknesses, and, most importantly, (c) identification of areas of motor strength on which to capitalize in remedial programming. Several supplementary tests are suggested, since it is unlikely that the standard school psychology testing battery will provide sufficient opportunities to observe these functions.

Domain VII. Social-Emotional Functioning

As mentioned earlier, the impact of TBI on the social-emotional functioning of the survivor is perhaps the least understood and most often overlooked of the three major categories of potential sequelae (i.e. physical, cognitive, social-emotional).

Case Notes

LATERALIZATION OF DAMAGE — ***Kerry, a 14-year-old female, was being assessed in relation to a long-standing, very severe seizure disorder. Her disorder was the result of a TBI she survived at age 10. Many different anti-seizure medications were attempted but none was successful. It was not uncommon for her to experience several violent, tonic-clonic (grand mal) seizures each day. Schooling, sleep, and social activities were greatly disrupted and she and her family were desperate. Neurologists, on the basis of extensive EEG workups, were convinced the primary site of the seizure disorder was the left temporal lobe. Neurosurgery to remove the temporal lobe, a fairly common procedure with severe seizure disorders, was recommended. A neuropsychological evaluation was recommended as a final pre-surgery screening procedure. The evaluation uncovered a diffuse pattern of impairments. Functions associated with the left temporal lobe were no more impaired than many other areas of the brain. These findings mitigated against surgery, which was then canceled. Although there is no "happy ending" with respect to the seizure disorder, the temporal lobe was not removed, thus avoiding perhaps more complications in this child's functioning.***

As with the other domains, the use of multiple sources is crucial to obtaining a clear picture of the changes in social-emotional behavior brought on by the TBI. Unlike the other domains, however, there are no instruments specifically designed to highlight the deficits associated with brain injury. The approach typically used by neuropsychologists is to administer a battery designed to measure personality characteristics.

In terms of the focus of your assessment of this domain, it may be helpful to revisit the social-emotional symptoms associated with TBI:

1. behavioral control problems (disinhibition/impulsivity);
2. poor self-esteem/self-image;
3. mood disorders (lability, apathy, social withdrawal/indifference, depression);
4. denial of disability;
5. anxiety disorders;
6. inappropriate social/sexual behavior; and
7. aggressive, agitated behavior.

While these are common symptoms, each case is different. It is not enough to simply establish the presence or absence of each of these symptoms because we do not know exactly what the TBI student's personality profile was prior to the injury. ***The*** **crucial question is, "How has the brain injury *changed* the individual's personality?"** To answer this effectively, you must attempt to develop a good concept of what the TBI student's personality was like before the injury. The best sources of this information are *not* tests, but rather information obtained from parents, friends, teachers, and the TBI student. The best method of obtaining relevant information from these sources is the interview. You should carry out these interviews prior to any personality testing.

Assessment of Social-Emotional Functioning

The interview. The clinical interview can be the most effective part of the overall TBI assessment. It allows you to follow up on hypotheses derived from reviewing the student's records and from previous evaluations (Hynd and Willis, 1988). Nuttall and Ivey (1986) list the following strengths and weaknesses of the interview technique.

STRENGTHS

- Flexibility
- Ability to uncover processes
- Personal contact
- Best method for obtaining history
- Opportunity for observation

WEAKNESSES

- Expense
- Time
- Bias

It is probably best to begin with a structured interview format. This will help you to maintain some consistency from case to case. Waaland and Bohannon (1992) have developed an excellent screening technique for TBI that provides a framework for a structured interview and history-taking.

Your focus should always be on what has changed as a result of the brain injury. Although it may seem to be a straightforward question, there are many factors making this a difficult area to clarify. Denial (on both the family's and TBI student's part) and simply not remembering accurately how the TBI student was prior to the injury present formidable obstacles to overcome. You must pursue seemingly clear comments in great detail through specific questioning to get a good picture of the changes that have occurred because of the injury. As an example, a TBI student may say that he or she is "sad a lot." Clarifying questons should include: How often is the student sad? When does it happen? What does "sad" mean? Many TBI students or family members can relate a particular instance of the presenting problem. This may be the best place to start. Whatever they say first when asked for differences due to the injury is probably very important to them and should be carefully considered. Although the interview and history-taking process may seem time consuming, it will save you time in the long run. Thorough interviewing will allow you to focus in on specific difficulties and reduce irrelevant testing.

Global measures of social-emotional functioning. Before discussing global personality inventories, it is important to mention the contribution of frontal lobe deficits to the social-emotional difficulties that plague TBI students. Deficits in frontal lobe or executive, higher order functions (discussed earlier) overlap considerably with this domain. The relationship of impulse control/disinhibition to inappropriate sexual/social behaviors highlights the organic nature of the TBI student's behavioral problems. Poor reasoning and judgment and impulse control problems following TBI probably account for the most troublesome behaviors experienced by parents and teachers. It is important for all concerned to realize that these behaviors are largely beyond the TBI student's control or even, perhaps, awareness!

The question of organic vs. psychiatric etiology presents one of the most difficult diagnostic decisions that neuropsychologists face. Your diagnostic responsibility will be made somewhat easier by the fact that you already have sufficient reason to support an organic hypothesis. The only remaining issue involves clarification of any symptomology that may have been present prior to the brain injury.

The symptoms associated with TBI will show up on standard personality instruments such as the **Personality Inventory for Children-Revised** (PIC-R; Wirt et al., 1990) or the **Achenbach Child Behavior Checklist** (CBCL; Achenbach & Edelbrock, 1983) or, for older children, the adolescent form of the **Minnesota Multiphasic Personality Inventory** (MMPI-A; Hathaway & McKinley, 1982; or MMPI-2; Butcher, Dahlstrom, Graham, Tellegen, & Kaemer, 1989). These are all psychometrically strong instruments that have the advantage of ease of administration and scoring. There are computerized interpretive systems available for most commonly used global personality inventories, including the PIC-R and MMPI-A. The information gained from these instruments can help to support or refute the information gleaned from interview sources, without bias. In trying to develop the preinjury "portrait" of the TBI student, you might try administering instruments such as the PIC-R, asking the parents (both mother *and* father) to fill it out as they would have before the brain injury. This can be a particularly revealing technique that can be adopted to almost any personality instrument.

Those of you who have training and experience in administering the **Rorschach** should consider using it with TBI students. The Exner System (1986), particularly if used with the computer hypothesis generation program, is particularly useful with and sensitive to the effects of TBI (R. Conder, personal communication, March 7, 1996).

Specific measures of social-emotional functioning. In personality measurement, it is probably best to begin with global measures and use these results to concentrate on specific symptoms through more focused measures. Measures of individual differences in global personality, such as those just mentioned, may elicit symptom profiles involving several personality traits. It is also possible that you have enough information (e.g. from the interviews and/or previous evaluations) to pursue more specific areas of social-emotional functioning.

Since depression is a frequent effect of TBI, it would be wise to include a scale for this symptom alone. Useful inventories devoted to surveying the existence and intensity of depressive symptoms include the **Reynolds Child Depression Scale** (RCDS) and **Reynolds Adolescent Depression Scale** (RADS) (Reynolds, 1987). These scales possess good psychometric qualities, take only 5-10 minutes to administer and are hand scorable. Other techniques include the **Children's Depression Inventory** (CDI; Kovacs, 1992), a 27-item scale which is actually a downward extension of the popular **Beck Depression Inventory** (Beck, 1987). Like the Reynold's scales, the CDI is easy to administer and score. Its major drawback is in the weak normative data, but that may have been corrected with recent revisions.

Another frequently seen effect of TBI is lowered self-esteem. Techniques designed to elicit feelings of self-esteem and self-worth include the **Piers-Harris Children's Self-concept Scale** (PHCSCS; Piers, 1984; see Appendix B), the **Coopersmith Self-Esteem Inventory** (SEI; Coopersmith, 1981; see Appendix B), and the more recently developed **Multidimensional Self Concept Scale** (MSCS; Bracken, 1991) and **Self-Esteem Index** (SEI; Brown & Alexander, 1991). All of these instruments are relatively well standardized, easy to administer and score, and take 10-20 minutes to complete. Take time to look through any inventories you administer to check on "unusual" items the student may have endorsed — unusual in terms of their suggestion of such things as psychotic thought patterns, possible indications of suicidal ideation, or self injury, etc. These responses are sometimes "lost" in multiple item factor scores. Ask the student to provide more information about unusual responses. This is a particularly effective technique if you find you do not have time to administer follow-up projective-type tests.

Consider using a battery approach to social-emotional assessment that involves both personality inventories and projective techniques. A sample comprehensive battery might typically include personality inventories such as the PIC or MMPI-2 (for older students), a depression inventory, such as the Reynolds, and a self-concept inventory, such as the Piers-Harris. Projective techniques might include a "battery" of projective drawings including the **House-Tree-Person** (HTP; Buck, 1981), and **The Kinetic Drawing System for Family and School** (Knoff & Prout, 1985). Consider including a "static" family drawing, i.e. family portrait and the BG in this battery also. The drawing battery can be scored using a "major indicators" approach, emphasizing such things as size, placement, pressure, and avoiding specific indicators with weak or inconsistent research support.

To these batteries, consider adding an **incomplete sentence form** (there are many versions available), which you should dictate because subtle writing or spelling deficits may inhibit the magnitude of the response. During this first administration, note those responses that are somehow "provocative" and return to them during a second administration asking for clarification, or elaboration. (See Appendix B for a commercially available version of this instrument, the **Sentence Completion Series**.)

Projective responses can also be obtained through thematic approaches such as the **Thematic Apperception Test and Children's Apperception** Test (TAT & CAT; Murray, 1938), the **School Apperception Method** (SAM; Soloman & Starr, 1968), or a combination of these. (I will often use a few cards from the TAT coupled with a few from the SAM in order to elicit feelings related to home/family vs. school themes.) For those of you who are not advocates of projective techniques, the **Roberts Apperception Test for Children** (Roberts & McArthur, 1982) may be a more tolerable alternative. The Roberts has a relatively standardized scoring system and relatively good normative data.

This all seems like a lot of testing, but you should consider using a battery approach to personality testing since social-emotional assessment is a complex area under the clearest of circumstances, and even more so with TBI students. Many of these instruments are relatively short and some can be completed by the student alone.

In general, you are searching for indications of current social-emotional status (including awareness of deficits), what coping mechanisms the TBI student is currently using to deal with his or her circumstances, and what supportive resources the student may have available intrinsically or from his or her environment. It is very important to get some feeling for the support available to the TBI student from family and friends. You can usually get this information as you interview these individuals for changes they have noticed in the TBI student. This information can be very helpful in determining the need for counseling/therapy, and in helping school personnel understand and cope with the TBI student's "new" personality.

Summary: Domain VII

The impact of TBI on social-emotional functioning is often overlooked in spite of the fact that these problems can be the most troublesome to those who interact with the student. As a start in assessing this domain, and to set your expectations, we reviewed the common social-emotional symptoms displayed by the TBI student. Not every student will display all of these symptoms, and in fact, the variations will be extensive. It is most important to establish what has changed in the student's personality as the result of the TBI. To do this accurately you need to find out what the personality profile of the student was before the injury. As a framework for your assessment, consider starting with interviews with as many sources as possible to help you build the preinjury "picture" of the TBI student. This information will help you focus the remainder of your social-emotional assessment efforts. It is suggested that you consider a global inventory first, particularly if you do not have sufficient information to narrow your testing. Once you have the global information (or if you have sufficient information to skip the global inventory stage) you can begin to focus on specific symptoms associated with TBI, such as depression and self-esteem. Several testing instruments and techniques were suggested, but feel free to use those tests/techniques with which you are most comfortable.

Domain VIII. Academic Achievement

This is an area of assessment that has not been well addressed in the TBI or in most neuropsychological literature. In most cases, it appears that the role of achievement testing is primarily to establish baselines to measure progress or establish the need for special services. There are no achievement tests designed specifically for TBI students, although the cognitive effects mentioned earlier will, of course, become evident during achievement testing.

The primary purposes for administering achievement tests with TBI students include the following:

1. to establish current levels of functioning across basic academic areas;
2. to compare these levels with those of the student prior to the brain injury (if preinjury data are available), or to compare current levels with expected levels based on age; and
3. to determine patterns of strengths and weaknesses for appropriate programming.

In other words, achievement testing serves much the same purposes for TBI students as for any other student. There are at least three important differences, however. **First**, make every effort to obtain a reasonable estimate of the student's preinjury academic performance. Interviews with the teacher(s) from the TBI student's most recent school experiences, previous standardized testing results, talking with parents, and discussing this with the TBI student can generally give you a good estimate of preinjury (premorbid) abilities. Ask the student what subjects he or she found easiest before the injury and which were most difficult. Be sure to ask this of the student's parents as well. This information alone can give you a fairly good expectation of what the student's preinjury academic strengths and weaknesses were. This preinjury profile allows you to judge the effects of the brain injury on academic abilities. **Second**, you must keep this preinjury academic skills profile in mind when planning remedial programming. As an example, if preinjury academic achievement patterns are ignored, teachers may try to remediate weak academic areas only to discover that the student was weak in these areas before the injury. This is an important consideration primarily because it can lead to a very frustrated student (and family). **Third**, keep in mind the current deficits of the student when developing the remedial program. If a student has documented brain damage to an area known to serve a particular skill (and the student displays weaknesses in that skill area as well), consideration should be given to compensatory remedial programming rather than skill development, i.e. component training. (More on this in the next section.) Trying to teach a TBI student material that he or she is physiologically incapable of learning is a sure way to build frustration and perhaps encourage acting out behavior.

Measures of Academic Achievement

This is an area of assessment that is very familiar to the school psychologist. There will be no attempt to suggest specific tests for this domain since you are perhaps more familiar with the available tests of academic achievement than the average neuropsychologist. In many situations, allied staff will administer the academic testing.

As with other assessments for exceptional child decision making, it is probably best to begin with a global achievement battery such as the **Woodcock-Johnson Psycho-Educational Test Battery-Revised** (WJ-R; Woodcock & Johnson, 1989). Ylvisaker et al. (1994) claim that the WJ-R is more sensitive to cognitive deficits following TBI than the Wechsler tests. Consider the **Wechsler Individual Achievement Test** (WIAT; Wechsler, 1992), and/or the **WRAT-3**. The former because it matches up well with the Wechsler intelligence tests and the latter to perhaps more readily observe how the student approaches spelling and arithmetic.

Once the results of the global measure of achievement (e.g. WJ-R) are available, the school psychologist can then focus on, (a) integrating these test results with those of previous evaluations (e.g. rehabilitation test results), (b) clarifying how the identified deficits will affect the TBI student's school performance, and (c) identifying any hidden issues related to achievement test performance in TBI students. As an example of this latter point, standardized achievement test results for TBI students are often inaccurate because they mask the TBI student's true deficits. Achievement tests administered in highly structured, distraction-free environments, with clear instructions delivered in a one-to-one setting, may inadvertently compensate for TBI deficits noted in more natural environments (e.g. attentional difficulties, reduced endurance, poor organization and initiation, and stress) (Ylvisaker et al., 1994). Also, it is well known that students with frontal lobe damage will present as normal or near normal in achievement and intelligence in spite of serious learning difficulties.

The next step would be to pursue any deficits noted in the global testing (keeping in mind the masking effects just discussed). There are far too many individual tests and techniques to cover indepth here. Many of the criterion-referenced techniques used by special educators should be explored also. The primary purpose in this stage of achievement assessment is to specify as much as possible the deficit(s) in order to apply comparably specific remedial programming. If a reading difficulty is suggested by the global testing, pursue this deficit in greater depth with other tests such as the oral reading measures or through informal testing. If you are having difficulty pinning down the deficit, seek the help of a reading expert. One final note. Expect the TBI student to be relatively unaware or to deny obvious academic achievement deficits.

Conducting TBI Evaluations: Some Suggested Procedures

In order to give you some practical assistance in assessing students with TBI, the following general suggestions are summarized. Although they are set up in a stepwise format, feel free to use them as you see fit.

Step One: Getting Organized

Testing TBI students will definitely take you longer than testing other students. This must be understood! Through careful organization of the testing sequence, however, it is possible to keep the testing time to a minimum. Also, as you become familiar with some of the new supplementary tests and develop a battery with which you are comfortable, the testing time will be shortened even more.

An important aid in getting organized is to consider making up a TBI testing battery notebook. A large three-ring binder is excellent for this purpose. The notebook should contain a section for each of the domains typically covered during your TBI evaluation. Each section should contain a list of tests you might use to assess each domain. For each test/technique list some basic information, e.g. what the test purportedly measures, the age range of the test, standardized instructions, administration time, scoring and interpretation information, normative data, etc. As you acquire additional tests or uncover additional information about the tests you are currently using, add this information to the notebook. It is very important that you keep up with the research on each test you use for TBI evaluations. We are continually uncovering new information about TBI. A notebook such as this will help you organize the extensive testing information you will be dealing with in TBI cases.

Consider also that there are many tests appropriate for assessing brain injured children and adolescents, and it is impossible to learn them all. Select a few at first, enough to cover the major domains, and learn just these. Add others when you feel you are comfortable with the first battery. Always start with a comfortable "core" battery made up of an intelligence test, achievement battery, and possibly a test of visuoconstruction ability.

To summarize "getting organized":

- List the tests and what each measures.
- Do not try to learn every test available. Learn a few well.
- Stay up to date with the research on the tests you use.
- Always start with a comfortable "core" testing battery.

Step Two: Gather All Available Data Prior to Testing

An ongoing debate centers on whether or not to bias yourself with information about the student you will be assessing before you test. Unfortunately, we are usually already biased by the fact that the student has been referred for evaluation. It would seem rather unusual to have someone referred for testing for no reason. Regardless of your personal position on this issue, it is strongly suggested that you obtain **every available bit of information** on TBI referrals *before testing*.

Included in available data may be evaluations done prior to the TBI student's re-entry into the schools, such as those done at the rehabilitation facility. Generally speaking, the evaluations done at rehabilitation facilities are very comprehensive. In addition, they are done by staff who are usually very familiar with TBI, its effects and appropriate remedial planning.

If the student has spent a period of time at the facility, periodic progress reports will also be available. These reports can be very helpful in determining what worked and what did not while the TBI student was a patient at their facility. North Carolina Procedures allow you to use these evaluations for placement if they are relatively current. This is a great saving of time and cost, and more importantly, it is unlikely that the school will be able to duplicate the comprehensiveness and expertise involved in the rehabilitation evaluations. Usually, the rehabilitation facilities will work closely with the school system where the TBI student will be returning. Staff members may even be willing to come and consult before the TBI student re-enters as well as after. If the facility is too far away for such personal contact, staff members will often send video tapes demonstrating progress as well as techniques that have been attempted. Use their expertise!

If this information is available, these cases will probably represent the "easiest" TBI students to reenter your school system. More difficult cases will be those TBI students who have not received any rehabilitation or those students whose injury was, at first, thought to be mild. These students often do not experience acute hospitalization or rehabilitation, but begin to display significant effects sometime after the injury.

If the TBI student did not attend a formal rehabilitation program, you should attempt to obtain any available medical information on the reentering student. Consider asking the parents to secure the medical records. They are usually able to get this information more easily, and may often have them already. Medical reports will contain helpful information regarding the site and extent of the brain damage. Knowledge of this information can help set your expectations regarding recovery and help focus your assessment on those problems usually associated with the type of injury involved. Some helpful information to look for in the medical reports includes:

1. emergency room (ER) intake and/or surgery report;
2. CT, MRI scan, and EEG results;
3. coma depth/length information;
4. seizure activity;
5. secondary physical and/or medical problems;
6. initial course of recovery; and
7. current medications.

This information can assist you in many ways. **First**, you will learn much about TBI from reading these reports and reliving the actual trauma your TBI student has experienced. **Second**, you will get some impression of what the presenting situation (e.g. intake report from the ER) was and what was done at that time. If brain surgery was performed, you should find reports of exactly what the surgeon did, what was found and the medical course after the surgery. **Third**, you will get information related to the brain damage itself such as CT and MRI scans and EEG results. There are reports from each of these procedures and the final results are usually summarized at the bottom of the report. **Fourth**, you will get information (e.g. coma depth and length, post-traumatic amnesia period, initial course of recovery) that will help you establish a perspective regarding the severity of the TBI, as well as some feeling for prognosis for recovery. Such knowledge may help you in setting a perspective for goals in remedial programming. **Finally**, you will get information regarding any complicating factors (e.g. physical disabilities or weaknesses, medication needs) that will help you in designing your remedial program.

Step Three: Interpreting Data from Other Sources

Once you receive the rehabilitation, medical, etc. information on a particular TBI student, it may be in a form unfamiliar to you, or they may have provided more information than you can absorb. All of this information can be helpful, but most of the information is summarized in reports that are done at entry and again at discharge. Reviewing these reports can give you a good overview of the progress the student has made and the profile of strengths and weaknesses (and how they changed over the course of the hospital stay). Progress notes of the therapists and nursing notes can be helpful but they are often difficult to interpret (not to mention read). Other helpful bits of information are the ER report, which will usually indicate such things as whether or not the TBI survivor was unconsciousness at the scene, and the surgery report, if surgery was necessary. What follows is an example of an actual emergency room and surgery report (some information has been changed for confidentiality).

Note those passages where phrases have been underlined as important to your purposes and an attempt has been made to clarify some of the medical jargon. In time you will be able to decipher these reports, but it helps to have a good medical dictionary available.

Sample Emergency Room Report

History: This is a 16 year-old, white female reportedly struck by an automobile today. She had loss of consciousness (*an important predictor of recovery outcome*) at the scene. The history was somewhat unclear although on evaluation in ER she was noted to have leftward eye deviation (*suggesting left hemisphere injury because she is using the "good" part of the brain to see*) and to move her extremities non-purposefully to stimulation. The patient did not follow commands (*both non-purposeful movement and not following commands suggests unconsciousness/coma and severity*). She was then intubated and medically paralyzed and taken for radiographic studies. CT scan showed evidence of subdural or epidural hematoma on the left side (*begin to picture what cognitive and/or social-emotional abilities may be compromised, i.e. language/verbal difficulties*). There was also evidence of edema (*or brain swelling, also suggestive of severe TBI*). Patient was then taken emergently to OR for an exploratory laparotomy (*exploratory surgery, in this case for possible internal injuries. Note that this is in addition to the brain injury*). Considering the patient's history of poor responsiveness in the ER and then transient pupillary dilation with some edema and a very thin clot on the left side, the possibility of intercranial pressure monitoring was considered. This was some concern because there was some edema possibly some early contusion on the left. The actual hematoma was quite thin and only seen in a limited area on one slice of the CT scan so that surgical removal would not result in significant removal of the intercranial mass effect (*in this case the edema [mass effect] was probably being caused by factors other than the hematoma*).

The procedure and risks of ICP monitor (*this is also referred to as an intercranial "bolt" because of its shape and is surgically inserted into the skull to measure the degree of pressure caused by the edema*) placement was discussed with the parents and they agreed to the procedure.

This was carried out under sterile technique in the OR while the other staff were doing the exploratory abdominal laparotomy. The initial intercranial pressure was 18 mmHG. When anesthesia was reversed she did move extremities to painful stimulation. The patient's ICP with head elevated in the NICU was approximately 12-14 following another dose of Mannitol (*this is a medication that helps absorb excess CSF that may be contributing to the edema*).

The patient will be monitored and given further therapy if indicated. Also she was started on Dilantin therapy because of the possibility of early contusion and the significant head injury. *(Dilantin is commonly used prophylactically as an anti-seizure medication. It is not uncommon to find patients on this or similar medication for long periods after the TBI.)* The patient's clinical condition was discussed with the parents. This is serious at this time and I was unable to predict accurately at this point what her overall recovery might be or if she will recover at all.

Step Four: History Taking

There is no more important part of a TBI assessment than the history taking. One important reason is the information you obtain regarding the TBI student's premorbid (preinjury) academic/intellectual abilities, and socio-emotional status. To effectively assess the effect of the brain injury you must have a good sense of how the TBI student functioned before the injury. This information is the best way to avoid setting unattainable intervention goals that can be very frustrating for the student and the school staff.

TBI students who were classified as exceptional before the injury represent the easiest situations. There is usually a great deal of test data and observational information available in the student's files to help establish a baseline prior to the injury.

Because it is rare to have test data available from before the injury, it is important to know how to put together a reasonable estimate of how the TBI student functioned prior to the injury. Begin by checking the student's school

Case Notes

PREINJURY TEST DATA — ***Gloria was an extremely bright child who was tested for a gifted program at 5 years of age. Her IQ score at that time was over 150. She entered the gifted program and had great success both in this program and in school. A few years later, at the age of 8, she was involved in a tragic automobile accident as a passenger. Her brain injury destroyed most of her left hemisphere. Neuropsychological testing done after the accident revealed an IQ of 70. The fact that an IQ test was completed prior to the accident vividly demonstrated the effect of the injury and also greatly helped Gloria's family obtain a very large settlement to assist in her future schooling and medical needs.***

Info Box

Predictors of severity — It is advisable to learn the most commonly used predictors of severity following brain injury in order to facilitate your remedial planning. The most commonly used indicators of severity are coma depth and length, and post-traumatic amnesia period (PTA). (Be careful not to rigidly apply these indicators to every TBI referral. Keep in mind the earlier caveat that there are no two brain injuries alike, owing to the complexity of the CNS.) Depth of coma, as judged by the Glasgow Coma Scale (Teasdale & Jennett, 1974) or Children's Coma Scale (Raimondi & Hirschauer, 1984) are fairly reliable indicators of severity, while length of coma seems to be a better prognosticator of overall recovery. Generally speaking, any coma length beyond 24 hours is considered serious. Lengthy coma, such as a month or more, are usually predictive of poor outcome. Post-traumatic amnesia (PTA) is also associated with prognosis. As you may recall, PTA refers to the length of time following the injury where the survivor has no meaningful memory. In most cases there is a period of amnesia preceding the injury (referred to as retroactive amnesia) and a period after the injury referred to as either PTA or anterograde amnesia. If the PTA is any longer than one hour, it suggests moderate severity. Fortunately, very few TBI survivors can recall the incident itself that led to their brain injury.

records for previous grades and the results of any standardized tests administered by the school. Ask the teacher(s) who had the student in class prior to the TBI for an assessment of the student's strengths and weaknesses. Ask the parents or the student for information regarding outside interests or hobbies. Analyze these interests and hobbies on the basis of left vs. right hemisphere skills (e.g. if one student liked to spend a lot of time reading vs. another who preferred painting, this would generally suggest what skill area strengths the student possessed). These preferences will probably correlate with their academic strengths and weaknesses.

Obtaining a good premorbid history is more an art form than an exact science, and you will get better at it with time. In general, ask as many persons familiar with the student as many questions as possible. Do not forget to question the student as well. His or her recollection of progress in school may be quite accurate. This is more often true with students surviving milder brain injuries. Do not rely on these recollections solely, however, since past memories can be distorted in TBI students and they are prone to denial and disinhibition.

As a final note, consider structuring your history/interview questioning areas in the same sequence as the domains in your report. It will help to organize your data and expedite report writing.

Step Five: Administering the Tests

This step actually involves the following processes.

1. planning the testing session in advance; and
2. evaluating your progress between testing sessions

Planning the Testing Session in Advance. You should plan your TBI assessments in advance because of the complexities involved. Just prior to your testing session, list the tests/techniques you are planning to use for the specific case. There will generally be a "core" battery of tests you will start with in most TBI cases. As we have discussed, these core tests usually will include a test of general intelligence such as one of the Wechsler tests, and a test of academic achievement (unless this is done by an allied staff member). Some neuropsychologists will use a short form of a test of intelligence. However, if used properly, the full test will provide you with much more information than a short form. For school psychologists the use of a short-form IQ test is probably not an option since categorization requires IQ scores based on administering a full test.

Now arrange a "game plan," including which tests you will administer and in what order. Having this planned beforehand will reduce your anxiety and speed up the session. Plan on starting the assessment by taking a good history, administering the age-appropriate Wechsler, then moving to a memory battery such as the WRAML or WMS-R (again, depending on the age of the student). You might find it easier to do the history in a separate session prior to the testing session. The information gleaned during the history session may have an affect on the tests you select or the testing sequence. As an example, proper sequencing of tests will allow you to administer "non-competing" tasks during the delay portions of the memory test as previously mentioned. Always have some non-competing, "fill-in" type tasks ready if there is still time before the delay portions of the memory test expire. These can include informal testing of hand strength, the incomplete sentence blank, other personality testing measures, etc., as long as the "fill in" tests do *not* involve memory.

Evaluating Your Progress Between Testing Sessions. While it may be possible to complete the assessment of a TBI student in one testing session, during the first few assessments you may want to give yourself a chance to interpret what you have done midway through. The core battery will take approximately 2-4 hours (depending on whether or not the history portion is included as part of the first testing session). These tests will give you a good general overview of the student's functioning. From here you can begin to plan your second testing session. To do this most effectively, score the tests you have administered during the first testing session and begin a preliminary interpretation of your findings thus far. While it's not possible in this manual to go into all the possible findings you might encounter, look for specific areas of low scoring that seem to have a common "theme" possibly related to what you already know about the student's deficits. These themes will help you choose where to go with the next testing session(s).

Note if an impairment in a basic process such as memory, attention, higher order/executive function (e.g. impulsivity) could have accounted for any low scores. If so, pursue the identified processing problem further with supplementary testing and/or limit testing. Remember, most tests involve almost all of the domains to some degree. It's your job to partial out the memory, attention, etc. component in developing the common themes.

Step Six: Analyzing and Interpreting the Test Results

In the typical TBI evaluation, you will use several instruments and techniques. This will result in a considerable amount of data to analyze and interpret. As with the testing itself, the first step is to somehow organize this volume of data to simplify the task of analysis and interpretation. The following suggestions are offered as a method of organizing this test data.

1. Create a separate data summary/analysis sheet. This step will facilitate the organization of the test data.

2. Arrange your data on this sheet in the same sequence of domains as your final report format. (This should also closely follow the sequence of tests administered.)

3. For each domain, record the test(s) administered (including each subtest) with the raw score and some form of normative score (e.g. percentile, T-score, standard deviation, etc.). Using a common normative score will make data analysis easier, although this may not always be possible. It is usually relatively easy to summarize your testing results in standard deviations. The "norms" on some of the less rigidly standardized neuropsychological tests are often presented in means and standard deviations. Using the mean plus or minus one standard deviation can give an approximation of the normal range. Significant weaknesses will present as scores one or more standard deviations below the mean. Significant strengths will be

Case Notes

INTERPRETATION EXAMPLE — *Jimmy, an 8-year-old TBI survivor, attained a score of 10 on the Digit Span subtest of the WISC III. Digits Forward raw score was 8 and Digits Backward was 3. His raw score total of 11 converted to a scaled score of 10 on this subtest.*

Let's use this example to examine the brain functions involved in the Digit Span subtest. To begin with, this subtest is actually two different test (Digits Forward and Digits Backwards), each with different demands. These demands are, in turn, affected differently by brain damage. Both parts of the Digit Span subtest require auditory attention to orally presented numbers, and both rely on short-term retention. From here on, however, there are great differences. Digits Forward appears to measure something related to efficiency of attention similar to Kaufman's (1979) "Freedom from Distractibility" concept. Digits Backward, however, involves a much more complex and different process. The student must comprehend a more complex set of instructions, and store data briefly while transposing them mentally before responding. Clearly, Digits Backward is more a test of attention and memory than Digits Forward and thus tends to be more difficult for TBI students, particularly those with left hemisphere damage. However, In the scoring procedures, both tests are added together to obtain the scaled score as if they were measuring the same abilities (Lezak, 1995). Thus, if a TBI student does well in Digits Forward (as Jimmy did) and very poorly in Digits Backwards (as many TBI students do) the scaled score alone will not reflect the difficulties the student had in completing this task.

one or more deviations above the mean. Neuropsychological test data is usually analyzed on the basis of identified weaknesses with "strengths" represented by performances in the normal range or above.

4. Once steps 1-3 are completed, you can "eyeball" the results on the basis of the pattern of weaknesses. Further analysis of these weaknesses may allow you to perhaps generalize to other similar task situations in the classroom.

Guidelines to Assist in Interpreting TBI Assessment Results. Although it's not possible to account for every circumstance you will encounter, here are some basic "rules" that may be helpful in interpretation.

1. **Scores on global intelligence measures, such as the Wechsler, cannot be interpreted in brain injury survivors in the same manner as with non-injured individuals.**

These instruments are not designed to measure subtle behaviors such as failure to act purposefully, rational thinking, and dealing effectively with the environment, (Mapou & Spector, 1995). A normal or high score on these tests does not necessarily mean normal performance. You must observe *how* the student completed the items, and you must analyze the error patterns with TBI in mind to interpret the student's performance.

2. **Do not always take tests at their face value.**

Tests don't always measure what they say they measure or they may measure other functions as well, perhaps further clouding the issue. Mapou & Spector (1995), state that there may be many reasons for failing a specific test. Scores do not always communicate the full information given in the individual's performance (Goldberg & Costa, 1986).

Careful detailing during the assessment of how the student performed that task can often show you specifically why he or she performed poorly. [Consider also the suggestions mentioned in the sections on testing the limits through the use of informal testing.]

3. **In situations of apparent multiple deficits, be certain to exhaust all efforts to identify common, generalized weaknesses among the deficits (Walsh, 1995).**

There is no real purpose served by identifying a "laundry list" of deficits. These lists will serve to confuse the referral source and, more importantly, draw attention away from the relatively few significant deficits that are probably directly and indirectly influencing others. It is your job to bring order and focus to the student's deficit pattern(s). Ask which weakness could cause poor performance on these seemingly individual tasks. The data analysis sheet should facilitate this process. Look for common threads among the various deficits identified. You may find support for a pervasive problem such as attention or memory.

General Interpretive Hypotheses. What follows are some general interpretive guidelines that may be useful in analyzing the test performance of TBI students with documented injury to either the left or right hemisphere.

With left hemisphere damage, in general expect depressed:

- Verbal vs. Performance scale scores on the Wechsler;
- expressive language;
- language milestones (in young children or in children injured prior to or during language acquisition); and
- reading performance (more than computation performance).

With right hemisphere damage in general expect depressed:

- Performance vs. Verbal scale scores on the Wechsler;
- receptive language;
- visuospatial, visuoconstruction, visuoperceptual performance; and
- awareness of deficits.

Step Seven: Writing the Report

Some suggestions regarding the writing of TBI reports include the following.

1. **Avoid jargon**

   This holds with any report, of course, but is even more important in TBI reports. As you begin to become familiar with the jargon in brain injury and neuropsychology, it may be irresistible to use some of this terminology. As you have seen in this manual, a common, understandable term can be used in almost every instance where technical jargon is used.

2. **Respect the "turf" of other professionals involved**

   There may be situations in which you honestly believe something was not done correctly (or at all) by a physician or some other professional. Be sure, however, to respect the other disciplines involved in these cases. It can be very complicated at times to know your professional boundaries. It's OK to suggest that a TBI student should be examined by a neurologist if the family has nobody tracking a complicated case. It is not OK, however, to suggest that the family see a neurologist if the TBI student is being followed by a family practitioner (even though you may not personally agree with the choice of medical professional). Remember, no one knows everything about TBI. We are all still trying to figure out how to deal with TBI students.

3. **Be sure to differentiate quantitative from qualitative findings**

   It's important to identify those qualitative data you obtained from your observations of the TBI student's performance and to be careful not to become "overly zealous" with these findings. Phrases such as "appears to be" and "may suggest" are very appropriate in interpreting data with little or no normative support.

4. **Try to "reduce" the data to a few specific interpretations and recommendations**

   It is your job to make sense of the mass of information you will probably accrue with these students. In general, try to sift through the data looking for the few major findings that seem to "jump out at you" in describing the TBI student. Usually, other problems will be related to these major findings. Consider identifying these major findings at the end of the report (instead of a summary or conclusions section), and follow each major finding with a recommendation(s). This format seems to help the reader focus in on the major problems and solutions quickly. (A sample TBI report is shown in Appendix C.)

A Sample Assessment Sequence

The following demonstration is designed to stimulate, not structure, your thinking. As a professional, you have assessment instruments, techniques and a sequence with which you have become comfortable. A suggested battery should proceed from general to specific with successive testing to identify deficits as clearly as possible.

(Note. This example was developed with the assumption that the TBI student would not have had sufficient or recent pre-assessment data. The extent of your battery is governed by the extent of existing pre-assessment data. If you have the results of a recent comprehensive assessment from a rehabilitation facility, it may only be necessary to reframe these results to develop the incoming student's IEP and/or add any assessment information required to establish the need for special services.)

First testing session: Goal— to obtain basic cognitive and social-emotional levels and to identify domain-specific weaknesses for further assessment.

1. CORE: Age-appropriate Wechsler + general academic achievement battery

   (Consider limit testing after completing these tests if time allows.)

2. General memory instrument (e.g. WRAML, TOMAL)

   (Note. I would recommend a general memory battery in almost all TBI assessments because of the frequency of this problem in TBI and because the most measures of global intellectual ability and academic achievement do not contain specific measures of memory.)

3. Global measure of personality (e.g. PIC-R, MMPI-A, etc.)

4. Analyze your results based on the suggestions made in the manual (e.g. error analysis), and identify areas you wish to pursue further.

Second testing session: Goal — to pursue strengths and weaknesses suggested in first testing session in greater detail.

1. Conduct domain specific assessment in areas identified.

   As an example, if language is identified as a specific problem area, tests such as the

CELF-R can be administered by you or an allied staff member such as the speech-language pathologist. If a specific memory impairment (e.g. auditory, visual) or information processing problem (e.g. slow processing) emerges, you should consider supplementary memory testing using some of the instruments suggested. Consider using limit testing techniques with these supplementary tests to uncover additional information about processing problems since there may not be formal tests available for these factors.

2. Re-analyze the testing, interview and observation data to this point and determine if further data gathering is necessary. Plan your next assessment session if one seems necessary. Keep in mind that your goals for the assessment are the development of an appropriate IEP for the student and to gather whatever information may be helpful for intervention programming.

SECTION FOUR:
School Reentry and Appropriate Programming for TBI Students

SCHOOL REENTRY

The first step in appropriate programming for TBI students is proper school reentry. In getting a clear picture of the procedures involved with reentry, however, it is important to discuss the sequence of events in the recovery of the TBI student just prior to reentering the school setting.

(Note. What follows assumes that the TBI student has experienced some form of rehabilitation prior to attempting to reenter school.)

The Rehabilitation Process

Once the TBI student is stabilized medically at an acute care hospital, he or she may progress to a rehabilitation program depending on need and, unfortunately, financial resources. Rehabilitation is provided on a continuum of services ranging from inpatient care (for some moderate and almost all severe brain injuries) to outpatient or in-home therapy services (for less severe injuries). The greater percentage of TBI survivors (approximately 80%) will not require long-term inpatient care (although some intervention or rehabilitation is generally needed even in the case of mild injury). The remaining 20% will require intensive rehabilitation after medical stabilization. Patients who start out in the inpatient setting generally recover and progress through the various levels of the rehabilitation continuum and eventually are released to the care of their families. Some very severely injured survivors must be placed in long-term care facilities or nursing homes because they need a high degree of medical care by trained professionals. This is often the case with prolonged coma (sometimes referred to as vegetative state) and/or other, serious medical care cases.

In the rehabilitation setting, the TBI survivor will experience a range of therapies including psychology (e.g. counseling or therapy), neuropsychological assessment, physical therapy (e.g. for ambulation), occupational therapy (e.g. for fine motor control), speech and hearing therapy (e.g. for communication), and educational services. Many rehabilitation facilities have a school or classroom on site.

Factors that Affect Recovery from TBI

There are some general factors that affect the success of TBI survivor's rehabilitation and recovery.

Time since injury: The recovery "window". There is no "typical" brain injury recovery sequence. As a general rule, the greatest gains after injury are made during the first six months to two years, with the rate of recovery falling sharply during the second year.

Although gains have been reported after two years, these are usually relatively small. It is sometimes difficult to determine whether these later gains are due to the recovery of damaged neurons (sometimes called spontaneous recovery), to the individual learning to compensate for deficits, or both.

Because of this recovery "window," it is always important to determine when the injury occurred. As an example, if you are working with a TBI student who was injured three months ago vs. a student who was injured three years ago, the time difference would have important implications in terms of the type of interventions you would choose (e.g. remediation or compensation), as well as what the overall expectations for success might be. The first student may progress rapidly whereas the second survivor has probably stopped or greatly slowed in terms of recovery of function.

Injury severity. Severity is also a factor in TBI recovery. Research suggests that this factor may have the most significant impact on successful outcome. Longer coma duration (Filley, et al., 1987); longer posttraumatic amnesia duration (Ewing-Cobbs, et al., 1990); depth of lesion (damage) (Ommaya and Gennarelli, 1974); the presence of intercrainial hematomas (Mayer & Walker, 1982); diffuseness of damage (Filley, et al.,1987); and extent of secondary brain injury (Gentry, et al., 1988) have all been identified as impacting the rate and extent of recovery from TBI.

Severity of injury can impact ceiling effects in recovery. Students with milder forms of TBI may not appear to make significant gains despite great effort. It is important in these situations to have a good sense of preinjury cognitive levels to put gains in perspective. In the case of severe injuries, significant gains can be made in the first few months. In these situations, it is important to remember that significant early gains should not be taken to mean that this rate of recovery will continue, or that the TBI student will make a "complete recovery".

Family factors. In spite of well designed intervention programs, factors such as the quality of parental supervision, and the family functioning in general, have been known to impede the progress of the student (Rivara, et al., 1993). As an example, environmental safety factors can sabotage a well intended intervention. Many of the TBI students were high risk-takers before their injury. (This is probably why they were injured in the first place.) This behavior is unlikely to stop after the injury, and may even worsen due to impaired judgment and disinhibition. Parents must take take care in monitoring the student's safety after a brain injury. Allowing a TBI survivor to get back on the ATV or motorcycle that contributed to the initial injury may not be the wisest course of action.

Basic Principles of Brain Injury Rehabilitation

There is much to be learned from the rehabilitation field about how to intervene with TBI students. What follows are some basic principles drawn from the brain injury rehabilitation that we can use as a foundation in developing our school programming for TBI students.

1. **Clarity:**

TBI students commonly have injuries that compromise abilities necessary for communication. Though they appear to be able to hear you, this is no assurance that they understand you. Expectations for these students must be very clear for them to be successful. In general, never assume a TBI student understands you until you do such things as have him or her repeat the question or instructions.

2. **Repetition:**

Due to slow processing, memory and attention impairments, etc., it is important to repeat instructions and remedial activities, perhaps many times. Because the TBI student is able to successfully complete a task today does not mean he or she will do the same tomorrow.

3. **Structure and Consistency:**

TBI students need a great deal of structure and consistency in their lives in general. This is also true in the school setting. Structure and consistency help to simplify the environmental demands the re-entering TBI student must face. In the rehabilitation setting, survivors of TBI find a great deal of comfort in predictable routines. It helps them make sense of what appears to be a confusing, fast-paced world. Lack of structure creates anxiety and confusion. There are significant efforts to create and maintain this structure in the rehabilitation setting. As an example, rehabilitation hospitals will make a concerted effort to keep the TBI survivor's nursing and therapy staff the same throughout his or her inpatient stay. Some facilities will put pictures of the survivor's staff in their room to remind them who will be attending them. Schools should try to simulate this high level of structure during the initial re-entry stage, by selecting only a few school staff members who will work with the student on a regular basis. Structure can then be reduced gradually as the student's tolerance increases.

4. **Flexibility:**

TBI rehabilitation is a relatively new and developing science. We simply don't know all the answers yet. Therefore, we must be flexible in developing our intervention programs. Periodic monitoring of TBI students' progress is crucial. For the recently injured student, what worked last week may not work this week. Placing these students in exceptional child classifications with triennial evaluations as the only monitoring mechanism can be a disaster. You will learn the most effective intervention strategies for your TBI students only by constantly monitoring their progress. Although this will teach you what might work with the next TBI student, be prepared to shift gears quickly, as each TBI student can be very different from the next.

School Reentry Procedures

The appropriate handling of the school reentry process for the TBI student is, perhaps, one of the most overlooked aspects of the total recovery process. This appears to be particularly true for the TBI student who has not had the good fortune of a formal rehabilitation program.

In these cases, the responsibility for determining whether or not a TBI student is ready to re-enter and how to go about appropriate re-entry, must be assumed by the school staff in consultation with appropriate professionals, e.g. neuropsychologist. In rehabilitation settings, an interdisciplinary team member (generally the education specialist or the case manager) takes on the role of liaison with the school system where the TBI student will be re-entering. In the school setting, the school psychologist may be in the best position to assume a comparable role (Begali, 1994), although interested/involved teachers, social workers, or other staff members can act as a "case manager" for the student.

For the TBI student who has been fortunate enough to experience a formal rehabilitation program, the re-entry process can be considerably easier and more organized. When the TBI student is in the final stages of his or her rehabilitation program, the professionals on the TBI student's interdisciplinary team will generally begin to plan for school re-entry. This should be a coordinated process involving physicians, neuropsychologists, therapists, teachers, and family (Shurtleff, et al., 1995).

Except for slightly different emphases, many similarities exist between the services provided by the schools and those provided by rehabilitation facilities. Both follow the interdisciplinary team model, which can include many similar disciplines, i.e. physical and occupational therapists, speech and communication specialists, medical consultation, psychologists, and educational specialists. The interdisciplinary rehabilitation model would be an excellent choice for the school to follow in assessing and intervening with TBI students.

Things to Consider Before the TBI Student Reenters

The school has the responsibility for adequately preparing for the re-entering TBI student. Mira et al. (1992), have outlined critical elements that should be in place before the TBI student re-enters.

1. Provisions for the TBI student's basic safety and access. This includes such things as:
   - non-slip flooring, appropriate ramps, handrails, elevators, hall traffic;
   - access to restrooms, water fountains, the cafeteria;
   - need for preferential seating;
   - assistance for activities of daily living (e.g. toileting, dressing, etc.);
   - need for adaptive physical education;
   - need for assistive devices (e.g. communication devices, etc.); and
   - need for special transportation.

2. **An informed school staff.** The school staff must be educated as to what to expect in the transition of a TBI student and about the nature of TBI itself. The school psychologist should consider presenting brief inservices on TBI. (Mira et al., 1992, is an excellent resource for developing these in-service training sessions.)

3. **A staff that has the resources to provide an intensive, interdisciplinary educational program.** The school must be prepared to accommodate the diverse and potentially changing needs of the TBI student. In a sense, the school should initially attempt to simulate the services provided by the rehabilitation program.

This will demand an interdisciplinary approach, perhaps using a wide range of resources available at the school as well as some resources not yet available.

4. **A structured and controlled, yet flexible environment and program.** Although this seems a conflict in terms, in the initial stages of re-entry, the level of structure in the TBI student's program should simulate the level present at the rehabilitation program, gradually allowing less structure as the student progresses. The frequently changing cognitive and emotional profile of the TBI student dictates that flexible programming be adopted as well. Special environmental and schedule accommodations are very often necessary. The school program should use whatever resources are necessary to meet the needs of these students.

   In terms of placement, the more constricting programming options (e.g. self-contained programs) will generally not provide adequate program flexibility and will not be able to adjust to the changing needs of these students. For TBI students who may be beyond major recovery advances (e.g. more than 2-3 years post-injury), the need for program flexibility may be lessened. The best programs will be those that identify the needs of the TBI student in the IEP and provide access to *whatever services or programs best fit those needs.*

5. **The provision of special, assistive equipment.** Devices that assist in communication, response enhancement, and ambulation must be in place *before* the TBI student returns. The need for these devices can be obtained from the rehabilitation program staff. Generally speaking, several assistive options will have been tried, with varying results, at the rehabilitation program. Knowing this information will save you considerable time and expense.

6. **Ability to design and implement behavioral programming for disruptive behaviors.** As we learned earlier, disinhibition, frustration and acting out can be part of the TBI student's profile at varying times in the recovery process. These behaviors may be transient or permanent. School staff need to anticipate these behaviors and plan to intervene early. Families should be included in such plans whenever possible, for continuity in the home environment. Lehr (1990), has addressed behavioral management planning in detail.

   Redirection can be a valuable skill to develop in dealing with acting-out behaviors. Abstract reasoning is often compromised in TBI students, so value clarification, etc. approaches will not work as well as simply changing the subject. Unfortunately, part of the reason redirection is effective with these students is due to their memory dysfunction. Once you shift the topic for a few moments, they will often forget what it was they were upset about.

7. **Knowledge of resources available to TBI students.** Initially, the case manager from the rehabilitation facility will be an excellent source for information regarding available resources for TBI survivors. If there is a social worker on the school staff, this individual is probably in the best position to know of such resources. Whoever is determined to be the school's "TBI Case Manager" should set about learning

what resources are available. This information can be obtained from the national and state organizations for TBI (e.g. The National Brain Association, and The North Carolina Brain Injury Association). These organizations can be very helpful in tracking down needed resources. (They also provide an annual listing of resources.) In addition, many cities and towns have TBI support groups that can assist in identifying local resources and help facilitate the adjustment of the TBI student and family members. Local neurologists and neuropsychologists should also be sought out for assistance or consultation. In North Carolina, the SDPI has provided a list of local neuropsychologists who have been approved for providing services and supervision on TBI cases.

Preparing the School Staff for the TBI Student

In general, the school staff needs to know the following to establish effective reentry and programming for the TBI student.

1. current physical conditions and/or limitations;
2. current medical and neurological status, including prescribed medications;
3. self-care needs (toileting, etc.);
4. required or helpful assistive devices;
5. concerns regarding social-emotional behavior;
6. current status of communication abilities;
7. ongoing therapy needs (physical/occupational, etc.);
8. all neuropsychological, cognitive, academic, and social-emotional testing data available;
9. data on interventions attempted and the results/progress;
10. arrangements for follow-up either by the rehabilitation facility and/or the student's local physician; and
11. comments regarding long-term prognosis.

Some specific suggestions in preparing school staff for the TBI student. Mira, et al. (1992) have identified a specific agenda for staff training in preparation for an incoming TBI student. These items include:

1. **General information about the effects of TBI** - Do not assume staff members know about TBI! In fact, very few individuals are aware of the true nature of brain injury. Recently, a study assessed the level of knowledge about brain injury in the general public. The results showed that almost 50% of those questioned thought that a second blow to the head can help a person regain their memory (Willer, Johnson, Rempel & Linn, 1993). What most people know about brain injury is what they have seen in the movies or on television, where individuals appear to suffer severe blows to the head with no apparent injury or wake up from long comas as if nothing happened. Parker (1990), maintains that professionals do not fare much better in terms of knowledge of the effects of brain injury. This is particularly true of the subtler forms of TBI, e.g. "mild" TBI.

2. **The differences between a TBI student and other exceptional children** - Many TBI children have been (and unfortunately still are) placed in other exceptional categories. The reasons for this are unclear, but it is certain that lack of knowledge about TBI is one of them. We know that in those TBI students who have been injured recently (e.g. within two years), it is very possible for their performance profile (and thus intervention needs) to change dramatically, making traditional placements inappropriate. With information such as this, the school staff will be better prepared to respond to questions regarding the needs for services in these students.

3. **Specific information about the reentering TBI student** - This information will provide an excellent opportunity to discuss TBI in general, with special relevance to the entering student. Be careful to guard the TBI student's confidentiality rights in school-wide discussions. (The student and the family's permission should be sought before any in-depth explanation to staff who are not directly involved with the case.) Your explanation about the TBI student should include:

   - expected long-term problems;
   - necessary related services (e.g. physical/occupational therapy, etc.);
   - transition techniques to be used;
   - any necessary physical, safety, and/or schedule modifications; and
   - preliminary instructional strategies and the IEP.

(Note. Remember that the family also needs to be prepared for your course of action. You will find that including the family in preliminary discussions and/or allowing them to sit in on presentations and training sessions such as the above will be very helpful. I have used other TBI survivors in some school presentations. These students often feel a special need to tell their story. This can be a very dramatic addition to the presentation.)

Preparing for the Transition from Rehabilitation Program to School

To ease the transition for the re-entering TBI student (and the school staff), it is crucial that effective communication be established with the rehabilitation facility as soon as possible but definitely *prior* to reentry. If the TBI student will be coming to your school directly from a rehabilitation program, there are some things the school staff can do prior to reentry that can ease the transition back into school.

1. Contact the student's family to see if a timeline has been established for discharge from the rehabilitation program.

2. Once a discharge timeline has been established, get permission from the student's family to contact the rehabilitation program to set up a meeting to discuss reentry.

   During this contact, request the following information from the rehabilitation program:

   - medical history;
   - results of any evaluations (Rehabilitation facilities will generally have: (a) a

comprehensive baseline assessment from when the student entered their facility, (b) periodic (usually weekly) progress reports from each discipline, and (c) a comprehensive assessment report at discharge. The school staff should make *every effort* to obtain these reports.);
- interventions attempted and results;
- any special needs (e.g. assistive devices, transportation, etc.); and
- suggested items for the student's reentry IEP.

3. Request consultation from the rehabilitation program during the reentry period. It will be best if the rehabilitation staff member(s) can come to some of the initial reentry/IEP meetings at the school. Another option is to have a school staff member (preferably the identified "case manager" for the re-entering student) attend the last few team meetings at the rehabilitation facility to gain an understanding of the status of the student and to apprise the rehabilitation staff of what is available at the school. If distance prohibits this, request that a video tape be made of rehabilitation staff working with the student (or go to the rehabilitation program and make one yourself). If none of this is possible, be sure to call the designated rehabilitation staff member often during reentry.

4. In these early meetings with the rehabilitation staff, you are seeking answers to the following questions:

   - **What period of time and what type of program (if any) should occur prior to reentry?**

     It is often effective to have a period of homebound instruction precede reentry to familiarize the student with the demands of the school routine. This period can also be very helpful in assessing such things as the fatigue level of the student, and if he or she will be able to tolerate the proposed curriculum. Homebound instruction can give the student a "running start" to facilitate the actual school reentry process.

   - **When in the school schedule is it best to consider reentering the student?**

     This is an important, yet often overlooked consideration and can make or break the reentry process. It is generally better to start the school reentry program for mild to moderate TBI students after a natural break, such as spring vacation or the Christmas/New Year holiday break. This will allow the TBI student to begin on a fairly even basis with the other students. More severe TBI students should start after the summer break, after receiving a period of homebound instruction. Each situation is different, however, and may require different arrangements.

     The school professionals (with consultation from the rehabilitation staff) are in the best position to make the decision regarding when the TBI student is ready to reenter. If there was no rehabilitation, seek the consultation of a professional with expertise in TBI to help decide when the student is ready to reenter. It is generally not a good idea to let the family and/or the TBI student determine when the reentry should begin, since they are generally "too close" to the situation to be objective and may not be aware of the all the ramifications. They should, however, be involved in the decision-making process.

- **How intensive should the initial academic schedule be?**

  Intensity can be defined as the length of day and/or level of difficulty. As mentioned, a period of homebound instruction may prove helpful in determining the initial academic schedule. When in doubt (which is normal in most TBI cases), it is best to start very slowly. It is much easier to convince the family, student, and school staff to increase the intensity as opposed to dropping back. For students with moderate to severe TBI and/or those have been through fairly extensive rehabilitation, you may want to consider one period (approximately one hour) a day for at least a week. The subject area for that hour should be something in which the student is strong (based on post-injury evaluation), and preferably with a teacher who expresses a desire to take this student on as a challenge. Often, the identified teacher is the TBI student's teacher from before the injury. Be certain to support this/these initial teacher(s)!

  The length of the program can be extended as the student progresses. Also, keep in mind that it is not unusual for TBI students to experience a phenomenon akin to "good days, bad days." This is very common and has to do with the physiological recovery process. Because of this, the TBI student's progress may be or appear to be somewhat erratic. It is probable that this phenomenon will smooth out over time. During this good day-bad day period, however, it may be difficult to establish a rate of progress.

- **What are the two or three problems or issues that will be most important to monitor during the first few days?**

  The profile of strengths and weaknesses of the TBI student is usually very complex, with frequent fluctuation. To simplify the reentry and intervention of these students, it is often helpful to narrow the problem areas to a few major areas. (These areas will probably impact many of the other problems.) If all who are working with the student (including the parents) focus on these 2-3 major problem areas, the success of the reentry and interventions will be maximized. It will require frequent meetings of the student's reentry/intervention team to determine and maintain this focus. You will find that it is worth the effort, however.

Programming for TBI Students

In discussing intervention programming for TBI students, it is important to remember that the field of brain injury rehabilitation is not yet an exact science. As with any new science or discipline, the initial efforts have gone into assessment and diagnosis. In terms of

INFO BOX

Criteria for school reentry — A list of criteria has been proposed to assist in judging whether or not the TBI student is ready to tolerate the classroom environment. These criteria include the ability to:

1. Attend to a task for 10-15 minutes.
2. Tolerate 20-30 minutes of general classroom stimulation (movement, distractions, noises).
3. Function within a group of two or more students.
4. Engage in some type of meaningful communication.
5. Follow simple (one- or two-step) directions.
6. Give evidence of learning potential.

(Cohen, Joyce, Rhoades, and Welks, 1985)

These criteria can be very helpful as initial objectives in judging the ability of the TBI student to succeed in the classroom. Because they were not intended to fit every student and every situation, care must be taken to not apply them rigidly. As an example, these criteria would probably not be suitable for very young children or some severe TBI students. Flexibility in TBI programming should be a basic philosophy. Nevertheless, these criteria provide a good starting point for decision making.

appropriate interventions, we are still in the process of discovering what works and what doesn't with respect to brain injury. As an example, the Cognitive Rehabilitation Society, one of the first associations devoted to cognitive intervention in brain injury survivors, is only a few years old.

Our lack of expertise in cognitive rehabilitation is particularly true in the case of children and adolescents. As of this writing, there has been only one book published on the subject of cognitive rehabilitation in children and adolescents (Ylvisaker, 1985), while several have been written on adult rehabilitation (Lehr, 1990). Much of what we do in child and adolescent TBI intervention is borrowed from adult rehabilitation efforts and those techniques that have been developed for other cognitive and behavioral disorders other than brain injury. The developmental issues in children mentioned earlier also have a great deal to do with our lack of specificity with regard to TBI interventions. It's one thing to try and remediate brain injury in an adult; it's quite another to try to remediate an injury while the brain is still developing.

Although TBI can be devastating to anyone regardless of age, many individuals in the TBI community believe the return to a "normal" life can be more difficult for the school-age child or adolescent. A primary focus in adult brain injury rehabilitation is the return to work. In the case of the child or adolescent, the parallel goal is the return to school. Both can be tremendously difficult. There may be, however, some subtle "advantages" for adults returning to work, as compared with the return to school. Most adults have chosen their vocation, probably on the basis of strengths or interests they possess that match their job. Also, the adult worker has probably performed his or her job for some time prior to the TBI, thus many of the skills necessary for job skills are "old learning." Old learning is generally preserved in the TBI survivor; however, the child or adolescent must return to a setting where new material must be learned every day and where he or she will be tested on these abilities as well. New learning is much more difficult for the reentering TBI survivor.

Developing an Intervention Program

(Note. The terms intervention, remediation or retraining are used interchangeably although there are actually some minor differences in their meaning.

Programming for TBI students (and probably for all students) should proceed through the following basic sequential stages.

1. Assessment — to establish baseline strengths and weaknesses
2. Development of interventions— in accordance with the assessment
3. Careful monitoring of interventions through periodic follow-up assessments — to establish effectiveness. These periodic assessments need not be full evaluations. Specific assessments of targeted impairments is preferable.
4. Re-development of interventions if a.) effectiveness has not been established, or b.) the interventions are no longer effective due to progress/change on the part of the TBI student.

Factors that Influence an Intervention Program for TBI Students. In developing intervention programs for TBI students, there are many factors that must be considered, some of which we have already discussed. Knowledge of these factors should assist in developing effective intervention programs. Some of the more significant factors include the TBI student's:

- pre-injury performance profile;
- self-awareness regarding deficits; and
- motivation level.

1. **Pre-injury performance profile:** It is widely recognized that TBI tends to exacerbate the premorbid (preinjury) cognitive and behavioral profile of the survivor (Rivara, et al., 1993). We must realize that the TBI student is now working with a dysfunctional brain, particularly with respect to learning. If the student was having difficulty with a particular subject or activity before the injury, it is logical to assume that the subject or activity will be even more difficult for the student after. In essence, this means that if the TBI student was somewhat of a behavior problem before the injury, he or she will likely be more of a behavior problem after the injury. The same holds true for cognitive weaknesses. If a TBI student was weak in

specific cognitive areas (e.g. math, reading etc.) premorbidly, he or she will have even more difficulty in that area after the injury.

Having a clear idea of the student's premorbid (pre-injury) cognitive strengths and weaknesses will greatly assist the development of your interventions and programming.

Unless you have access to comprehensive preinjury performance data (e.g. as in the case of a student who was previously classified as exceptional), it is not possible to accurately judge the effectiveness of post-injury interventions. How then do you determine the student's pre-injury performance levels?

A clear understanding of premorbid cognitive, behavioral, and motivational levels will give us the necessary background upon which to apply new remedial techniques. There is, perhaps, no more frustrating situation for a TBI student than to be asked to perform at a level after TBI that he or she was unable to do before the injury.

2. **The TBI student's self-awareness of deficits:** It is not uncommon for the TBI student to deny impairments, particularly cognitive and behavioral impairments. We do not know the exact etiology of this denial, but theories include the role denial may play as a coping mechanism (albeit ineffective) that allows the student to deal with the loss of abilities. Given the connotation of the phrase, it is very difficult for an individual to admit that he or she is "brain damaged." Denial is often a factor in catastrophic injuries, and TBI is no different.

   This phenomenon may also be associated with the generalized poor reasoning and judgment that follows TBI. The term denial may be a misnomer, since to deny something, one must first realize that it exists. It is not clear whether some TBI students have this ability. It may be more accurate to think in terms of not being aware of their deficits. Regardless of etiology, however, the results are the same. It is difficult to implement an intervention program if the student cannot see the need or benefit. Recognition and acceptance of deficits is often a long time coming with TBI students (if ever) and this must be factored into any remedial planning.

   Once recognition and/or acceptance set in, some TBI students experience a very intense frustration and even depression regarding how "different" they are compared to what they once were. One of the saddest and most frustrating phenomena about TBI is the fact that these students can remember how they were before the injury and yet this knowledge cannot be acted on. They become frustrated when they can no longer perform at their pre-injury levels. This is true of no other exceptional category. Learning disabled, educably mentally handicapped, etc. students have been so since birth and have no recollection of previous differences in performance.

3. **The student's motivation level:** Poor motivation is a common effect of TBI. It is a difficult problem to remediate in students who do not have the additional complications associated with TBI. Many TBI students may have a history of

motivational problems prior to their injury. And, like other characteristics, these problems will tend to worsen after the TBI.

Many impairments specific to TBI contribute to low motivation levels. As an example, can you imagine the frustration and resulting loss of motivation in not being able to remember what you read, sometimes from paragraph to paragraph? Memory disruption also interferes with the student's appreciation of progress. The natural reinforcement inherent in the learning process may not be available to these students. Attentional problems cause simple, frustrating mistakesthat constantly plague the TBI student. In addition, remembering how easily he or she used to perform simple tasks can itself promote low motivation.

The site of the brain injury can contribute to lower motivation levels as well. Injuries to the frontal lobes can manifest themselves in a loss of initiative (Lezak, 1995). Right hemisphere damage, in general, leads to more depression and loss of initiative. Also, substance abuse (particularly marijuana), which is relatively common in older TBI students, can exacerbate poor motivation.

Basic Forms of Intervention with TBI Students

Cognitive rehabilitation or cognitive retraining are terms commonly used in rehabilitation facilities to describe the instructional techniques and theories designed

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Determining preinjury (premorbid) performance levels — Several methods for determining pre-injury performance levels appear in the literature. Unfortunately, most of these methods have been developed using adult populations. There are some methods, however, that may be adapted to the analysis of preinjury performance in children and adolescents. As a start, consider the student's performance on selected subtests of the Wechsler during your core battery that are known to be resistant to the effects of brain injury. The Wechsler Information, Vocabulary and Comprehension subtests, appear to be most resistant to TBI effects (Lezak, 1995). The reason these subtests are resistant is because they rely heavily on old, preserved memory and learning.

One method is to strike a mean from these subtests and use this mean to infer a mean pre-injury Verbal Scale performance mean. Care needs to be taken to be certain these subtests are somewhat consistent within themselves. Very high or very low scores would weaken this mean considerably. This method will work best with those students who have more academic experiences. It will be less effective with younger children (e.g. 6-8 years).

Add to this mean any information from previous teachers, school grades, and any results of preinjury standardized testing. An "eyeball analysis" of these data for consistency could be used to approximate the students preinjury cognitive performance levels. This is a very rough method and should only be used when more reliable data is not available.

specifically for brain injury survivors. In the rehabilitation setting, these services can be provided by a cognitive therapy specialist or one or more of the other therapy disciplines. Cognitive retraining is used to describe specific techniques used to help TBI survivors deal with cognitive deficits. Cognitive rehabilitation is a somewhat broader term, defined as a combination of cognitive retraining and supportive counseling. As mentioned earlier, cognitive rehabilitation is a relatively new field developed around the need to retrain brain injured individuals.

Although cognitive retraining can take place anywhere, the most successful programs attempt to simulate actual environments in order to maximize transfer and generalization of instruction. For this reason, school applications would be the most effective vehicle for TBI students (Mira et al., 1992). It is unlikely that school psychologists will be able to provide these direct services to TBI students at the intensity level required; however, they will be counted on to determine the basic goals of these services and to monitor program effectiveness.

Attempts to retrain TBI survivors' cognitive skills typically fall into three general approaches: (a) component training, (b) compensatory training, and (c) functional/integrative training (Lehr, 1990).

Component Training

This approach involves direct remediation of defects, which, in the case of TBI students, will include attention, memory, communication skills, reasoning, etc. This type of training perhaps most closely simulates special education training approaches. For TBI students, component training relies on the premise that injured tissue can recover and that stimulating the brain in areas of deficit will speed the recovery before deficits become entrenched and resistant to intervention (Rourke et al., 1983). It seems best suited for: (a) programming early in the recovery "window" period (i.e. within one to two years following injury), and (b) younger TBI students who may not yet have the ability to learn compensatory techniques. This approach has been criticized on the basis of slow progress and the frustration it can produce by focusing exclusively on weaknesses. It is best not to use this approach with TBI students manifesting low motivation, low frustration tolerance, or poor self-image.

Compensatory Training

This approach takes two forms. The first involves modifying the TBI student's environment by using such techniques as cues/supports from others, or modifying the physical space to accommodate the student's physical and cognitive needs. The second form involves teaching the TBI student compensatory techniques to avoid or circumvent deficits. Typical examples of this form of training might include teaching memory strategies such as using a note book for all memory needs, leaving notes about the house for daily routines, or teaching processing strategies such as cognitive self-talk, or pneumonic devices to avoid impulsive decision making. This approach tends to be more effective with older students, since it does not focus on weaknesses but rather on using the abilities spared in the injury in developing compensatory strategies. The other positive aspect of compensatory strategies is that they are quick. The positive effects of speedy solutions to some problems on the TBI student's self-image and the families anxiety should not be overlooked.

Functional and Integrative Training

This is not a distinct approach as much as a culmination or final stage of the intervention processes. It emphasizes generalization of learned strategies to the student's actual environment (e.g. classroom). Sequentially, this should be the final step of either component and/or compensatory training. Simulation activities, in which the student gets a chance to try skills in lifelike situations, characterize this stage. It should be noted, however, that generalization of learned skills is a difficult process even under the best of circumstances. Because the TBI student's capacity for abstraction may be severely limited, generalization is a genuine challenge, particularly for students with moderate to severe injuries. In these situations it is perhaps best to begin with transfer of skills before attempting generalization. Transfer puts less demand on abstract thinking skills.

Some Implementation Suggestions

In working with children and adults, you will find all of these techniques valuable depending on such factors as the age of the TBI survivor, the timing of the intervention (i.e. whether or not the survivor is short- or long-post injury), severity of the injury, and tolerance and/or motivation level. Consider starting with component training, particularly if the TBI student is still in the recovery "window" or just to see whether the deficits will respond to direct stimulation. Move to compensatory training when the student reaches a plateau or if you sense that component training is not working or not being well tolerated. In many cases, it may be best to go directly to compensation techniques to teach the TBI student how to "negotiate" the demands of his or her environment quickly. Examples of these immediate compensations include a notebook or pad to record assignments, appointments, important thoughts, etc., a map to find classes in a complex high school setting, or appointing a "buddy" or school staff member to be sure the student can find the next class, etc. You will need to use compensatory strategies of this type almost immediately when the TBI student re-enters the school. Do not wait simply because you want to be sure to exhaust the benefits of component training. Component training can still go on while the compensatory strategies are in place.

With either or both of these approaches you will need to be certain that the student can use them independently in the actual environment. Some activities lend themselves to a "walk through" technique where you and the TBI student can do the activity together, starting with structured, frequent cues gradually reducing the cues and prompts as he or she learns the activity. Getting from class to class, or taking the bus to school and back home are activities where walk through strategies can be effective. You can also employ a simulation technique for note- or test-taking weaknesses. As an example, you can simulate classroom note taking by having the student take notes while you are reading aloud. You can also administer tests simulating the test type (e.g. essay, multiple choice, etc.) used in a particularly troublesome subject. In both of these activities it is also possible to simulate the classroom environment by adding distractions, such as a radio which can be turned up gradually, or by talking to the student while he or she is trying to take the simulated test. You can learn a great deal about the TBI student's coping style and strategies through techniques such as these.

Some Comments on the use of Computers in Cognitive Retraining

There are many excellent computer programs available for enhancing the cognitive retraining of brain injury survivors. The key to using these programs is in *how* they are to be used. When cognitive retraining techniques were initially developed, they were basically pencil-and-paper activities coupled with simulation strategies. As computers became more available, there was a big push to use this new technology. Unfortunately, there were many abuses of this technology by individuals who saw the computer as a means of working with many TBI survivors simultaneously. In the early days of computer use for cognitive retraining, it was not unusual to see a room full of TBI survivors sitting in front of computers, with little or no staff direction.

We now know that the computer is just another tool to be used in cognitive retraining. Unfortunately, research on the effectiveness of computer training in remediating cognitive skills in TBI survivors is not encouraging (Ylvisaker et al., 1994). In the hands of an experienced cognitive retraining specialist, however, the computer can be a valuable tool particularly in the early stages of recovery and for very specific skills, such as attention, scanning, processing speed, etc. In integrating computer training into the intervention program of a TBI student, Ylvisaker et al. (1994), suggests that professionals keep the following points in mind.

1. At most, computers should augment other comprehensive remedial efforts.
2. Matching computer training to student needs should be a careful and systematic process. (Avoid trying to "bend" whatever programs you may have available to the student's needs.)
3. Improving a skill through computer training is only the first step. Transfer and generalization to the real world must be the end result. (This is typically done best through on-site training or simulation exercises.)
4. The computer can only be used for certain deficits. As an example, behavioral and/or social-emotional problems are not suited for computer training.

Issues to be Addressed in Developing the TBI Student's IEP

Blosser and DePompei (1994), have developed a comprehensive process for designing Individualized Educational Plans (IEP) for TBI students, involving the following four steps:

1. **Preplanning**, i.e. increasing the educator's knowledge of TBI and gaining an understanding of the TBI student's educational needs;

2. **Planning**, i.e. collaboration with family, rehabilitation staff, and school team to determine goals and strategies;

3. **Implementation**, i.e. putting the plan into action;

4. **Evaluation**, i.e. determining if the goals and strategies were successful.

The development of the IEP for the TBI student may at first be somewhat intimidating for the school staff. As a beginning school personnel should consider using the suggestions provided in the rehabilitation reports (particularly the discharge report) or suggestions from the rehabilitation staff (if the student has had the benefit of a formal rehabilitation program). If the TBI student has been evaluated and/or is being treated by a professional with expertise in TBI, consider inviting the professional to the IEP development meeting. Once the initial "mysteries" about TBI are worked through, school personnel will do an excellent job of handling these IEPs. What follows are questions and issues that may be helpful.

1. **As a start, determine how the TBI appears to have affected the student's functioning using the domains stated in the TBI definition.** This can be done using the reports provided by the rehabilitation facility if they are available. If such data is not available, you will need to establish a baseline of functioning using the techniques outlined in Section III. It may also be necessary to involve an outside neuropsychologist either for an evaluation or consultation. Use the effects of TBI listed in Section I as a starting point. They will suggest areas of focus you may not have considered.

2. **Given this profile, what is the most appropriate program to meet the TBI student's needs?** Be sure to include: (a) the best method for presenting academic material to the student (e.g. visually, auditorily, etc.), and (b) the best method of evaluating the student's progress. Do not confine your thinking to only that was on is available at the particular school. (Apart from the fact that this may make you vulnerable to complaints and possible litigation, you will never get appropriate services or equipment if you don't ask for them.) Be careful not to place the student in a classroom or program that does not have the flexibility to re-develop the IEP if the student's functioning changes rapidly.

   Perhaps the best arrangement for TBI students is to categorize them as TBI with an IEP that allows the student to move between programs as he or she progresses. This, of course, will be more true of TBI students who have been injured relatively recently (i.e. within the last one or two years). For the TBI student who is long-post injury (i.e. beyond three years), there will be relatively little change in functioning due to brain tissue recovery. For these students, what they are demonstrating at the time of placement will likely be their functioning pattern for a long time to come or permanently. In spite of what may be behavior to the contrary, however, they should still be categorized as TBI even though the best program available may be a self-contained LD class or the EMH program. *Remember, etiology and programming is different than in these other exceptionalities.*

3. **Setting appropriate goals.** Be certain to set realistic goals. Keep in mind that early rapid improvement does not guarantee continued progress at the same rate and certainly does not guarantee return to preinjury functioning levels. TBI students who have suffered moderate or severe injuries will almost certainly be left with some residual impairment, although the range of impairment will vary as will the rates of recovery. Students who have suffered "mild" TBI, on the other hand, may return (or appear to return) to full preinjury functioning after a period of time.

Lehr (1990) has identified three qualifiers that may be helpful in selecting programming goals.

- **Which deficit is affecting the student the most?**

Although this appears to be intuitively logical, it seems to be rarely considered. Reports usually identify several problem areas which are usually followed by a virtual "laundry list" of recommendations (some of which appear to have little specific bearing on the problems identified). In addition, there is usually no attempt to prioritize these recommendations. In almost all cases, it is possible to identify one or two problems that have some relationship (often causative) on the rest of the identified problems areas. By focusing on these one or two problems you will probably have a significant impact on the others. Also it is far easier, and clearer to both teacher and TBI student, to focus on a few problems instead of many.

- **Which can be most easily/quickly improved ?**

The TBI student, the teacher, and the parents want to see progress as quickly as possible. Early success will have a positive impact on TBI student's self-concept and help increase motivation. Speedy success will ease the parents' anxiety and it will help build the confidence of teachers faced with a difficult situation. The trick is finding a major area needing remediation that can be affected relatively quickly. As suggested, memory can impact many cognitive and social-emotional areas. A significant impact on the TBI student's memory disorder will often have a positive "domino" effect on other problems.

- **Which is most important to the student and family?**

In developing the remedial program for the TBI student, the support of family members cannot be overlooked. You will need their support almost as much as the

TBI student will. Also, the family can be very helpful to you in implementing your intervention program. Involve them in the intervention decision process whenever possible. You will soon learn from the student and family members which of the student's difficulties has influenced him or her the most. Chances are that these problems are very important to school personnel as well.

4. **What physical or medical problems will possibly interfere with the student's functioning?** Most school personnel are familiar with serving the physical and medical needs of exceptional students. One problem with this area, however, is overly focusing on these needs. This can be tempting since the physical problems are quantifiable and relatively familiar to school personnel. As a result of this focus, the TBI student is often placed in an inappropriate category such as Other Health Impaired (OHI). As it turns out, however, the physical and medical problems encountered by these students, while certainly important, are usually not the problems that provide their greatest obstacles. Placement in an OHI program may go a long way toward accommodating their medical and physical problems but it may take the focus off more debilitating problems in cognitive or social-emotional areas.

5. **Appropriate follow-up and monitoring.** As stated earlier, the functioning levels of TBI students can change, sometimes rapidly, depending on how long it has been since their injury. Traditional triennial evaluations obviously would not pick up these changes in time to move the student to a more appropriate program level. As indicated in the N.C. Procedures, the progress of TBI students should be periodically monitored during the first two years following the injury. Rather than full evaluations, however, brief focused assessments of target behaviors can provide valuable data in monitoring the TBI student's progress. These assessments should include interviews with relevant parties, informal testing (e.g. curriculum based assessment, etc.), and formal assessment.

   As a rule of thumb, the maximum period between assessments for the TBI student who is less than two years post-injury should be six months. If the student is less than one year post-injury, he or she should be evaluated in some fashion every three months.

6. **Accounting for social-emotional needs.** This is perhaps the most overlooked need of TBI students. Many factors contribute to this phenomenon. Difficulties in accurately measuring emotional factors, denial on the part of the student and family, counselor availability, and time are only a few reasons. Issues of depression, self-esteem, and motivation can make cognitive progress difficult if not impossible. Parents need to be made aware of this as well. Every TBI IEP development committee should address the student's counseling needs. This can occur in the school or the parents can make outside arrangements if they or the student prefer. The external counselor or therapist should be acquainted with TBI and the problems inherent with working with TBI students in a therapeutic relationship. Such professionals are not easy to find. It may be necessary for the school psychologist to consult with the counselor or therapist regarding TBI and/or the student's unique emotional problems.

The following summary list can be used as a framework in developing the student's IEP. At a minimum, the IEP of the TBI student should account for:

1. scheduling needs (e.g. length of day);
2. physical needs (e.g. mobility, transportation, seating);
3. instructional needs (e.g. speed of instruction, classroom assistance, presentation modifications, material modifications, test format modifications, assistive devices, etc.);
4. emotional support needs (e.g. counseling); and
5. system needs (e.g. "case manager", orientation assistant, IEP monitoring process, etc.).

(Savage, 1991)

Some Sample Techniques and Modifications to Include in the TBI Student's IEP

The following list of possible recommendations are examples gleaned from many sources. They are listed here only to stimulate your thinking. Your TBI student's IEP may require unique recommendations in addition to those listed.

Memory:

- Have the student write important assignments, meetings etc, in a notebook. Make sure he or she carries the notebook at all times. *(Note: Males often resist carrying "appointment books". Try using a very small (3 x 5) notebook that they can keep in their pocket.)*
- If the student has memory problems, try cueing before giving him or her the answer. This technique may reveal a retrieval problem.
- Allow the student to use tape recorders or other students as note takers, calculators, and lap-top computers in class.
- Provide written or taped backup for multistep directions or tasks.
- If you are using a reinforcement program, remember that the TBI student may not consistenly remember what he or she must do to receive the reinforcement. Students will also "lose track" in programs that attempt to delay the reinforcement for too long a period.
- Always provide immediate and frequent feedback.
- Provide repetition and frequent reviews of material being taught.

Attention:

- Provide a separate area with significantly reduced distractions for test taking, studying, etc.

- Make certain you have the student's attention before addressing him or her and double check to be sure you are being understood. Don't simply rely on the fact that the student is facing in your direction!
- Have the student repeat and/or write any instructions.

Processing speed:

- Allow extra time for test taking, etc. to account for slowed processing.
- Allow the student sufficient time to respond to oral questioning. Be prepared for what seems like long periods of time for some TBI students to formulate answers.
- Allow extra time for completing fine-motor tasks.
- Understand that many TBI students are very aware of being "slow." It is just as frustrating for them as it may be for you.

Communication/sensory difficulties:

- Allow the student to take tests orally if reading is affected.
- Arrange the student's seat in class to account for hemianopsia (field-cut) problems.
- Teach the student to use verbal cues to compensate for field-cut problems e.g. "always look all the way to the left/right."
- TBI students can be very concrete. Avoid abstract language such as double negatives, etc. in test construction and lectures.
- Teach the student to ask you or others to slow down or to repeat instructions. *(Note: They are often embarassed to do so.)*
- Provide structure, clarification, and repetition at all times.

Disorientation/confusion:

- Appoint a "buddy" or school staff person to assist in day-to-day activities such as getting to and from class.
- Have the student check in and out of school each day. Structure all free time at first until you know they can be responsible.
- Account for special transportation needs, e.g. using the special bus or a taxi instead of the regular bus because of the confusion created by the commotion and the student's vulnerability to other students' actions.

Higher-order/executive problems:

- Teach the student self-regulating techniques, e.g. for impulsivity - "stop," "look," "check," "act," etc. Use their language in developing any self-talk strategy.

Special scheduling, assistance needs:

- Allow the student to come into the school or class after other students have entered to reduce the confusion of busy hallways. Be sure to do this only until they appear able to tolerate the confusion.
- Carefully evaluate the need for assistive devices. Consult with the rehabilitation staff or other experts before obtaining such devices.
- Start reentry programs with a very short daily schedule (to allow for fatigue), building the time gradually as the student develops more tolerance.
- Be certain the student is ready for activities such as driver education. Consult the rehabilitation program or a local expert (occupational therapist, etc.) for a driving evaluation. Be sure there are no physical obstacles to driving, such as field-cut, fine/gross motor difficulties, etc.

Motivation:

- Consider supportive counseling for students with low motivation.
- Have the student graph his or her progress as a consistent reminder.
- Have the student save his or her work for later comparison.

Motor problems:

- Always involve the physical and occupational therapists when establishing IEP recommendations for TBI students.
- Allow students to use a typewriter or computer to reduce fine-motor demands in writing.

Parents:

- Help the parents understand the ramifications of TBI such as the possible negative effects of entering school prematurely.
- Outside tutoring is very helpful (especially "process" tutoring). Encourage parents to consider tutoring throughout the summer breaks, a time when TBI students lose much more ground than non-TBI students.

Staff suggestions:

- Identify a member of the school staff as the "case manager" for each TBI student. This person will oversee and monitor the student's program and act as a contact person for the staff and family.

- Establish and maintain a relationship with the rehabilitation facility that discharged the student for use as a resource.
- Plan on frequent communication "checks" with other staff involved in the student's program.

These are only a few suggestions to get you started. You will be able to add to this list easily once you begin to work with TBI students. Mira et al., (1992) and Ylvisaker et al., (1994) are excellent resources for additional ideas regarding the IEP. Remember, try to be flexible yet creative in your IEPs, and keep in mind that strategies you have been using all along will often work with TBI students with some modification.

Dealing with the Family of the TBI Student

It is important to understand the devastating impact of moderate or severe TBI on the student's family. In many cases they have been told their child will not survive or will never recover from coma. Even in the best of circumstances, once the rehabilitation stage is over, they alone will bear the burden of responsiblity for the care of their child for many years to come. The family of the TBI student will often experience the same stages of grief as when a close family member dies. Even though their child survives, they have, in fact, lost the child they once knew.

There are some excellent resources available to help you in understanding the plight of the family in dealing with TBI. As an example, Mira et al.(1992), have suggested some sources of distress the family must endure when confronting TBI.

1. **Lack of information.** By the time you begin working with the re-entering TBI student, the family will have been through a virtual roller coaster of emotions. Starting with the trauma of the initial accident, they may have been given little or no information regarding what happened to their child's brain or whether or not the child will survive. Very often in the early stages of TBI the physicians simply do not know. Attempts to try and educate family members during these early stages often prove fruitless, as they are too upset and distracted to hear what they are being told.

2. **Uncertain outcome.** The parents and family of the TBI child or adolescent will receive very little information regarding prognosis. This uncertainty will follow the family throughout the acute hospitalization stage into the rehabilitation and often beyond. If the survivor is lucky enough to experience rehabilitation, more accurate prognoses regarding outcome will begin to emerge. Even at this stage, however, due to such things as denial, the euphoria of their child surviving the initial accident, family members will often hear only what they want to hear. It is not unusual to see families that are still holding out for significant recovery several years after the TBI and the survivor has long since reached a plateau in recovery. This desperation and denial often make it very difficult to convince family members of appropriate programming needs.

3. **Financial stresses.** Formal rehabilitation programming is tremendously expensive. It is not uncommon for the cost to be as much as $1,000 per day. Most medical insurance coverage has limits on how much can be spent on rehabilitation. That limit can be reached very quickly at $1,000 per day. Even under the best of circumstances, very difficult and sometimes devastating decisions may have to be made regarding cost vs. care.

4. **Disruption of family life and roles.** Professionals who work in brain injury rehabilitation will often say that the impact of a TBI has the effect of "making or breaking" the family. In traumatic situations such as these, one of the parents (typically the mother) will often assume a major role in the care of the TBI survivor. This often causes a disequilibrium in the family role "assignments," leading to conflict and sometimes dissension. Marital discord is common.

Siblings are affected also. They often experience the same sequence of emotions (e.g. guilt, anger, grief, loss, etc.) felt by the parents, yet their emotions are usually not addressed. They often feel isolated and left to their own devices. They may be given family responsibilities they can't handle or resent. Some families become more united, rallying around the survivor's plight in a very positive way. Unfortunately, many become dysfunctional. Addressing the families' needs early in the recovery or reentry process can help prevent deterioration.

5. **Behavior problems.** As mentioned earlier, TBI can significantly alter an individual's personality characteristics. These behavioral changes are not well understood. Because they are not well understood, it is not uncommon for the counseling needs of the TBI student to go unaddressed in the IEP. This leaves the teacher and family to deal with these issues alone. In addition, the need for the family to gear up for these behavioral issues comes at a time when the physical and emotional resources are low.

6. **Dealing with the schools.** Unfortunately, an additional source of stress for the family can often be the negotiations with the school. In their efforts to get their child the services they think he or she needs, the family can feel as though they are in a battle of wills. If the student was in a rehabilitation facility, he or she received an intensive array of services in a very structured system, provided by a very knowledgeable staff. Family members usually know little about what schools can provide for their TBI student (and, frankly, the schools aren't sure of this either). They often assume the schools can provide the same level of services. These circumstances, along with confusion and grief of the TBI itself, present a situation that is ripe for conflict and miscommunication. Often, families will contact a professional external to the school to act as an advocate after their first few visits to the school out of sheer frustration. They may have been told their child will be placed in a program for "retarded" or "emotionally disturbed" children, etc. All this exacerbates the already high levels of anxiety and anger in the parents. Sadly, it doesn't have to be like this.

What Families Need from the School

What can school personnel do to make the communication with the families of TBI students more effective? As a beginning, the school can anticipate and try to address the stressors just discussed.

1. **Provide information about TBI to the families.** As you begin to work with TBI students, you will acquire the training and experience to pass on needed information to parents. In the interim, there are sources for this information listed in the annotated bibliography.

2. **Involve the family in intervention strategies.** You will need to involve the parents in the IEP process. This will allow you to pass on some helpful information. In addition, the parents can be a valuable resource for continuity in cognitive and behavioral programming. Programs that involve home and classroom methods stand a better chance of success. These experiences have the added benefit of giving the parents a more realistic impression about the effects the brain injury is having on their child and the difficulties teachers may be facing in the classroom.

3. **Try to get family members involved in a local TBI support group.** Apart from offering much needed emotional support, these groups also help the parents negotiate insurance and medical issues, and many other links to resources available for TBI survivors. Think about starting a group in your school for TBI students and perhaps other family members. Local experts will generally be willing to co-lead or contribute in some way to such efforts.

4. **Use TBI families as resources for newly injured students and their families.** This is related to the support group notion. Consider asking TBI students already in programs at your school and/or their parents to contact new re-entering TBI students. Families of TBI students often have become leery of the "establishment" from past negative experiences. While they might not hear what professionals have to say, they may find comfort in the advice or advocacy of another family with similar problems.

Families of TBI students need your help. Their path is a very difficult one under the best of circumstances, and they have few resources available to them. This discussion, relative to the families of TBI students, assumes that the student has been fortunate in experiencing a period of formal rehabilitation. The scenario for students and their families who have not had this care is even more traumatic, with little in the way of support. This can also be said of "mild" TBI students who, in addition, are at the curious disadvantage of having similar deficits as more involved TBI students, while not having the obvious symptoms or recognition associated with more severe forms of TBI. These students are expected to perform as they always have because they "look fine," although, of course, they are not.

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APPENDIXES

Appendix A: Glossary of Terms

The following terms are often found in brain injury and neuropsychological literature:

Abnormal postural tone. Greater than normal tone of muscles used to hold the body in ordinary positions, such as sitting or standing.

Abscess. A localized collection of pus in a cavity.

Acalculia. The inability to perform simple problems of arithmetic.

Adiadochokinesia. Inability to stop one movement and follow it immediately with movement in the opposite direction.

Agenesis. The failure of a area of the brain or body to develop.

Agnosia. Failure to recognize familiar objects although the sensory mechanism is intact. May occur for any sensory modality.

Agraphia. Inability to express thoughts in writing.

Akinetic mutism. A condition of silent, alert-appearing immobility that characterizes certain subacute or chronic states of altered consciousness. Sleep-wake cycles are retained, but externally obtainable evidence for mental activity is absent; spontaneous motor activity is lacking; patient appears to be aware but inactive. Exhibited by patients with high brain stem lesions.

Alexia. Inability to read.

Amnesia. Lack of memory about events occurring during a particular period of time.

Aneurysm. A balloonlike deformity in the wall of a blood vessel. The wall weakens as the balloon grows larger and may eventually burst, causing a hemorrhage.

Anomia. Inability to recall names of objects. Patients with this problem often can speak fluently but have to use other words to describe familiar objects.

Anosmia. Loss of the sense of smell.

Anoxia. Lack of oxygen. Cells of the brain need oxygen to stay alive. When blood flow to the brain is reduced or when oxygen in the blood is too low, brain cells are damaged.

Anterograde amnesia. Inability to consolidate information about ongoing events following brain injury. Difficulty with new learning.

Anticonvulsant. Medication used to decrease the possibility of a seizure (e.g., Dilantin, phenobarbital, Mysoline, Tegretol).

Aphasia. Loss of the ability to express oneself and/or to understand language. Caused by damage to brain cells rather than deficits in speech or hearing organs.

Aphasia, expressive. Inability to find or formulate the words to express oneself, even though the knowledge of what one wants to say is present.

Aphasia, global. Severely limited residual ability to communicate with others. Includes both expressive and receptive aphasia.

Aphasia, nonfluent. Characterized by awkward articulation; limited vocabulary; hesitant, slow speech output; restricted use of grammatical forms; and a relative preservation of auditory comprehension.

Aphasia, receptive. Problems in understanding what others attempt to communicate.

Aphasia, subclinical. Evidence of impaired linguistic processing on testing, which is not obvious in casual interactions.

Apraxia. Inability to carry out a complex or skilled movement; not due to paralysis, sensory changes or deficiencies in understanding.

Apraxia, constructional. Inability to assemble, build, draw or copy accurately; not due to apraxia of single movements.

Apraxia, ideomotor. Deficit in the execution of a movement due to inability to access the instructions to muscles stored by previous motor experience.

Arteriovenous malformation (AVM). A "tangle" of blood vessels present from birth that may be prone to bleeding.

Astereognosis. Inability to recognize things by touch.

Ataxia. A problem of muscle coordination not due to apraxia, weakness, rigidity, spasticity or sensory loss. Caused by lesion of the cerebellum or basal ganglia. Can interfere with a person's ability to walk, talk, eat and perform other self-care tasks.

Bilateral. Pertaining to both right and left sides.

Brain death. A state in which all functions of the brain (cortical, subcortical and brain stem) are permanently lost.

Brain plasticity. The ability of brain structures and functions to be molded and shaped according to environmental demands; diminishes with maturation.

Brain scan. An imaging technique in which a radioactive dye is injected into the bloodstream, after which pictures of the brain are taken to detect tumors, hemorrhages, blood clots, abscesses or abnormal anatomy.

Brain stem. The lower extension of the brain where it connects to the spinal cord. Neurologic functions located in the brain stem include those necessary for survival (breathing, heart rate) and for arousal (being awake and alert).

Cerebellum. The portion of the brain (located at the back) that helps coordinate movement. Damage may result in ataxia.

Cerebral angiography. A medical test involving injection of dye into an artery so the vascular system of the brain can be studied through an x-ray. Can detect aneurysms, tumors and circulation problems.

Cerebral compression. Condition in which the brain substance is pushed aside and compressed because of the presence of a brain tumor, an aneurysm, a swelling or a hematoma.

Cerebral infarct. Condition in which the blood supply is reduced below a critical level and the brain tissue in that region dies.

Cerebrospinal fluid (CSF). Liquid that fills the ventricles of the brain and surrounds the brain and spinal cord.

Circumlocution. Use of other words to describe a specific word or idea that cannot be remembered.

Clonus. A sustained series of rhythmic jerks following quick stretch of a muscle.

Coma. A state of unconsciousness from which the patient cannot be aroused, even by powerful stimulation.

Concussion. A common result of a blow to the head, usually causing unconsciousness, either temporary or prolonged. Physiologic and/or anatomic disruption of connections between some nerve cells in the brain may occur.

Confabulation. Verbalizations about people, places and events with no basis in reality. The patient appears to fill in gaps in memory with plausible facts.

Conjugate movement. Movement of both eyes simultaneously in the same direction; convergence of the eyes toward the midline (crossed eyes) is a disconjugate movement.

Contractures. Loss of range of motion in a joint due to abnormal shortening of soft tissues.

Contralateral. Opposite side.

Contusion. A bruise; a blow to the head that bruises the brain.

Cortical blindness. Loss of vision resulting from a lesion of the primary visual areas of the occipital lobe. Light reflex is preserved.

Contrecoup. Bruising of brain tissue on the side opposite that on which the blow was struck.

CT scan/computerized axial tomography. A series of x-rays taken at different levels of the brain that allows the direct visualization of intracranial structures. A scan is often taken soon after an injury to help decide if surgery is needed. The scan may be repeated later to see how the brain is recovering.

Decerebrate posture (decerebrate rigidity). Exaggerated posture of extension as a result of a lesion to the prepontine area of the brain stem, which is rarely seen fully developed in humans. In reporting, it is preferable to describe the posture seen.

Decorticate posture (decorticate rigidity). Exaggerated posture of upper extremity flexion and lower extremity extension as a result of a lesion to the mesencephalon or above. In reporting, it is preferable to describe the posture seen.

Decubitus. Pressure area, bed sore, skin opening, skin breakdown. A discolored or open area of skin damage caused by pressure. Areas most prone to breakdown are the buttocks or backside, hips, shoulder blades, heels, ankles and elbows.

Diffuse axonal injury (DAI). A shearing injury of large nerve fibers (axons covered with myelin) in many areas of the brain. It appears to be one of the two primary lesions of head injury, the other being stretching or shearing of blood vessels from the same forces, producing hemorrhage.

Diffuse brain damage. Injury to cells in many areas of the brain rather than in one specific location, due to the brain moving about and tissue being torn, stretched and bruised.

Diplopia. Seeing two images of a single object; double vision.

Disinhibition. Inability to suppress (inhibit) impulsive behavior and emotions.

Disorientation. Not knowing where you are, who you are or the current date. Health professionals often speak of a normal person as being oriented "times three," which refers to person, place and time.

Distal. Far from the point of attachment.

Doll's-eye maneuver. The eyes appear to move in the direction opposite to the motion of the head when the head is gently rotated.

Dysarthria. Difficulty in forming words or speaking them because of weakness of muscles used in speaking. Speech is characterized by slurred, imprecise articulation. Tongue movements are usually labored, and the rate of speaking may be very slow. Voice quality may be weak; drooling may occur. Dysarthria may accompany aphasia or occur alone.

Dysphagia. A swallowing disorder characterized by difficulty in oral preparation for the swallow or in moving material from the mouth to the stomach. This definition also includes problems in positioning food in the mouth.

Edema. Collection of fluid in tissue, causing swelling.

EEG (electroencephalogram). A recording of the procedure that uses electrodes on the scalp to record electrical activity of the brain. Used for detection of epilepsy, coma and death.

EMG (electromyography). A process involving the insertion of electrodes into muscles to study the electrical activity of muscle and nerve fibers. It may be somewhat painful to the patient. Electromyography helps diagnose partial denervation.

Embolism. The sudden blocking of an artery or a vein by a blood clot, bubble of air, deposit of oil or fat, or small mass of cells deposited by the blood flow.

Endotracheal tube. A tube that serves as an artificial airway and is inserted through the patient's mouth or nose. It passes through the throat and into the air passages to help breathing. To do this it must also pass through the patient's vocal cords. The patient will be unable to speak as long as the endotracheal tube is in place. It is this tube that connects the patient to a respirator.

Evoked potential. Registration of the electrical response of brain cells, as detected by electrodes placed on the surface of the head at various places. The evoked potential, unlike the waves on an EEG, is elicited by a specific stimulus applied to the visual, auditory or other sensory receptors of the body. Evoked potentials are used to diagnose a wide variety of central nervous system disorders.

Executive functions. Planning, setting priorities, sequencing, self-monitoring, self-correcting, inhibiting, initiating, controlling or altering behavior.

Frontal lobe. Front part of the brain, involved in planning, organizing, problem solving, selective attention, personality and a variety of "higher cognitive functions".

Glasgow Coma Scale. A standardized system used to assess the degree of brain impairment and to identify the seriousness of injury in relation to outcome. The system involves three determinants — eye opening, verbal responses and motor responses — all of which are evaluated independently according to a numerical scale that indicates the level of consciousness and degree of dysfunction. Scores run from a high of 15 to a low of 3. Persons are considered to have experienced a "minor" head injury when their score is 13 to 15. A score of 9 to 12 is considered to reflect a "moderate" head injury, and a score of 8 or less reflects a "severe" head injury.

Glasgow Outcome Scale. A system for classifying the outcome of head injury survivors. The categories constitute "good recovery," in which the patient appears to regain the preinjury level of social and career activity (even if there are some minor residual abnormal neurologic signs); "moderate disability," in which the patient does not regain the former level of activity but is completely independent with respect to the activities of daily living; and "severe disability," defined as a state wherein the conscious, communicating patient is still dependent on the help of others. The original scale had five outcome categories; the newest scale has eight. This scale relates to functional independence and not residual deficits.

Hematoma. The collection of blood in tissues or a space following rupture of a blood vessel. Hematoma in the brain can be epidural — outside the brain and its fibrous covering but under the skull; subdural — between the brain and its fibrous covering; and intracerebral — in the brain tissue.

Hemianopsia. Visual field cut. Blindness for half the field of vision. This is not the right or left eye but the right or left half of vision in each eye.

Hemiplegia. Paralysis of one side of the body as a result of injury to neurons carrying signals to muscles from the motor areas of the brain.

Hemiparesis. Weakness of one side of the body.

Hemorrhage. Bleeding that occurs following damage to blood vessels. Bleeding may occur within the brain when blood vessels in the brain are damaged. (See Hematoma.)

Hydrocephalus. Enlargement of fluid-filled cavities in the brain; not due to brain atrophy.

Imperception. Failure to perceive stimulation on one side of the body when both sides are being stimulated simultaneously (double simultaneous stimulation). It is not due to a primary sensory deficit, such as deafness or blindness, but appears to be an attentional deficit. It is less severe than "neglect" and may occur in a patient recovering from neglect.

Intercerebral. Between the cerebral hemispheres.

Intracranial pressure (ICP). Cerebrospinal fluid (CSF) pressure measured from a needle or bolt introduced into the CSF space surrounding the brain. It reflects the pressure inside the skull.

Intracranial pressure monitor. A device used to determine the pressure within the brain. It consists of a small tube (catheter) attached to the patient at the skull by either a ventriculostomy, subarachnoid bolt or screw that is then connected to a transducer, which registers the pressure.

Ipsilateral. Pertaining to the same side of the body.

Ischemia. A severe reduction in the supply of blood to body tissues.

Locked-in syndrome. A condition resulting from interruption of motor pathways in the ventral pons, usually as a result of infarction. This disconnection of the motor cells in the spinal cord from controlling signals issued by the brain leaves the patient completely paralyzed and mute but able to receive and understand sensory stimuli; communication may be possible by code, using blinking or movements of the jaw or eyes, all of which are spared.

Memory, audiovisual. Auditory memory is the ability to recall a series of numbers, lists of words, sentences or paragraphs presented orally. Visual memory requires input of information through visual-perceptual channels. It refers to the ability to recall text, geometric figures, maps and photographs. A head-injured survivor with impaired visual memory may have to refer to a road map many times to reach a nearby destination. A brain-injured inpatient may need frequent assistance from staff to locate his room. A patient with impaired auditory memory will be likely to require frequent reminders of orally presented task instructions from staff. Notably, information may be encoded in memory using words or visual images independent of the mode of presentation.

Memory, delayed. The ability to recall information several minutes following presentation. There is no particular specification of the required time interval; typically it is ten minutes or more. This type of memory is most important because patients are often required to recall instructions related to their medical care for hours, days, weeks or months. For example, patients with impairments in delayed memory may forget where they have left things. Additionally, preserved information in immediate memory becomes part of delayed memory.

Memory, episodic. Memory for ongoing events in a person's life; more easily impaired than semantic memory, perhaps because rehearsal or repetition tends to be minimal.

Memory, immediate. The ability to recall numbers, pictures or words immediately following presentation. Patients with immediate memory problems have difficulty learning new tasks because they cannot remember instructions. This form of memory relies upon concentration and attention.

Memory, long-term. In neuropsychological testing, this refers to recall 30 minutes or longer after presentation. Requires storage and retrieval of information that exceeds the limit of immediate span.

Memory, recall. Ability to retrieve information without renewed exposure to the stimulus

Memory, remote. Information an individual correctly recalls from the distant past. There is no specific requirement for the amount of elapsed time, but it is typically more than six months to a year. Preserved information from delayed memory becomes part of remote memory.

Memory, semantic. Memory for facts, usually learned through repetition.

Memory, short-term. Primary or "working" memory, i.e., a limited-capacity system that holds up to seven chunks of information over periods of 30 seconds to several minutes.

Nystagmus. Involuntary horizontal, vertical or rotary movement of the eyeballs.

Occipital lobe. Region in the back of the brain that processes visual information. Damage to this lobe can cause visual deficits.

Paraparesis. Weakness of the lower limbs.

Paraphasic error. Substitution of an incorrect sound (e.g., tree for free) or related word (chair for bed).

Paraplegia. Paralysis of the legs (from the waist down).

Parietal lobe. One of the two parietal lobes of the brain, located behind the frontal lobe at the top of the brain.

Parietal lobe, right. Damage to this area can cause visual-spatial deficits (e.g., the patient may have difficulty finding her or his way around new or familiar places).

Parietal lobe, left. Damage to this area may disrupt a patient's ability to understand spoken and/or written language.

Persistent vegetative state (PVS). A condition in which the patient utters no words and does not follow commands or makes any response that is psychologically meaningful. The transition form coma to vegetative behaviors reflects movement from a period of no response to the internal or external environment (except reflexively) to a state of wakefulness but with no indication of awareness (cortical function). A patient in this state may have a range of biological responses at the subcortical level, eye opening (with sleep and wake rhythms) and sometimes the ability to follow with the eyes. Normal levels of blood pressure and respiration (vegetative functions) are maintained automatically.

Physiatrist. A physician who specializes in physical medicine and rehabilitation. A physiatrist is an expert in neurologic rehabilitation, trained to diagnose and treat disabling conditions. The physiatrist examines the patient upon admission to assure that medical issues are addressed and provides appropriate medical information to the patient, family members and members of the treatment team. The physiatrist follows the patient closely throughout the admission and oversees the patient's rehabilitation program.

Post-traumatic amnesia (PTA). A period of hours, weeks, days or months after injury, during which the patient exhibits a loss of day-to-day memory. The patient is unable to store new information and therefore has a decreased ability to learn. Memory of the PTA period is never stored; therefore, things that happened during that period cannot be recalled. May also be called anterograde amnesia.

Proprioception. Sensory awareness of the position of body parts, with or without movement. Combination of kinesthesia and position sense.

Prosody. Inflections or intonations of speech.

Proximal. Next to or nearest the point of attachment.

Quadriparesis. Weakness of all four limbs.

Quadriplegia. Paralysis of all four limbs (from the neck down). British authors often use the prefix "tetra" to mean four, so they may describe a patient as having tetraplegia.

Retrograde amnesia. Inability to recall events prior to the accident; may be a specific span of time or type of information.

Scotoma. Area of blindness of varying size anywhere within the visual fields.

Seizure. An uncontrolled discharge of nerve cells, which may spread to other cells nearby or throughout the entire brain. It usually lasts only a few minutes. It may be associated with loss of consciousness, loss of bowel and bladder control and tremors. May also cause aggressive or other behavioral change.

Shunt. A procedure to draw off excess fluid in the brain. A surgically placed tube running from the ventricles deposits fluid into either the abdominal cavity, heart or large veins of the neck.

Skull fracture. Break of the bones surrounding the brain. A depressed skull fracture is one in which the broken bone exerts pressure on the brain.

Spasticity. An involuntary increase in muscle tone (tension) that occurs following injury to the brain or spinal cord, causing the muscles to resist being moved. Characteristics may include increase in deep tendon reflexes, resistance to passive stretch, clasp knife phenomenon, and clonus.

Spatial ability. Ability to perceive the construction of an object in both two and three dimensions. Spatial ability has four components: the ability to perceive a static figure in different positions, the ability to interpret and duplicate the movements of various parts of a figure, the ability to perceive the relationship between an object and a person's own body sphere, and the ability to interpret the person's body as an object in space.

Spontaneous recovery. The recovery that occurs as damage to body tissues heals, with or without rehabilitation. It is very difficulty to know how much improvement is spontaneous and how much is due to rehabilitative interventions. However, when the recovery is guided by an experienced rehabilitation team, complications can be anticipated and minimized, and the return of function can be channeled in useful directions and progressive steps so that the eventual outcome is the best that is possible.

Status epilepticus. Continuous seizures; may produce permanent brain damage.

Strabismus, external. Outward turning of the eye, which may be due to a lesion of the oculomotor nerve (III) causing paralysis of the medial rectus muscle.

Strabismus, internal. Inward turning of the eye, which may be due to a lesion of the abducens nerve (VI) causing paralysis of the lateral rectus muscle.

Subarachnoid screw (bolt). A device for measuring intracranial pressure that is screwed through a hole in the skull and rests on the surface of the brain.

Subdural. Beneath the dura (tough membrane) covering the brain and spinal cord.

Tactile discrimination. The ability to differentiate information received through the sense of touch (i.e., sharp/dull); two-point discrimination (the ability to recognize two points applied to the skin simultaneously as distinct from one single point).

Temporal lobes. There are two temporal lobes, one on each side of the brain, located at about the level of the ears. These lobes allow a person to tell one smell from another and one sound from another. They also help in sorting new information and are believed to be responsible for short-term memory. Each temporal lobe has different responsibilities:

Right lobe: Mainly involved in visual memory (memory for pictures and faces).

Left lobe: Mainly involved in verbal memory (memory for words and names).

Thrombus. Blood clot.

Tracheostomy. A temporary surgical opening at the front of the throat providing access to the trachea or windpipe to assist in breathing.

Tremor, intention. Coarse rhythmic movements of a body part that become intensified the harder one tries to control them.

Tremor, resting. Rhythmic movements present at rest that may be diminished during voluntary movement.

Unilateral. Pertaining to only one side.

Unilateral neglect. Paying little or no attention to things on one side of the body. This usually occurs on the side opposite the location of the injury to the brain, because nerve fibers from the brain typically cross before innervating body structures. In extreme cases, the patient may not bathe, dress or acknowledge one side of the body.

Ventricles, brain. Four natural cavities in the brain that are filled with cerebrospinal fluid. The outline of one or more of these cavities may change when a space-occupying lesion such as a hemorrhage or tumor has developed in a lobe of the brain.

Ventriculostomy. A procedure for measuring intracranial pressure by placing a measuring device within one of the fluid-filled, hollow chambers of the brain.

Verbal apraxia. Impaired control of proper sequencing of muscles of the tongue, lips, jaw and vocal cords that are used in speech. These muscles are not weak, but the control of them is defective. Speech is labored and characterized by sound reversals, additions and word approximations.

APPENDIX B:
TEST DESCRIPTIONS AND ORDERING INFORMATION

Achenbach Child Behavior Checklist — The CBCL is available from University Medical Education Associates, One South Prospect Street, Burlington, Vermont 05401-3456. 802-656-8313.

Purpose: An instrument by which parents may rate their children's behavior.

Description: The CBC covers characteristics in eight areas: energetic, active; curious, thoughtful; aggressive, assertive; fearful, anxious; social, friendly; excitable, tense; cooperative, conforming; and cheerful, expressive.

Age Range: The checklist is appropriate for children ages 2 years 5 months to 5 years but is also used with emotionally disturbed children aged 6-14 years.

Norm data: Normative data is available for ages cited.

Administration time: Parents can complete the checklist in 20-40 minutes.

Children's Category Test (CCT) — This test can be ordered from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378

Purpose: A nonverbal measure of higher order cognitive abilities.

Description: The Category Test, originally developed by Halstead, now comes in booklet form. The original version involves the projection of seven sets of items, with a total of 208 items. Each set is organized on the basis of a different principle, such as number of objects, ordinal position of an add stimulus, etc. Subjects must use feedback they receive from their correct and incorrect guesses on the series of items in each subtest to infer the rule behind the subtest. No clues are given as to what the rule might be. There is an adult version and a computer version available as well.

Age Range: 5-16 years

Norm data: Standardized on a national stratified sample.

Administration time: 15-20 minutes

Children's Auditory Verbal Learning Test-2 — The CAVLT-2 manual and test booklet is available from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: To assess verbal learning, immediate memory span, susceptibility to interference, and recognition memory.

Description: The CAVLT-2 is composed of 1 recognition and 2 free-recall memory word lists designed specifically for young people. The first free-recall word list is presented for 5 trials. The second free-recall test is presented as an interference list, after which the individual is asked to recall words from the first list. Following a brief delay, retention is assessed by a second recall test of the words from the first list. Finally, words from a new recognition list are presented; the individual must decide whether each word was included in the original free-recall word list.

Age Range: 6 years 6 months-17 years 11 months

Norm data: Normative data are provided for 12 age groups and include learning trial scores.

Administration time: 25 minutes

Children's Depression Inventory (CDI) — The CDI is available from Western Psychological Services, 12031 Wilshire Blvd., Los Angeles, California 90025-1251. 1-800-648-8857.

Purpose: To measure cognitive, affective, and behavioral signs of depression in school-age children and adolescents.

Description: The inventory includes 27 items. The child marks the choice that best describes his or her feelings or behavior over the past 2 weeks. The test requires less than 15 minutes. Results can be scored and profiled in 10 minutes. There are CDI Short Form (CDI-S), which includes 10 items and gives you a general indication of depressive symptoms. The CDI discriminated children with major depressive or dysthymic disorders from normal students and from those with other psychiatric conditions. It measures symptom severity and is sensitive to changes in depression over time.

Age Range: 7-17 years

Norm data: Available on total score and 5 subscores by age and gender.

Administration time: 15-20 minutes

Clinical Evaluation of Language Fundamentals-3rd Edition (CELF-3) — The CELF-3 is available from Psychological Corporation. P.O. Box 839954, San Antonio, Texas 78204-2498. 1-800-228-0752. A screening form of the CELF-R is also available.

Purpose: A comprehensive measure of language functioning including syntax, semantics, and memory.

Description: The full diagnostic battery consists of 11 subtest. Different sets of subtests are administered for students 5-7 years and those 8 years and older. All students complete the following three core subtests: oral directions, formulated sentences, and recalling sentences. Other selected subtests depending on age of the student include linguistic concepts, sentence structure, word classes, semantic relationships, word structure, sentence assembly, listening to paragraphs, and word associations. Three global standard scores are provided: Receptive Language, Expressive Language, and Total Language.

Age Range: 6-21

Norm data: The CELF-R was nationally normed on a representative sample of 2,400 students.

Administration time: 50-60 minutes

Connor's Teacher Rating Scales (CTRS) — The CTRS is available from The Psychological Corporation, Order Service Center, P.O. Box 839954, San Antonio, Texas 78204-2498. 1-800-228-0752.

Purpose: Help identify a variety of behavior problems.

Description: CTRS is available in both a long (39-item) and a short (28-item) form. The short form is not a strict subset of the long form, and has different content. Both forms are completed by the child's teacher. CTRS-39 includes scales for Hyperactivity, Conduct Problem, Emotional Overindulgent, Anxious-Passive, Asocial, and Daydream-Attendance Problem. CTRS-28 includes scales for Conduct Problem, Hyperactivity, and Inattentive-Passivity.

Age Range: 3-17 years

Norm Data: CTRS-39 reports norms for children ages 4-12 years. CTRS-28 reports norms for children ages 3-17 years.

Administration Time: 20-30 minutes

The Continuous Performance Test (CPT) Computer Program — The CPT computer program can be obtained from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: To screen individuals ages 4-19 years suspected of having attention problems.

Description: The CPT computer program can be administered directly to the individual, using the PC keyboard or mouse. The program also provides an optional tutorial to prepare the test-taker for the task. The manual also documents the development, recent research information, and clinical use of the CPT. Administration normally takes 14 minutes and the results can be accessed immediately. Results can be viewed on the screen, printed out as a report, or saved as an ASCII file for use within other reports. The enhanced narrative report includes new information and features.

Age Range: 4-19 years

Norm Data: The test version contains norms which are automatically compared to the general population norms and a large data base for comparison to ADHD norms. The User Manual describes the normative data and presents groups by age level for comparison purposes.

Administration time: 15-20 minutes

Controlled Oral Word Association Test (Word Fluency) — No specific material is required. This test is also included in the Neurosensory Center Comprehensive Examination for Aphasia distributed by the Neuropsychology Laboratory of the University of Victoria.

Purpose: The purpose of the test is the spontaneous production of words beginning with a given letter or a given classification within a limited amount of time (verbal association fluency). Word fluency is often used as a measure of frontal lobe functioning.

Description: The subject is asked to produce as many words as possible beginning with a given letter in a limited period of time. The label "Word Fluency" for this test may be misleading, since verbal productivity in conversation or in continuous sentences is not measured. Instead, the test measures production of individual words under restricting search conditions (i.e., a given letter of the alphabet). F, A, and S are the most commonly used letters for this test, although other researchers have used C, F, L, and P, R, W. Animal (or food) names have been used for younger children, and "things in the kitchen," "things in a store," etc., have also been used. The examiner records the word as the testee responds.

Age Range: Children through adults.

Norm data: Children and adolescent norms are available in Spreen and Strauss (1991).

Administration time: 5-10 minutes

Coopersmith Self-Esteem Inventory — The test is available from Consulting Psychologists Press, Inc., 3803 East Bayshore Road, PO Box 10096, Palo Alto, California 94303. 1-800-624-1765.

Purpose: To measure self-esteem/self-image.

Description: Unavailable

Norm Data: Unavailable

Administration time: Unavailable

Detroit Tests of Learning Aptitude (3rd Edition) — The DTLA-3 Manual, Response Forms, Examiner Record Booklets, Summary/Profile Forms, and Picture Book is available from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: Measures general intelligence and discrete learning ability aptitudes.

Description: One of the most widely used tests of specific abilities. The DTLA-3 includes 11 subtests and 16 composites. The Overall Composite is obtained by combining standard scores from all 11 subtests in the battery. The Optimal Level Composite comprises the 4 highest standard scores, providing the best estimate of the individual's overall potential.

Age Range: 6-17 years

Norm data: The DTLA-3 was normed on more than 2,500 students in 36 states.

Administration time: 50 minutes to 2 hours

Expressive and Receptive One-Word Picture Vocabulary Tests-Revised — There are two levels of the test, 2 years through 11 years 11 months and 12 years through 15 years . Each level must be purchased separately. Pro-Ed, 8700 Shoal Creek Boulevard, Austin, Texas 78757-6897. 1-512-451-8542

Purpose: The EOWPVT-R and ROWPVT-R measure Expressive and Receptive language.

Description: The EOWPVT-R requires the student to name a picture. In contrast, the ROWPVT-R does not require oral response and instead only requires the child to gesture to the appropriate picture. When used together, comparisons can be made between the child's receptive and expressive vocabulary skills. Each test can be administered and scored in approximately 15 minutes.

Age Range: 2 years to 11 years 11 months (EOWPVT-R) and 12 to 15 years (ROWPVT-R)

Norm sample: The original tests were normed on 1118 children aged 2-12 years.

Administration time: 15-20 minutes each

Finger Tapping Test or Finger Oscillation Test — The finger tapping mechanism can be ordered from Reitan Neuropsychology Laboratory, 1338 East Edison Street, Tucson, Arizona 85179 (602) 882-2022 or Psychological Assessment Resources, Inc., P.O. Box 98, Odessa, Florida, 33556-0998. 1-800-331-8378.

Purpose: To measure the motor speed of the index finger of each hand and to assess subtle motor impairment. (Performance tends to be worse in the hand contralateral to the brain injury.)

Description: Using the finger tapper, the subject is instructed to tap as fast as he or she can using the index finger alternating between preferred and non-preferred hand for five consecutive 10-second trials with a maximum of 10 trials for each hand. Approximate administration time is 10 minutes.

Age Range: 6 years 8 months to 12 years 14 months; adults

Norm sample: Norms for children are provided in Spreen and Strauss (1991).

Administration time: 5-10 minutes

Gordon Diagnostic System (GDS) — This test can be ordered from Michael Gordon, Ph.D., P.O. Box 746, Dewitt, New York 13214.

Purpose: To measure attention.

Description: The GDS is an electronically controlled device that can be used to measure visual attention on three tasks - delay, vigilance, and distractibility. The child watches stimuli presented in an electronically controlled window and responds by pushing a button as selected "targets" appear. The system is capable of extensive data interpretation procedures. Cost may be prohibitive (approximately $1,500.00).

Age Range: 6 through adult

Norm data: Extensive normative data tables are available.

Administration time: 30 minutes

Grooved Pegboard — The grooved pegboard can be ordered from Psychological Assessment Resources, Inc., P.O. Box 98, Odessa, Florida, 33556-0998. 1-800-331-8378.

Purpose: To measure manipulative dexterity and to evaluate lateralized brain damage.

Description: Pegboard consists of 25 holes with randomly positioned slots. The Grooved Pegboard requires more complex visual-motor coordination than most pegboards. Pegs with a key on one side must be rotated to match the hole before they can be inserted.

Age Range: 10-64 years

Norm Data: Norms are available for ages 6 - adult.

Hand Dynamometer — The Smedley dynamometer can be ordered from the Stoelting Company, Oakwood Center, 620 Wheat Lane, Wood Dale, Illinois 60191.

Purpose: The purpose of this test is to measure hand strength and to evaluate lateralized brain damage.

Description: This frequently used measure of hand strength (Reitan & Davidson, 1974) requires the subject to hold the upper part of the dynamometer in the palm of the hand and to squeeze the stirrup with the fingers as hard as he or she possibly can.

Age Range: 6 years - adult

Norm Data: Norms are available for ages 6 - adult.

Administration time: 5 minutes

Hooper Visual Organization Test (VOT) — The VOT can be ordered from Western Psychological Services, 12031 Wilshire Boulevard, Los Angeles, California 90025,-1251. 1-800-648-8857.

Purpose: This is a test of visual closure, particularly the ability to rearrange conceptually pictures that have been disarranged.

Description: This test consists of 30 drawings of common objects on 4" x 4" cards in a ringbinder (test booklet). Each object is cut into two or more parts and illogically arranged in the drawing. The task is to name the object. The test is similar to other fragmented figures tests. Although originally designed to differentiate adult subjects with and without brain damage (Hooper, 1958), several studies have attempted to delimit its use more closely. The 1983 edition ("developed by the staff of Western Psychological Services", no author) is based on Hooper's original studies, but adds references to more recent studies, age- and education-corrected raw score tables, and a T-score conversion table.

Age Range: 25-64 years

Norm Data: Available for adults only (25-64 years), but can be used to screen older adolescents.

Administration time: 15 minutes

House-Tree-Person (H-T-P) Projective Drawing Technique — The H-T-P can be ordered from Western Psychological Services, 12031 Wilshire Boulevard, Los Angeles, California 90025-1251. 1-800-648-8857.

Purpose: A projective personality technique.

Age Range: 3 years to adult

Norm Data: No norms are available, but several texts that assist in interpretation are available from Western Psychological Services.

Administration time: 15-30 minutes

IVA Computerized Visual & Auditory Continuous Performance Test — Can be ordered from Braintrain, 727 Twin Ridge Lane, Richmond, Virginia 23235. 1-800-822-0538.

Purpose: Designed to assess impulsivity, inattention and hyperactivity.

Description: This test presents visual and auditory 1s and 2s in a pseudorandom pattern requiring shifting of sets between the two modalities. These administration and scoring are completely automated and all test instructions are presented both visually and aurally by the computer.

Age Range: Children through adults (No ages specified).

Norm Data: Normative data base of 487 normal individuals.

Administration Time: 15-20 minutes

Kinetic Drawing System for Family and School - The Kinetic Drawing System manual and scoring booklets is available from Western Psychological Services, 12031 Wilshire Blvd., Los Angeles, California 90025-1251. 1-800-648-8857.

Purpose: To assess children's perceptions of important relationships at home and at school.

Description: Kinetic Family Drawing asks the child to draw his or her family doing something, while Kinetic School Drawing asks for a picture of the child interacting with relevant school figures. The introduction of action increases the diagnostic information available in the drawings, providing more insight into the child's feelings and functioning. To administer the Kinetic Drawing System, you need only a pencil, blank paper, a Scoring Booklet, and approximately 20 minutes with the child. The family drawing is requested first, then the school drawing. In each case, the child draws the picture, and then the examiner asks questions in order to clarify its meaning. To guide this inquiry process, the Manual provides a series of suggested questions. Scoring is simple and clear-cut. The examiner checks each drawing for the presence or absence of specific characteristics, all listed in the Scoring Booklet. Once scored, the drawings can be easily interpreted using interpretive hypotheses provided in the Manual, along with case studies.

Age Range: 3 years to adult

Norm Data: No formal norms are available, however, the handbook facilities scoring and interpretation.

Administration Time: 20 minutes

Matching Familiar Figures Test — The MFF was developed by Dr. Jerome Kagan, Department of Psychology, William James Hall, Room 1514, Harvard University, 33 Kirkland St., Cambridge, Massachusetts 02138. 617-495-3870. (There is no copyright on this test. It can be copied without obtaining permission.)

Purpose: The MFFT is designed to measure cognitive impulsivity.

Description: The child must select the exact replica of a stimulus design from among 6 similar designs. Mean latency to first response and total errors comprise the scoring.

Age Range: 6-12 years

Norm data: The only normative data available can be found in an article by Neil Salkind - Salkind, N. J. (1978). Development of norms for the matching familiar figures test. ISAS Catalog of Selected Documents in Psychology, 8, No. 61 (MS. No. 1718).

Motor-Free Visual Perception Test-Revised — The MVPT-R manual, test plates, and recording forms are available from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: To assess visual perception without motor requirements.

Description: The MVPT-R is an expansion of the original MVPT, with 4 new plates added to the original 36 plates. Although it was designed to assess visual perception in all children, the MVPT-R is especially useful with those who may have learning, cognitive, motor, or physical disabilities. It may be used as a screening tool as well as for diagnostic and research purposes.

Age Range: 4 to 11 years 11 months

Norm data: Norms have been extended to age 11 years 11 months.

Administration Time: 15-20 minutes

Multi Dimensional Self-Concept Scale (MSCS) — The MSCS Manual and Record Forms can be ordered from The Riverside Publishing Company, 8420 Bryn Mawr Avenue, Chicago, Illinois 60631. 1-800-767-8378.

Purpose: To assess global self-concept and six context-dependent domains that are functionally and theoretically important in the social-emotional adjustment of youth and adolescents.

Description: Each domain of the MSCS can be administered and scored independently of the others. By using all six domains, a measure of the individual's global self-concept can be obtained. The MSCS can be used for clinical appraisal or research in a variety of settings - counseling, school, mental health, hospital, corrections, social service, etc. It can also be used for guiding interviews and treatment and evaluating effectiveness of programs/treatments.

Age Range: 9-19 years

Norm Data: Normed on 2,501 subjects grades 5-12.

Administration Time: 20-30 minutes

Multilingual Aphasia Examination (MAE) — This test can be ordered from the Psychological Corporation, P.O. Box 839954, San Antonio, Texas 78204-2498. 1-800-228-0752.

Purpose: To evaluate presence, severity, and qualitative aspects of aphasic language disorders.

Description: The MAE is compromised of 11 subtests: visual naming, sentence repetition, controlled word order, oral spelling, written spelling, block spelling, token test, aural comprehension of words and phrases, reading comprehension of words and phrases, rating of articulation, and rating of praxic features of writing.

Age Range: 6-69 years

Norm Data: Standardized on 229 normal children 6 to 12 years.

Administration Time: 50-60 minutes

Paced Auditory Serial Addition Test (PASAT) — The PASAT can be ordered from the Neuropsychology Laboratory, University of Victoria, P.O. Box 1700, Victoria, British Columbia V8W 3P5, Canada.

Purpose: This test is a serial addition task used to assess the rate of information processing and sustained attention.

Description: This test was devised to provide an estimate of the subject's rate of information processing (or the amount of information that can be handled at one time). The subject is required to comprehend auditory input, respond verbally, inhibit encoding of one's own response while attending to the next stimulus in a series. A prerecorded tape delivers a random series of 61 numbers from 1 through 9. The subject is instructed to add pairs of numbers such that each number is added to the one immediately preceding it. The second is added to the first, the third to the second, the fourth to the third, and so on. For example, if given the numbers "1,9," the answer is "10"; if the number is "4," this is added to the previous "9" or give the answer "13"; and so on. The same 60 numbers can be presented in four different trials, each differing in their rate of digit presentation (2.4, 2.0, 1.6, 1.2 seconds). The PASAT increases processing demands by increasing the speed of stimulus input. The duration of each spoken digit is about 0.4 second.

Age Range: 16 to 69 years

Norm Data: Based on samples of healthy adults, ages 16 to 69.

Administration Time: 15-20 minutes for all 4 trials.

Peabody Picture Vocabulary Test-Revised (PPVT-R) — The PPVT-R can be ordered from American Guidance Service, Publisher's Boulevard, Circle Pines, Minnesota 55014.

Purpose: To assess receptive vocabulary.

Description: The PPVT-R requires the subject to choose one of four items displayed on a card as depicting the word spoken by the examiner. Items become increasingly difficult until the subject misses six out of eight items. Two equivalent forms are available. Time required to administer is 10-20 minutes.

Age Range: 2 years 5 months to adult

Norm data: The revised version was standardized on a representative sample of the U.S. population. Norms are provided for ages 2.5 to 40 years old.

Administration Time: 20-30 minutes

Personality Inventory for Children (PIC) - Revised — Revised manuals, administration booklets, answer sheets, and scoring key can be obtained from Western Psychological Services, 12031 Wilshire Boulevard, Los Angeles, California 90025-1251. 1-800-648-8857. Computer scoring and interpretations disks are available from the same source. A young children's version (ages 3-6 years) is also available.

Purpose: The PIC is a comprehensive personality evaluation which is completed by the child's parents.

Description: The PIC is a true/false statement questionnaire for the parent, similar to the MMPI. The full-length version contains 600 statements. The revised format booklet allows the scoring of four broad factor dimensions of childhood psychopathology (externalizing behavior, internalizing behavior, social incompetence, cognitive dysfunction), based on the first 131 items (Part I) only. The first 280 items (Parts I and II) allow scoring of abbreviations of the four dimensions and 12 clinical scales (achievement, intellectual skills, development, somatic concerns, depression, family relations, delinquency, withdrawal, anxiety, psychosis, hyperactivity, social skills). The first 421 items (Parts I, II, and III) allow scoring of all scales in full, whereas the 600-item version is needed if scoring of research scales is desired.

Age Range: 3-16 years

Norm data: The normative data from which the profiles were created are based on a sufficiently large data base that exists for children 6-16 years old; this data base takes into account the U.S. census in terms of race and socioeconomic status.

Administration Time: Parents can complete the PIC in 50-60 minutes.

Piers-Harris Children's Self-Concept Scale — The Piers-Harris is available from Western Psychological Services, 12031 Wilshire Boulevard, Los Angeles, California 90025-1251. 1-800-648-8857.

Purpose: To assess feelings of self-concept in children and adolescents.

Description: The Piers-Harris is an 80-item self-report measure for children and adolescents 8-18 years old. Scores on six subscales may be obtained: behavior, intellectual and school status, physical appearance and attributes, anxiety, popularity, and happiness and satisfaction. Twenty to 30 minutes are needed to administer the test with about the same amount of time needed for scoring.

Age Range: 8-18

Norm data: Normative data for the total score are based on a sample of 1,183 children from a small town in Pennsylvania in the early 1960's. Means and standard deviations for other more recent samples are provided in the manual.

Administration Time: 20-30 minutes

Purdue Pegboard Test — The pegboard, manual, and record forms can be ordered from Lafayette Instrument Company, Inc., P.O. Box 5729, Sagamore Parkway, Lafayette Indiana 47903, or from Technolab Industries Ltd., 5757 Decelles Avenue, Suite 329, Montreal, Quebec H3S 2C3, Canada.

Purpose: In addition to its use in personnel selection, the Purdue Pegboard has been used in neuropsychological assessment to assist in localizing cerebral lesion and deficits. The board contains two parallel rows of 25 holes each. Pins (pegs), collars, and washers are located at the extreme right-hand and left-hand cups at the top of the board. Collars and washers occupy the two middle cups. In the first three subtests, the subject places as many pins as possible in the holes, first with the preferred hand, then with the nonpreferred hand, and finally with both hands, within a 30-second time period. To test the right hand, the subject has to insert as many pins as possible in the holes, starting at the top of the right-hand row. The left-hand test uses the left row. Both hands then are used together to fill both rows top to bottom. In the fourth subtest, the subject uses both hands alternately to construct "assemblies", which consist of a pin, a washer, a collar, and another washer. The subject must complete as many as possible within one minute.

Age Range: 5 years, 5 months to adult

Norm Data: Normative data for various ages gathered from several independent studies.

Administration Time: 5-10 minutes

Rey Auditory-Verbal Learning Test (RAVLT) — The RAVLT is available from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: The purpose of this test is to assess verbal learning and memory.

Description: The RAVLT consists of 15 nouns read aloud for five consecutive trials. After each trial the subject recalls as many of the nouns as possible. Then an interference list of 15 nouns is administered and the subject is asked recall as many words as possible from the first list. After 20 minutes has elapsed, the subject is again asked to recall the first list. Then a story is read with the words from the first list included or a list of 50 words with the first list of words included. The subject is asked to identify words from the first list.

Age Range: 13 to adult

Norm data: See Spreen & Strauss (1991). Learning curve, delayed recall, recognition memory, and interference can be scored. Normative data are available for school children 13-16 (Munsen, 1987), and adults 16-84 (Geffen et al., 1990). A comparable test for younger children is the CAVLT.

Administration Time: 10-15 minutes

Rey-Osterrieth Complex Figure Test — The ROCFT is available from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: To assess visuospatial constructional ability including planning and organization skills, problem-solving strategies, perceptual, motor, and memory functioning.

Description: The subject copies the figure and then is asked to reproduce it from memory. Immediate and delayed memory recall can be measured.

Age Range: 6 years to adult

Norm data: The performance is scored for correctness of the details and their placement.

Taylor (1989) offers 18 scoring criteria. A Canadian sample of school children and adults can be used for normative data (Kolb & Whishaw, 1985) for ages 6-85.

Administration Time: 10 minutes excluding delay period.

Rey Visual Design Learning Test (RVDLT) — There is no commercial source. The used may refer to the following description to prepare the materials.

Purpose: The purpose of this test is to assess nonverbal learning and memory.

Description: The RVDLT is a brief, easily administered measure that assesses immediate memory span, new learning, and recognition memory. The test was developed by Rey and translated into English by Graves and Sarazin in the University of Victoria Laboratory. The test consists of 15 simple geometric forms, each on a separate stimulus card (10 x 7 cm), presented at a rate of two seconds per card. After all card have been presented, the subject must draw all the designs that he or she can recall. This procedure is repeated five times. In the second part, the subject must identify the 15 designs from an array of 30 designs.

Age Range: 9 years to adult

Norm Data: Norms were based on samples of Swiss school children, aged 9-15 years.

Administration Time: 15 minutes

Reynolds Adolescent Depression Scale (RADS) — The RADS Manual, Hand-Scorable Answer Sheets, and Scoring Key can be purchased from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: Screen for depressive symptoms in adolescents.

Description: The RADS was developed to assess depressive symptomatology in adolescents. It is well suited for screening individuals or large groups of students in school or clinical settings.

Age Range: Grades 7-12

Norm Data: Available for grades 7-12. (Can be computer scored.)

Administration Time: 10-15 minutes

Reynolds Child Depression Scale (RCDS) — The RCDS Manual, hand-scorable answer sheets, and scoring key are available from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: To screen for depressive symptoms in children.

Description: The RCDS was developed to screen for depression in children and can be used individually, in school, or in clinical settings. It provides school and mental health professionals with a straightforward, easily administered measure for the evaluation of the severity of children's depressive symptoms. The RCDS can also be used in research on depression and related constructs.

Age Range: Grades 3-6

Norm Data: Available for grades 3-6. (Can be computer scored.)

Administration Time: 10-15 minutes

Robert's Apperception Test for Children (RATC) — The RATC Test Pictures, Record Booklets, and Manual are available from Western Psychological Services, 12031 Wilshire Boulevard, Los Angeles, California 90025-1251. 1-800-648-8857.

Purpose: The RATC is a personality instrument designed to measure adaptive and maladaptive functioning.

Description: This test measures both adaptive and maladaptive functioning on the following scales: Reliance on Others, Support-Other, Problem Identification, Unresolved Problems, Anxiety, Support-Child, Limit Setting, Resolution, Aggression, Depression, and Rejection. Three additional dimensions - Atypical Response, Maladaptive Outcome, and Refusal - serve as critical indicators. These scales and indicators can then be linked, on an Interpersonal Matrix, to particular people in the child's life. This helps you determine the nature, intensity, or absence of significant interaction with various family members, peers, teachers, and others. The RATC can be effective with children who are just entering counseling or therapy. It is also useful in measuring change over the course of treatment.

Age Range: 6-15 years

Norm data: The RATC provides norms, grouped by age and sex, for a sample of 200 well-adjusted children ages 6-15.

Administration Time: 20-30 minutes (Scoring: 15 minutes).

School Apperception Method (SAM)

Purpose: To elicit information pertaining to children's significant emotional and academic adjustment difficulties in school.

Description: Consists of 22 cards of detailed drawings depicting school-related and classroom scenes. Children are asked to tell a story with each card with a "beginning and an end". Ordering information is unavailable..

Age Range: K through 9th grade

Norm Data: No norms are available

Administration Time: 30-40 minutes

Self-Esteem Index (SEI) — The SEI is available from Pro-Ed, 8700 Shoal Creek Boulevard, Austin, Texas 78757-6897. 512-451-3246.

Purpose: To measure the way individuals perceive and value themselves.

Description: The self-report format requires subjects to read the SEI items and then to classify each item on a Likert-type scale as always true, usually true, usually false, or always false. There are four scales on the SEI. Academic Competence measures self-esteem in school, education, academic competence, intelligence, learning, and other scholarly pursuits. Family Acceptance measures self-esteem at home and within the family unit. Peer Popularity addresses the quality, importance, and nature of relationships and interactions with individuals outside the family unit. Personal Security contains statements such as distinctive traits of body, character, conduct, temperament, and emotions. Overall self-esteem is measured by the Self-Esteem Quotient. In addition, the four SEI scales each yield a standard score, and percentile ranks are provided.

Age Range: 7 years through 18 years 11 months

Norm Data: The SEI was normed on a large, representative sample of 2,455 students from 19 states.

Administration Time: Approximately 30 minutes.

Sentence Completion Series (SCS) — The SCS is available from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378

Purpose: A personality test used to identify themes underlying concerns and specific areas of distress.

Description: The SCS consists of 8 self-report forms, each with 50 content-valid sentence stems pertaining to specific areas of concern: Adult, Adolescent, Family, Marriage, Parenting, Work, Illness, and Aging. The client completes each unfinished sentence with the first thought that comes to mind. The SCS is self-administered for those who possess adequate reading ability. Forms may be administered orally for clients who are unable to read and write. The instrument is scored by the clinician who examines that statements and draws inferences from the responses. Because only a few sentence stems are common across the 8 forms, multiple forms can be used with little redundancy to maximize the breadth of information obtained from a client.

Age Range: Adolescents and adults.

Norm Data: No norms are available.

Administration Time: 10-45 minutes per form.

Sentence Repetition — Tape, manual, and scoring forms are available from the Neuropsychology Laboratory, University of Victoria, P.O. Box 1700, Victoria, British Columbia, V8W 3P5.

Purpose: To assess verbal sequential memory for sentences.

Description: A tape is played on which 22 sentences of increasing length are recorded. The subject is asked to repeat the sentence after each is played. Several studies have shown that this test discriminates between non-brain injured and brain-injured children and adults.

Age Range: 6 years to adult

Norm data: Spreen and Strauss (1991) provide normative data for 6-13 year olds and adult populations.

Administration Time: 10-15 minutes

Stroop Color and Word Test — The test can be ordered from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: To measure attention and the ability to suppress a habitual response, and shift his or her perceptual set to conform to changing demands.

Description: The test consists of three white cards with 10 rows of five items. Color names (blue, green, red, yellow) are printed in black type in Part 1, printed in colored ink for Part 2, printed in non-corresponding ink color for Part 3, and in Part 4 the subject is given the card used in Part 2. The time to complete the task is increased when the subject is asked to name the color of the ink rather than the non-corresponding word. The approximate time required to administer is 5 minutes. Practice effects can improve performance.

Age Range: Grade 2 - adult

Norm data: Data are available for grade 2 to adult.

Administration Time: 5 minutes

Stroop Neuropsychological Screening Test (SNST) — The SNST is available from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: Screen for brain damage.

Description: This standardized version of the Stroop consists of 2 parts. In the Color Task, the individual reads aloud a list of 122 color names in which no name is printed in its matching color. In the Color-Word Task, the individual names the color of ink in which the color names are printed. The SNST can be administered and scored by individuals with limited training. Interpretation of the resulting Color and Color-Word scores requires professional training in psychology, psychiatry, or educational testing. A stopwatch is required to administer each 2-minute test.

Age Range: 18-79

Norm Data: The SNST was standardized on 156 adults ages 18-79. Norms are provided for 2 age groups, 18-49 and 50. The test correctly differentiates 79%-92% of brain-damaged from normal adults. Test-retest reliability is .90.

Administration Time: 5 minutes

Symbol Digit Modalities Test (SDMT) — The SDMT is available from Western Psychological Services, 12031 Wilshire Dr., Los Angeles, California 90025-1251. 1-800-648-7838.

Purpose: To measure attention and short-term visual memory through both written and oral modalities.

Description: The test was constructed and developed on neuropsychological principles and is a simple test that normal children and adults easily perform. The SDMT requires the examinee to substitute a number, either orally or written, for randomized presentations of geometric figures. The appropriate number is shown in a key containing the Arabic numbers 1 through 9, each of which is paired with a different geometric symbol. The SDMT offers an economical method for early screening of apparently normal children and adults for possible covert manual motor, visual, learning, and/or other cerebral defects.

Age Range: Children 8 years and older and adults.

Norm data: The SDMT was administered to 1,874 boys and 1,806 girls (N=3,680) ages 8 through 17. All children in the sample were from normal classes in grades 3 through 12. Adult norms for the SDMT were obtained using two samples of 420 and 887 adult volunteers (N=1,307).

Administration Time: 10 minutes

Test of Memory and Learning (TOMAL) — The TOMAL is available from Western Psychological Services, Inc., 12031 Wilshire Boulevard, Los Angeles, California 90025-1251. 1-800-648-8857.

Purpose: Provides a systematic and comprehensive assessment of memory in children and adolescents.

Description: TOMAL includes 10 core and 4 supplementary subtests. These measure both verbal and nonverbal memory. These subtests provide scaled scores and percentiles. They are also used to derive the following composite scores: Verbal Memory, Nonverbal Memory, Composite Memory, Delayed Recall, Learning Index, Attention and Concentration, Sequential Memory, Free Recall, and Associative Recall. The Delayed Recall Index differentiates strongly among children and adolescents with specific neurological diseases and lesions in specific brain sites. It can also serve as a measure of "forgetting", and may be of particular interest when contrasted with the Composite Memory Index and the Learning Index.

Age Range: 5-19 years

Norm Data: Standardized on a nationally representative sample of more than 1,00 children and adolescents, and evaluated at the item level for gender and ethnic bias, TOMAL can be administered with confidence to both boys and girls, across U.S. ethnic populations.

Administration Time: 45 minutes

Thematic Apperception Test (TAT) & Children's Apperception Test (CAT) — The manual and 31 cards can be ordered from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Author: Henry A. Murray, Ph.D.

Purpose: Assess the perception of interpersonal relationships.

Description: The TAT and CAT are widely used projective test for the assessment of children, and adults. It is designed to reveal an individual's perception of interpersonal relationships. The TAT consists of 31 cards that serve as stimuli for stories and descriptions about relationships or social situations. The cards include specific subsets for boys, girls, men, and women. The information obtained from the picture cards can be used for diagnosis, therapy, or research.

Age Range: Children and adults.

Norm Data: No norms are available for the TAT or CAT.

Administration Time: 45-60 minutes for all cards.

The Token Test for Children— The Token Test for Children is available from The Riverside Publishing Company, 8420 Bryn Mawr Avenue, Chicago, Illinois 60631. 1-800-767-8378.

Purpose: The purpose of this test is to assess verbal comprehension of commands of increasing complexity.

Description: The Token Test for Children is a rapid and effective screening measure of subtle receptive language dysfunction in children.

Age Range: 3-12 years (Other versions are available for older adolescents and adults.)

Norm data: Standardized on more the 1,300 children.

Administration Time: 10 minutes

Trail Making Test — The manual and copies of Parts A and B for children or adults can be purchased from Reitan Neuropsychology Laboratory, 1338 East Edison Street, Tucson, Arizona 85719. (602) 882-2022.

Purpose: To assess visual search, attention, mental flexibility, and fine-motor functioning.

Description: The test comes in both child and adult forms. Using a pencil, the subject connects 25 encircled numbers randomly arranged on a page in the correct order for Part A. Part B consists of connecting numbers and letters in alternating order. Approximately 5-10 minutes are required for administration. Significant practice effects have reported for test-retest reliability over short intervals. Part B is more sensitive to brain damage and the individual's ability to shift course during an activity and to deal with more than one stimulus at a time.

Age Range: 8 to adult

Norm data: Norm data for the children's version (ages 8-15) and adult version (ages 15-79) is provided in Spreen & Strauss (1991).

Administration Time: 5 minutes

Vigil Continuous Performance Test — The Vigil Kit can be ordered from The Psychological Corporation, Order Service Center, P.O. Box 839954, San Antonio, Texas 78204-2498. 1-800-228-0752.

Purpose: Verbal and nonverbal assessment of ADHD and psychosis.

Description: Computer administered and scored, the test consists of several modules including the on-screen presentation of verbal targets (simple geometric shapes, or shapes in specific spatial configurations). Vigil can aid in the comparison of attentional abilities for verbal and nonverbal material.

Age Range: 6-90 years

Norm Data: Unavailable

Administration Time: Eight minutes for each test.

Visual Search and Attention Test (VSAT) — The VSAT is available from Psychological Assessment Resources, Inc., P.O. Box 998, Odessa, Florida 33556. 1-800-331-8378.

Purpose: Measure attentional processes.

Description This norm-referenced test quickly measures attentional processes commonly disrupted in acute and chronic brain damage or disease. The VSAT consists of 4 visual cancellation tasks that require the subject to cross out letters and symbols that are identical to a target. It yields an overall attention score and provides separate scores for left- and right-side performance to assess visual field defects, unilateral spatial neglect, or syndromes that affect the perception of portions of the visual space.

Age Range: 18 year and older

Norm Data: Normative data is provided by age groups from 18-60+.

Administration Time: 6 minutes

WAIS-R as a Neuropsychological Instrument (WAIS-R NI) — The WAIS-R NI is available from The Psychological Corporation, Order Service Center, P.O. Box 839954, San Antonio, Texas 78204-2498. 1-800 228-0752.

Description: The WAIS-R provides information useful as part of a comprehensive psychological evaluation, neuropsychological evaluation, or an initial screening to determine the need for a more complete evaluation. For use in the assessment of adults with known or suspected brain dysfunction, WAIS-R NI contains subtests and modifications for WAIS-R subtest administration, recording, and scoring. Most of the subtest modifications enable you to obtain standard scores. Because WAIS-R NI permits a finer analysis of an examinee's test behavior, it assists you in analyzing cognitive functioning.

Age Range: Same as WAIS-R

Norm Data: No norms for modifications

Administration Time: Varies

Wechsler Memory Scale-Revised — The kit can be ordered from the Psychological Corporation, P.O. Box 839954, San Antonio, Texas 78204-2498. 1-800-228-0752.

Purpose: A comprehensive measure of memory for older adolescents and adults.

Description: The WMS-R requires approximately 1 hour to administer. The WMS-R include 13 brief subtests: Information and Orientation Questions, Mental Control, Figural Memory, Logical Memory I and Logical Memory II, Visual Paired Associates I and Visual Paired Associates II, Visual Reproduction I and Visual Reproduction II, Digit Span, and Visual Memory Span.

Age Range: 16-74

Norm data: Norms are available for ages 16-74 years old.

Administration Time: 50-60 minutes

Wepman Auditory Discrimination Test — Second Edition (ADT) - The Wepman Test is available from Western Psychological Services, 12031 Wilshire Blvd., Los Angeles, California 90025-1251. 1-800-648-8857.

Purpose: To detect auditory discrimination problems in young children.

Description: Using a very simple procedure, the ADT assesses the child's ability to recognize the fine differences between phonemes used in English speech. The examiner reads aloud 40 pairs of words, and the child indicates, verbally or gesturally, whether the words in each pair are the same or different. The entire test can be administered and scored in just 5 minutes.

Age Range: 4 - 8 years.

Norm data: The ADT offers norms based on a stratified national sample of approximately 2,000 children. It provides standard scores and percentile norms at half-year intervals for children between the ages of 4 and 8 years. It can also be used as a gross screening of auditory discrimination in older children although there are no norms.

Administration Time: 5-10 minutes

Wide Range Assessment of Memory and Learning (WRAML) — The kit can be ordered from the Psychological Corporation, P.O. Box 839954, San Antonio, Texas 78204-2498. 1-800-228-0752.

Purpose: Comprehensive measure of memory for children and adolescents.

Description: Assesses number/letter memory, sentence memory, story memory, visual memory, and learning across repeated visual, verbal, and cross-modal tasks. Delayed recall is also measured. The WRAML requires approximately 1 hour to administer. The test kit includes a manual as well as the assorted visual materials needed.

Age Range: 5-17

Norm data: Norms are based on 2,363 children representative of the national population in terms of age, sex, race, regional residence, and metropolitan/nonmetropolitan residence.

Administration Time: 50-60 minutes

Wisconsin Card Sorting Test (WCST) — The kit can be ordered form Psychological Assessment Resources, Inc. Psychological Assessment Resources, Inc., P.O. Box 98, Odessa, Florida, 33556-0998. 1-800-331-8378.

Purpose: To assess the ability to form abstract concepts, and shift and maintain the set.

Description: Four stimulus cards are placed in front of the subject with differing geometric shapes, numbers, and colors. The subject is given 64 response cards with designs similar to the stimulus cards. The subject is told to match each of the 64 cards to the stimulus cards, first matching by color, then form, then number. The cycle is repeated. Reliability data is unavailable. Validity studies indicate sensitivity to brain injury, particularly frontal lobe damage.

Age Range: 6 years 5 months-89 years

Norm data: Performance is scored for perseveration, nonperseverative error score, number of trials to complete the first category, failure to maintain a set, and a "learning to learn" score. Chelune and Baer (1980) provide norms for 105 school age children with average IQ. By age 10, children's performances are similar to those of young adults (Heaton, 1981). The kit includes a manual with means and standard deviations for normal and brain-damaged patients for 12+ years.

Administration Time: 15-30 minutes

Appendix C:
Sample TBI Test Report

NEUROPSYCHOLOGICAL REPORT

CONFIDENTIAL **CONFIDENTIAL**

Name:	**Jane Doe**
Date of Birth:	**10-76**
Date of Testing:	**3-92**
Chronological Age:	**15-4**
Examiner:	**N. William Walker, Ed.D.**

Reason for Referral

Jane was referred for neuropsychological testing by an educational placement consultant, to obtain a comprehensive evaluation of Jane's strengths and weaknesses in order to target appropriate future educational placements. Mr. and Mrs. Doe are in the process of trying to identify remedial programming/schools which seem specifically suited for Jane's cognitive difficulties.

Background Information

Jane is a 15-4 year-old, right-handed female. According to her mother and previous reports, Jane was the product of a unremarkable pregnancy and birth. She was developing normally until 14 months of age when she suffered a traumatic brain injury as the result of a fall from a second story window of her home. Specifics related to the site and extent of Jane's brain injury were not available, but her parents mentioned hearing that the damage to the brain was "diffuse". She remained in a coma for approximately one month. According to the parents' reports Jane's injuries left her with severe speech and learning difficulties. In addition, she apparently lost much of her premorbid motor skills and did not walk alone again until approximately 3 1/2 years of age.

Jane is currently in the 7th grade in the county public school system and is being served through exceptional child programming using the Educable Mentally Handicapped category. Jane lives at home with her mother and father. Her parents are very involved in her schooling and general welfare. As an example, they have decided that if necessary the family will relocate geographically in order to provide Jane with an appropriate remedial program.

Behavioral Observations

Jane was brought to the testing site by her mother and separated easily to begin the evaluation. Jane presented as pleasant and friendly although somewhat immature socially. When walking to the testing area, she grasped the examiner's hand along the way as would a younger child. Because of Jane's relatively slow response style, it was necessary to spread the testing over three sessions. Throughout the three testing sessions rapport was easily attained and she was, in general, very cooperative and compliant. Jane's speech was difficult to understand at times but with repeated sessions it became easier to follow her. Jane stated that she liked spelling but "hated math". Her pencil grasp was awkward and somewhat tense appearing. On written and drawn items she used rough, uncontrolled strokes. She appeared to have difficulty manipulating some of the smaller pieces in the testing and also appeared to have some difficulty maintaining her seating from time to time, appearing as though she was losing her balance in the chair. At times Jane appeared to forget her place during the testing and it was necessary to repeat instructions. In addition, she did not appear to have a good grasp of her strengths and weaknesses.

Jane's general affect was appropriate. She was enthusiastic and attempted all tasks in a persistent, although often ineffective manner. At times, however, she became silly and somewhat childish interpersonally. She often did not appear to be aware of the limits of the testing situation, stopping to converse in the middle of a timed test, etc. Also, she had a tendency to terminate quickly as items grew more difficult. She would, however, continue with encouragement. In spite of these somewhat negative statements, Jane was a delightful individual to test. It's easy to see why she is well liked.

Tests Administered

Wechsler Intelligence Scale for Children - Revised (WISC-R)

Peabody Picture Vocabulary Test - Revised (PPVT- R)

Wide Range Assessment of Memory and Learning (WRAML)

Children's Auditory Verbal Learning Test (CAVLT)

Trail Making Test (Part B)

Symbol Digit Modalities Test (SDMT)

Matching Familiar Figures Test (MFFT)

Bender Gestalt Test (BG)

Berry Test of Visual-Motor Integration (VMI)

Finger Tapping Test

Grooved Pegboard Test

Diagnostic Achievement Battery-2 (DAB-2)

Test of Non-Verbal Intelligence (TONI)

Personality Inventory for Children (PIC)

Incomplete Sentence Blank (Dictated)

Reynolds Adolescent Depression Scale (RADS)

Parent Interview

Record Review

Test Findings and Interpretation

Intellectual Functioning

Jane was administered the WISC-R to obtain a profile of her general intellectual abilities. The WISC-R is made up of several subtests each measuring somewhat different abilities. In addition, this test results in three major scores, the Full Scale IQ which is considered to be an overall measure of intelligence, a Verbal IQ which represents the individual's verbal comprehension abilities, and a Performance IQ which represents the individual's abilities on tasks demanding visuoperceptual/construction abilities. On this instrument, Jane achieved a Full Scale IQ of 64 (Verbal IQ 73; Performance IQ 58). Her Full Scale IQ fell at the 1st percentile as compared with a national sample of individuals in her age group. Full Scale, Verbal and Performance IQ scores from the past two evaluations were 69, 72, 70 in 1989 and 60, 67, and 60 in 1986. Thus, her performance on this evaluation was roughly comparable to past results.

There was a significant discrepancy (15 points) between Jane's Verbal and Performance IQ scores, suggesting a general strength on those tasks emphasizing verbal comprehension over visuoperceptual/construction abilities. A breakdown of Jane's individual WISC-R subtests follows. Subtest scores from the most recent previous evaluation (1989) are shown in parentheses for comparison. Scores of 8 to 12 are generally considered to be in the average range.

VERBAL SUBTESTS		PERFORMANCE SUBTESTS	
Information	5 (8)	Picture Completion	3 (7)
Similarities	8 (6)	Picture Arrangement	5 (5)
Arithmetic	3 (3)	Block Design	4 (5)
Vocabulary	7 (5)	Object Assembly	5 (7)
Comprehension	5 (5)	Coding	1 (3)
Digit Span	4 (5)		

Although there are some changes in Jane's individual subtest scores as compared with her previous testing, the overall pattern is similar. In general, subtests emphasizing verbal abilities (in particular abstract verbal ability) appear to be more comfortable for Jane with notable exceptions on specific items demanding long-term memory and on those with social contexts. Subtests emphasizing visuoperceptual and visual memory skills appear to be very difficult for her. It should be noted also that Jane's scores on these subtests (Picture Completion and Coding) had a major impact on her overall Performance IQ score on this testing.

In order to validate the findings of the WISC-R and to assess Jane's receptive language abilities, the PPVT-R was administered. Jane's standard score (roughly comparable to an IQ score) on this instrument was 72, which falls at the 3rd percentile, as compared with a national sample of individuals in her age group.

The TONI was administered as a further check on the reliability of findings related to intellectual functioning. This instrument is regarded as a measure of overall intellectual ability also, however, verbal/auditory demands are minimized in favor of visual input modes. Jane attained a standard score of 65 on this test.

The results of the PPVT-R and TONI suggest that the WISC-R results are valid, although the Performance IQ score obtained may be a slight underestimate of her abilities in this area.

Attention/Concentration Ability

Jane was administered three tests which are specifically designed to assess attentional ability. The Matching Familiar Figures Test (MFFT) is a visual matching task that measures the individuals ability to use time efficiently in a problem-solving situation. It is particularly sensitive to impulsive responding. On this task, Jane's average response time across the 12 items of the task was 13.5 seconds while making a total of 6 errors. Although this instrument is not normed on individuals Jane's age the performance for the closest age group (12 years) indicates an average response time of 12.3 seconds with an average of 8 total errors. Thus, Jane's performance on this test appears to be within normal limits. Impulsivity does not appear to be a problem at this time.

A second task, the Symbol Digit Modalities Test (SDMT), also measures attentional processes. In addition, it is possible to analyze test results in terms of the impact of oral versus written performance on SDMT performance. Jane's score during the oral phase of the test was superior to that which she obtained during the written phase. However, both performances were significantly below average. The average performance for an individual Jane's age would be: Oral Phase = 53, Written Phase = 53. Jane's scores were 27 and 16 respectively. Interestingly, when asked which mode was easier, Jane stated "writing" in spite of her performance. This is probably due to her long-standing difficulties with speech.

The third task, Part B of the Trail-Making Test (TMT), requires the individual to simultaneously maintain concentration on two parallel tasks under timed conditions. Part B of the TMT is reported to be very sensitive to brain injury. Jane took 3 minutes and 7 seconds to complete this task while making 4 errors. Average performance for an individual her age is approximately 49 seconds with no errors.

Thus, Jane's overall performance in this area suggests relatively normal impulse control. Concentration and attention, appeared to be weaknesses. However, it should be noted that Jane's performance on these instruments was seriously affected by her slow response style causing her scores to be significantly below average on two of the three tasks. Also, task complexity, such as in the case of the Trail-Making Test appears to exacerbate her attentional difficulties.

Memory Functioning

Jane was administered the Wide-Range Assessment of Memory and Learning (WRAML) to screen for any major difficulties in her overall memory and learning abilities. This test is made up of several subtests, each of which measures a different aspect of the memory process. The scores from these subtests are combined into the major factors of memory listed below. Jane's Index Scores (comparable to standard scores) on these factors along with percentile rankings are listed below.

	Index Score	Percentile
Verbal Memory	68	2.00
Visual Memory	51	0.08
Learning	69	2.00
General Memory	55	0.30

These scores are all significantly below the average range for individuals in Jane's age range, however, they are comparable to her overall intellectual level. Relative to her overall performance on this instrument, Jane does display a significant weakness in visual memory.

To corroborate the above results, Jane was administered the Children's Auditory Verbal Learning Test (CAVLT). The CAVLT tests an individual's verbal/auditory memory processes including the ability to learn through this mode. Jane's standard scores for each section of this test are listed below.

CAVLT Subtest	Standard Score
Immediate Memory Span	82
Level of Learning	89
Immediate Recall	65
Delayed Recall	72

These results appear to represent a somewhat higher performance than the WRAML and support Jane's relative verbal/auditory (over visual) memory strengths. Jane appears to be able to learn material best through verbal/auditory over visual input modes. Jane's pattern of responses on the CAVLT also support the attentional difficulties noted earlier.

Visuoperceptual/Construction Abilities

The Bender Gestalt was administered to Jane as a measure of gross visuoconstruction integration ability. This instrument requires the individual to copy (draw) a series of geometric designs. On this task, Jane performed well below her expected age level. On limit testing, she did appear to be able to recognize her errors but seemed unable to correct them on successive attempts. This type of performance suggests that Jane's perceptual abilities appear to be intact. Her errors appeared to be the product of fine-motor weaknesses or weaknesses in the integration of the two abilities (perceptual and motor). In terms of scoring, Jane's performance was similar to that obtained in the previous (1/86) evaluation which places her at a level roughly comparable to that of an 8 year old child. The results were corroborated through an administration of the VMI with comparable results. On the VMI Jane attained a maturational age of 7 years, 2 months. Overall, these results suggest that there has been relatively little growth if any in visuoconstruction abilities over the past few years, at least as measured by these instruments.

Motor Functioning

Jane was administered two instruments, The Finger Tapping Test and the Grooved Pegboard Test, both of which are designed to measure subtle differences in fine-motor ability often associated with neurological injury. On the Finger Tapping Test Jane averaged 34 and 22.8 taps with her right (dominant) and left hand respectively. Average performance for an individual Jane's age is 46.6 and 42.5. On the Grooved Pegboard Test, Jane completed the task with her right hand in 110 seconds with 0 errors and 187 seconds with her left hand with 7 errors. Average completion time for a child her age is 82 seconds on either the right or left hand.

Overall, the results of these tests of fine-motor functioning suggest that Jane's motor speed and dexterity are significantly below average corroborating the earlier speculation of diffuse brain injury. There was, however, some indication of a lateralized (left-side) weakness, suggesting the possibility of right cerebral hemisphere damage. This latter finding would help to corroborate Jane's visuoperceptual/construction weaknesses noted earlier.

Academic Achievement

Jane was administered the DAB-2 as a measure of academic functioning. Her standard scores for the individual areas measured on this instrument are listed below.

DAB-2 Subtest	Standard Score
Listening	79
Reading	67
Writing	53
Math	52

While all these scores are significantly below average it should be noted that they are within the expected range given her overall level of intellectual functioning. Also, the norms for the DAB-2 go to 14 years, 11 months only, six months below Jane's current age. Although her standard scores would probably be somewhat lower, it is unlikely they would be significantly lower than indicated above. These scores suggest that Jane is achieving reasonably well, in proportion to her intellectual level. There is some indication of relative weaknesses in writing and math which are supported by her performance on other portions of the evaluation. These abilities can be compromised by either diffuse and/or right hemisphere damage. Jane proved to be a good listener on this task and worked persistently which will work in her favor in school.

Personality Functioning

Mrs. Doe was asked to complete the Personality Inventory for Children (PIC) to gain her perspective of Jane's overall social-emotional functioning. In addition, the Incomplete Sentence Blank (ISB) and the Reynolds Adolescent Depression Scale (RADS) were administered to Jane. Mrs. Doe's responses suggest that she sees Jane's social-emotional well being as within normal limits. Mrs. Doe sees Jane's school difficulties as almost solely attributable to intellectual, developmental, and achievement factors. It was interesting to note the absence of the TBI as a contributing factor in Mrs. Doe's perception of Jane's academic problems and her omission of Jane's immature social development. These findings may suggest some denial on the part of Mrs. Doe regarding the impact of the TBI on Jane's overall functioning. The results of ISB and RADS supports Mrs. Doe's impressions of Jane's social-emotional state with the exception of social maturity and some evidence of anxiety. It is clear Jane's level of social-emotional functioning is considerably lower than her chronological age. In general, she presents as somewhat childish and naive. It seems likely that she would be very vulnerable to those who may be inclined to take advantage of her.

MAJOR FINDINGS AND RECOMMENDATIONS:

With respect to the initial referral questions the following findings with specific recommendations are presented:

1. Based on this and past evaluations, Jane is functioning intellectually at or around the 1st percentile as compared with national norms for individuals in her age group. This overall intellectual functioning level has been replicated repeatedly in previous evaluations as well. Jane's intellectual development appears to be stable as demonstrated by her consistent performance over the past few evaluations. It is important to keep this functioning level in mind in future school programming. Clearly, Jane's friendliness and enthusiasm along with her relative strengths in verbal abilities allow her to appear to be more intellectually gifted than she actually is. This is, of course, a positive characteristic except for the additional pressure it may place on her to meet the higher expectations of those who are not aware of her true ability level. Because of a great many factors, not the least of which is the fact that she is an attractive, hard-working, and very pleasant individual, it will be easy for teachers and others to expect more of her than she may be capable of delivering. There were subtle signs of anxiety in this evaluation and the possible beginnings of early avoidance of potential failure situations, all of which may be related to school and home pressures to extend herself beyond her capabilities.

   <u>Recommendations:</u> Rather than a specific recommendation, all those who work with Jane must be made aware of her true strengths and weaknesses so as to not put undo pressure on her to perform. This is a "fine line" issue, but since Jane is so highly motivated to please and does not appear to have a good sense of her strengths and weaknesses, care must be taken in letting her set her own pace.

   In view of the nature of Jane's cognitive profile and the cause thereof, the most appropriate classification would appear to be the Traumatic Brain Injured (TBI) category with appropriate compensation training for her deficits, most notably communication skills. In this respect, consideration should be given to using programs and services designed for communication impaired students.

   Since Jane's programming will involve the use of a variety of supportive services, consideration should be given to assigning a case manager to oversee the implementation of her IEP and to allow better communication among the services.

2. Jane's communication difficulties are perhaps the most critical issue to address. Given that Jane's strengths lie in verbal comprehension, this issue takes on even more importance.

   <u>Recommendations:</u> A modified output technology evaluation should be considered to answer questions such as - What is the best output mode for long-term effectiveness? Should Jane use a voice activated computer to enhance communication? It is desirable that she be able to communicate in as close to a "normal" fashion as possible to enhance her life socially and to foster her own feelings of self-worth. This latter issue is a very important one. If it is determined that oral speech is the "best" mode for her, articulation and language therapy should be strongly emphasized.

3. Socially, Jane presents as a much younger individual. Given her age and grade level, it is important to consider the risk her social immaturity may hold for her. Jane is a friendly, gregarious individual who might easily be taken advantage of socially.

   <u>Recommendation:</u> Short-term counseling with an emphasis on emerging social issues for the teenager should be strongly considered.

4. Jane is a very hard-working individual who appears to have "held her own" academically. This persistence should be cultivated carefully so as to not discourage her prematurely.

   <u>Recommendation:</u> New material must be advanced at a gradual pace with repetition, feedback and reinforcement closely linked temporally.

5. There were several indicators of fine-motor difficulty and slowness. Also, there were signs of gross-motor problems -e.g. balance.

   <u>Recommendation:</u> If it has not been done recently, Jane should be evaluated by both a physical and occupational therapist for possible intervention.

6. Jane's task approach skills, as demonstrated during this evaluation, tended to reduce her effectiveness. As an example, she did not appear to recognize the limits of the testing session and would often break out in irrelevant conversation in the midst of a timed subtest. Also, there were indications of poor strategy development, particularly in the area of memory.

   <u>Recommendation:</u> An analysis of Jane's task approach skills should be considered and an appropriate intervention plan involving her tutor and teachers should be developed. Memory strategy training should be considered emphasizing such devices as appointment books, tape recorder (for classroom notetaking), and possibly mnemonic devices. Memory training should emphasize auditory over visual techniques.

7. Jane appears to have a relatively good level of attention and concentration which is compromised by her slowed processing giving the appearance of poorly developed skills in this area. She is seriously handicapped on any timed test.

   Recommendation: Jane should be permitted to take tests in an untimed format. Also, given her strength in verbal areas, taking tests in an oral format should be explored provided the teacher is comfortable with Jane's communication difficulties. A note taker or some other technique such as tape recording lectures should be considered.

8. Jane's verbal/auditory memory is superior to her visual memory. This should be kept in mind during class instructions.

   Recommendation: Material presented in a solely visual fashion may not be retained as well and should be converted to verbal/auditory format whenever possible.

9. Jane's visual-motor difficulties do not appear to have responded to intervention over the past few years. If anything, her performance in this area may have dropped somewhat.

   Recommendation: Further remedial attempts should recognize the possible futility of this approach and efforts should be made to begin searching for compensatory strategies such as word processors, typewriters, etc.

10. Personality testing did not detect major pathology although there was some anxiety present which appeared to be tied to academic failure. Issues related to denial and a somewhat naive impression of Jane's social development were also present.

    Recommendation: Brief, supportive family counseling dealing specifically with issues of denial and social development as it affects teenage years would seem particularly appropriate.

11. In terms of appropriate future school programming, I would suggest that two factors are primary - communication and social development. Whatever program/school appears able to offer the best opportunity to cover these two areas effectively should be strongly considered.

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